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TUSTUMENA REPLACEMENT VESSEL
CONCEPT SPECIFICATIONS

PREPARED FOR
ALASKA MARINE HIGHWAY SYSTEM
KETCHIKAN, AK

26 AUGUST 2022
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REV P4

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**SECTION 0
GENERAL REQUIREMENTS**

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SECTION 0 GENERAL REQUIREMENTS

0.1 PROJECT OVERVIEW

Under this Contract, the Contractor shall provide a new steel-hulled roll-on/roll-off (ro-ro) passenger vessel to be owned by the State of Alaska and operated by the Alaska Marine Highway System (AMHS), a division of the State of Alaska Department of Transportation (ADOT). AMHS will primarily operate the vessel in a limited “Oceans” service route¹ between Homer and Kodiak, Alaska, and to/from these ports to various other regional port cities of Southwest Alaska, including many along the Aleutian Chain, as well as to/from Auke Bay and Yakutat. Additionally, the vessel must be designed for safe transit coastwise and along limited oceans and partially protected routes from its southwest Alaska service area to more southern ports where periodic maintenance, repair, and refurbishment of the vessel may be accomplished at qualified shipyards. Such qualified shipyards are located in southeast Alaska (Ketchikan), Washington, and Oregon.

The vessel shall be designed for operating continuously while serving the ports throughout its service area, day and night (24 hours per day), and through all seasons of the year. Similarly, the vessel shall be capable of operating continuously when transiting from its operating area to aforementioned qualified shipyards in southeast Alaska, Washington, and Oregon, at any time of the year.

Extreme tidal ranges and strong winds are routinely encountered at ports along the vessel's service route. In addition, many of the ports served have modest docking facilities (e.g., no dedicated transfer ramp or other standard loading facilities). As such, a unique vehicle handling system will be required for the vessel to safely and efficiently load and unload passengers and vehicles under such conditions. This handling system, the requirements for which are specified herein, is a key driver of the vessel's inherent design configuration.

The required vessel is primarily defined by the Contract Documents, which include these Technical Specifications, the Contract Drawings, and associated supporting calculations and technical materials attached as appendices to the Construction Services Contract Form. Some requirements pertinent to design and construction, however, are also found within the General and Supplementary Conditions. The Contractor is obliged to comply with all Contract Documents. In conjunction with this responsibility, the Contractor must be conversant with each part of the Contract in order to be fully aware of requirements applicable to the vessel's design and construction.

Principal design, operation, and classification characteristics of the vessel are listed below in Technical Specification Section 0.2.

The Contractor shall satisfactorily perform all work and details connected therewith to engineer and complete the vessel's detail design, and construct, equip, outfit (as required), test, and deliver the vessel to the State, fully certificated² and warranted for the intended service. The

¹ Operating no more than 50 nautical miles from shore.

² The State understands that, with respect to the ship's USCG Certificate of Inspection (COI), the Contractor can only provide a temporary COI due to certain crew certification requirements required for the final COI that are

completed vessel shall fully comply with all requirements applicable to certification of the vessel by the U.S. Coast Guard (USCG), as well as all other salient regulatory body requirements and guidelines (e.g. EPA for applicable emission standards; ADA for accessibility and other services and features to accommodate passengers with disabilities). The completed vessel shall also fully comply with all American Bureau of Shipping (ABS) classification society requirements applicable to achieving the ABS classification society designations specified below in Section 0.2.

The vessel shall be delivered new and complete in all respects and outfitted to the extent required by the Contract.

The Contractor shall be responsible for the complete integration of all structures, components, and distributive systems with one another, including physical, mechanical, electric, electronic, monitoring, and control aspects. This integration includes achievement of full compliance with all contractual requirements.

Due to the vessel's physical size and tonnage, and the number of passengers, crew, and vehicles carried, the requirements of SOLAS, and its invoked references, are the primary regulations governing the design, construction, and regulatory certification of the ferry. However, in certain instances, the State, to enhance safety or achieve other objectives, has chosen to invoke more stringent regulations in the Contract. Where this is the case, the more stringent standards are described herein.

The Contractor should note that while the Contract Documents have been developed in accordance with applicable regulations, the package does not show or repeat all requirements cited in regulatory body publications that must be met in order to obtain the regulatory body approvals and certifications required by the contract. The Contract Documents also do not address peculiar requirements that may be imposed by the regulatory bodies relative to the design and construction details and methods selected by the Contractor for this particular vessel, though conformance with all such requirements is required within the scope of this Contract. Any and all work, services, materials, etc., necessary for regulatory body compliance, including but not limited to the regulatory requirements identified at Technical Specification Section 1E.3 shall be furnished by the Contractor under the original Contract price. The Contractor is responsible for incorporating any applicable regulations not inherently addressed in the Contract Documents. The Contractor is also to comply with applicable regulations relative to any authorized changes made to the Contract Documents.

The Contract Documents describe the functional, performance, and technical requirements applicable to the vessel's design and construction in significant detail. Nonetheless, the Contractor must develop final design solutions and details consistent with the Contract Documents; the Contractor's construction methods; arrangement and routing schemes for miscellaneous equipment, piping, cabling, and ductwork; and other detail considerations (hereinafter referred to as the Contractor's Production Design. All work, services, materials, and documentation necessary for the engineering and production of Contractor's Production Design shall be furnished by the Contractor under the original price. In conjunction with developing

beyond the scope of this contract. For complete discussion of the Contractor's responsibility regarding the COI, see Technical Specification Section 1A.2.

design solutions consistent with the Contract Documents, the Contractor shall perform calculations and other design checks needed to verify that the prescribed performance and operational characteristics will be achieved. For example, relative to piping and ventilation systems design, the Contractor must, through calculation and tests, verify that flow rates, pressures, and similar parameters, as prescribed in the Contract, are in fact achieved by the systems developed by the Contractor. Note that the dimensions of such piping and ducts shown in Contract Drawings may need to be modified to achieve the intended minimum flow rates and maximum flow velocities.

The Contractor's Production Design responsibilities are further delineated in Sections 1D and 1E and General Conditions, Section 5.13.

No oral statement of any person shall modify or otherwise affect the terms or scope of this Contract. Changes to the Contract terms and scope shall be made in accordance with the General Provisions of the contract, as may be amended by Special Provisions and Addenda.

0.2 VESSEL OPERATIONAL AND DESIGN REQUIREMENTS

Principal vessel operational and design characteristics are below. See Technical Specification Section 1E.3 for further description of applicable regulatory certification requirements:

Operational Characteristics and Classification

Vessel Type..... Roll-On/ Roll-Off Passenger Vessel (ROPAX)
 Service Type Domestic Only
 Service Route Type..... Oceans (No more than 50 nautical miles from shore)
 Range/Endurance 4,000 nm (20 days)
 Society Classification..... ABS ✱A1, , ✱AMS, ✱ACCU Ferry Service
 Primary regulations SOLAS, 46CFR Subchapter J, 33CFR

Design Characteristics

Hull/Superstructure Material Steel
 Length Overall 330'-0"
 Length at Waterline..... 329'-0"
 Beam, Maximum..... 74'-0"
 Draft, Design Waterline 15'-10"
 Air Draft..... 90'-0"
 Displacement, Lightship 4,188 LT
 Service Speed..... 15.0 knots
 Maximum Speed approx. 18.8 knots
 Embarked Crew 38 Persons (+ up to 11 Persons in addition to the Crew)
 Passenger Capacity 250 Persons
 Provisions for Physically Challenged Passengers..... Yes
 SOLAS Safe Return to Port (SRtP) compliant Yes
 SOLAS Orderly Evacuation and Abandonment compliant Yes

	Vehicle Lane Length (Total - All Lanes).....	1,220'
	Vehicle Types Legal Highway Vehicles (w/ Length Restrictions)	
125	Vehicle Capacity (Alaska Standard Vehicles ³).....	58
	Vehicle Capacity (Standard Vans ⁴ + Alaska Standard Vehicles).....	14 + 26

0.3 TERMS, DEFINITIONS AND ABBREVIATIONS

The abbreviations and definitions given in General Provisions Section 101 apply to these Specifications. The following additional terms and abbreviations also apply:

AAC	Alaska Administrative Code
ABS	American Bureau of Shipping
ABL	above base line
ABYC	American Boat and Yacht Council
AC	alternating current
✱ACCU	Automatic Centralized Control – Unattended Engine Room. The Maltese Cross symbol signifies that these systems have been assembled, tested, and installed under ABS survey.
ACM	asbestos-containing material
ADOT	Alaska Department of Transportation
AGMA	American Gear Manufacturers Association
AHU	air handling unit
AIS	Automatic Identification System
AISI	American Iron and Steel Institute
AMHS	The Alaska Marine Highway System
✱AMS	This classification notation indicates that a vessel's machinery, heaters, and systems have been constructed and installed under ABS survey in accordance with the requirements of the ABS Rules.
ANSI	American National Standards Institute
API	American Petroleum Institute
Area	The area available for arrangement after losses from structure, insulation, linings, and distributive systems.
ARPA	automatic radar plotting aid
ASME	American Society of Mechanical Engineers

³ Alaska Standard Vehicle = 20' long x 6.67' wide x 7'-0" high x 6,000 pounds.

⁴ Standard Van = 41.2' long x 8.0' wide x 13.5' high x 68,000 pounds.

ASNE	American Society of Naval Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
ASV	autonomous surface vehicle
ATS	Automatic transfer switch
AWG	American Wire Gage
AWS	American Welding Society
BCC	Bridge Control Console
BERP	bolted equipment removal plate
BHD	Bulkhead
BMEP	brake mean effective pressure
BNWAS	Bridge Navigational Watch Alarm System
CCTV	closed circuit television
CFR	Code of Federal Regulations
CMGC	Contract Manager/General Contractor
CMS	Continuous Maintenance Survey
Construct	See General Conditions, Section 1.2 “Definitions”
Contract	See General Conditions, Section 1.2 “Definitions” .
Contractor	See General Conditions, Section 1.2 “Definitions”
Contract Technical Package	The Technical Specifications, Contract Drawings, and any associated supporting calculations and technical reports, provided in the RFP).
COG	center-of-gravity
CPM	Critical Path Method
CPP	controllable pitch propeller
CPVC	chlorinated polyvinyl chloride
CRES	corrosion resistant steel
CSA	Canadian Standards Association
CVK	Center Vertical Keel
DC	direct current
Detail Design	Detail Design is an alternative term for Production Design, which is defined in General Conditions, Section 1.2
DFT	dry film thicknesses
DGLONASS	Differential Global Navigation Satellite System
DGPS	Differential Global Positioning System
DIN	Deutsches Institut für Normung
DLT	Design Line Tension

DoD	United States Department of Defense
DSC	Digital Selective Calling
Dwg	drawing
E3	electromagnetic environmental effects
ECDIS	electronic chart display and information system
EDG	emergency diesel generator
EGR	exhaust gas recirculation
EMI	electromagnetic interference
EMS	energy management system
EOS	Engineer's Operating Station
EOT	engine order telegraph
EPA	Environmental Protection Agency
EPIRB	emergency position-indicating radio beacon
FAA	Federal Aviation Administration
FCAN	full capacity above normal
FCBN	full capacity below normal
FCC	Federal Communications Commission
FCU	fan coil unit
FEA	Finite Element Analysis
FM	Factory Mutual Research Corporation
FMEA	Failure Mode Effect Analysis
FMR	Forward Machinery Room
rpm	feet per minute
FS	Factor of Safety
Furnish, Install, and/or Provide	See General Conditions, Section 1.3 "Usage Notes".
GA	general alarm
GCs	General Conditions for CMGC Construction Services
GFCI	ground fault circuit interrupter
GMDSS	Global Maritime Distress and Safety System
GPs	General Provisions for CMGC Preconstruction Services
GPT	General Purpose Transceiver
GSA	General Services Administration
HF	high frequency
HMI	human-machine interface
HPU	hydraulic power unit
HVAC	heating, ventilation, and air conditioning

IACS	International Association of Classification Societies
IBS	integrated bridge system
ICP	Interior Communications Platform
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFB	Invitation for Bid
IMACS	integrated monitoring, alarm, and control system
IMO	International Maritime Organization
IMS	information management system
INMARSAT	International Marine/Maritime Satellite
I/O	input and output
IPS	International Pipe Standard
ISO	International Standards Organization
IWRC	Independent Wire Rope Core
JIC	Joint Industry Council
KG	"Center of Gravity above the Keel" or "Kilograms", depends on context
LAN	local area network
Lb or #	pound
LCD	liquid crystal display
LCG	longitudinal center of gravity
LCS	local control station
LED	light emitting diode
LLTM	long lead time material
LMI	load moment indicating
LOP	local operator panel
LRIT	Long Range Identification and Tracking
LSA	Liferaft Systems Australia
LVP	low voltage protection
LVR	low voltage release
MAOT	Maximum Anticipated Operating Tension
MARAD	United States Maritime Administration
MARPOL	International Convention for the Prevention of Pollution from Ships (short for Marine Pollution)
MCC	Main Control Console
MCR	maximum continuous rating

MCS	Machinery Control Station
MCP	motor circuit protector
MCT	multi-cable transit
MES	Marine Evacuation System
MF	medium frequency
MHZ	Main Horizontal Zone
MMS	maintenance and management system
MOR	means-of-rescue
MPT	Male Pipe Taper (male NPT) or Mechanical Pipe Thread (non-tapered variety), depends on context
MSC	Marine Safety Center
MSD	marine sanitation device
MT	Magnet Particle Test
MVZ	Main Vertical Zone
NACE	National Association of Corrosion Engineers
Naval Architect	The firm Glosten, Inc., of Seattle, Washington, which prepared the contract technical package
NAVTEX	Navigational Telex
NBL	Nominal Breaking Load
NC	National Coarse
ND	non-destructively
NDE	non-destructive examination (or evaluation)
NDT	non-destructive test(ing)
NEMA	National Electrical Manufacturers Association
NF	National Fine
NFPA	National Fire Protection Association
NHT	National Hose Thread
NIBS	Navigational Integrated Bridge System
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPS	nominal pipe size
NPSH	Net Positive Suction Head
NPT	National Pipe Thread
NRC	noise reduction coefficient
NSF	Foundation for Sanitation
NST	National Standard Thread

NSTM	Naval Ships Technical Manual
NTP	Notice to Proceed
NUC	Not-Under-Command
NVCC	noise and vibration control consultant
NVIC	USCG Navigation and Vessel Inspection Circular
OBRP	onboard repair parts
OCMI	Officer in Charge of Marine Inspection
OS	operating system
OSHA	Occupational Safety and Health Administration
Owner	The State of Alaska
Owner's Representative(s)	The Resident Engineer. Also other designated agents or employees of the State, to the extent that those individuals have been authorized by the State, through the Resident Engineer, to act on the State's behalf.
OWHT	oily water holding tank
OWS	oily water separator
PA	public address
PBX	Private Branch Exchange
PCB	polychlorinated biphenyl
PIDS	passenger information display system
PST(P)	Periodic Safety Test (Procedure)
PLC	programmable logic controller
PMG	permanent magnet generator
PMS	power management system
PP	propylene and polypropylene
Prepare	The term 'prepare' means to develop or produce data or information for submittal and distribution to AMHS.
PT	Dye Penetrant Test
PTO	power take off
PVC	polyvinyl chloride
PWM	Pulse Width Modulating
QA/QC	Quality Assurance/Quality Control
QWR	Quarterly Weight Report
RAI	rudder angle indicator
RAM	Restricted-in-Ability-to-Maneuver
Regulatory Body	See General Conditions, Section 1.2 "Definitions"
Resident Engineer	See General Conditions, Section 1.2 "Definitions"

rms	root mean square (or quadratic mean)
ro-ro	roll-on/roll-off
RPM	revolutions per minute
SAE	Society of Automotive Engineers
SART	search and rescue radio transponder
SATCOM	satellite communication
SCBA	Self-Contained Breathing Apparatus
SNAME	Society of Naval Architects and Marine Engineers
SOLAS	Safety of Life at Sea Convention
SPL	sound pressure level
SRtP	safe return to port
SSAS	ship security alert system
SSB	single side band
SSDG	Ship Service Diesel Engine
SSPC	The Society for Protective Coatings
SSV	Single Source Vendor
STC	Sound Transmission Class
State	The Owner, the State of Alaska
State-furnished	State-furnished has the same meaning as “Owner Furnished”. See General Conditions, Section 1.2 “Definitions”.
STRM	stateroom
Subchapter F	Subchapter F of U.S. Code of Federal Regulations, Title 46, Chapter I
Subchapter H	Subchapter H of U.S. Code of Federal Regulations, Title 46, Chapter I
Subchapter J	Subchapter J of U.S. Code of Federal Regulations, Title 46, Chapter I
Subchapter S	Subchapter S of U.S. Code of Federal Regulations, Title 46, Chapter I
Subchapter W	Subchapter W of U.S. Code of Federal Regulations, Title 46, Chapter I
SWBS	Ship Work Breakdown Structure
SWL	Safe Working Load
T&R	Technical and Research
TBD	To Be Determined
TBL	Tested Breaking Load
TCG	Transverse Center of Gravity
TDH	Total Discharge Head

Technical Specifications	See General Conditions, Section 1.2 “Definitions”..
THD	total harmonic distortion
TIA	time impact analysis
TLI	tank level indicator
Ton	The term “ton” means long ton (2,240 pounds)
TPI	“Threads per inch” or “Tons per inch immersion” (depends on context)
TRV	<i>Tustumena Replacement Vessel</i>
UHF	ultra-high frequency
UHMW	Ultra-High Molecular Weight Polyethylene
UL	Underwriters Laboratory
UPS	uninterruptible power supply
USAB	United States Access Board
USCG	United States Coast Guard
USPHS	United States Public Health Service, United States Department of Health and Human Services
USSG	United States Standard Gauge
UT	Ultrasonic Test
UWILD	Underwater Inspection in Lieu of Drydocking
VAC	Voltage in Alternating Current
VCG	Vertical Center of Gravity
VDC	Voltage in Direct Current
VDR	Voyage Data Recorder
VETS	vehicle elevator and turntable system
VFD	variable frequency drive
VHF	very high frequency
VGP	US EPA Vessel General Permit
VoIP	Voice over Internet Protocol
WEAT	weathertight
WERP	welded equipment removal plate
WHO	World Health Organization
Working Day	Working Day has the same meaning as “Business day”. See General Conditions, Section 1.2 “Definitions”
Working Drawing	Working Drawing has the same meaning as “Shop Drawing”. It is a type of Production Document and a manifestation of Contractor’s Production Design. See General Conditions, Section 1.2 “Definitions”

- 130 Additional abbreviations applicable to invoked rules, regulations, and standards may be found in Section 1E.3.

0.4 CONTRACT DRAWINGS

The following Contract Drawings (to be developed) apply.

ADOT Dwg. No.	Title
Lines and General Arrangements	
13105.11-070-001-001	General Arrangement
13105.11-099-002-002	3D Outboard Renderings
13105.11-070-001-003	Hull Lines Plan
13105.11-114-001-001	Hull Appendages
13105.11-070-001-005	Fire Zone Diagram
13105.11-070-001-006	Emergency Evacuation Plan
Structure	
13105.11-070-001-007	Pilothouse Visibility Plan
13105.11-663-015-001	Pilothouse Arrangement and Details
13105.11-099-002-001	3D Structure Model
13105.11-099-002-003	3D Animated Movie (Elevator Movie)
13105.11-100-002-001	Hull Scantling Model
13105.11-101-002-001	Hull Plans
13105.11-101-002-002	Hull Sections
13105.11-101-002-003	Hull Frames, fwd, mid body, aft
13105.11-101-002-004	Midship Section
13105.11-101-002-005	Hull Elevations
13105.11-101-002-006	Hull Decks Platforms, and Flats, fwd, mid body, aft
13105.11-101-002-007	Typical Details
13105.11-101-002-008	Hull Girders and Misc BHDs, fwd, mid body, aft

ADOT Dwg. No.	Title
13105.11-101-002-009	Hull Stem & Keel
13105.11-101-002-010	Shell (side and bottom) fwd, mid body, aft
13105.11-101-004-001	Misc Structural Hatches
13105.11-101-004-002	Misc Hull Port and Framing Details
13105.11-101-004-004	Side Door and Framing
13105.11-101-002-011	Welding Schedule & Details
13105.11-150-003-001	Superstructure Plans
13105.11-150-003-002	Superstructure Sections
13105.11-150-003-003	Superstructure Elevations
13105.11-150-008-001	King Post Integration
13105.11-150-003-004	Deck house Longitudinal structure
13105.11-150-003-005	Deck House Frames, Fwd, Aft
13105.11-150-003-006	Deck House Decks, Fwd, Aft
13105.11-150-003-007	Deck house sides and ends
13105.11-150-004-001	Watertight Doors and Framing details
13105.11-150-004-002	Weathertight Ventilation Closures
13105.11-150-004-003	Weathertight Doors, Framing, and Sill Heights
13105.11-150-004-004	Window and Framing Details
13105.11-171-008-001	Masts Arrangement and structure
13105.11-179-079-001	Passenger Boarding Ladder Arrangement
13105.11-182-050-001	Equipment Foundations
13105.11-182-050-002	AZIPOD Foundations
13105.11-182-050-003	Engine Foundations
13105.11-182-050-004	Thruster Tunnels
13105.11-182-050-005	Mooring Foundations

ADOT Dwg. No.	Title
13105.11-580-010-001	Mooring Arrangement and Installation
13105.11-580-010-002	Anchor Handling Arrangements
13105.11-201-050-001	Propulsion Room Arrangement
13105.11-201-050-002	Propulsion Arrangement
13105.11-301-087-001	Electrical Equipment Arrangement
13105.11-312-076-001	Emergency Generator Room Arrangement
13105.11-501-050-001	Main Machinery Rooms Arrangements
13105.11-501-050-002	Fin Integration
13105.11-501-002-001	Equipment Removal Sketch
13105.11-568-050-001	Bow Thruster Room Arrangement
13105.11-575-050-001	Vehicle Elevator Machinery Room Arrangement
13105.11-301-087-000	Electrical One Line Diagram
13105.11-330-092-001	Lighting Systems
13105.11-391-090-001	Wireway Arrangement Plan
13105.11-422-094-001	Navigation Light Arrangement
13105.11-301-087-003	Hazardous Zones Plan
13105.11-430-095-001	Interior Communications
13105.11-430-095-002	IT & Computer Network Block Diagram
13105.11-436-091-001	Machinery Alarm, Monitoring & Control
13105.11-441-093-001	Antenna Arrangement
13105.11-264-057-001	Lube Oil System Diagram
13105.11-264-057-002	Waste Oil System Diagram
13105.11-342-063-001	Exhaust System Diagram
13105.11-342-059-001	Jacket Water Cooling System Diagram
13105.11-506-011-001	Vents, Fills, Overflows and Sounding Tubes Diagram

ADOT Dwg. No.	Title
13105.11-508-075-001	Piping Insulation Schedule
13105.11-512-012-001	Vehicle Space Heating and Ventilation Diagram
13105.11-512-012-002	Deckhouse HVAC Diagram
13105.11-513-064-001	Machinery Spaces HVAC Diagram
13105.11-514-065-001	Chilled Water System Diagram
13105.11-517-058-001	Waste Heat and Hydronic Heating System Diagram
13105.11-521-013-001	Firemain System Diagram
13105.11-522-013-001	Vehicle Space Deluge System Diagram
13105.11-522-013-002	Accommodation Spaces Sprinkler System Diagram
13105.11-524-058-001	Seawater System Diagram
13105.11-524-011-001	Sanitary Flushing System Diagram
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13105.11-526-011-002	Vehicle Space Drain System Diagram
13105.11-528-011-001	Plumbing and Interior Deck Drain System (Gray Water) Diagram
13105.11-528-011-002	Plumbing and Interior Deck Drain System (Black Water) Diagram
13105.11-529-011-001	Bilge System Diagram
13105.11-529-011-002	Trim & Ballast System Diagram
13105.11-532-059-001	Fresh Water Cooling System Diagram
13105.11-533-059-001	Potable Water System Diagram
13105.11-541-056-001	Fuel Oil Service and Transfer System Diagram
13105.11-551-072-001	Compressed Air System Diagram
13105.11-556-057-001	Hydraulic Systems
13105.11-593-070-001	MSD & Sewage Transfer Diagram
13105.11-593-052-001	Oily Water System Diagram

ADOT Dwg. No.	Title
13105.11-169-004-001	Stern Door Integration
13105.11-169-004-002	Stern Door Drawing (Vendor Drawing)
13105.11-101-004-003	Side Door Arrangement
13105.11-556-057-002	Stern Door Hydraulic Control Plan
13105.11-169-004-004	Elevator Deck Hatch
13105.11-583-016-001	Lifesaving Equipment Arrangement
13105.11-621-025-001	Joiner Arrangement Plan
13105.11-635-007-001	Insulation Arrangement Plan
13105.11-651-017-001	Galley Arrangement
13105.11-662-050-001	Engineers Operating Station Arrangement and Details

SECTION 1A SERVICES

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SECTION 1A SERVICES

5 1A.1 INTENT

The intent of these Specifications, their appendices, and accompanying Contract Drawings is to outline and illustrate the work required in this Contract. This is a Production-Design-and-Construction Contract and, as such, the Contractor is solely responsible for the development of the detail design and for providing all engineering (including, but not limited to, documentation and
10 Working Drawings), labor, material, services, equipment, tools, transportation, and supplies necessary to complete the work in accordance with the Contract Drawings, Specifications, and the terms of the Contract.

It is not the intent of these Specifications and the Contract Drawings to include every detail of the work. Specifically, the work items in this Contract have typically been developed only to
15 define the necessary performance or concept. Accordingly, all other design and details are left for the Contractor to fully engineer and define in the Working Drawings and final “as-built” plans. Therefore, the omission, in the specifications and/or Contract Drawings, of any material or equipment that would be detrimental to the seaworthiness or the serviceability of the vessel and necessary for the proper operation of the items installed, the inclusion of which is in keeping
20 with good shipbuilding practice, shall be provided by the Contractor at his expense to the satisfaction of the Resident Engineer.

1A.2 GENERAL CONTRACT SERVICES

The Contractor shall satisfactorily perform all work and details to engineer, construct, equip, outfit, test, and deliver the vessel to the Resident Engineer, fully certified, not including crew
25 certifications, and ready for intended service. The completed vessel shall comply with all requirements applicable to meeting classification, as well as all requirements of the regulatory bodies cited.

Until completion of all work and the vessel’s departure from the Contractor’s facilities, the Contractor shall provide all necessary plant facilities, engineering, labor, services, materials,
30 machinery, equipment, outfit, gas-freeing, spare parts, appurtenances, tools, appliances, transportation, supplies, fuel, water, power, lighting, air, steam, crane services, lift and disposal services, rigging, communication, mooring lines, line handling, wharfage, docking, and shifting of the vessel.

The Contractor shall obtain all approvals for the work and vessel certificates required by USCG, ABS, and other regulatory bodies. The vessel shall be delivered with all required classification
35 and inspection certificates provided.

The vessel shall also comply with the latest USCG regulations, IMO/SOLAS regulations, and both USCG and IMO regulations and recommendations for the prevention of pollution at the time of contract signing

40 All Contractor technical and other submittals provided under this contract (plans, calculations, test documentation, purchase orders, etc.) are subject to Owner review and approval unless otherwise noted.

1A.3 TECHNICAL SPECIALISTS AND MANUFACTURER FIELD ENGINEERS

As part of the work and within the original Contracted price, the Contractor shall utilize the services of technical specialists and manufacturers' field engineers to monitor highly specialized work. Such work is expected to include but not be limited to on-site advisement regarding, or supervision of, critical equipment installation, alignment, initial start-ups, adjustments, calibrations, and testing. For purposes of these services, "critical" equipment shall include but not necessarily be limited to the following:

1. Main propulsion diesel generator sets.
2. Ship service auxiliary diesel generator sets.
3. Azimuthing stern propulsors.
4. Bow thrusters.
5. Fin stabilizers.
6. Propulsion and electrical power generation control and distribution systems.
7. Oil-fired hot water heater.
8. HVAC systems.
9. Sewage treatment system.
10. Radar.
11. PBX telephone.
12. Satellite communications systems.
13. All alarm, safety, and lifesaving systems and equipment.
14. Vehicle Elevator, Turntable, and associated closures
15. Stern Door

All services provided by technical specialists and field engineers shall be the Contractor's responsibility.

Each field engineer and technical specialist shall submit an interim progress report within (48) hours following each site visit describing the adequacy, quality, and condition of the installation as applicable to their equipment or work. Each field engineer and technical specialist shall submit a final installation report within fourteen (14) days following completion of installation and successful dockside testing and, if applicable, Sea Trial testing of the supplied equipment. Copies of all reports shall be provided to the Resident Engineer within two (2) days of receipt by the Contractor.

1A.4 CARE OF THE VESSEL

1A.4.1 General

Responsibility for protection of the vessel shall rest totally with the Contractor until delivery and operational acceptance of the vessel, as addressed in the General Conditions for CMGC Construction Services. The Contractor will be held responsible for and make good, at his expense, any and all damage and/or loss to the vessel, and/or its machinery, and/or its stores,

80 outfit, furniture and furnishings, spare parts, tools, and removable equipment while the vessel is located at his facility and up to the time of delivery and operational acceptance by the State.

The Contractor shall safeguard the vessel's machinery and electrical equipment. The use of said machinery and equipment shall be only upon approval by the Resident Engineer and under the supervision of trained and competent personnel.

85 The Contractor shall protect, by cribbing, masking, and other means, all machinery, equipment, finished surfaces, and any other items or surfaces requiring protection during the course of the work.

The Contractor shall at all times, insofar as conditions of the work will permit, keep the openings of the vessel closed against the weather. Temporary deck openings shall be bounded by a coaming of sufficient height as to divert any water on the deck from entering any of the spaces below, and have personnel fall restraints (i.e., appropriate temporary handrails, etc.).

90 The Contractor shall keep all installed pipelines drained, including fixtures, pumps, traps, and tanks, to maintain cleanliness and avoid damaging piping or fixtures by corrosion or freezing. Any damage caused through the Contractor's neglect or failure to comply fully with this requirement shall be repaired at the Contractor's expense, to the satisfaction of the Resident Engineer.

1A.4.2 Safety and Security

100 The name(s) and telephone number(s) of the Contractor's safety representative(s), Ship's Superintendent(s), and Project Manager shall be provided, in writing, to the Resident Engineer prior to the commencement of any work to ensure 24-hour communication capabilities for safety-related issues.

The Contractor shall provide and maintain security rounds (monitoring for flooding, fire, and pilferage), continuing through operational acceptance of the vessel by the State. Security rounds shall be made at a minimum of every six hours.

105 1A.4.3 Fire and Asphyxiation Protection

1A.4.3.1 General

110 During the Contract performance period, the Contractor shall provide and be solely responsible for all firefighting protection onboard the vessel as may be required by various regulatory bodies, including the local fire department and port authority. Toward this end, the Contractor shall maintain a comprehensive and effective system of fire prevention, fire detection, and firefighting while the vessel is in the Contractor's control, and develop and provide a fire protection plan that describes the overall manner in which protection to personnel and the vessel will be provided, per the requirements of the Contract.

115 Note: The Contractor shall not incorporate the use of the vessel's firefighting/ alarm systems, equipment, or State personnel in planning his firefighting protection.

1A.4.3.2 Fire Watches

The Contractor shall establish a plan for providing and maintaining fire watches, as needed, to prevent fires, as the vessel develops from initial fabrication through final construction to delivery. This plan, which shall form part of the fire plan described in Section 1A.4.3.3, shall include but not be limited to the following provisions:

1. Fire watch shall be the sole duty of assigned fire watches.
2. Fire watches shall be established and maintained in all locations where combustible materials are present in hotwork areas.
3. Where combustible material exists on both sides of any interior bulkhead or deck where hotwork is being performed, a fire watch shall be maintained on both sides of the boundary.
4. Fire watches shall remain on site after completion of hotwork until the affected surface and adjacent materials have cooled significantly to preclude all opportunity for fire, but in no case shall this time be less than 30 minutes.
5. The Contractor shall schedule fire watches and monitor the proper placement of same. The Contractor's failure to do so will result in the Resident Engineer halting all work, at the expense of the Contractor, until the Resident Engineer is satisfied that the Contractor will comply with the fire watch requirements.

1A.4.3.3 Fire Plan

See General Conditions Section 5.3.

1A.4.4 Gas-Freeing of Tanks/Voids and Gas-Free Certificates

As vessel construction proceeds, the Contractor shall certify "gas-free," "safe for hotwork," and "safe for entry" any and all tanks, voids, bilges, and other closed, unventilated, or poorly ventilated spaces/areas that may at any time constitute personnel safety, fire, or explosion hazards.

"Gas-free," "safe for hotwork," and "safe for entry" certification may be necessary. For example, at some point after petroleum products have been transferred to the vessel, after bilge water has accumulated during vessel launch and machinery testing. A similar situation would be after a tank or void has been left closed and/or without powered ventilation after construction and coating. The Contractor shall be accountable for monitoring potential development of hazardous situations that would dictate the need for gas-free certification(s) and initiating and completing such certification(s) to maintain a safe working environment on the vessel throughout the construction period.

The Contractor shall properly dispose of all accumulations of oily bilge water in accordance with local and federal environmental regulations using Contractor-furnished equipment. Such accumulations are expected to arise from time-to-time after the ship is launched and moored at the Contractor's facilities.

The Contractor shall provide all labor and materials necessary to obtain and maintain the necessary gas-free certifications for affected spaces and areas and post the necessary hazard warnings and "safe for hotwork" and "safe for entry" signage at entrances to the tanks, voids, and other work areas.

The Contractor shall obtain and maintain up-to-date marine chemist's test certificates depicting the status of unsecured tanks and voids in accordance with OSHA regulations and as outlined herein. A copy of these certificates shall be provided to the Resident Engineer. In addition, copies of the test certificates and summary sheets certifying the status of all compartments and open tanks and voids shall be posted by the Contractor at the following locations, as vessel construction proceeds:

1. Main access gangway to the vessel (summary sheets).
2. Boat Deck Foyer, near Purser's Counter (summary sheets); applies after this area is constituted in the erection process.
3. At each compartment, and open tanks and voids (individual certificates).

1A.4.5 Flooding Protection

A comprehensive and effective plan for flooding prevention, flooding detection, and damage control shall be maintained once the vessel is waterborne. Pumps shall be readily available should flooding be detected. Plan shall be submitted to Owner.

1A.4.6 Freeze Protection

A comprehensive freeze protection plan shall be developed and implemented to protect the vessel and vessel systems in the event of cold weather. Plan shall be submitted to Owner.

1A.4.7 Hull Protection

Rigid control of welding and grounding shall be maintained for the protection of the hull and its systems and appendages. Control shall be maintained during the entire time the erected vessel is waterborne or in drydock.

To ensure proper protection of the vessel, and in keeping with the Contract and Contractor health, safety, and environment program, the following minimum requirements shall be adhered to:

1. Any welding power source used on the vessel shall not be used for any other vessel or structure.
2. Ground (return) cables attached to the vessel shall never be grounded to any other vessel or structure.
3. All welding cable, electrode, or ground shall be completely insulated and never permitted to drop into water.
4. Grounding lugs shall be tightly secured to grounding plates, and contact surfaces shall be thoroughly cleaned to base metal.
5. Prior to welding Contractor shall disconnect power supplies to sensitive equipment as required by various equipment suppliers.

1A.4.8 Cleanliness and Material Protection

All parts of the vessel shall be maintained in good and clean condition throughout the construction period. Special measures shall be taken to prevent wear, damage, corrosion, or

other deterioration. Any such defects that develop shall be corrected by the Contractor prior to delivery.

All materials intended for use and installed on the vessel shall be protected until time of acceptance of delivery of the vessel by the State, in accordance with Section 5.3 and 5.4 of the contract General Conditions.

1A.5 SERVICES APPLICABLE TO STATE-FURNISHED ITEMS

1A.5.1 State-Furnished Material Associated with Vessel Construction

State-furnished material, if applicable to the Contract, will be delivered or made available to the Contractor at his place of business. The cost of handling and placing all materials after they are delivered to the Contractor is included in the Contract price and no separate payment will be made.

The Contractor shall receive, transport, inspect for transit damage, check for agreement with bills of lading, insure, protect during construction, provide secure and covered storage for, and install aboard the vessel the aforementioned State-furnished material. An inventory of State-furnished material, as received by the Contractor, shall be provided to the Resident Engineer.

The Contractor shall be held responsible for all State-furnished material delivered to him.

Deductions will be made from any monies due to him if necessary to make good any shortages and deficiencies, from any cause, and for any damage that may occur after delivery and for any subsequent demurrage charges. Material or equipment damaged through improper storage or handling shall be replaced with new at the Contractor's expense.

The Resident Engineer may reject for use on the project any of the aforementioned material and/or equipment improperly stored or handled by the Contractor.

1A.5.2 Handling of Other State Material Received at the Contractor's Facility

The State will have material shipped to the Contractor's facility during the course of the Contract that is unrelated to the Contract work and intended for the ship's crew or other State employees.

The Contractor shall be responsible for receiving, transporting, checking for damage, etc., of these materials in the same way as stipulated above for State-furnished material. Up to 50 deliveries of such material, of up to 50 pounds each (e.g. one 100lb delivery is equivalent to two 50lb deliveries, etc), shall be accepted by the Contractor and delivered to the Resident Engineer at the project office or to the ship, as applicable to the delivery. The Contractor's efforts regarding these deliveries shall be part of the Contractor's responsibility under the Contract. As such, the Contractor shall not be entitled to additional monies beyond the original Contract price for the first 50 deliveries falling within the prescribed weight limit.

1A.6 FUEL OIL, MACHINERY FLUIDS, POTABLE WATER AND WASTES

The costs of all diesel, hydraulic, and lubricating oils, water, and other fluids expended prior to the vessel's arrival at the place of delivery and after any trials shall be borne by the Contractor within the originally contracted price of work. Similarly, the cost of removing and properly disposing of all waste fluids which must be removed from the vessel prior to its arrival at the place of delivery shall be borne by the Contractor within the originally contracted price of work.

Upon arrival of the vessel at the place of delivery and after any trials, the Contractor and the Resident Engineer shall jointly sound all diesel, lubricating, and hydraulic oil tanks, potable water tanks, and machinery sumps. All machinery lubricating and hydraulic oil sumps shall be at normal operating levels at the time of the joint soundings. In cases where sump levels do not comply with this requirement, the Contractor shall fill the sumps before taking final soundings of the clean lubrication and hydraulic oil storage tanks.

All potable water tanks shall be filled to nominal 95% full levels and all waste tanks shall be empty to low suction at the time of the joint soundings. If these requirements are not met, the Contractor shall immediately take whatever steps are necessary to correct the discrepancies at the Contractor's expense.

The State will reimburse the Contractor at his cost (i.e., without Contractor mark-up) for all diesel, hydraulic, and lubricating oil on board the vessel at the place of delivery as determined from the joint soundings. The Contractor shall provide supplier invoices to the State for verification of the Contractor's unit costs.

1A.7 LAUNCHING, DRYDOCKING AND UNDERWATER VIDEO SURVEY

1A.7.1 Vessel Launch

The Contractor shall be responsible for the safe launching of the vessel. Launching and outfitting shall be performed in a depth of water sufficient to ensure that the vessel is not grounded at any time.

1A.7.2 Vessel Drydocking

1A.7.2.1 General

Following Dock Trials, but before Sailaway Acceptance Trials (Acceptance Trials), the vessel shall be drydocked, cleaned (including gratings and sea chests), and all exterior hull surfaces which had not previously been painted (i.e., keel surfaces in way of previous keel block settings) and all areas of damaged paint shall be prepared and painted in accordance with Technical Specifications Section 631.

Before departing on the delivery voyage, if the vessel has continually been in the water for more than sixty (60) days, it shall be drydocked and the bottom cleaned prior to departure.

The Contractor bears total responsibility for all drydocking evolutions that occur before acceptance of vessel delivery by the State.

1A.7.2.2 Docking Plan

A docking plan shall be developed by the Contractor incorporating actual dimensions taken from the ship before launching or while in drydock prior to delivery. The plan shall include the following information:

1. A plan view of the ship and the blocking arrangement.
2. Sections to illustrate the transverse blocking arrangement, including the midship and typical sections and areas where high blocking is required and stability in dock is a consideration.

3. A profile of the ship supported on the pier keel blocks.
4. Location of bow thruster, bilge keels, docking plugs, impressed current system anodes, and zinc anodes.
5. Location of keel blocks and side blocks in three different docking positions, such that the entire ship's hull can be painted.
6. Location of bitts and chocks on both profile and plan views.
7. Frame spacing of ship on profile view.
8. Indication of major transverse bulkheads on profile view.
9. Notes on the profile view near the stern propulsors, fin stabilizers, and other removable appendages, specifying the clearance below keel bottom required for their removal.
10. Notes on the profile view indicating the clearance required beyond the stern reference point for removal of shafting.
11. Table of critical dimensions.
12. Table of displacements and other properties for docking.
13. Trim table for propeller clearances.
14. A list of openings in the shell, together with locations and including but not limited to piping discharges and sea chests.
15. Tables of offsets for side block and keel blocks, as required.
16. Any other information considered to be of aid in docking the ship.

1A.7.3 Underwater Video Survey

An underwater survey of the ship's hull shall be provided by the Contractor, performed in general agreement with the guidelines of NVIC 189.

Once all hull markings and preparations have been made, a video tape with audio commentary shall be made of all external areas of the underwater hull, including stern propulsors, fin stabilizers, hull protective system, and all other attached appurtenances. The video shall clearly show the hull reference system, required by 46 CFR 71.50-5, which shall be used to determine the diver location relative to the hull.

1A.8 TESTS AND TRIALS

Tests shall be conducted by the Contractor in accordance with the provisions herein, ABS rules, USCG requirements, and the following references:

1. SNAME T&R Bulletin No. 3-39, Guide to Shop and Installation Tests.
2. SNAME T&R Bulletin No. 3-47, Guide for Sea Trials.
3. IEEE 45, Electric Installation on Shipboard series.

Tests and related inspections shall occur in stages to identify and remedy defective or improperly specified equipment, deficient design/installation/construction, and related problems as early as possible. Towards this end, test agenda and related procedures shall be developed for the

following stages or inspections, with testing as applicable to the item of work, material, equipment, or system:

1. Stage 1 – Shop Inspections and Factory Acceptance Tests.
- 310 2. Stage 2 – Construction Inspections and Tests.
3. Stage 3 – Operation and Performance Tests.
4. Stage 4 – Dock Trials.
5. Stage 5 – Builder’s Sea Trials.
6. Stage 6 – Acceptance Trials.
- 315 7. Stage 7 – Special Tests.

Additional test procedure/acceptance specifics are provided in various applicable sections of the specifications.

320 All portions of the vessel and all work thereon including structure, fittings, systems, and machinery shall be thoroughly tested after installation. Testing shall demonstrate satisfactory workmanship, proper working order, alignment of all moving parts, tightness, suitability for the purpose intended, and compliance with the requirements of these specifications. Any defects that may develop or become apparent from these tests shall be corrected by the Contractor and then retested.

325 Tests shall be conducted at reasonable times, and the Resident Engineer, inspectors, and surveyors shall be notified a reasonable period in advance of the scheduling of tests so that they may arrange to be present.

The Contractor shall provide all meters, gauges, and other special equipment and supplies required, and shall be responsible for their proper installation, calibration, and use. The Contractor shall also be responsible for their removal at the conclusion of the various tests.

330 The Contractor shall also provide all personnel required to run the tests and to record the data from them. The Contractor shall ensure that applicable Working Drawings are available at the test site during inspections and testing. The Contractor shall ensure that appropriate regulatory body witnesses are present during testing.

335 Of necessity, some testing may be repetitive from one stage to the next. This is intentional and is done to ensure that equipment is properly installed and operating prior to acceptance.

1A.8.1 General Requirements Applicable to Trials

340 Successful completion and approval of Dock Trials is a prerequisite to conducting Builder’s Sea Trials and successful completion and approval of Builder’s Sea Trials is a prerequisite for Acceptance Trials. All pre-Dock and Sea Trial planning items listed in the SNAME T&R Bulletins and other guidelines applicable to the project shall be performed prior to commencing trials.

During the conduct of required trials and related tests, the vessel shall be under the control of the Contractor, with representatives of the Resident Engineer and regulatory bodies on board to determine whether work done by the Contractor has been satisfactorily performed.

345 During the conduct of required trials and related tests, the Contractor shall provide a crew and pilot licensed for the water to be navigated and the vessel tonnage. Operation of the vessel and its equipment and systems, and control of tug services and dockside assist personnel, shall be carried out by these licensed persons in a safe manner.

350 The Contractor shall provide fully trained emergency response squads to respond to emergency conditions during trials.

The Contractor shall plan on the attendance of an additional twenty-five (25) persons to be designated by the Resident Engineer for Builder's Sea Trials and Acceptance Trials.

Builder's Sea Trials and Acceptance Trials shall be conducted in deep unconfined navigable waters suitable for speed trials (depth greater than 145').

355 Weather and sea conditions shall be suitable for collection of the data and in accordance with the provisions of SNAME T&R Bulletin 3-47. The actual location of the trials shall be at the discretion of the Contractor.

A complete set of technical manuals shall be made available to the Resident Engineer during trials. During Sea Trials, data shall be readily available to observers and trial results posted.

360 After tests and trials, and after arrival at delivery acceptance port, all strainers shall be cleaned, all filter elements, fluid and air, shall be replaced with new filters, and all systems' hydraulic and lubricating oils shall be changed.

1A.8.2 Stage 1 – Shop Inspections and Factory Acceptance Tests

365 Shop inspections and factory acceptance tests shall be conducted by the manufacturers for major equipment, systems, and assemblies listed below to demonstrate proper manufacture, assembly, function, and compliance with performance criteria prior to shipment.

370 Shop inspections and tests shall be performed in accordance with the recommendations of SNAME T&R Bulletin No. 3-39 as supplemented by other requirements of the regulatory bodies, the provisions of these Specifications, and the general practices of the equipment manufacturers.

Stage 1 of the test and trial program shall consist of at least the following shop inspections and tests for the following equipment fitted on the vessel:

1. Main propulsion generator sets and ancillary equipment.
2. Ship service auxiliary generator sets and ancillary equipment.
- 375 3. Emergency diesel generator sets and ancillary equipment.
4. Azimuthing stern propulsors and ancillary equipment.
5. Bow thrusters and ancillary equipment.
6. Fin stabilizer system.
- 380 7. Machinery plant control and monitoring system and ancillary equipment, including motor-operated valves.

8. Control and power distribution switchboards and ancillary equipment, including stern propulsor motor drives, bow thruster motor drives and vehicle elevator motor drive.
9. HVAC chiller unit.
10. Marine sanitation device.
- 385 11. Life/rescue boats and associated davit systems.
12. Oil-fired hot water heater.
13. Turntable.
14. Elevator subassemblies.
15. Mooring and anchoring winches.

390 **1A.8.3 Stage 2 – Construction Inspections and Tests**

Construction inspections and tests are static demonstrations that precede operational testing. These tests and inspections shall verify that equipment, systems, and fabricated construction materials are installed in accordance with design documents and the requirements of the manufacturer and regulatory bodies.

395 The inspections and tests shall be performed in accordance with the requirements of the regulatory bodies, the provisions of these Specifications, and recommendations of the equipment manufacturers.

Stage 2 of the test and trial program shall consist of at least the following inspections and tests:

- 400 1. Cleanliness tests to verify the cleaning and flushing of all Contractor-fabricated and installed piping systems.
2. Hydrostatic (and/or pneumatic when permitted) testing of all Contractor-fabricated and installed piping systems.
3. Load testing of load-bearing vehicle elevator system components.
- 405 4. Insulation resistance testing (conductor to conductor and conductor to ground) and continuity verification of all Contractor-installed electrical power and lighting cables and connections.
5. Equipment alignments, such as alignment of motor-driven auxiliaries.
6. Static load testing of all load-bearing hull fittings, including, but not limited to, padeyes, bitts, and chocks.
- 410 7. Static load testing of deck fittings, bolt-down fittings, padeyes, and lift points.
8. Pressure testing of Contractor-fabricated structural and independent tanks.
9. Tightness testing of weather deck doors, scuttles, windows, port holes, roller doors, or other similar vessel features intended to be sealed to prevent passage of liquid, gas, or atmosphere, including penetrations in watertight bulkheads and decks.
- 415 10. Calibration of instrumentation.
11. Welding inspections and NDT/QA checks.
12. Protective coating inspections and QA checks.

13. Hull fairness and alignment inspections and QA checks of structural fabrications.

1A.8.4 Stage 3 – Operation and Performance Tests

420 Operation and performance tests shall be conducted to verify that equipment and systems operate and perform within the limits and tolerances prescribed by the design and the requirements of the manufacturer and regulatory bodies.

425 The operation and performance tests shall be performed in accordance with the recommendations of SNAME T&R No. 3-39, as supplemented by other requirements of the regulatory bodies, the provisions of these Specifications, and recommendations of the equipment manufacturers.

Stage 3 of the test and trial program shall consist of at least the following operation and performance tests:

1. All operational functions of equipment and systems shall be fully demonstrated.
2. All performance criteria established for equipment and systems shall be fully verified.
- 430 3. All control settings, safety trips, interlocks, alarms, fail-safe features, emergency shutdowns, and other control features for equipment and systems shall be fully demonstrated. Demonstrations shall include all interconnecting cable and sensing devices.
- 435 4. All local and remote controls (including wireless) for equipment and systems shall be fully demonstrated at all stations.
5. All local and remote instrumentation for equipment and systems shall be fully verified at all locations.
6. Heat run tests for all electric motor-driven auxiliaries shall be conducted.

440 Generator load testing shall be performed using reactive load bank(s) having the capacity to fully load each generator in single and parallel operation at the regulatory-required load test values. The load bank(s) shall be suitable for performing transient response tests and verifying governor and associated control system settings, safety trips, interlocks, and automatic start-up and transfer of the load between generators.

445 Power quality shall be verified to ensure that the harmonic voltage distortions are in line with the predicted levels and less than the allowable limits. Harmonic measurements shall be taken at the 690VAC main switchboard, 480 VAC ship service switchboard, 208/120 VAC load centers, and 480 VAC emergency switchboard (while connected to the main switchboard only). Harmonic measurements shall meet the recommendations of the *ABS Guidance Notes on Control of Harmonics in Electrical Power Systems*. Where two or more systems or equipment items
450 interface, the tests shall also demonstrate satisfactory alignment and performance of the systems and equipment as a whole.

1A.8.5 Stage 4 – Dock Trials

All installation, operation, and performance tests of the following systems shall be completed and approved prior to commencing Dock Trials:

- 455 1. Fire main.
2. Sound-powered telephone systems.

3. Sliding watertight door system.
4. Ventilation shutdown systems.
5. Engine and fuel system shutdown systems.
- 460 6. Fire detection system.
7. Machinery room fixed fire extinguishing system.
8. General alarm system.
9. Bilge level monitoring system.

465 Dock Trials consisting of simultaneous dockside operation of the diesel generating plant, diesel generating plant controls, and associated auxiliaries shall be conducted to demonstrate readiness for Sea Trials. In addition, certain installation, operational, and performance tests unrelated to the machinery plant but of particular interest in preparation for Builder's Sea Trials shall be conducted as part of Dock Trials, as specified herein.

470 Dock Trials shall be performed in accordance with the recommendations of SNAME T&R Bulletin No. 3-47 as supplemented by other requirements of the regulatory bodies, the provisions of these Specifications, and recommendations of the equipment manufacturers.

Dock Trials shall consist of at least the following:

1. Propulsion Plant Preparation Tests. These tests shall include:
 - a. Non-operational cold checks of the plant.
 - 475 b. Confirmation of proper operation of monitoring instrumentation.
 - c. Static tests of emergency shutdowns, alarms, speed-limiting devices and over-speed trips.
 - d. Other applicable start-up preparation tests, including checking coolant and lubricant levels.
- 480 2. Propulsion Generator & Motor Spin and Load Tests. The propulsion generators, motors, and their controls should be operated during the spin test. The manufacturer should be consulted regarding the details of the spin test to identify any operating limitations and to optimize the benefits from the test. The following items shall be included:
 - a. Check air gap measurements (prior to spin test)
 - 485 b. Check lubricating oil system including proper pressure, temperature controls, operation of standby or emergency lube oil pumps, sight flow fittings, and bearing temperatures
 - c. Check speed and direction controls to the extent practicable under no load operation
 - 490 d. Vibration readings should be taken and included in the shop test report. Vibration measuring procedures and recommended limits are shown in ISO 4867 Code for the Measurement and Reporting of Shipboard Vibration Data as well as SSC-330 Practical Guide for Shipboard Vibration Control and Attenuation.
 - e. Check operation of cooling equipment
 - f. Check operation of rectification equipment

- 495 During the dock trial a sample of lube oil from active parts of the system should be taken
and analyzed to determine its conformance with specifications. Fuel samples should also
be taken and analyzed.
- 500 3. Main Propulsion Units Load Tests. The dock trial of each main stern propulsor should be
of sufficient duration to allow the units to be warmed up in accordance with the
manufacturer's instructions and temperatures to stabilize, as well as to allow operation at
maximum dock trial RPM, ahead and astern. Generally, a dock trial of at least six hours
shall be performed, including two hours at maximum ahead dock trial RPM and one-half
hour maximum astern dock trial RPM, of the main propulsion system is sufficient.
505 During the dock trial a sample of lube oil from active parts of the system should be taken
and analyzed to determine its conformance with specifications.
4. Steering Systems. Complete functional testing of stern propulsor steering, and associated
controls and instrumentation, shall be performed.
5. Bow Thruster(s) Tests. Complete functional testing of the bow thrusters, controls, and
instrumentation shall be performed.
- 510 6. Fin Stabilizer Tests. Complete functional testing, that may be performed dockside with
the fins retracted, shall be performed.
7. Cathodic Protection System Tests. Proper function of the cathodic protection system shall
be confirmed.
- 515 8. Auxiliary Systems Tests. The proper operation of all auxiliary systems and their
components shall be verified, including at least the following:
- a. Compressed air system.
 - b. Lube oil systems.
 - c. Diesel oil systems.
 - d. Bilge systems.

520 e. Potable water system.

 - f. Seawater service and cooling systems.
 - g. HVAC systems operation and balancing.
 - h. MSD, gray water and sewage system.
 - i. Ballast system.

525 j. Sanitary flushing system.

 - k. Firefighting systems.
 - l. Waste heat recovery and hot water heating systems.
 - m. Waste oil transfer system.
 - n. Oily water separator system.

530 o. Chilled water system.

 - p. Deck wash system.
9. Ship service & Emergency Diesel Generator Tests. The generators shall be tested in
single generator and parallel operating modes. The diesel generators' response to

transient load changes and all low voltage relays, safety trips, alarms, interlocks, and controls shall be tested. All controls and instrumentation for the automatic start-up/shutdown of generators and transfer of load between generators shall be also tested, including the EDG.

10. Vehicle Elevator and Turntable Tests. The elevator turntable shall be tested in normal operation, manual operation, and emergency modes. Tests shall include door/ramp deployment and closing on both sides, hoistway hatch operation, and hinged deck operation (see Technical Specifications Section 575).

11. Lifesaving Equipment Tests. The life/rescue boats and their winches and davits shall be tested for proper operation and performance. MES shall be tested per manufacturers recommendations.

12. Lighting Systems Tests. All lighting systems shall be tested for proper operation and performance.

13. Thermographic Testing. All electrical switchboards, distribution panels, and power connections (480 V and above) shall be tested by an independent tester with experience in reporting shipboard electrical thermographic results. Dockside testing shall include all systems that can be powered up safely at the pier.

14. Exterior Communication Equipment Tests. All exterior communication equipment shall be tested for proper operation and performance, including tests for radio interference.

15. Navigation Equipment Tests. All electronic navigation and sounding equipment, associated alarm systems, and the ship's whistle and foghorn shall be tested for proper operation and performance. Proper installation of the compasses and all other navigation equipment shall be verified.

16. Anchor Handling Equipment and Ground Tackle Tests. The anchor-handling equipment and ground tackle shall be tested by raising and lowering the anchors.

17. Internal Communication Systems. All internal communication systems required for vessel operations and safety shall be functionally demonstrated.

18. Shipboard Network and Communications Systems. All aspects of the shipboard network and communications systems shall be functionally demonstrated.

19. Power Quality Tests. Harmonic measurements shall be taken at each switchboard to ensure voltage distortions are less than the allowable limits.

1A.8.6 Stage 5 – Builder's Sea Trials

All installation, operation, and performance tests of the following systems shall be completed and approved by the end of Dock Trials and before Builder's Sea Trials:

1. Stern door.
2. Side door/ramps.
3. Vehicle elevator, fully functional and certified to carry passengers and freight.
4. Turntable, fully functional and certified to carry passengers and freight.
5. Hoistway hatch.
6. Hinged decks.

At the time of Builder's Sea Trials, the vessel shall be in a state of material readiness suitable to meet any possible emergency at sea, such as collision, fire, man overboard, personnel injury, or grounding. The Contractor shall provide calculations to demonstrate adequate stability of the vessel. The Contractor shall provide a written notice to the Resident Engineer that the vessel is in the aforementioned condition and deemed safe to take to sea for trials. This correspondence shall be transmitted to and received by the Resident Engineer at least two (2) days before commencing Builder's Sea Trials.

The Contractor shall obtain all USCG certificates required to conduct Builder's Sea Trials. Prior to trials, the vessel shall be equipped with all necessary safety, firefighting, and lifesaving apparatus as required by the USCG.

Temporary rigging, industrial equipment, and debris shall be removed from the vessel before Builder's Sea Trials. Sufficient tooling, parts, and expendables for normal and emergency plant operation shall be maintained onboard the vessel at the time of trials. All paint shall be dry at the time of trials. All exterior non-skid deck coatings shall be complete and dry at the time of the trials.

All draft marks and tank soundings shall be read dockside immediately prior to departing for Sea Trials and dockside immediately upon returning. The specific gravity and salinity shall be determined at the time draft marks are read, unless waived by the Resident Engineer.

Builder's Sea Trials shall be conducted at sea prior to Acceptance Trials to check the operation of the machinery installation; make any adjustments necessary to establish proper operation; check compliance with vessel, equipment, and systems performance requirements; and establish the vessel's readiness for Acceptance Trials.

Builder's Sea Trials shall be performed in accordance with these Specifications, as supplemented by requirements of the regulatory bodies and recommendations of the equipment manufacturers.

Builder's Sea Trials shall include the following trial events and related tests. Other tests and trials shall be made at the Contractor's discretion:

1. Ahead Endurance Trials. This trial shall be conducted at the maximum continuous service rating of the engines for a period of not less than 4 hours duration.
2. Astern Trial. This trial shall be conducted in accordance with the propeller manufacturer's recommendations regarding duration and maximum shaft speed.
3. Ahead and Astern Steering Test. This trial shall be conducted in accordance with the propeller manufacturer's recommendations regarding duration and maximum shaft speed.
4. Machinery Plant Control System Tests. Control system tests shall include local and remote stations and emergency controls.
5. Navigation Equipment Tests: The compasses and electronic equipment shall be adjusted and calibrated as appropriate during initial phases of the trials. The Contractor shall demonstrate the mechanical and electrical intrasystem and intersystem adjustments and alignment of the stern propulsors and vessel's navigational system elements, including sonar, radar, gyrocompass and repeaters, and other navigation equipment.
6. Thermographic Testing. Any thermographic testing that could not be done safely at full power during Dock Trials shall be completed or repeated.

- 615 7. Loss of Electrical Power Test. This test shall be conducted to demonstrate safe operation of the vessel and emergency backup systems under loss of electrical generating power.
8. Quick Reversal from Astern to Ahead Test. Two tests shall be conducted in accordance with the manufacturer's recommendation regarding duration and maximum shaft speed.
- 620 9. Quick Reversal from Ahead to Astern Test. This test shall be performed with the vessel proceeding ahead at maximum vessel speed. Stopping time and head reach shall be recorded.
10. Auxiliary System Test. Auxiliary systems and components that could not be fully tested during Dock Trials shall be tested.
- 625 11. Lifesaving Equipment Tests. The life/rescue boats and their winches and davits shall be deployed, operated, and recovered.
12. Fin Stabilizer System Tests. The fin stabilizers shall be deployed, tested for proper function, and retracted.
13. Anchor Handling System Test. Both anchors shall be deployed and recovered in shallow and deep water.

630 **1A.8.7 Stage 6 – Acceptance Trials**

Acceptance Trials shall be conducted at sea to demonstrate compliance with Specifications, Contract Drawings, and all other contractual obligations, as a prerequisite to regulatory certification and sailaway acceptance of the vessel by the Resident Engineer.

635 Acceptance Trials shall be performed in accordance with these Specifications, as supplemented by other requirements and recommendations of the regulatory bodies, in accordance with SNAME T&R Bulletin No. 3-47, and equipment manufacturers' recommendations.

Acceptance Trials shall be conducted with the vessel at the full load displacement, start of service life condition.

640 Acceptance Trials shall consist of at least the following trial events and related tests conducted in accordance with approved test memorandums:

1. Ahead Economy Trials. The economy trial shall be conducted at the 15-knot speed continuously for a period of four (4) hours. The fuel consumed during this trial shall be determined.
- 645 2. Ahead Endurance Trials. This trial shall be conducted at the maximum rating of the main engines for a period of not less than four (4) hours duration. Displacement shall be noted at the beginning and end of this trial.
- 650 3. Performance Trials. This trial shall be conducted at multiple speed build-up, recording HP load, fuel consumption, and speed achieved. Speed steps shall begin at 80 RPM and increase at 10-RPM increments to rated RPM holding at each step for twenty (20) minutes or time necessary to take stable, accurate readings. Testing shall be accomplished on reciprocal courses at each RPM.
4. Speed Trials. Speed trials shall be conducted with the vessel on reciprocal courses in accordance with SNAME T&R Bulletin No. 3-47, at loads corresponding to 80% and

- 655 100% MCR. The vessel displacement at the beginning of the speed trials shall be the full load condition plus remaining Contract modification and service life margins.
5. Astern Trial. This trial shall be conducted in accordance with the propeller manufacturer's recommendations regarding duration and maximum shaft speed.
6. Machinery Plant Control System Tests. Control system tests shall include tests from the bridge, bridge wing consoles, IMACS, and local control stations.
- 660 7. Ahead Steering Test. This trial shall be conducted in accordance with the requirements in SNAME T&R Bulletin No. 3-47.
8. Astern Steering Test. This trial shall be conducted in accordance with the propeller manufacturer's recommendations regarding duration and maximum shaft speed.
9. Turning Circle Test. This trial shall be performed both at full speed and at 15 knots.
- 665 10. "Z" Maneuver Test. Both 10°/10° and 20°/20° heading angle change tests shall be conducted at vessel speeds of 15 knots and full speed.
11. Pullout Tests. Shall be performed to port and starboard in conjunction with the Turning Circle Test.
- 670 12. Spiral Test. Either the direct or reverse spiral tests shall be performed if the Pullout Tests identify any directional instability, but only to the extent necessary to determine the spiral loop width.
13. Thruster Tests. The bow thruster tests shall include the dead-in-water test described in SNAME T&R Bulletin No. 3-47 and the following additional test:
- 675 a. Tests shall be performed to determine the lateral thrust in both directions at zero speed with each bow thruster individually and with both bow thrusters operating simultaneously.
14. Emergency and Lifesaving Equipment Survey. The vessel's emergency and lifesaving equipment shall be surveyed for proper stowage and provisioning.
- 680 15. Quick Reversal from Ahead to Astern Test. This test shall be performed with the vessel proceeding ahead at maximum vessel speed, and also with the vessel proceeding at 15 knots. Stopping time and head reach shall be recorded. Each test shall be repeated once. Displacement shall be determined and noted.
- 685 16. Quick Reversal from Astern to Ahead Test. Two tests shall be conducted in accordance with the manufacturer's recommendations regarding duration and maximum shaft speed. Displacement shall be determined and noted.
- 690 17. Slow Speed Maneuvering Tests. Tests shall be performed that demonstrate the vessel's ability to satisfy the slow speed maneuvering requirements.
18. Crabbing Maneuver Tests. Tests shall be performed to demonstrate the vessel's ability to perform crabbing maneuvers (lateral movement of the vessel with no significant fore or aft vessel motion). The maximum sideways velocity achievable using the crabbing maneuver shall be determined with both one and two bow thrusters operating and to both port and starboard. Displacement, wind speed, and relative wind direction, shall be determined and noted.
- 695 19. Standardization Trials. This test shall be performed in accordance with the requirements in SNAME T&R Bulletin No. 3-47.

20. Anchor Windlass Tests. This test shall be performed in accordance with the requirements in SNAME T&R Bulletin No. 3-47.

21. Navigation Equipment Tests. Proper calibration of the compasses and electronic equipment shall be verified by USCG and ABS prior to Builder's Sea Trials. They do not need repeating if no major changes have taken place that affect navigation equipment.

22. Power plant and switchboard tests. These tests shall demonstrate automatic power management, starting and stopping of diesel generators, paralleling of diesel generators, power limiting, and blackout recovery.

23. Miscellaneous Auxiliary Systems Tests. Auxiliary systems that are not suited for complete testing under dockside conditions, or which can more accurately be tested while underway, shall be tested during these trials. These include, but are not limited to, the following:

a. Galley equipment to be used for making and serving meals during trials.

b. HVAC systems.

c. Potable water system.

d. Trim/Ballasting system.

e. MSD and Sewage system.

f. Communication equipment.

g. Navigation equipment.

h. Lube oil systems.

i. Fuel oil systems.

j. Hydraulic oil systems.

k. Cooling water systems.

l. Boats and davits.

m. Anti-fouling system.

n. Cathodic protection.

24. Airborne Noise Survey: See Stage 7 testing below.

25. Vibration Survey: See Stage 7 testing.

The performance of auxiliary propulsion plant components shall be observed and recorded, and other special considerations applicable to the diesel generating plant shall be implemented during trials as delineated in SNAME T&R Bulletin No. 3-47.

After Acceptance Trials have been completed, the vessel shall be returned to the Contractor's facility and selected equipment, as required by the regulatory bodies and as recommended by manufacturers, shall be immediately opened for post-trial examination. These examinations

730 shall include, but not be limited to hull structural inspection (all spaces, including underwater diver inspection) and superstructure (where visible).

1A.8.8 Stage 7 – Special Tests and Reports

1A.8.8.1 Airborne Noise Survey

735 An airborne noise survey shall be performed during Acceptance Trials by the Contractor's NVCC following the general procedures of IMO Resolution A.468 (XII). The NVCC shall provide an airborne noise survey test procedure no later than sixty (60) days before the start of Acceptance Trials.

740 All compartments shall be complete. All propulsion, auxiliary, and hotel systems shall be operating. HVAC shall be balanced and operating. Measurements of overall, A-weighted SPLs relative to 20 micro-Pascals shall be made in all normally accessible compartments and machinery spaces. The survey shall be performed with propulsion operating at MCR. The measured sound levels shall be equal to or less than the limits specified in Technical Specifications Section 1E.11.2. The NVCC shall provide an airborne noise survey test report within thirty (30) days of completion of the survey. The report shall document the ship operating conditions, instrumentation, results, and corrective actions needed to achieve the stated noise limits (if necessary).

1A.8.8.2 Vibration Survey

750 An underway vibration survey shall be performed during Acceptance Trials by the Contractor's NVCC following the general procedures of ISO 6954. The NVCC shall provide a vibration survey test procedure no later than sixty (60) days before the start of Acceptance Trials.

Vibration shall be measured as required by ISO 6954 in selected passenger spaces, crew accommodations, and working areas. At least three measurements shall be made on each deck in the bow, middle, and aft areas of the ship.

755 Vibration from 1 to 100 Hz shall be measured for the hull girder, superstructure, and masts, with the vessel underway in water with a minimum depth of five times the full load draft of the vessel for comparison to fatigue limits. Measurements shall be taken at steady speed runs in 5 RPM increments from half of full power RPM to full power RPM. A steady acceleration run of 10 RPM increase over two (2) minutes shall be performed using "Peak Hold" sampling. Additional runs of several minutes each of smaller RPM increments shall be taken as required to determine any resonant conditions.

760 All vibration levels shall be equal to or less than the limits specified in Technical Specifications Section 1E.11.3. The NVCC shall provide a vibration survey test report within thirty (30) days of completion of the survey. The report shall document the ship operating conditions, instrumentation, results, and corrective actions needed to achieve the stated noise limits (if necessary).

All rotating equipment shall have baseline vibration readings taken and recorded under load.

1A.8.8.3 Emissions Testing

Opacity checks of stack emissions shall be made to confirm compliance with regulatory requirements, including 18 AAC 50.070.

770 1A.8.8.4 Vehicle Elevator and Turntable Testing

Technical Specifications Section 575 outlines the special testing requirements for the vehicle elevator and turntable system.

1A.8.9 Tests and Trials Program Planning Documentation

775 The Contractor shall prepare a comprehensive test program plan defining the approach to be used to implement the inspection, test, and evaluation requirements of all the tests and trials required in this section and throughout these Specifications.

As part of the test program plan, a test program numbering system shall be developed that is related to the test stage and the Specification section associated with the particular test. This system shall be used to assign identifying numbers to inspection, test, and trial documentation.
780 The same number shall be assigned to all documentation and data associated with a particular event.

A test program index shall be developed and maintained to provide a complete tabular listing of all inspections, tests, and trials to be conducted, including any recommended special (Stage 7) tests. The index shall list by test number and title all Contractor-conducted inspections, tests,
785 and trials. Initial test program plan and index shall be provided 60 days before the first anticipated test/inspection activity.

1A.8.9.1 Test Program Status Report

Status reports shall be furnished depicting the completion status of all required tests and trials as of the date of report. The first report shall be submitted thirty (30) days after submittal of the test
790 program plan. The report shall be updated and resubmitted to the Resident Engineer every four (4) weeks during periods of reduced activity and every week during periods of increased activity. Status will be a topic of progress meetings and management reviews.

1A.8.9.2 Inspection, Test and Trial Memorandums

795 Individual memorandums shall be written for each stage of the test program and for each equipment item, system, and construction fabrication being tested. Individual memorandums shall also be written for each trial event.

A basic test memorandum format shall be submitted for review at the same time as the test program plan. All memorandums shall have the same general format and shall include, but not be limited to, the following:

- 800
1. Identification of the equipment, system, and fabrication to be inspected and tested.
 2. Identification number as described above.
 3. References to regulatory body requirements, technical documents, and Specifications.
 4. Safety issues and plans for safe conduct of test.
 5. Quality assurance coordinator certification (written) that the equipment, system, or
805 fabrication is ready for inspections and testing.
 6. Identification of prerequisite test conditions, inspections, tests, and trial events.
 7. Statement(s) of required inspection and test conditions.

8. Explanation(s) of necessary inspection and test preparations.
9. List of all required instrumentation and equipment necessary for conducting the inspections and tests. Spaces shall be provided for recording the current calibration date of the instrumentation used.
10. System or component rating, design condition, Specifications, and other salient technical information.
11. Detailed inspection and test procedures that simultaneously address all requirements of the Resident Engineer, regulatory bodies, the Specifications, Contract Drawings, and the recommended procedures of equipment manufacturers.
12. Data forms that include appropriate figures and diagrams and spaces for recording the quantitative values determined during the conduct of the inspections and tests. Each data form shall also indicate expected performance values and tolerance limits (acceptance criteria) for each measured parameter. Expected performance values shall conform to manufacturers' recommendations, Specifications, or regulatory body requirements, whichever are more stringent.
13. Spaces for dates, weather, humidity, temperature, nameplate data, and other pertinent information, along with signatures of Contractor's test and QA personnel, the Resident Engineer's observers, and representatives of the cognizant regulatory agencies.
14. Block diagrams or simplified schematics, as applicable.
15. Comment sheets to record significant events and observations of the Resident Engineer's witness, regulatory body representatives, and Contractor's test and QA personnel during inspection and testing.
16. Appendix for the later incorporation of the manufacturer's service representative field reports.

Each test memorandum and trials agenda booklets shall be submitted to the Resident Engineer for review and approval at least thirty (60) days prior to conducting the inspections and tests. Test memorandums shall be submitted as they are completed, in lieu of bulk submittal (to allow for the Resident Engineer review).

A trials agenda shall be prepared covering all trial events and inspections to be conducted during Dock Trials, Builder's Sea Trials, and Acceptance Trials. A separately bound agenda booklet, with applicable memorandums and schedule attached, shall be provided for each of the three sets of trials.

1A.8.9.3 Test Memorandum Reports

Completed memorandums shall be submitted to the Resident Engineer. Completed memorandums shall include any marked-up pages of the test procedure, all completed data sheets, comment sheets, field reports, and all supporting data such as computer printouts, strip charts, electronic files, and photographs. All test data that are not an integral part of the test procedures shall be annotated with the test number, date, and any other pertinent information. Completed memorandums bearing the signatures of test and QA personnel, and representatives of the Resident Engineer and cognizant regulatory agencies, shall be submitted to the Resident Engineer for review within fourteen (14) days following completion of inspections and testing.

850 The Resident Engineer shall be provided with a copy of field data sheets as recorded immediately following the completion of the inspections and tests.

Following each on-site visit, the Contractor shall require field engineer(s) of all major equipment manufacturers and SSVs to submit a report to the Resident Engineer that describes the inspection and test findings. These reports shall be attached to and submitted with the test program memorandums. Manufacturer's field engineer reports shall not be considered as a substitute for memorandums.

1A.8.9.4 Conduct of Tests and Trials

Each inspection, test, and trial shall be witnessed by the Resident Engineer, except where the Resident Engineer may provide written authorization to proceed with a particular event without the Resident Engineer present.

860 A minimum of twenty-four (24) hour notice shall be provided to the Resident Engineer that a required inspection and test will take place. A minimum of 48-hour notice shall be provided to the Resident Engineer on weekends that a required inspection and test will take place. A minimum of two (2) weeks written notice shall be provided to the Resident Engineer for upcoming Dock Trials, Builder's Sea Trials, or Acceptance Trials.

865 The Resident Engineer may elect to witness shop inspections and tests at the manufacturers' facilities. The Contractor shall notify the Resident Engineer at least fourteen (14) days in advance of when a shop inspection and test is to occur. The Resident Engineer will then elect whether to attend. A minimum of two (4) week notice shall be provided for any testing to be conducted at any foreign manufacturers' facilities.

870 Coordinating witness of tests and trials by regulatory bodies shall be wholly the responsibility of the Contractor.

Field engineers of all major equipment manufacturers and SSVs shall be on site and shall be required by the Contractor to be on site during the initial checkout and testing of their supplied equipment.

875 The Resident Engineer shall have freedom of access to all test personnel and representatives of the manufacturer and regulatory bodies to discuss any aspect of the inspection, test, and problems found.

880 The signing of any memorandum data sheets by the Resident Engineer signifies only that the inspection and test were conducted in accordance with the approved memorandum, and that the Resident Engineer believes that data were accurately recorded. The Resident Engineer acceptance of the completed memorandum will be documented by separate correspondence from the Resident Engineer to the Contractor.

To minimize rescheduling of tests, equipment and systems shall be checked and pretested as necessary to ensure readiness for witnessed testing.

885 Subsistence shall be provided during Sea Trials for 25 persons serving as State representatives (the Resident Engineer and his designated observers) during Builder's Sea Trials, and for 25 persons serving as State representatives during Acceptance Trials. The State representatives

shall be assigned a secure space to store outerwear, bags, and supplies. Office space, tables, and chairs shall be supplied. If the vessel is out overnight, suitable berthing arrangements shall be made. Where transportation between the vessel and shore is required, and where transportation between points of debarkation and the shipyard is required, the Contractor shall furnish the transportation.

1A.8.9.5 Test Performance and Data Collection

All inspections, tests, and trials shall be performed in accordance with the Contractor-developed and the Resident Engineer-approved test agenda, and memorandums prepared in accordance with these Specifications.

During extended steady-state tests and trials, data shall include lubricating oil, fuel oil, cooling water, exhaust gas, combustion air pressures and temperatures, propulsion plant RPM, and other necessary data, which shall be recorded at regular intervals not exceeding 30 minutes. Data shall be recorded more frequently if required by regulation or recommended by the equipment supplier, or regulatory bodies. Data shall also be recorded more frequently, as necessary, to reveal the true operating conditions being observed or to forewarn of component or system malfunction during tests of transient performance and tests of short duration.

Actual performance values observed shall be recorded during each test event, rather than noting that performance is “satisfactory.”

A machinery log shall be maintained from the start of factory testing up to the time of vessel delivery. The log shall record the dates and times at which machinery and other equipment were operated. The log shall also include date and time entries for any transfers of oil or hydraulic fluids to and from machinery, any repair or maintenance work performed on machinery subsequent to initial start-ups, and any other information pertinent for record purposes. A separate log sheet shall be maintained of the accumulated hours on major machinery and other equipment.

1A.8.9.6 Termination of Tests and Trials

A test shall be terminated if the equipment being tested fails to meet the acceptance criteria of the test procedure. The cause of the failure shall be identified. Performance of those parts of a test that are not affected by the failure may continue, if acceptable to the Resident Engineer. After correction of the failure, the test procedure shall be rerun at the Contractor’s expense; however, if acceptable to the Resident Engineer and the regulatory agencies, those steps previously accomplished and not affected by the failure or correction need not be repeated.

If, during the course of Sea Trials, unfavorable weather conditions exist which would endanger the vessel or which would compromise or put in question the validity and accuracy of the test results, the trials shall be terminated for later rescheduling at the Contractor’s expense. The trials shall be rescheduled by the Contractor, subject to the approval of the Resident Engineer.

Trials shall be terminated and rescheduled at the Contractor’s expense in cases where the scheduled trial time is insufficient to complete the trial agenda.

Once a test has been confirmed and is subsequently canceled or deferred for any reason, the Resident Engineer shall be notified immediately.

Correction of defects or deficiencies shall be accomplished as specified in the Contract. Following the examination and correction of defects or deficiencies, the equipment shall be closed and made ready for service.

Where an inspection, test, or trial event has been completed and the results accepted by the Resident Engineer and/or regulatory bodies, and the equipment and system is subsequently modified and/or the integrity of previous testing compromised by ongoing work, the acceptance of the completed memorandum is retracted and the testing shall be repeated to the satisfaction of the regulatory bodies and the Resident Engineer.

1A.8.9.7 Reports of Dock and Sea Trials

Reports of Dock Trials, Builder's Sea Trials, and Acceptance Trials shall be submitted to the Resident Engineer for review.

The content and format of the Dock Trial report shall be similar to that provided for memorandum reports described above.

The content and format of the Sea Trial reports shall be in general accordance with 46 CFR 78.21 and IACS Recommendation 71, as supplemented and modified to accommodate the particular provisions of this vessel's test program and type of trials conducted.

A draft version of the Sea Trial report shall be provided to the Resident Engineer for comment within one (1) week following completion of the subject trials. The final reports shall be provided within two (2) weeks following receipt of the Resident Engineer comments regarding the draft reports.

The Acceptance Trials report shall include the following subsidiary reports:

1. Trials report for speed.
2. Trials report for fuel consumption.
3. Trials report for bow thruster performance.
4. Trials report for low speed and crabbing maneuvers.
5. Trials report for zigzag tests.
6. Trials report for turning circles and pullout tests.
7. Trials report for special demonstrations, tests, and/or verifications of performance criteria stated in the Specifications.
8. Trials report of information necessary for developing the Contractor-furnished, Pilothouse-mounted maneuvering poster and booklets required by the USCG.

1A.8.9.8 Sea Trials Handbooks

Prior to getting underway, a handbook shall be provided to the Resident Engineer and all regulatory body personnel to be on board during Builder's Sea Trials and Acceptance Trials, plus twenty-five (25) extra copies and one (1) electronic pdf version. The handbook shall preferably be pocket size and shall include, as a minimum, the following information:

1. Emergency procedures for collision, fire, and man overboard events, and designated emergency squads.

2. Schedule of trial events.
3. Organizational chart or list that provides names of individuals responsible for control of the vessel and conduct of each event.
4. Roster of individuals on board (riders list).
5. Plan view of deck arrangements showing locations of muster stations, lifesaving appliances, and first aid stations.

1A.9 INCLINING AND STABILITY ASSESSMENT

1A.9.1 General Scope

This section sets forth requirements for the preparation of documentation for, and the conducting of, a stability test (lightweight survey and inclining experiment) to be performed by the Contractor under the direction of the State's naval architect. This section also delineates requirements for:

1. Providing a trim and stability booklet for the vessel based on the stability test results.
2. Obtaining a stability letter from the USCG.
3. Providing copies of same to the Resident Engineer.
4. Obtaining a coastwise load line certificate in order to leave the shipyard if the USCG stability letter has not been received.

The State's naval architect is responsible for having the stability test procedure, stability test report, and trim and stability booklet examined and accepted as satisfactory by the cognizant USCG OCMI authority, in addition to obtaining required approvals from the USCG MSC, as a prerequisite to final acceptance of these documents by the Resident Engineer.

The State's naval architect and the Contractor shall plan for and complete the lightweight survey and inclining experiment in sufficient time to provide the Resident Engineer with the USCG-approved trim and stability booklet and stability letter at least seven (7) days prior to the date of vessel delivery.

The State's naval architect will have the stability test procedure, stability test report, and trim and stability booklet examined and accepted as satisfactory by the cognizant USCG OCMI office, as may be required by this authority, as well as approved by the USCG MSC, as prerequisites to final acceptance of these documents by the Resident Engineer.

1A.9.2 Stability Test (Lightweight Survey and Inclining Experiment)

After completing vessel construction, the Contractor, under the direction of the State's naval architect shall conduct a State- and USCG-witnessed stability test (lightweight survey and inclining experiment) in accordance with ASTM F1321. The lightweight survey shall be conducted in conjunction with, and as an immediate precursor to, the inclining experiment.

A stability test procedure shall be prepared by the State's naval architect and submitted for approval to the USCG MSC, the cognizant USCG OCMI office, and the Resident Engineer at least four (4) weeks prior to the test. This procedure shall conform to ASTM F1321 and these Specifications and shall contain all of the information required by 46 CFR 170.085 and 46 CFR

1005 170 Subpart F. A stamped, USCG-approved copy of the stability test procedure shall be submitted to the Resident Engineer.

The Contractor shall provide all labor and materials associated with planning and executing the stability test. The State's naval architect will be responsible for obtaining USCG and Resident Engineer approval of the results. Required labor and material includes, but is not limited to:

- 1010 1. Vessel preparation, cleaning, calibrated weight-measuring devices, line-handing services, and lift/crane services (as needed for measuring weights of items on board and moving inclining weights).
- 1015 2. To minimize the number of weight items to be added, deducted, or relocated to establish lightship condition, and to facilitate accurate lightweight and stability findings, the Contractor shall ensure that stability test preparatory provisions are made in accordance with ASTM F1321. These provisions include, but are not limited to, the following:
- 1020 1. The contracted work shall be substantially complete. Any lightweight items not otherwise already installed shall be at least located on board in their final locations.
2. Shipyard equipment and other items associated with the contracted work, but not part of the ship's lightship condition, shall be removed from the vessel to the maximum extent practicable. Those items that cannot reasonably be removed prior to the survey shall be moved to the vessel's centerline wherever practicable.
- 1025 3. The ship shall be cleared of tools, debris, staging, and other temporary material associated with the contracted work to the maximum extent practicable in accordance with ASTM F1321.
4. Machinery fluids are to be at their operating levels.
5. Ship's tankage shall be adjusted to conditions conforming to ASTM F1321.
6. Ship's voids and empty tanks (those evacuated to low suction) shall be opened and gas-freed in preparation for visual verification of "dry" status and possible stripping of residual fluid in accordance with ASTM F1321.
- 1030 The Contractor shall provide a small boat capable of carrying at least four (4) people with appropriate personal flotation devices for reading draft marks and taking freeboard measurements and shall provide labor to shift mooring lines. All work on the vessel shall be subject to the requirements of the tests; for example, all workers shall clear the vessel during the stability readings of freeboards and draft marks.
- 1035 A copy of the stability test field data, signed by the USCG and State witnesses, shall be submitted to the Resident Engineer immediately after the test by the State's naval architect. A stability test report shall be prepared and submitted for review/acceptance by the USCG and approval by the Resident Engineer within seven (7) days after the test by the State's naval architect. The submittal shall request that the calculated lightship weight and center of gravity be
- 1040 accepted as the new lightship characteristics for the vessel. The State's naval architect shall use the computer stability model provided by the Resident Engineer to calculate the lightship weight data. The stability test report, as approved, shall be provided to the Resident Engineer in an electronic format in Microsoft® Word and/or Excel for Windows files. A stamped, USCG-approved copy of the stability test report shall be submitted to the Resident Engineer.

1045 The Resident Engineer has ultimate authority to accept or reject the stability test based on
compliance or non-compliance with the established and approved procedures and other Contract
requirements, and accuracy of measurements or measuring conditions. The Resident Engineer,
or his designated representative, will be present during the stability test to observe the precision
1050 of the work, including the precision and bias of all measurements, measuring conditions, and
correlation coefficients for the plot of tangents and waterlines.

The Contractor and State's naval architect shall plan for and complete the stability test in
sufficient time to provide the Resident Engineer with the required number of copies of the
accepted trim and stability booklet (see Section 1A.9.3) and a USCG stability letter at least seven
(7) days prior to the date of operational acceptance. See Section 1A.9.3 for requirements
1055 regarding USCG examination and acceptance of the booklet.

1A.9.3 Trim and Stability Booklet and Stability Letter

The State's naval architect will provide a USCG-approved trim and stability booklet for the
vessel reflecting the "as-built" stability condition of the vessel and the USCG-approved and
Resident Engineer-approved data.

1060 The State's naval architect will also provide a final General HydroStatics (GHS) computer model
of the vessel, reflecting the vessel in completed form.

The trim and stability booklet shall meet the requirements of 46 CFR 170 Subpart D, utilizing
the State's standard format. The Contractor shall submit the final Booklet to the Resident
Engineer in an electronic format utilizing Microsoft® Word and/or Excel for Windows file.

1065 One (1) original plus six (6) copies of the USCG-examined/accepted and stamped trim and
stability booklet and stability letter shall be provided to the Resident Engineer at least seven
(7) working days prior to the date of vessel delivery. In the event that the State's naval architect
fails to obtain and provide a USCG-examined and accepted booklet and stability letter by the
specified date, the State's naval architect shall obtain stability guidance from the USCG,
1070 allowing the vessel to operate on its schedule and routing with its normal passenger, vehicle, fuel
oil, and potable water loads. It is the State's naval architect's responsibility to maintain such
stability guidance in force until the final USCG-reviewed/accepted trim and stability booklet is
provided to the Resident Engineer.

1A.10 WEIGHT CONTROL

1075 The Contractor shall prepare a weight control plan to manage the weight and center of gravity of
the vessel as the design and construction progresses. The plan shall include the following:

1. An overall description of the approach, procedures, and organizational controls to be
implemented to ensure compliance with the weight, KG, trim, and list requirements of the
Contract.
- 1080 2. A discussion of design risk with respect to the vessel's naval architectural characteristics,
including special weight control problems and the areas that will receive weight control
emphasis.
3. A discussion of the methodology to be used in adjusting margin accounts.
4. A description of the computer software that will be used in the weight control effort.

- 1085 5. A discussion of the weight determination techniques to be employed, including weighing of equipment, machinery, and modules.
6. A listing of the equipment that will be used to perform actual weight measurements including capacity, accuracy tolerance, and calibration frequency.
7. A discussion of the detail to which the vessel construction drawings will be calculated.
- 1090 8. The reporting schedule and cutoff dates for weight input.
9. The planned action for verification of mill tolerances, welding, and paint factors.
10. Description of the weight control organization, including the weight control coordinator and his/her management and technical authority relative to the overall design effort.
- 1095 11. The management actions that will be taken upon detection of weight and margin trends tending to cause contractual values to be exceeded.
12. The method and degree of weight control that will be required of subcontractors.
13. A discussion of the construction monitoring techniques that will be used to ensure that the vessel, as constructed, is accurately reflected in the weight reports and meets contractual requirements.
- 1100 14. A discussion of weight control training to be administered to personnel involved in the design and construction of the vessel.

Technical Specifications Section 1D.8 addresses related weight estimating and reporting requirements.

1A.11 MODELS AND MOCK-UPS

1105 1A.11.1 Scale Models

The Contractor shall provide two (2) 1:75 scale display models of the vessel. The models shall be detailed, including lifesaving appliances and of presentation quality. Mount models on teak or oak wood base, fitted with glass cover. Deliver models in durable, re-usable shipping crates. Models to be reviewed and approved by Resident Engineer, prior to shipping from producer's facility.

1110

1A.11.2 Mock-Ups

The Contractor shall prepare full scale mock-ups and three-dimensional computer models of the following spaces and features:

1. Pilothouse.
- 1115 2. Galley, Scullery, and Public Serving and Dining Areas. 3D model only.
3. EOS.
4. Anchor Handling and Stowage Arrangement. See Technical Specifications Section 581.2.1 for more details.

1120 The mock-ups shall represent the three-dimensional arrangement of these spaces, including the associated cabinetry, equipment, controls, and furniture. Moreover, mock-ups are intended to reveal potential interferences that may be avoided without cost to the Resident Engineer or the Contractor during detail design and engineering, and in some cases, by issuance of a change

order to resolve issues not foreseen in the Contract Drawings. As such, mockups shall show the following, in correct intended locations:

- 1125
 - 1. Fully outfitted control consoles.
 - 2. Personnel and maintenance accesses.
 - 3. Furniture.
 - 4. Bulkhead-mounted/installed electrical and mechanical systems.
 - 5. Overhead interferences from ducting, piping, and lighting.
- 1130
 - 6. Deck height and workspace heights.
 - 7. Visible cableways and cable trays (if present).
 - 8. Visible bulkhead and deck transits, and vent pipes (if present).
 - 9. Sinks.
 - 10. Electrical outlets.
- 1135
 - 11. Windows.
 - 12. Doors and sills.
 - 13. Any installation likely to impact use of the space or interfere with other specified installations.

1140 The mock-ups shall incorporate actual equipment whenever possible. If the equipment is not available at the time of construction of the mock-ups, accurate representations of the equipment shall be provided. Large items of furniture or equipment shall be modeled in cardboard, plywood, foam, or other suitable material. The mock-up of large items shall include markings for door swings and drawer pulls. Similarly, access for maintenance shall be identified by suitable means.

1145 Mock-ups shall be constructed within four (4) months of Contract NTP, shall be used for design verification and transfer review, and shall be left in place until all Production Design Drawings that impact the spaces are complete and reviewed and approved by the Resident Engineer.

1150 The anchor handling and stowage arrangement mock-up shall be a 1:7 scale mock-up of the bow, anchor, and anchor handling and stowage, fabricated to be operable to allow for verification of proper shipping and unshipping of the anchor.

1A.12 SPARES AND SPECIAL TOOLS

1A.12.1 General

The Contractor shall provide all spares required by ABS and, additionally, all other required onboard repair parts (OBRP), as specified herein.

1155 The OBRP list shall be developed from the equipment manufacturers' recommendations, based on maximum voyage duration of sixty (60) days, with the vessel operating in remote areas not easily supported from ashore. OBRP shall include filters, bulbs, and any other parts required for preventative maintenance with a frequency of semi-annual or greater (daily, weekly, monthly,

etc.), and hourly maintenance of under 2,000 hours frequency. Provide ORBP list 365 days prior to delivery for review and approval.

The Contractor shall also develop a suggested spare parts list over and above those required by ABS and OBRP. This list shall be developed from the equipment manufacturers' recommendations and contain items that are required for preventative maintenance cycles of greater than semi-annual, and greater than 2,000 hours. It shall also include items not readily stocked by the vendor, with a greater than ninety (90)-day lead-time. The list shall include prices, time intervals, and weights of the suggested parts. The Contractor shall provide the vendor-recommended spare parts list to the Resident Engineer at least 365 days prior to delivery. If parts have a lead-time exceeding 365 days, the Contractor shall provide information on these long-lead parts to the Resident Engineer sixty (60) days plus lead time prior to delivery. Any items requiring climate-controlled storage shall be identified as such. The Contractor will not be held responsible for the weight of the spare parts stored on board the vessel.

The Contractor shall provide a suggested depot spares list for all SSVs. This list shall be provided to the Resident Engineer at least thirty (30) days prior to release of manufacture for the vessel system components. The depot spares list shall be based on each SSV's recommendation for major overhaul maintenance (5 to 15 years), major casualty, and/or underwater body damage repair.

The Resident Engineer may select the desired parts from these lists (vendor-recommended spares, depot spares) for Contractor purchase by means of a delivery order. Prices for each component shall include packaging suitable for long-term inside storage. Each item and its outside packaging shall be identified by indelible marking (including barcode), consistent with the Resident Engineer's chosen MMS and to the satisfaction of the Resident Engineer.

The Contractor shall provide inside warehousing and material management for all ABS, OBRP, depot stores, and procured vendor-recommended spares identified above. In addition, the Contractor shall provide warehousing/material management for all State-furnished equipment and materials.

1A.12.2 Packaging and Preservation

Items shall be packaged in accordance with manufacturer's instructions for climate-controlled storage.

Contractor shall perform all required equipment storage maintenance and preservation activities as prescribed by the equipment manufacturers from time of receipt at the Contractor's facility up to equipment commissioning and start up. Typical preservation actions include periodic inspections, periodic parts rotations, greasing, oil aerosol coating, desiccant replacement, anti-condensate heater functioning checks, etc. Contractor shall maintain a running log of preservation activities for each piece of equipment with activity description, time interval, due dates and blank fields for Contractor to fill in actual dates activities were carried out. Log shall be kept current and provided monthly to Resident Engineer.

1A.13 RIGHT OF ACCESS

The Resident Engineer and other State personnel and their guests, Regulatory Body inspectors/surveyors, and the Resident Engineer's contracted personnel shall be granted

1200 unrestricted access to and the right to visit and inspect any area of the vessel, at any time throughout the duration of the Contract. This includes all off vessel areas where production fabrication/assembly may be taking place and equipment stored. Said personnel shall be furnished with such information and assistance by the Contractor as is required for complete and detailed inspections.

1205 As a condition of gaining access to the vessel, personnel on the vessel under the terms of this subsection will be required to have their own insurance to cover the Contractor's liability. Every effort will be made by the Resident Engineer and the Resident Engineer's contracted personnel to minimize interference with the Contractor's work.

1210 Contractor shall notify the Resident Engineer immediately if the Contractor believes that the Resident Engineer or any of his designees has interfered with the Contractor's work.

Presence of the Resident Engineer personnel, vessel crew, and/or State's contracted personnel shall not relieve the Contractor from the responsibilities of vessel inspection, supervision, and quality assurance.

1A.14 INSPECTIONS AND CERTIFICATES

1215 1A.14.1 Inspections

All work under this Contract shall be subject to the inspection and approval of the Resident Engineer, the USCG and all other applicable regulatory bodies. State and regulatory body representatives shall have free access to the vessel and the Contractor's plant at all times for the purpose of inspecting materials and work in progress.

1220 The Contractor shall pay for all regulatory fees that may arise as a result of the review or approval of the work described by this Contract.

1225 The Contractor is responsible for properly presenting all completed work for acceptance inspection and for giving adequate notice to the Resident Engineer and regulatory bodies that the work in question is complete and is ready for inspection. Acceptance by agents of the regulatory bodies is mandatory, but only preliminary. Final acceptance will be determined only by the Resident Engineer.

1230 Inspections, tests, measurements, or other acts or functions performed by the Resident Engineer are to be recognized as being for the sole purposes of assisting the Resident Engineer in determining with reasonable assurance that the rate of progress and quality of work, as well as quantities and quality of materials, comply with the Contract. Such acts or functions shall in no manner be construed to relieve the Contractor from determining to his own satisfaction that he is in full compliance with the Contract requirements at all times; nor to relieve him of responsibility for the work assigned to him by the Contract.

1235 Work and materials not meeting the Contract requirements shall be made good. Unsuitable work and materials shall be replaced, notwithstanding that such work or materials may have been previously inspected or that payment therefore may have been included in a progress estimate.

If the Resident Engineer requests it, the Contractor shall remove or uncover such portions of the completed work as may be directed. After examination, the Contractor shall restore said portions

1240 of the work to the standard required by the Contract. Should the work thus exposed or examined prove acceptable to the Resident Engineer, the uncovering or removing and the replacing of the covering or the making good of the parts removed shall be paid for by the State at actual labor rates and material cost. Should the work so exposed or examined prove unacceptable to the Resident Engineer, the uncovering or removing and replacing of the covering and the making good of parts removed shall be at the Contractor's expense.

1245 Failure of the State or Resident Engineer to discover materials not in accordance with the Contract shall not be deemed as acceptance of such work or materials, or as a waiver of the provisions of the Contract. No payment shall be construed as acceptance of the work or of material not in accordance with the Contract.

1A.14.2 Regulatory Body Approvals and Certificates

1250 All necessary certificates and/or documents covering the approval and indicating compliance as a result of the contracted work shall be obtained by the Contractor and provided to the Resident Engineer. All fees for classification, including testing and certification of materials and equipment furnished by the Contractor, shall be borne by the Contractor. Those certificates and documents that are obtained by the Contractor and are required to be mounted or framed aboard
1255 the vessel shall be provided to the Resident Engineer.

All work shown on the plans and/or in the specifications that are less than what is required by the applicable regulatory bodies shall be performed by the Contractor to the requirements of the regulatory bodies at the Contractor's expense and without schedule impact to the State.

1260 The attendance of ABS shall be requested, and fees paid by the Contractor, as required, to insure the vessel satisfies ABS requirements for the contracted work.

1A.15 CREW TRAINING

The Contractor shall develop and conduct hands-on training by factory-certified representatives for the vessel's personnel on each of the following systems/equipment for the indicated minimum hours of training:

- 1265
1. Vessel control systems and conning stations (16 hours).
 2. Main propulsion control and monitoring systems (16 hours).
 3. Main propulsion plant and steering systems (generators, drives, propulsors) (32 hours).
 4. SSDGs (16 hours).
 5. Bow thrusters (8 hours).

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 6. Fin stabilizers system (8 hours).
 7. IMACS (24 hours).
 8. Power conditioning and distribution equipment (8 hours).
 9. PMS (16 hours).
 10. Hot water heater (4 hours).

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 11. Sewage treatment system (4 hours).

12. OWS (4 hours).
13. Centrifuges/purifiers (4 hours).
14. HVAC systems (16 hours).
15. Communication/phone systems (8 hours).
- 1280 16. Lifesaving, firefighting, safety, and emergency systems and appliances (16 hours).
17. Refrigeration machinery (8 hours).
18. Anchor windlass and capstans (4 hours).
19. Vehicle elevator and turntable system (see Technical Specifications Section 575) (16 hours).
- 1285 Training on the propulsion plant and bow thruster shall be provided for six (6) of the State's personnel at the manufacturer's production facilities or other established training facility of the manufacturer that is acceptable to the Resident Engineer. The training shall cover operation, maintenance, overhaul, and troubleshooting. The training shall include hands-on training, with the actual model series supplied under the Contract, in addition to appropriate classroom
- 1290 instruction. The training shall be scheduled to be completed within at least fourteen (14) days, but no more than 120 days, prior to the scheduled date of operational acceptance of the vessel. The dates of training shall not coincide with the dates of Dock Trials or Builder's Sea Trials and shall be agreed to by the Resident Engineer. Travel and per diem costs for the Resident Engineer personnel will be borne by the Resident Engineer.
- 1295 Training for lifesaving, firefighting, safety, and emergency systems and appliances shall address the maintenance and operation of the life/rescue boats and davits, marine evacuation systems, and fixed firefighting systems, as well as operation and location of the vessel's alarms, fire dampers, fire doors, and all other vessel emergency safety features and appliances. This training shall be conducted by persons with the appropriate knowledge of the attendant systems and
- 1300 appliances, but need not include representatives from each manufacturer. This training shall be formatted to include general safety familiarization training for all of the vessel's personnel and maintenance training for eight (8) crewmembers.
- Individual training manuals shall be provided for each crew member attending the training sessions. Manuals shall meet the requirements of instruction books described in Technical
- 1305 Specifications Section 1D.

1A.16 COMPARTMENT CLOSEOUTS

- After sea trials and after all work on the vessel is substantially complete, each compartment or space in the vessel shall be inspected with the Resident Engineer present to check such things as fixtures, lighting, HVAC controls, piping/supports, cable banding/supports, labeling, coatings,
- 1310 joiner doors, outfitting, and other miscellaneous items in the compartment. Compartments include every accessible space on the vessel including main/auxiliary machinery spaces, lockers, service trunks, voids, overheads above removable ceiling panels, etc. Where practical, compartments proven to be satisfactory to the Resident Engineer, shall be "closed out" by locking or otherwise preventing general access to the space.

1315 A booklet of compartment closeout checklists shall be provided that documents the tests and inspections for each space on board. The booklet shall be submitted to the Resident Engineer for review and approval at least forty-five (45) days prior to commencing compartment closeouts. The checklist shall be periodically updated, and a status of compartment closeouts shall be submitted to the Resident Engineer every week.

1320 Completion of all compartment closeout inspections shall be a prerequisite to acceptance of the vessel by the Resident Engineer.

1A.17 MEETINGS

1A.17.1 Progress Meetings

1325 The Contractor shall conduct weekly progress meetings with the Resident Engineer. Such progress meetings shall commence upon start of construction at the Contractor's facility.

1330 The Contractor shall prepare an agenda before each progress meeting providing synoptic statements of progress made since the last meeting, current and pending activities, current and potential problem areas that could affect project cost or scheduling, and inspections planned for the following week. Each week's agenda shall address safety and include review of the status of the:

1. Schedule of Deliverables (Technical Specifications Section 1D.11).
2. Project Schedule (Technical Specification Section 1D.3).
3. Drawing Schedule (Technical Specifications Section 1D.4).
4. Material Control Schedule (Technical Specification Section 1D.5).
- 1335 5. Compartment Close-Outs (Section 1A.16) during last thirty (30) days of the Contract.
6. Other germane topics shall be added to the agenda as required e.g. design/construction/contract issues, requests for information, material substitution requests, change proposals/orders status, etc.

1340 A copy of the agenda shall be provided to the Resident Engineer not less than 24 hours prior to each scheduled meeting date.

**SECTION 1B
DELIVERY AND ADDITIONAL CONTRACTOR COSTS**

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SECTION 1B DELIVERY AND ADDITIONAL CONTRACTOR COSTS

1B.1 INTENT

This section describes the requirements for vessel delivery to the State and additional contractor costs.

10 1B.2 DELIVERY

The Contractor shall complete the contracted work and deliver the vessel to the Delivery Port in accordance with the General Conditions and within the allotted Contract time.

The Contractor shall provide and arrange for all other delivery services needed to deliver the vessel to the Delivery Port from the Contractor's facility. This includes but is not limited to required crewing, pilotage, tugs, transit fees, longshoring, and oil-spill contingent fees.

15 1B.3 BONDING AND INSURANCE

The Contractor shall include the costs of bonding and insurance as required by the Contract.

SECTION 1D
PLANNING, SCHEDULING, AND TECHNICAL DOCUMENTATION

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SECTION 1D DESIGN REQUIREMENTS

1D.1 INTENT

10 This section sets forth requirements for planning and scheduling functions, engineering services, Working Drawing preparation, and technical documentation preparation to be performed by the Contractor.

1D.2 GENERAL

15 The Contractor shall advise the Resident Engineer, on a daily basis, as to the progress of the work. The Resident Engineer shall also be kept advised as to the status of regulatory approvals by receiving copies of all correspondence to and from the regulatory bodies, either upon or within two (2) working days of the Contractor's or subcontractor's issuance or receipt of any such correspondence.

20 Working Drawings, drawing schedules, and material orders are to be prepared by the Contractor and submitted to the Resident Engineer for review, comment, and approval. In addition, all Working Drawings required by the regulatory bodies shall be submitted by the Contractor to the regulatory bodies for approval. Final Working Drawings, drawings for mounting on board the vessel, drawings for filing on board the vessel, drawings for the Resident Engineer's office use, and instruction books shall be furnished by the Contractor as specified herein.

25 All submittals to the resident Engineer, Owner, System Integrators, Design Agent, or other entity designated by the Resident Engineer shall be submitted through Submittal Exchange and in accordance with the Agreed Communication Plan. Access codes and log-ins to Submittal Exchange shall be provided by the Resident Engineer.

1D.3 PROJECT SCHEDULE

30 The Project Schedule developed during Preconstruction Phase and approved by the Department at the time of final GMP Negotiations shall be the Project Schedule at the outset of the Construction Phase.

1D.3.1 Schedule Requirements

The schedule shall meet all requirements of Section 3.6 of the General Provisions.

1D.3.2 Schedule Updates

35 The CPM schedule shall be updated monthly once the work commences. The updated CPM schedule shall include the dates when activities were actually started and when they were completed, the physical percentage of work complete, and the estimated remaining duration for each activity in progress.

The electronic files provided by the Contractor shall be capable of generating the following reports:

- 40 1. Sorted by Total Float.

2. Sorted by Craft Code, secondarily by Early Start.
3. Sorted by Cost Code, secondarily by Early Start.
4. Sorted by Early Start.
5. Sorted by Late Start.

45 The initial and each updated CPM schedule shall also be provided to the Resident Engineer electronically. The data provided shall be a complete copy of all information contained in the basic schedule database.

Updating the CPM schedule to reflect actual progress made shall not be considered a revision to the CPM schedule.

50 **1D.3.3 Schedule Revisions**

If, as a result of the monthly schedule update, the CPM schedule no longer represents the planned prosecution or progress of the remaining work, the Resident Engineer may request, and the Contractor shall submit, a revision to the CPM schedule.

55 The Contractor may also request revisions to the CPM schedule in the event the Contractor's planning for the remaining work is revised.

1D.3.4 Time Impact Analysis

When Contract modifications are initiated by either the Resident Engineer or the Contractor, a change to the CPM schedule may be experienced. If the change indicates that a revision of the CPM schedule and related resources are needed, the Contractor shall submit to the
60 Resident Engineer, in both written and electronic format, a time impact analysis (TIA) illustrating the influence of each Contract modification on any of the interim completion dates and the Contract completion date.

The Resident Engineer may elect to perform an independent TIA of any change. If the Resident Engineer performs such an analysis, the results will be provided to the Contractor. The TIA shall
65 include a fragmentary network (FRAGNET), demonstrating the time and resource impact to each and every affected activity in the CPM schedule, utilizing the most recent update as the basis for measuring the change. The activity durations used in the TIA shall also be those included in the latest update unless adjusted by mutual agreement. Activity delays shall not automatically mean that an extension of the Contract completion date is warranted or due the Contractor. A Contract
70 modification or delay may not affect existing critical activities or cause non-critical activities to become critical.

Extensions of time to interim completion dates or to the overall Contract completion date under the Contract will be granted only to the extent that:

- 75 A. Equitable time adjustments to the activity or activities affected by the Contract modification or delay exceeds the total float of the affected activity or subsequent paths and extends any interim completion date or the overall Contract completion date, and
- B. The Resident Engineer agrees to a time extension in lieu of directing an acceleration of the work effort under the Contract.

Each TIA shall be submitted to the Resident Engineer within ten (10) calendar days after notice of direction for a Contract modification is given to the Contractor, or the Contractor provides notice of an impact to the Resident Engineer.

Approval or rejection in writing by the Resident Engineer of each TIA will be made within ten (10) calendar days after receipt. Upon approval of the Contractor's TIA, and if so warranted under the terms of the Contract, a Contract modification will be issued incorporating the TIA and any warranted extension to interim completion dates or to the overall Contract completion date. Subsequent weekly schedule updates shall then reflect the agreed-upon changes to the CPM schedule (and related resources) as well as the approved time extension.

1D.4 DRAWING SCHEDULE

Within thirty (30) days after NTP, the Contractor shall submit a drawing schedule for Resident Engineer review and approval. The drawing schedule shall list all proposed Working Drawings required to accomplish the work, including all arrangement, installation, detail, and other drawings as detailed in Technical Specifications Section 1D.6. The drawing schedule shall include those to be prepared by vendors and subcontractors in addition to those prepared by the Contractor directly.

The drawing schedule shall contain the following for each drawing listed:

1. Contractor's drawing number.
2. AMHS drawing number.
3. Drawing title including the Resident Engineer's project number.
4. Scheduled date on which each drawing will be submitted for approval.
5. Columns for recording the following:
6. Actual date(s) of the initial (and subsequent) submittal(s).
7. Date(s) of approval of each drawing.
8. Status of the Resident Engineer's response.
9. Identification of the latest revision (by number or letter) of each drawing.
10. Identify which drawings are required to be submitted to Class an each regulatory agency for approval, review and/or information and include:
11. Actual dates of such approvals
12. Serial numbers of the approval letters .

The drawing schedule shall be revised to show all changes and progress/delays, and submitted to the Resident Engineer **monthly**. A "final as-built" drawing schedule shall be submitted **fifteen (15) days** prior to delivery of the vessel.

The drawing schedule shall be an item of discussion at the progress meetings required by Technical Specifications Section 1A.17.

The drawing schedule shall be updated continuously to incorporate each and every submittal of the same item. The Contractor shall supply the drawing schedule in paper and electronic

formats. The electronic format shall be readable on the Contractor-provided project office computers by Microsoft® Excel.

1D.5 MATERIAL CONTROL SCHEDULE

Within thirty (30) days after NTP, the Contractor shall submit a material control schedule listing the material and equipment to be purchased by the Contractor for incorporation into the contracted work, exclusive of items classified as “stockroom” materials. The schedule format shall provide at least the following information:

1. Pertinent Specifications section.
2. Equipment name, model number, and technical description of material/equipment.
3. Name of vendors/manufacturers.
4. Commitment dates.
5. Purchase order numbers.
6. Purchase order issues and releases for manufacture.
7. Required and estimated/actual delivery dates of materials/equipment for the vessel.
8. Buy America applicability and status.

The material control schedule will include, as a minimum, all items requiring USCG/ABS certification and/or a ‘Buy America’ certificate. A template for the material control schedule is attached as Appendix B [pending].

The schedule shall be revised to show all changes and progress, and paper and electronic copies shall be submitted monthly in time to be received by the Resident Engineer no later than the first of each month until all listed items have been received by the Contractor.

The material control schedule shall be an item of discussion at the weekly progress meetings (discussed in Technical Specifications Section 1A.17).

1D.6 ENGINEERING SERVICES AND WORKING DRAWINGS

The Contractor shall be responsible for and shall provide all production level engineering services necessary for the work and delivery of the vessel in accordance with the requirements of the Contract Documents. Engineering services include technical calculations including, but not limited to:

1. Structural engineering of the hull and superstructures, as well as, calculations for temporary shoring (if necessary) and machinery foundations.
 - a. Full lofting and structural detailing
 - b. Foundation design, including natural frequency calculation.
 - c. Structural detail development, including penetration details
 - d. Welding detail development
2. Launching calculations.
3. Vehicle elevator and turntable system design.
4. Passenger/service elevator(s) design.

5. Passenger boarding ladder design.
6. Hinged mast design.
- 155 7. Mechanical engineering to size equipment, piping/ventilation components (flow, pressures, friction losses, etc.) including torsional analysis of mechanically driven machinery.
8. Joinery, outfitting, and insulation installation detail development.
9. Electrical engineering to perform the following:
 - 160 a. Circuit breaker coordination.
 - b. Short circuit and voltage drop analysis for the vessel's electrical system.
 - c. Harmonic power analysis.
 - d. Propulsion system dynamic analysis
 - e. Interior Communication systems development.

165 Engineering services shall also include surveys, material selection, preparation of diagrams, sketches, schedules, data, and preparation of all Working Drawings, and "as-built" plans.

All aspects of the contracted work shall be shown with detailed Working Drawings. All Working Drawings, including 3D models, developed by the Contractor for construction of the vessel, including any revisions thereto, shall be submitted to the Resident Engineer for review.
170 All work undertaken in advance of this review shall be at the Contractor's risk. The Contractor shall develop 2D Working Drawings from a 3D model showing the fit, installation and maintenance accesses of specific equipment, pipe, duct, cable, and associated systems.

In addition to all drawings needed for ABS and USCG approval, the Contractor shall produce Working Drawings showing the following information:

- 175 1. Arrangement details of all public, crew and service spaces. Vehicle Deck arrangements showing the vehicle layout, loading and parking details, as well as space marking and color scheme diagrams.
2. Docking plan, showing location of all seachests, transducers, thrusters, and overboard discharges, docking plugs, anodes, and hull attachments, with at three docking block configurations. The docking positions shall ensure 100% coverage of the bottom paint.
- 180 3. Tank capacity and sounding tables including all tanks and equipment sumps (note: tank tables shall reflect the actual arrangement of sounding tubes).
4. Equipment Arrangements of all machinery spaces.
5. Equipment Arrangements and systems diagrams for the vehicle elevator and turntable, passenger/service elevators, side/stern doors, boarding ladders, and fin stabilizers.
- 185 6. Electrical block diagrams, wiring diagrams, control schematics, wire ways diagrams, machinery alarm and control diagrams including alarm and indication points lists as well as screen displays.
7. Operational piping and instrumentation diagrams for all pipe and system drawings.
- 190 Drawings shall include a callout for the system volume that is not covered by the tank capacity table listed above.

8. Standalone consolidated valve list reflecting the valve labeling to be used on all drawings.
9. Consolidated motor list including bearing application.
- 195 10. Consolidated pump list including bearing and mechanical seals application.
11. Consolidated set point list for instrumentation and control including all vendor supplied equipment.
12. Consolidated regulatory hull valve list including valve specifications.
13. Launching plan
- 200 14. Lifesaving equipment plan.
15. Fire plan.

The Contractor shall also develop and submit all other Working Drawings, studies, and calculations as required throughout the Technical Specifications and Appendices and as required by ABS and USCG, as a minimum. See Technical Specifications Sections 100 through 600 of these Specifications for specific additional requirements pertaining to Working Drawing content.

Additional Working Drawings shall be developed by the Contractor as necessary to perform the work described by the Contract Documents. An electronic copy of all Contract Drawings will be provided to the Contractor after Contract Award.

Working Drawings shall be complete in all arrangements and details (including equipment locations, guards, routing of piping/tubing/ductwork/electrical cabling). Working Drawings shall serve to gain regulatory approval and facilitate future use by the Owner for maintenance, modification, and repair activity when updated to final as-built versions.

Working Drawings shall be complete in every respect and sufficient in detailed information to describe the fabrication, purchase and installation of equipment and components, and the structural and system represented.

The Contractor shall submit to the Resident Engineer for approval **within thirty (30) days of NTP** a full sample Working Drawing format for each drawing size to be used, showing a typical Sheet 1 and Sheet 2, including title block, reference, general notes, and revision table format. The standard drawing size is 11" x 17". Booklets of details and calculations may be on sheets that are 11" x 17" or 8½" x 11".

NOTE: The Resident Engineer will not accept resubmittal of a Resident Engineer-furnished sketch or a Contract Drawing as constituting a Working Drawing. Working Drawings are required to contain complete construction detail and arrangement information.

Working Drawings shall be produced using computer-aided design (CAD). Upon final submittal, the Contractor shall provide to the Resident Engineer the data files in AutoCAD 2019 or translated to AutoCAD 2019. An index of drawing number/drawing name/electronic file number shall be provided as a file in the package. See Section 1D.7 for more requirements on final as-built drawings.

230 The Resident Engineer will review the Contractor's Working Drawings to determine compliance
with the Contract. The Resident Engineer's review does not relieve the Contractor of
responsibility for adherence to the Technical Specifications and Appendices unless it has, in
writing, called attention to deviations from same at the time of Working Drawing submittal.
Approval of a Working Drawing does not constitute approval of a deviation, mistake, or
235 omission, nor does it alleviate the Contractor's responsibility to address any and all regulatory
comments. The Resident Engineer's approval of a deviation does not relieve the Contractor of
the responsibility for satisfactory operation of the system or equipment. Work performed by the
Contractor prior to the Resident Engineer's review and approval of the Contractor's Working
Drawings will be at the Contractor's risk and expense.

240 For Working Drawings with multiple decks involved, the deck being shown on a particular sheet
shall be so labeled near the bottom right-hand corner of the sheet.

Symbols on Working Drawings shall conform to recognized marine commercial standards.

Complete bills of materials shall be shown on Working Drawings, shall include item numbers,
quantities required, and shall be identified by material specification/model number, ASTM,
245 ANSI, NEMA, and other standards as appropriate.

All Working Drawings shall be initialed in the title block by the drafter and the engineer
responsible for the design, prior to submittal to the Resident Engineer. The Working Drawings
and, where applicable, calculations shall identify, by name or initials, the engineer and
supervising engineer checking the drawing. A registered professional engineer, who shall be
250 responsible for the design, shall stamp all calculations. The professional engineer shall be
licensed for the discipline in which they are performing.

For those Working Drawings and calculations developed by subcontractors/vendors not under
the direct supervision of the professional engineer, the professional engineer shall review such
Working Drawings and calculations and submit a supplemental report. The report shall identify
255 the Working Drawing or calculation and state that it has been reviewed and approved for this
installation by the professional engineer.

Each Working Drawing and calculation shall be checked and completed before submitting to the
Resident Engineer. Working Drawings and calculations without appropriate signatures and
Working Drawings that are not complete will not be reviewed by the Resident Engineer and will
260 be returned to the Contractor for completion. Returned Working Drawing submittals do not
count towards fulfilling the Contractor's obligations with regard for scheduling. Returned
Working Drawings must be resubmitted, complete, within the scheduled time.

The Contractor shall submit Working Drawings and engineering calculations to the Resident
Engineer in a timely fashion according to the approved project schedule and drawing schedule.
265 The Working Drawings and engineering calculations shall be submitted by the Contractor
sufficiently in advance of their need to permit detailed review by the Resident Engineer and
other reviewing agencies, taking into account the possibility of rejections, revisions, and re-
submittals. The Resident Engineer will not review these Working Drawings without supporting
calculations. The Resident Engineer will mark submittals "approved," "conditionally approved
270 subject to comments," or "returned for revision and re-submittal."

Engineering calculations and Working Drawings submitted to the Resident Engineer for approval will normally be acted upon within ten (10) Business days of receipt provided that submittals are made as available and not delivered in large batches. Delays to work by reason of lack of approvals of engineering calculations and Working Drawings are considered a risk to the Contractor and shall not constitute the basis of a claim for additional compensation and/or an extension of Contract time.

Two (2) 11" x 17" size and one (1) electronic copy of each Working Drawing and four (4) copies of each document/report shall be submitted to the Resident Engineer for review and approval.

Contract Drawings and Contract Technical Specifications shall not be referenced on the Contractor's developed Working Drawings.

All Working Drawing revisions shall be identified on the drawings. The title block of each Working Drawing shall note the drawing revision. Each time a Working Drawing is issued, it will have a unique sequential revision number or letter. Preliminary versions of the Working Drawings shall be sequentially numbered prior to Resident Engineer approval or conditional approval. The first approved version of the drawing shall be annotated Rev. '-'. Once the Resident Engineer has approved or conditionally approved the Working Drawing, all previous revision information shall be removed, and the Working Drawing shall be sequentially lettered starting with Rev. 'A', then 'B', 'C', etc., for each subsequent issue of the drawing.

The Resident Engineer shall provide a AMHS drawing number for each working drawing which shall be included as part of the project title in the Working Drawing's title block. Each Working Drawing shall have a unique drawing number.

All Working Drawings and documents are to be submitted to the USCG and ABS as required for regulatory approval. The Contractor shall be responsible for all regulatory fees. At the Contractor's option, he may submit those Working Drawings requiring USCG approval to ABS for review under the provisions of NVIC 10-82.

The Contractor shall not submit Working Drawings and documents under the provisions of NVIC 1092.

All Working Drawings produced for this Contract shall be in accordance with standard marine industry practices for installation drawings. Working Drawing sheets or portions of sheets showing arrangements or details shall be drawn to scale; include piece marks on all components; and include a complete material list, described below, fully describing each component.

Material lists shall include ASTM, ANSI, or equivalent material specifications and shall include the original manufacturers' names and the replacement part numbers of all items in addition to the vendors' part numbers. Where trade association designations are commonly used, such as Anti Friction Bearing Manufacturers Association (AFBMA) for bearings, such designations shall be used.

Working Drawing sheets or portions of drawing sheets showing electrical or piping in diagrammatic/schematic form shall be functionally representative of the system and shall include, at a minimum, the following:

1. Material schedule including ANSI and ASTM Standards.

2. Symbol list.
3. Equipment and instrumentation tables.
4. Pipe sizes, direction of flow, and hydraulic calculations nodes.
5. Piping component types (e.g., valves, strainer, reducing valves, etc.) and diagrammatic locations.
6. Instrumentation, diagrammatic locations and set points.
7. Relief valve set points.
8. System operation temperatures and pressures.
9. System test pressures.

Working Drawing sheets including electrical diagrams or schematics shall show all cable types and designations and all conductor designations. Cable and conductor designations shall correspond to the cable and conductor labels as installed on the vessel.

The Contractor shall place on board the vessel prior to delivery, half size drawings for use by the crew. These shall include Working Drawings as listed on the Working Drawing schedule in their latest revision at time of delivery. In addition, the following items shall be supplied to the vessel:

1. Stability Test Report in accordance with Technical Specifications Section 1A.9.
2. New USCG Stability Letter in accordance with Technical Specifications Section 1A.9.
3. Two (2) copies of all machinery test documents, both shop and trials tests, with performance data recorded.

1D.7 FINAL AS-BUILT DRAWINGS

The Contractor shall update all Working Drawings and stamp or otherwise clearly mark "FINAL AS-BUILT" in the title block with all alterations accurately reflecting systems (including installed lengths of cabling, piping, ductwork, etc.) and arrangements of the vessel as finally completed and accepted.

Within thirty (30) days after acceptance of the vessel, the Contractor shall, in addition to the number of Working Drawings and CAD files required elsewhere, deliver two (2) 11" x 17" prints (folded with the title block facing out) of each "final as-built" drawing to the Resident Engineer.

The list of "final as-built" drawings, previously referenced, shall include all Working Drawings produced and used by the Contractor to construct the vessel, and must bear USCG and ABS approval notations where required. Where the "final as-built" drawing is a later revision than the stamped drawing, the drawing revision of the stamped version shall be noted.

1D.8 WEIGHT ESTIMATING

1D.8.1 Weight Estimates

The weight estimate developed during the Preconstruction Phase and approved by the Department at the time of final GMP Negotiations shall be the Accepted Weight Estimate.

Working versions of the weight estimate shall be provided to the State's naval architect and Resident Engineer on a monthly basis throughout construction. The Contractor and the Resident Engineer shall agree on a final weight of the vessel to be delivered in accordance with these Specifications and related design parameters specified in Technical Specifications Sections 0 and 1E.7.

The weight estimate shall include all details of development and include any calculations that are required to confirm the values. Detailed design and construction margins shall be indicated. Regardless of the work breakdown structure used in scheduling and measuring the progress required in the contract, the weight estimate shall be reported in accordance with SWBS format and with subtotals in keeping with the Specifications sections.

The Contractor shall be responsible for obtaining the weight and center of gravity characteristics of all line items shown in the Accepted Weight Estimate to complete the vessel. Departures from the construction contemplated in the approved estimate, when initiated by either the Contractor or the Resident Engineer, which affect the light ship weight and centers of gravity, shall not be undertaken until the Contractor has submitted to the Resident Engineer their estimate of the effect of the departure on the weight values, and obtained written approval to proceed with the departure. The effective weight change shall be assigned to the responsible party, the Resident Engineer or Contractor, depending on whom is responsible for the increase or decrease with the change applied to the respective party's weight growth margin.

Throughout the development of Working Drawings and as material is procured or received, the weight estimate shall be updated and submitted at monthly intervals. The weights and centers of gravity of all items that are part of the vessel shall be determined and reflected in the weight estimate. These weights may be obtained by a combination of estimation or calculation from vessel Working Drawings and by weighing items.

Material and components shall be weighed to establish the accuracy of calculated weights and to provide unit weights for items such as insulation, steel, sheathing, and piping. Where factors or percentages are utilized, such as for calculation of paint and welding weights, the Contractor shall be prepared to substantiate values by realistic background information if requested.

Where development has occurred to components, systems, or a portion of the structure, and reliable information or completed vessel construction drawings are not available for the specific area of development, a re-estimate shall be made to obtain the most accurate available weight.

In order to comply with these Specifications, the Contractor shall prepare weight estimate related information as part of their procurement documents. Vendors shall be required to submit information on the current weight and location of the center of gravity of all major assemblies, equipment, fittings, or components to be installed on the vessel. The weights of the materials shall be confirmed by the Contractor by weighing the material when it arrives at their facility.

A margin shall be applied in each submittal of the weight estimates. This margin on weight and moment is to account for design changes to the current weight due to vessel Working Drawing development, growth of Contractor-furnished material, differing shipbuilding practices, omissions and errors in the vessel Working Drawing, unknown mill tolerances, outfitting details, variations between the actual vessel and its curves of form, and similar differences.

A final stability test shall be conducted by the State's naval architect as described in Section 1A.9. Scheduling of this effort shall be coordinated to occur after Substantial Completion and no later than 14 days prior to Builder's Sea Trials.

The weight of the vessel, as determined by the inclining test and properly adjusted for items to complete or remove, and as approved by the regulatory bodies, shall be the as-inclined lightship weight of the vessel. This lightship weight shall be compared to the lightship weight in the approved and accepted weight estimate.

1D.8.2 Quarterly Weight Report (QWR)

A detailed QWR in the 3-digit SWBS format shall be prepared by the Contractor and submitted to the State's naval architect and Resident Engineer, to document the current mass properties of the design and construction effort. The weight and moment data for all components and material of the finished vessel and their overall effect on the vessel's displacement, centers of gravity, list, and trim shall be included in the QWR. Weight and moment effects of weight reservations for equipment to be installed by the Resident Engineer after delivery shall be included in lightship. As vessel design or Working Drawings are prepared, and as material and equipment is selected, acquired, and received, the weight and centers of gravity for all items that comprise the vessel shall be determined and reported in the weight estimates. The weight estimate shall reflect the lightship that is projected for delivery, including the current mass properties values loads and margins.

The vessel's displacement, KG, list, and trim shall be compared to the design values. Report details shall indicate whether the information shown is estimated, calculated, or actually weighed. Weight estimates shall include summary sheets for lightship and all prescribed loading conditions with KG, metacentric height (uncorrected and corrected for the free surface effect of liquids in tanks), hydrostatic characteristics, list, trim, and drafts above the bottom of the keel at the perpendiculars and midship. The weight estimate shall include a notation explaining the cause of each significant change in weight or moment of an element in the estimate. The weight estimate shall include a summary sheet of the weight and KG impacts of Contract changes. Weight and KG margins for design and building shall be included. Weight estimates shall also include vehicle loads, passenger loads, and other required loads.

1D.8.3 Accepted Vessel Weight Report

An accepted vessel weight report shall be prepared by the Contractor to reflect the final status of the vessel design and construction effort that resulted in a delivered product, which will be based on the final stability test conducted by the State's naval architect. The lightship weight and KG shall be adjusted to correlate with the final stability test data. A design and building margin will be adjusted to account for irreconcilable differences between the final weight estimate and the final stability test. All required loads identified in Technical Specifications Section 1E.4 shall be added to lightship weight to verify that the vessel weight and KG comply with Contract requirements. Naval architectural not-to-exceed values, as delineated in Technical Specifications Section 1E.4, shall be included to verify that service life allowance requirements are met.

1D.9 PURCHASE TECHNICAL SPECIFICATIONS, REQUISITIONS AND PURCHASE ORDERS

430 The Contractor shall develop and submit for approval, purchase technical specifications for the following items:

1. Propulsion diesel generator sets.
2. Propulsion switchboard and phase transformers
3. Bow thruster drive motors
- 435 4. Propulsion azimuthing electric propulsors and attached propellers
5. Ship service diesel generators and switchgear
6. Emergency diesel generator and switchgear
7. Vehicle elevator and turntable systems and related closures
8. Passenger and service elevator machinery systems
- 440 9. Passenger boarding ladder systems
10. Life/rescue boat and davit system
11. Service boat and davit system
12. Marine evacuation system
13. Fin stabilizer system
- 445 14. Bow thrusters
15. Oil-fired hot water heater
16. Stern Door
17. Electro-hydraulic sliding watertight doors
18. HVAC air handlers
- 450 19. Marine sanitation device
20. Anchor windlass

The Contractor also shall submit, for approval, purchase specifications of any item for which the Contractor is requesting a substitution of material or equipment from that specified by the State or otherwise previously proposed by the Contractor and approved by the Resident Engineer.

455 These purchase specifications shall clearly define the salient characteristics of the items to be purchased for comparison to the State-specified item.

Each purchase specification shall contain a full technical description of the material to be ordered. The manufacturer's brochure or cut-sheet also shall be attached listing all characteristic and optional items for the product specified. Upon placement of all purchase orders, unpriced
460 copies shall be submitted to the Resident Engineer for information.

Three (3) prints and one (1) electronic version of all vendor drawings or literature shall be delivered to the Resident Engineer within two (2) weeks of receipt.

Correspondence and technical data affecting design features of vendor items shall be promptly provided to the Resident Engineer.

465 **1D.10 INSTRUCTION BOOKS, EQUIPMENT IDENTIFICATION LIST AND
 SPARE PARTS INVENTORY**

1D.10.1 Instruction Books

470 The Contractor shall prepare or obtain, collate and bind instruction books for all machinery, equipment, and systems provided by the Contractor, whether manufactured by the Contractor or not. The instruction books shall be clearly written in the English language with dimensions and tolerances displayed in the U.S. Customary System of Measurement. Text and tables displaying metric dimensions will be acceptable, provided that conversion to the U.S. Customary System is immediately obvious without reference to a conversion table.

475 Three hard copies on the collated instruction book and 1 electronic version shall be delivered to the vessel not later than the delivery date of the vessel.

The instruction books provided shall contain, as a minimum:

1. Complete theory of operation, as well as complete operating, installation, maintenance, troubleshooting and repair instructions (including parts lists). This shall be provided in sufficient detail for operating personnel to operate, maintain, and repair the equipment.
- 480 2. Maintenance instructions listed in a tabular form that includes a recommended periodicity for accomplishment of the maintenance item. The parts lists shall be complete with the parts described so that required repair parts may be easily identified and ordered. If a parts list has parts described for more than one piece, model or type of equipment, the Contractor shall ensure that the parts required for the piece, model or type being
485 furnished are clearly identified by an asterisk or some other method.
- 490 3. Assembly plans, sections, schematics, wiring diagrams and line art as is necessary to properly identify the various parts of the assembly, and careful documentation of periodic maintenance requirements. The parts lists shall be keyed to the plans and line art to provide identification of the various parts. Diagrammatics shall contain complete
information such as pump and fan characteristics, pipe or duct sizes, materials, flows, velocities (normal and maximum), pressure drops and other pertinent design data such as associated components, identification, and operation characteristics, including all control and alarm settings. Items that are merely advertisements for other or related equipment shall be omitted.
- 495 4. A list of manufacturer's recommended spare parts and special tools. The list shall include the unit price of each spare part and the manufacturer's part number and shall include diagrams or drawings as necessary.
- 500 5. Photographs to amplify the text, where required to ensure clear understanding of procedures to be used.
6. Information at least equivalent to that available to mechanics at an authorized overhaul facility of the manufacturer of the machinery or equipment covered. It is the intent of the State to totally maintain equipment provided under the Specifications, and sufficient information to do so is required. Omission of information due to reasons such as "not normally furnished" or "factory only" will not be acceptable.

505 7. Signed and completed test memorandums, as specified, for the applicable equipment and/or systems.

8. All equipment certifications: USCG, ABS, UL, FM, etc.

Additional requirements are contained in the Specifications for the particular system, equipment, or part. Instruction booklets shall not include information that is not pertinent to this vessel.

510 Samples of acceptable manuals are available from the Resident Engineer.

The Contractor shall not use OEM manuals intended for final delivery to the Resident Engineer as working manuals for use in installing and operating/testing the equipment. If the Contractor requires this information, then additional manuals/information must be ordered for that purpose with the attendant cost borne by the Contractor. Instruction manuals and books clearly showing misuse will not be accepted by the Resident Engineer.

1D.10.1.2 Engineers' Operating Manual

520 An Engineer's Operating Manual shall be provided, giving complete instructions regarding the operation of the integrated propulsion and electrical plant, and the related control systems and equipment. The manual shall be prepared in such a manner that it may be readily understood by operating personnel of limited experience and brief training, previously unfamiliar with the equipment and functions of the installation. This manual shall supplement instruction books on the individual pieces of equipment by relating the integration of the individual components. Duplication of material contained in the manufacturers' instruction books is not intended.

The following shall be included in the description of each system:

- 525 1. Index.
2. List of pertinent references such as installation drawings and manufacturers' OEM manuals.
3. General description of the system, and detailed descriptions and directions for operation, with reference to diagrams and schematics.
- 530 4. Warnings as to possible hazardous modes of operation and precautions required to minimize equipment damage and possible crew injury. These warnings shall be included in the text by means of either a different typeface, underscore, or an alternate print color.
5. For each piping and ventilation system, a straight-line diagrammatic representation of the system, with each component identified.
- 535 6. For each piping system, the design functions and limitations of the system shall be discussed and detailed directions for operation of the system provided.

A tabulation of all machinery components shall be included, giving design functions and limitations, information for understanding and operating the piping system, expected operation conditions, etc.

540 The book shall be prepared in preliminary form and be submitted for approval sufficiently in advance of ship completion to permit completion and delivery of the finished books to the vessel not later than the delivery date of the vessel. Three hard copies and 1 electronic version shall be delivered. Forty-five (45) days shall be allowed for State review of the manual.

1D.10.2 Equipment Identification List

545 The Contractor shall provide an Equipment Identification List, in booklet form, giving nameplate data, including serial number, of each piece of machinery and equipment on the ship.

1D.10.3 Spare Parts Inventory

550 The Contractor shall furnish three (3) sets of a completed Spare Parts Inventory list for the Resident Engineer and the Contractor to record the physical inventory of items to be taken at the time of the delivery inspection of the vessel. The inventory shall be recorded in one set, which shall become the original inventory. The other two sets shall be confirmed copies of the original set. The original and one set shall be signed by both the Resident Engineer and the Contractor, with the Resident Engineer receiving the original. The unsigned set shall be furnished to the vessel. The Spare Parts Inventory list shall also be provided to the Resident Engineer
555 electronically in Microsoft® Excel format.

1D.11 SUBMITTAL SCHEDULE

560 **Within thirty (30) days after Contract Award**, the Contractor shall submit a Submittal Schedule for Resident Engineer review and approval. A draft Submittal Schedule is attached as Appendix C . This draft Submittal Schedule is not all-inclusive and is meant to serve as a sample for the Contractor. The items on the draft Submittal Schedule shall be verified and expanded by the Contractor to include all deliverables.

The Submittal Schedule shall be updated continuously to incorporate each and every submittal of the same item, and all changes and progress/delays. Submittal Schedule revisions shall be submitted to the Resident Engineer prior to progress meetings in accordance with Section 1A.17.
565 A final Submittal Schedule shall be submitted fifteen (15) days prior to delivery of the vessel.

Appendix A Working Drawing Schedule

Appendix B Material Control Schedule Template

Appendix C Submittal Schedule

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SECTION 1E DESIGN REQUIREMENTS

1E.1 INTENT

This section prescribes general requirements applicable to the ship's final design and associated construction by the Contractor.

10 1E.2 UNITS OF MEASURE

All work shall be performed and presented using U.S. Customary System of Measurement (feet, pounds force, seconds), excepting where other units are expressly permitted or required for specific elements of the work.

15 1E.3 REGULATORY REQUIREMENTS AND INVOKED RULES AND STANDARDS

All work performed on the vessel shall be in compliance with the requirements of the various regulatory body rules and standards in force at the time of Contract signing, insofar as they may have jurisdiction or application. The following government and non-government documents and standards are referenced throughout these Technical Specifications. The following list is not intended to be an exhaustive list, additional government and non-government documents and standards may be referenced in these Technical Specifications. All documents and standard used shall be the latest version applicable.

ABS – American Bureau of Shipping

- ABS Rules for Building and Classing Marine Vessels (Marine Vessel Rules).
- ABS Guide for Construction of Shipboard Elevators.
- ABS Guide for Crew Habitability on Ships.
- ABS Guide for Nondestructive Inspection of Hull Welds.
- ABS Guidance Notes on Control of Harmonics in Electrical Power Systems.
- ABS Shipbuilding and Repair Quality Standard for Hull Structures During Construction.

30 AISC – American Institute of Steel Construction

- AISC Steel Construction Manual.

AISI – American Iron and Steel Institute

Alaska and Other Local Regulations

- Alaska State Regulations.
- Applicable State and Local Jurisdictional Regulations.

ANSI – American National Standards Institutes

- ANSI ASC A14.3, American National Standard for Ladders - Fixed - Safety Requirement.

- ANSI/ASME B4.1, Preferred Limits and Fits for Cylindrical Parts.
- 40 • ANSI/ASME B16.3, Malleable Iron Threaded Fittings.
- ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings.
- ANSI/ASME B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
- ANSI/ASME B16.11, Forged Steel Fittings, Socket-Welding and Threaded.
- ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- 45 • ANSI/ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings.
- ANSI/ASME B16.28, Wrought Steel Butt-Welding Short Radius Elbows and Returns.
- ANSI/ASME B16.34, Valves – Flanged, Threaded, and Welding End.
- ANSI/ASME B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
- 50 • ANSI/ASME B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
- ANSI/ASTM B163.11, Standard Specification for Seamless Nickel and Nickel Alloy Condenser and Heat-Exchanger Tubes.
- ANSI B36.10, Welded and Seamless Wrought Steel Pipe.
- 55 • ANSI B36.19, Stainless Steel Pipe.
- ANSI/IEEE C57.12.01, IEEE Standard for General Requirements for Dry-Type Distribution and Power Transformers.
- ANSI/ISEA Z358.1, Emergency Eyewash and Shower Equipment.
- ANSI/MSS SP-67, Butterfly Valves.
- 60 • ANSI/MSS SP-80, Bronze Gate, Globe, Angle, and Check Valves.
- ANSI/MSS SP-83, Class 3000 and 6000 Pipe Unions, Socket Welding and Threaded (Carbon Steel, Alloy Steel, Stainless Steels, and Nickel Alloys).
- ANSI/MSS SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- 65 • ANSI/NAAMM FP1001-07, Guide Specifications for Design of Metal Flagpoles.
- ANSI/NSF 14, Plastic Piping System Components and Related Materials.
- ANSI/NSF 61, Drinking Water System Components – Health Effects.

ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers

- ASHRAE Handbook, HVAC Applications Chapter: Noise and Vibration Control.

70 ASME – American Society of Mechanical Engineers

- ASME A17.1/CSA B44, Safety Code for Elevators and Escalators.
- ASME A17.2, Guide for Inspection of Elevators, Escalators, and Moving Walks.

- ASME A17.5/CSA B44.1, Elevator and Escalator Electrical Equipment.
- ASME A17.7/CSA B44.7, Performance-Based Safety Code for Elevators and Escalators.
- 75 • ASME B31.1, Power Piping.
- ASME SB62, Composition Bronze or Ounce Metal Castings.

ASNT – American Society for Nondestructive Testing

- ASNT SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.

ASTM – American Society for Testing and Materials

- 80 • ASTM A36, Standard Specification for Carbon Structural Steel.
- ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- ASTM A105, Standard Specification for Carbon Steel Forgings for Piping Applications.
- 85 • ASTM A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
- ASTM A182, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
- ASTM A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
- 90 • ASTM A194, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- ASTM A213, Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes.
- 95 • ASTM A216, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
- ASTM A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- ASTM A249, Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes.
- 100 • ASTM A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- ASTM A276, Standard Specification for Stainless Steel Bars and Shapes.
- ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
- 105 • ASTM A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- ASTM A320, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.

- 110
 - ASTM A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - ASTM A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 - ASTM A403, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- 115
 - ASTM A449, Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
 - ASTM A479, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
- 120
 - ASTM A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - ASTM A563, Standard Specification for Carbons and Alloy Steel Nuts.
 - ASTM A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
- 125
 - ASTM A743, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
 - ASTM A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - ASTM B75, Standard Specification for Seamless Copper Tube
- 130
 - ASTM B88, Standard Specification for Seamless Copper Water Tube.
 - ASTM B466, Standard Specification for Seamless Copper-Nickel Pipe and Tube.
 - ASTM B621, Standard Specification for Steam or Valve Bronze Castings.
 - ASTM C501, Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser.
- 135
 - ASTM D178, Standard Specification for Rubber Insulating Matting.
 - ASTM D975, Standard Specification for Diesel Fuel Oils.
 - ASTM D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- 140
 - ASTM D2047, Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces Measured by the James Machine.
 - ASTM E390, Standard Reference Radiographs for Steel Fusion Welds.
 - ASTM F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- 145
 - ASTM F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

- ASTM F441, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
- ASTM F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- 150 • ASTM F594, Standard Specification for Stainless Steel Nuts.
- ASTM F682, Standard Specification for Wrought Carbon Steel Sleeve-Type Pipe Couplings.
- ASTM F683, Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery.
- 155 • ASTM F707, Standard Specification for Modular Gauge Boards.
- ASTM F708, Standard Practice for Design and Installation of Rigid Pipe Hangers
- ASTM F721, Standard Specification for Gage Piping Assemblies.
- ASTM F722, Standard Specification for Welded Joints for Shipboard Piping Systems.
- ASTM F783, Standard Specification for Staple, Handgrab, Handle, and Stirrup Rung.
- 160 • ASTM F821, Standard Specification for Domestic Use Doors and Frames, Steel, Interior, Marine.
- ASTM F986, Standard Specification for Suction Strainer Boxes.
- ASTM F992, Standard Specification for Valve Label Plates.
- ASTM F993, Standard Specification for Valve Locking Devices.
- 165 • ASTM F994, Standard Specification for Design and Installation of Overboard Discharge Hull Penetration Connections.
- ASTM F998, Standard Specification for Centrifugal Pump, Shipboard Use.
- ASTM F1066, Standard Specification for Vinyl Composition Floor Tile.
- ASTM F1121, Standard Specification for International Shore Connections for Marine Fire Applications.
- 170 • ASTM F1123, Standard Specification for Non-Metallic Expansion Joints.
- ASTM F1138, Standard Specification for Spray Shields for Mechanical Joints.
- ASTM F1155, Standard Practice for Selection and Application of Piping System Materials.
- 175 • ASTM F1166, Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities.
- ASTM F1198, Standard Guide for Shipboard Fire Detection Systems.
- ASTM F1321, Standard Guide for Conducting a Stability Test (Lightweight Survey and Inclining Experiment) to Determine the Light Ship Displacement and Centers of Gravity of a Vessel.
- 180 • ASTM F1386, Standard Guide for Construction of Sounding Tube and Striker Plate for Tank Sounding.

- ASTM F1510, Standard Specification for Rotary Positive Displacement Pumps, Ships Use.

185 • ASTM F1511, Standard Specification for Mechanical Seals for Shipboard Pump Applications.

- ASTM F1718, Standard Specification for Rotary Positive Displacement Distillate Fuel Pumps.

AWS – American Welding Society

190 • AWS D1.1, Structural Welding Code – Steel.

- AWS QC1, Standard for AWS Certification of Welding Inspectors.

EPA – Environmental Protection Agency

- EPA, Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (VGP).

195 **FCC – Federal Communications Commission**

Hydraulic Institute

- Standards of the Hydraulic Institute, Design Practices for Marine Application.

IACS – International Association of Classification Societies

- IACS Recommendation 71, Guide for the Development of Shipboard Technical Manuals.

200 **IEC – International Electrotechnical Commission**

- IEC 60034, Rotating Electrical Machinery.
- IEC 60092, Electrical Installations in Ships.
- IEC 60146, Semiconductor Converters.
- IEC 60529, Degrees of Protection Provided by Enclosures (IP Code).

205 • IEC 61800, Adjustable Speed Electrical Power Drive Systems.

IEEE – Institute of Electrical and Electronics Engineers

- IEEE 45, Recommended Practice for Electrical Installations on Shipboard.
- IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems.

210 • IEEE 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.

- IEEE 515, Standard for Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Industrial Applications.

215 • IEEE 518, Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources.

- IEEE 841, Standard for petroleum and Chemical Industry – Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cade Induction Motors – Up to and Including 370 kw (500 hp).
- IEEE C95.1, Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
- IEEE C95.2, Standard for Radio-Frequency Energy and Current-Flow Symbols.

IESNA – Illuminating Engineers Society of North America

- IESNA RP-12, Recommended Practice for Marine Lighting.

IMO – International Maritime Organization

- IMO MSC.1/Circ 1331, Guidelines for Construction, Installation, Maintenance and Inspection/Survey of Means of Embarkation and Disembarkation.
- IMO MSC.1/Circ. 1387, Revised Guidelines for the Approval of Fixed Water-Based Local Application Fire-Fighting System for Use in Category A Machinery Spaces (MSC/Circ.913)
- IMO Resolution A.468(XII), Code on Noise Levels on Board Ships.
- IMO Resolution A.658(16), Use and Fitting of Retro-Reflective Material on Life-Saving Appliances.
- IMO Resolution A.752(18), Guidelines for the Evaluation, Testing and Application of Low-Location Lighting on Passenger Ships.
- IMO Resolution A.861(20), Performance Standards for Shipborne Voyage Data Recorders (VDRs).
- International Regulations for Preventing Collisions at Sea 1972 (Colregs).
- MARPOL, International Convention for the Prevention of Pollution from Ships
 - Annex V 73-78.
 - Annex VI 73/78.
- SOLAS, International Convention for the Safety of Life at Sea.

International Rules of the Road

ISO – International Standards Organization

- ISO 484-2, Ship screw propellers – Manufacturing tolerances – Part 2: Propellers of diameter between 0,80 and 2,50 m inclusive.
- ISO 3046-1, Reciprocating internal combustion engines – Performance – Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods – Additional requirements for engines for general use.
- ISO 5488, Ships and marine technology – Accommodation ladders.
- ISO 6954, Mechanical vibration – Guidelines for the measurement, reporting and evaluation of vibration with regard to habitability on passenger and merchant ships.

- ISO 7364, Ships and marine technology – Deck machinery – Accommodation ladder winches.

- ISO 8217, Petroleum products – Fuels (class F) – Specifications of marine fuels.

- 255 • ISO 13795, Ships and marine technology – Ship’s mooring and towing fittings – Welded steel bollards for sea-going vessels.

MARAD – Maritime Administration

Military Standards

- MIL-A-18001K, Anodes, Sacrificial Zinc Alloy
- 260 • MIL-DTL-24643C, General Specification for Cables, Electric, Low Smoke Halogen-Free, For Shipboard Use.
- MIL-F-1183J, General Specification for Fitting, Pipe, Cast Bronze, Silver Brazing.
- MIL-PRF-85045G, General Specification for Cables, Fiber Optic.
- 265 • MIL-STD-1310H, Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility, Electromagnetic Pulse (EMP) Mitigation, and Safety.

NEC – National Electric Code

NEMA – National Electrical Manufacturers Association

- NEMA MG-1, Motors and Generators.

NFPA – National Fire Protection Association

- 270 • NFPA 70, National Electrical Code.

OSHA – Occupational Safety and Health Administration

- OSHA Law & Regulations.

PVA - Passenger Vessel Association

- PVA Accessibility Guidelines

- 275 **Regulations on Navigation in Panama Canal Waters.**

SAE – Society of Automotive Engineers

- SAE J514, Hydraulic Tube Fittings.
- SAE J1942, Hose and Hose Assemblies for Marine Applications.

SMACNA - Sheet Metal and Air Conditioning National Association

- 280 **SNAME – Society of Naval Architects and Marine Engineers**

- SNAME T&R Bulletin No. 2-29A, Measurement and Evaluation of Structural and Machinery Vibration in Ships
- SNAME T&R Bulletin No. 3-37, Design Guide for Shipboard Airborne Noise Control.

- 285 • SNAME T&R Bulletin No. 3-39, Guide for Shop and Installation Tests, Panel M-19 Ship Trials.
- SNAME T&R Bulletin No. 3-47, Guide for Sea Trials (Progressive Speed, Maneuvering, and Endurance).
- SNAME T&R Bulletin No. 4-16, Recommended Practices for Ship Heating, Ventilation & Air Conditioning Design Calculations.
- 290 • SNAME T&R Code C-5, Acceptable Vibration of Marine Steam and Heavy-Duty Gas-Turbine Main and Auxiliary Machinery Plants, Panel M-20.

SSPC – Society for Protective Coatings

- SSPC VIS-1-89, Visual Standard for Abrasive Blast Cleaning.
- SSPC SP-6, Commercial Blast Cleaning.
- 295 • SSPC SP-7, Brush-off Blast Cleaning.
- SSPC SP-15, Commercial Grade Power Tool Cleaning.

UL – Underwriters Laboratories, Inc.

- UL 67, Standard for Panelboards (with Marine Supplement).
- 300 • UL 489, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures (with Marine Supplement).
- UL 506, Standard for Specialty Transformers.
- UL 508, Standard for Industrial Control Equipment (with Marine Supplement).
- UL 508A, Standard for Industrial Control Panels.
- UL 508C, Standard for Power Conversion Equipment.
- 305 • UL 746B, Standard for Polymeric Materials – Long Term Property Evaluations.
- UL 1008, Transfer Switch Equipment.
- UL 1598A, Standard for Supplemental Requirements for Luminaires for Installation on Marine Vessels.

United States Department of Labor

- 310 • Standard No. 1918, *Safety and Health Regulations for Longshoring*.

USAB – United States Access Board

- USAB Passenger Vessels Accessibility Guidelines.

USCG – United State Coast Guard

- Code of Federal Regulations (CFR)
 - 315 ○ Specifically, the following standards are highlighted in these Specifications due to their applicability:
 - CFR Title 46, Subchapter H.

▪ CFR Title 33.

- USCG Navigation Rules (72 Colregs, COMDTINST M16672.2D).
- NVIC 10-82, Acceptance of Plan Review and Inspection Tasks Performed by the American Bureau of Shipping (ABS) for New Construction or Major Modification of U.S. Flag Vessels.
- NVIC 1-89, Underwater Survey Guidance.
- NVIC, 2-89, Guide for Electrical Installations on Merchant Vessels and Mobile Offshore Drilling Units.
- NVIC 10-92, Coast Guard Recognition of Registered Professional Engineer Certificate of Compliance with Coast Guard Requirements.
- NVIC 9-97, Guide to Structural Fire Protection.
- United States Net and Gross Tonnage Admeasurement.

USPHS – United States Public Health Service

- USPHS/Maritime Administration Joint Publication No. PB 61010, Ratproofing of Ships. (to entitle the vessel to receive both a “Deratization Exemption Certificate” and a “Certificate of Sanitary Construction”).

WHO – World Health Organization

- WHO Guide to Ship Sanitation.
- WHO Guidelines for Drinking-water Quality.

1E.4 INTACT STABILITY

The vessel shall have sufficient intact stability to comply with applicable regulations of the USCG and ABS in all operating conditions and at all vessel life stages from delivery to end of service life. Using the Contractor provided weight estimates, the State’s naval architect will prepare and submit the intact stability calculations to the regulatory bodies for approval.

The stability assessment required by Technical Specification Section 1A.9 shall address the following loading conditions:

1. Full load condition with full fuel tanks, full freshwater tanks, and full consumables.
2. Mid-voyage condition, with 50% fuel, 50% freshwater, and 50% consumables.
3. Arrival condition with 10% fuel, 10% freshwater, and 10% consumables.

Conditions shall be considered with and without service life margin and with and without vehicle load. Service life margins are 5% of loaded weight (261 LT) and 2.5% VCG (0.72'). Vehicle load is 437 LT at a VCG of 32.06'. Load conditions shall include the conditions required by the International Code on Intact Stability (ISC), 2008 (2009 Edition). Fixed loads and locations used in the analysis for the full load conditions shall include the following in Table 1E-1. Partial loads cases shall be adjusted as needed.

Table 1E - 1 Fixed loads used in full load condition

Load	Weight (LT)	LCG (ft aft Frame 0)	TCG (ft stbd)	VCG (ft ABL)
Icing	38.40	140.10	0.00	56.28
Crew & Effects	6.90	119.20	-12.66	45.43
Passengers & Effects	26.23	145.90	-1.64	62.24
Stores & Provisions	25.76	226.76	-2.33	19.00
Vehicles	486.61	150.41	-0.25	30.84
Outfit	4.82	125.07	0.70	44.50
Service Life Margin	271.10	156.06	0	46.83

The ship's intact stability and characteristics of the associated load conditions shall conform to the requirements of the International Code on Intact Stability, 2008 (2009 Edition). Intact loading conditions shall be established with the assumption of ice accretion at the half accretion rate described in Part B, Chapter 6, Paragraph 6.3.1 of the Code.

Intact stability criteria shall include:

1. ISC Energy criteria.
2. ISC Severe wind and rolling criteria.
3. ISC Passenger heeling criteria.
4. ISC Passenger turning criteria.

Trim in the full load condition shall not exceed 12" by the stern. A maximum static trim of 6" by the bow is required. List in the full load condition shall not exceed 0.1° to port or starboard.

Permanent ballast shall not be used.

Variable water ballast in trim and peak tanks may be used to meet heel and trim requirements. Water ballast shall be a constant total load of freshwater transferred between tanks as needed. The total freshwater ballast need not include any emergency SW ballast required for severe icing conditions.

1E.5 DAMAGE STABILITY

Damage stability shall comply with SOLAS II-1, Parts B1 through B4. Using the Contractor provided weight estimates, the State's naval architect will prepare and submit the damage stability calculations to the regulatory bodies for approval. The standard methodology defined for passenger vessels shall be followed with additional conditions examined where the vehicle load is held at maximum while fuel and stores are reduced. In addition to the SOLAS defined damage conditions, conditions with 10% fuel and a full vehicle load shall be examined to the same criteria.

The SOLAS required damage stability index, N, shall be calculated with the formula used for ro-ro vessels on short international voyages and be no more than the total people on board.

1E.6 TONNAGE ADMEASUREMENT

Tonnage admeasurement, both registered gross and registered net, shall be established and assigned in accordance with United States Standard (46 CFR 69 Subpart C), International Convention (46 CFR 69 Subpart B), and Panama Canal tonnage measurement systems.

385 Tonnage admeasurement services shall be obtained by the Contractor from ABS, with approval and assignment of tonnage and receipt of tonnage certificates obtained from USCG.

Panama Canal tonnage measurement shall conform to the current Panama Canal Authority Admeasurement Regulations.

1E.7 DRAFT, LIST, AND TRIM

390 Maximum full load draft, including service life margin, shall be 16'-6" at zero trim and zero list.

The vessel shall be capable of ballasting to zero list in all realistic loading conditions, i.e., vehicles shall be parked as symmetrically as possible.

The vessel shall operate with close to even trim. No more than 12" aft, 0.2°, and no more than 0.1° forward trim. Trim ballast shall be employed to achieve allowable trims.

395 1E.8 ARRANGEMENTS, ACCESS, HEADROOM AND ERGONOMICS

1E.8.1 General Vertical and Horizontal Clearance Requirements

Unless otherwise specified, the minimum headroom in all spaces, except the Vehicle Space, shall be 6'-9". The Resident Engineer may approve deviations from this requirement on a case-by-case basis where this minimum headroom requirement is demonstrably impractical.

400 1E.8.2 General Vessel Access, Arrangement and Maintenance Requirements

405 All spaces aboard the vessel shall be provided with practical and convenient access, with passenger areas additionally configured to comply with ADA accessibility guidelines applicable to passenger vessels. In the latter regard, the vessel will be expected to comply with Chapters VI through X of the Passenger Vessel Association's proposed Accessibility Guidelines, which form a part of this contract (Chapters VI through X apply to ferries permitted to carry more than 99 passengers). **Production outfitting plans shall be submitted which show and demonstrate such compliance.**

410 Arrangements for examination, for access and cleaning, and for painting shall be provided for all compartments and all pockets in the vessel by means of permanent ladders, doors, manholes, scuttles, bolted plates, etc.

415 Restriction of access openings by pipes, valves, or other fittings shall be avoided. Locations where this is not possible shall be brought to the attention of the Resident Engineer. Such locations shall be provided with sufficient isolation fittings and take down joints to facilitate access. Ladders shall be located in line with the openings. Handrails and grabs to ensure safe access shall be provided and installed.

Adequate drainage shall be provided in all places where water or oil would tend to accumulate.

Piping and wiring shall be arranged for ease of access and maintenance in runways and tunnels as possible.

420 Access routes shall be kept clear of items that restrict passage or are a source of danger to passengers or crew.

Clear headroom in living, walking, and working areas shall be a minimum of 6'-9". Headroom in doors and arches shall be at least 6'-8".

425 Doors shall have a clear width in accordance with Technical Specification Section 624. Clear openings of doorways with swinging doors shall be the least width measured between the face of the door and the stop, with the door open 90°, or between doorstops. Sill heights for doors forming the watertight boundary of the superstructure shall be minimized to the greatest extent possible and in no case be greater than 15".

1E.8.3 Additional Requirements Applicable to Machinery Spaces and Casing

1E.8.3.1 Walkways and Free Passage

430 Fore-and-aft and athwartship walkways shall be provided on both levels in the machinery rooms and in all other spaces containing machinery and other equipment. These walkways shall be of sufficient extent and arranged to support the following functions:

1. Passage between spaces.
2. Machinery and equipment in-place maintenance and repair.
- 435 3. Visual safety inspections of piping, machinery, and other equipment, such as those performed during engineering rounds.
4. The movement of machinery via shipping routes and through the maintenance access openings between the Forward Machinery Space, Aft Machinery Space, and the Engineer's Workshop.

440 Primary walkways shall provide a clear path no less than 3' wide by 6'-4" high throughout their length. The width shall be increased where necessary to properly service items adjacent to the walkway. Primary walkways shall be provided as follows:

1. As the principal routes between spaces and to all doors and ladderways.
2. Around the following items:
 - 445 a. Propulsion diesel generator sets.
 - b. Auxiliary diesel generator sets.
 - c. Hot water heater.
3. Along at least one side of all principal equipment, including but not limited to, the following items:
 - 450 a. Fin stabilizers.
 - b. Diesel and lubricating oil centrifuges/filters.
 - c. Air compressors and receivers.

- d. MSD equipment.
- e. OWS.
- 455 f. Air conditioning and refrigeration units.
- g. All pump/motor sets.

Secondary walkways are considered to be any walkways that are not considered primary walkways defined above, such as “dead end” walkways terminating at bulkheads, side shell, or other obstruction. To the extent practicable, secondary walkways shall be of the same clear path dimensions as primary walkways, but may have reduced clear width and height where necessary to accommodate pipe runs and other interferences as approved by the Resident Engineer.

Fittings, piping, machinery/equipment components, and/or structure shall not be installed in such a manner as to hinder the free passage of, or cause injury to, an upright individual walking along normal ship’s routes in machinery spaces and within the casing.

465 1E.8.3.2 Maintenance and Inspection Access

Equipment and machinery shall be arranged and installed to facilitate access for use, maintenance, adjustment, or repair without disturbance of structure and other installed machinery or equipment. Typically, access shall be by means of permanent ladders, doors, manholes, scuttles and/or bolted plates.

470 Access to equipment shall permit ease of maintenance and operation, and shall permit the movement and positioning of the portable tools, test, and support equipment required to perform the maintenance and operational tasks. Permanent fittings and structure shall be kept clear of routes required for the removal of machinery, whenever possible.

Battens, gratings, and protective casings around pipes shall be made readily removable.

475 Access to sensing and control devices, filters, and similar components in fan rooms shall be given particular attention, due to the generally congested nature of these spaces. Access shall account for the need for periodic replacement of ventilation system components within fan rooms (in particular, filters) and inspection and cleaning of associated ductwork via access openings in the ductwork.

480 All access closures shall be provided with proper gaskets, cover plates, fasteners, hinges, hasps, and locks, as appropriate.

Restriction of access openings by pipes and valves or other items will not be acceptable. All trunks, casings, and enclosures shall be large enough to facilitate servicing of piping manifolds and similar appurtenances.

485 No construction shall preclude access for examination and/or maintenance of any compartment.

Special care shall be exercised in the location of access holes to double bottoms, machinery or equipment foundations, and other places difficult to reach.

Controls and valves shall not be located in areas rendered inaccessible by the positioning of other fittings.

490 BERPs or WERPs shall be provided for removal of large equipment and components where the
size of the item or component to be shipped or unshipped exceeds door or hatch sizes. Removal
of the BERPs or WERPs shall not require the removal of other fixed vessel structure. Ancillary
systems shall be kept clear of BERP or WERP openings. The selection of a BERP or WERP
495 shall be based on the regularity of need for equipment removal. Where equipment can be
expected to require removal every eight (8) years or less, a BERP shall be used for removal. For
longer periods, a WERP is acceptable. As a minimum, BERPs shall be provided in the Main
Deck above the Aft Machinery Space and Forward Machinery Space for removal of large
machinery and as listed in Technical Specifications Section 167.

500 Monorails, padeyes, and lifting fittings shall be provided and attached to adequate structure, to
permit equipment and machinery removals and installations. See Technical Specifications
Section 573.2.

Washers, dryers, and other domestic equipment shall be capable of being removed from the
vessel without dismantling the equipment, joiner work, or doorways.

1E.8.4 Machinery and Equipment Shipping Routes

505 The Contractor shall develop and provide a machinery removal drawing. Drawing shall show
designated routes and all required WERPs, BERPs, trolleys, ramps, and pad eyes. Equipment
removal shall utilize necessary lifting appliances described in Technical Specifications Section
573.2 as necessary.

510 Permanent fittings shall be installed in a manner that does not restrict routes for removal of
machinery and equipment.

Shipping routes shall be provided for removing various machinery and equipment items installed
throughout the vessel.

Special attention shall be paid to providing the most economical and efficient means possible for
future removal of the propulsion engine exhaust silencers through the casing side or stack top.

515 Care shall be taken to avoid obstructions to the removal and shipping of machinery and
equipment. In no case shall cableways or other substantial obstructions be located in way of
intended shipping routes. Where piping, ductwork, or other interferences cannot practicably be
routed in a manner that avoids interference, suitable takedown joints or similar features shall be
incorporated to make the interference readily removable.

520 Service routes shall be provided to move machinery components between the Aft Machinery
Space, Forward Machinery Space, and the Engineer's Workshop. These routes shall be served
by primary walkways and the bulkhead access openings.

1E.8.5 Additional Requirements Applicable to Vehicle Space

525 The Contractor is cautioned to ensure that required overhead and side clearances in the Vehicle
Space are achieved throughout the space. In this regard, the Vehicle Space height shall allow a
14'-6" high vehicle to pass over the tie-downs and the turntable without hitting overhead
structure (i.e., the bottom of the overhead beams or other interferences) when maneuvering in the
four center lanes and the routes to the side and stern doors. Allowance shall be made for the

530 additional height of vehicle tie downs and any additional height clearance required to couple/uncouple tractors and trailers. The Vehicle Space height beneath the Mezzanine Deck shall allow a 7'-6" high vehicle to pass over the tie-downs without hitting overhead structure.

Clear width for the vehicle lanes shall be 9'-6" each with an additional 3'-0" clear ADA lane/fire lane against the starboard casing, for a total of 50'-6" curb to curb.

535 Special care and attention shall be paid to the dimensioning and positioning of ventilation ducting and fans; wireways; sprinkler, draining, and other pipe runs; lighting fixtures; and other items installed in the Vehicle Space to avoid reducing the available clearance to less than that which is required. Equipment and materials shall not protrude inside the web frames, either vertically or horizontally.

540 Exceptions to the clearance requirements will be considered only on a case-by-case basis and must be approved in writing by the Resident Engineer. General and blanket approval to deviations from the clearance requirements will not be granted.

1E.8.6 Additional Requirements Applicable to the Casing

545 Ladders and platforms shall be provided within the casing, allowing suitable access for purposes of maintenance and inspection to the silencers, piping systems and other items installed in the casing.

1E.9 MATERIALS AND EQUIPMENT

1E.9.1 General - All Material and Equipment

550 See Section 5.9 of the General Conditions for "Buy America" requirements and other material certification requirements. The Contractor shall be responsible for enforcing these requirements on vendors and subcontractors.

All items requiring "Buy America," USCG and/or ABS approval shall have a material affidavit/certificate provided to the Resident Engineer prior to installation of the item.

555 All materials, machinery, and equipment provided by the Contractor shall be of commercial marine quality, in full compliance with the specifications and suitable for the intended use. Unless explicitly stated otherwise, all materials, machinery, and equipment shall be new and unused (except for factory testing), of current manufacture and currently supported by spare parts readily available in the United States. Where required by the specifications to conform to certain standards and requirements (such as those of the MARAD, USCG, ABS, SOLAS, ASTM, AISI or ANSI, etc.), such requirements shall be clearly indicated on purchase orders.

560 Contractor is responsible for complying with the governing "Buy America" requirements when providing equipment and materials under this Contract. If the State intends to seek a waiver from the Act's requirements, the Contractor shall prepare the request for a waiver to be submitted by the State. The Contractor shall be responsible for ensuring that its subcontractors comply with the requirements of the Act.

565 Gaskets, packing and seals shall be renewed on all machinery, equipment, flanged piping joints and manholes opened or dismantled by the Contractor during the course of the contracted work, at no additional expense to the State.

Steel plates, shape bars, castings, and forgings used throughout the vessel's structure shall meet the requirements of ABS for this class of vessel. Plates intended for flanging shall be cold
570 flanging quality. All materials used in the modifications to the vessel, including any material specified hereafter, shall be subject to the test and inspection requirements of ABS.

No progress payment on a pay item will be made until all steel certificates and USCG/ABS approval documents have been received by the Resident Engineer for the work for which payment is being requested.

575 Unless otherwise specified, all machinery, structure and outfit shall be designed to withstand the resultant forces of, and properly operate under, the following environmental conditions:

1. Permanent list of 15°.
2. Permanent trim of 5° (by bow/stern).
3. Roll of 30° (each side) with total rolling period of 13 seconds from horizontal.
- 580 4. Pitch of 10° (bow up/bow down) with total pitching period of 9 seconds.
5. Ambient air temperature between -20°F through +85°F.
6. Seawater temperature between +28°F through +85°F.

Note: Athwartships and fore/aft inclinations occur simultaneously.

All materials shall be free from imperfections of manufacture and from defects that adversely
585 affect appearance and/or serviceability. All sharp edges or projections that constitute, in the opinion of the Resident Engineer, a personnel hazard, shall be removed at no additional expense to the State. Ferrous materials required to be galvanized shall be galvanized, after fabrication of assemblies, by the hot dip process with a minimum of 98% pure zinc. Electrogalvanizing will not be accepted. Damaged galvanizing at joints between fabricated assemblies shall be repaired
590 in accordance with ASTM A780. In instances where some types of materials cannot be hot-dip galvanized, zinc silicate coating may be substituted, with prior approval of the Resident Engineer.

Materials referred to herein or on the Contract Drawings as "stainless steel" or "CRES" shall be Type 316 stainless steel of the appropriate ASTM specification for the intended service (e.g.,
595 Grade L for welded assemblies), except as may be required or allowed otherwise expressly by the Specifications. Type 304 will be allowed in place of Type 316 for use in Galley and for other interior applications where the material will not be subjected to routine or continuous contact with seawater.

600 All pressure grease fittings shall be of Monel. All fittings will be made accessible with either elbow bodies or extensions and shall be suitable for use with high-pressure grease guns.

All bolt heads and nuts shall be of hexagonal standard type in accordance with ANSI standards unless otherwise specified. Where required by the regulatory bodies, they are to be Heavy Series in accordance with ANSI-B18.2.1, Table 3. Lock washers and nuts shall be provided wherever

assemblies or items are bolted to the vessel's structure, except where the specifications or manufacturer requires other locking arrangements.

Nuts, bolts, fasteners, and fittings intended to be used in exterior or vehicle space locations shall be Type 316 stainless steel, unless otherwise approved by the Resident Engineer.

The Contractor shall be responsible for the protection, during the work and up through delivery of the vessel, of all material and equipment intended for use and installed aboard the vessel. Due consideration shall be given to the nature of the item during handling and storage.

The Contractor shall protect all items with finished surfaces from damage during work. Although not all-inclusive as to surfaces requiring protection, the protective methods of Table 1E - 2 shall be followed where applicable, except where alternative protective measures may be proposed by the Contractor and approved by the Resident Engineer. Protective measures for items not addressed in Table 1E - 2 shall be established by the Contractor and shall generally be consistent with the level of protection afforded to similar items included in Table 1E - 2.

The Resident Engineer may reject any material and/or equipment improperly stored or handled.

Material, equipment, and surfaces damaged or otherwise marred shall be repaired/replaced by the Contractor to the satisfaction of, and without additional expense to, the State (see Technical Specifications Section 631 for specific coating requirements).

Table 1E - 2 Acceptable methods of protecting items with finished surfaces

Activity	Subject Equipment/Material	Minimum Required Protection
Welding, grinding and cutting	Machinery/mechanical equipment All deck surfaces Bulkhead-mounted items (switchboards, electrical panels, controllers, windows, fixtures, artwork, etc.)	Plywood or other protective covering; fire blanket or other suitable non-flammable material approved by the Resident Engineer
Movement of workers and materials through space	Carpeting and tile Bulkhead-mounted items (switchboards, electrical panels, controllers, fixtures, artwork, etc.) Handrails	Protective covering; either 8 mil or thicker plastic with non-skid texture, hard board, scrap carpet, or rubber matting Protective covering; hardboard (delicate items) or cardboard Butcher paper/tape

Painting	All vertical and overhead finished surfaces Decks	Protective covering; either 8 mil or thicker plastic, butcher paper/tape Protective covering; either 8 mil or thicker with non-skid texture, hard board, cardboard, scrap carpet, or rubber matting
Any work above equipment that could be stepped on to accomplish work.	Machinery/mechanical equipment	Protective cribbing of 2x4 lumber and plywood framed around equipment capable of supporting workers

1E.9.2 General - Machinery Plant

625 The machinery plant shall be designed to properly operate under the range of interior and exterior environmental conditions to which it may be exposed, including but not limited to the general requirements of Section 1E.9.1. “Properly operate” as used herein shall mean that all components will perform their intended functions within design parameters throughout their design operating ranges. Irrespective of the aforementioned requirement and unless otherwise
630 specified for particular items, all systems and equipment shall also be rated for interior ambient air temperatures of no less than 122°F.

The type and rating of each machinery plant component shall be compatible with its service demand. Its size, weight, and complexity shall be held to a minimum consistent with reliable and economical operation and maintenance. Ratings of prime movers shall be sufficient to
635 ensure that operation of the prime movers in an overloaded condition will not be required to drive the respective machinery plant components at their rated conditions.

Engines and associated diesel oil handling equipment shall have been designed by the respective manufacturers for use with ASTM D975, No. 2-D grade diesel oil.

640 All machinery requiring lubricating or hydraulic oils shall be supportable using Chevron products. Manufacturer’s recommendations for lubricants shall identify the acceptable Chevron product. Contractor shall provide and update as necessary a vessel wide oil chart, identifying the oils intended to be used in all equipment (not just prime movers) utilizing lubricating or hydraulic oils.

645 The machinery plant shall operate over its entire operating range without exceeding noise and vibration limitations specified in Section 1E.11.

Emissions from machinery shall meet the air and water pollution control standards and regulations of the cognizant federal, state, and provincial regulatory authorities and the port, borough and municipal authorities having cognizance over the vessel’s ports of call.

650 Maintenance that should be accomplished underway shall not compromise the ability to maintain propulsive power through the podded stern propulsors. The design, configuration, and arrangement of machinery, equipment, and systems shall account for this requirement.

After tests and trials, and after arrival at delivery acceptance port, all strainers shall be cleaned, all filter elements, fluid and air, shall be replaced with new filters, and all systems' hydraulic and lubricating oils shall be changed.

655 **1E.9.3 Proven Performance Requirements**

660 All of the following listed equipment items shall be shown to have proven satisfactory performance in at least 6 previous marine installations with an average number of operating hours of no less than 20,000 hours, except where a lesser number of operating hours is specifically required below for particular items. To be considered as qualifying experience, equipment items must share basic design features and operating parameters appropriate to the equipment being qualified (including but not limited to power rating, number of cylinders, BMEP, RPM, bore, stroke, gear tooth loading, hydraulic pressure, BTU rating, design stress level of critical components and control characteristics).

1. Propulsion generator sets.
- 665 2. Propulsion generator set exhaust silencers.
3. Podded azimuthing stern propulsors (fewer hours may be allowed due to FHWA Buy American Restrictions, Contractor to submit to Resident Engineer a reference list if equipment cannot meet the required operating hours).
4. Bow thruster (500 hours required).
- 670 5. Sewage treatment plant.
6. HVAC plants and control system.
7. Hot water heater.
8. Fin stabilizers (5,000 hours required).

1E.9.4 State-Furnished Material

675 State-furnished material is discussed in Technical Specifications Section 1A.5.

1E.10 INTERFERENCE RESOLUTION

680 Where structure or equipment interferences that may arise during final design or construction require deviation from arrangement or clearance requirements prescribed by the Contract Drawings, the Technical Specifications, or State-approved Working Drawings, diagrams and/or sketches, such deviation shall only be made with the approval of the Resident Engineer. Any such deviations shall be at the Contractor's expense.

1E.11 VIBRATION AND NOISE CONTROL

1E.11.1 General

This section addresses vibration and noise control management, including the following:

- 685 1. Noise and vibration criteria.
2. Management methods and analyses required to predict noise and vibration levels in order to determine appropriate treatments.

3. Discussion (in part) of the noise and vibration mitigation methods.
4. Corrective actions required wherever compliance with the criteria is not demonstrated by initial measurements. Measurements for compliance are discussed in Technical Specifications Sections 1A.8.8.1 and 1A.8.8.2.

Other specific noise and vibration requirements are outlined in individual sections of these Technical Specifications.

Throughout these specifications, specific design measures and treatments are called for to assist in noise and vibration mitigation. Examples include the requirements for an acoustically treated EOS with “floating” bulkheads, deck, and ceiling; resilient mounts for the diesel generators, compressors, fans and blowers; and acoustically treated ventilation ductwork, bulkheads, and decks. Such required treatments shall supplement and be coordinated with other treatments selected by the Contractor in order to satisfy the noise and vibration criteria.

Noise and vibration criteria apply to calm water operation of the vessel in conditions from light load waterline through full load; with propulsion engines operating at all power levels through maximum rated power, and with concurrent operation of generators and normally operating auxiliaries such as refrigeration, air conditioning, and ventilation.

The State’s naval architect shall contract with a consultant having marketed expertise in shipboard noise and vibration control; see Section 1E.11.6. The NVCC shall be an active participant in final design and production engineering, inspection and production QA, and shall review change orders that impact noise and vibration.

The Contractor shall incorporate processes into final design and engineering, and in the Contractor's QA program, to ensure that the final vessel does not manifest objectionable noise and vibration. Such processes shall include inspection procedures to be employed during installation of the noise abatement materials and equipment installations.

1E.11.2 Noise Criteria

Airborne noise levels in interior spaces and topside weather deck locations shall not exceed the limits of Table 1E - 3. Spaces not listed in Table 1E - 3 shall have the same airborne noise criteria as listed spaces that support similar functions.

Table 1E - 3 Summary of noise limits by compartment, all values in A-weighted sound pressure level (SPL) relative to 20 micro-Pascals, dB(A)

Deck	Compartment Name/Type	SPL Limit [dB(A)]
Above Tank Top	Lower MSD Room	120
	Lower Forward Machinery Space	120
	Lower Aft Machinery Space	120
	Fin Stabilizer Rooms (Port/Stbd)	120
ER Flat	Bow Thruster Room	120
	Upper MSD Room	120
	Upper Forward Machinery Space	120
	Upper Aft Machinery Space	120

Deck	Compartment Name/Type	SPL Limit [dB(A)]
	EOS	75
	Laundry Room	75
	Log Office	65
	Workshop	80
	Exercise Room	65
	Stores/Chilled Rooms/Freezer	70
	Vehicle Elevator Machinery Space	120
	Thruster Room	120
Main	Vehicle Space (underway)	84
	Vehicle Space (dockside)	75
	Paint Lockers/Storerooms	70
Mezzanine	Crew State Rooms	60
	Crew Baggage Room	70
	Dirty Linen Room	70
	Training Room	65
Cabin	Deck Lockers (port/starboard)	70
	Passenger State Rooms	60
	Purser & Steward State Rooms	60
	Electrical Room	75
	Network Room	75
	Purser & Steward Offices	65
	Fan Rooms	90
	Public Heads/Shower Room	65
	Emergency Generator Room	120
	Vehicle Elevator Control Cab	75
Boat	Lounges (Observation & Side)	65
	Fan Room	90
	Dining Rooms	65
	Galley/Scullery	75
	Crew/Officer Mess & Lounge	65
	Observation Deck	65
Solarium	Pilothouse	65
	Elex & Copy Room	65
	Master Office	65
	Crew & Master Staterooms	60
	Fan Room	90
	Public Heads/Shower Room	65

Deck	Compartment Name/Type	SPL Limit [dB(A)]
	Solarium	65

1E.11.3 Vibration Criteria

720 The vessel and all vessel components shall be free from excessive vibration. Vibration is excessive when it either:

1. Exceeds the explicit requirements of these specifications;
2. Results in damage or danger of damage to vessel structure, machinery, equipment or systems;
- 725 3. Interferes or threatens to interfere with the proper operation of the vessel and all vessel components; or
4. Interferes with personnel safety, comfort, proficiency, or with vessel operations.

Vibration in normally occupied spaces shall meet the upper limit given in ISO 6954 as follows:

1. Classification A (4 mm/sec) – All passenger spaces.
- 730 2. Classification B (6 mm/sec) – Crew accommodations areas.
3. Classification C (8 mm/sec) – All working areas.

735 Hull girders, above-deck structures, and the superstructure vibration shall not exceed the fatigue limits or conditions given in (1) through (4) above. The vibration of the main mast and other structures supporting vibration-sensitive equipment shall be limited to that level acceptable to the various equipment manufacturers.

1E.11.4 Vibration Isolation/Resilient Mounts

740 The machinery listed in Table 1E - 4 shall be mounted on Christie & Grey (Fairhaven, MA) marine-grade vibration isolation (resilient) mounts, or equal. All mounts shall be inherently captive in design, or retainers shall be added. Collision chocks shall be incorporated where necessary for safety. Mount materials shall be compatible with their environment, including temperature and fluid aversion. See Technical Specifications Sections 311.3 and 500.3.

745 The mounts shall have sufficient stability to prevent excessive motion under the vessel motions. Sufficient clearance shall be provided to prevent the unit from striking vessel structure under extreme roll and pitch conditions. Where it is required to place two or more components together connected by shafting, the components shall be installed on a common sub-base with the resilient mountings installed between the sub-base and the vessel structure.

750 The vertical natural frequency for all isolated equipment shall be no greater than 50% of the lowest operating frequency of the equipment. For any single vibration isolated equipment item, the mount loads (and mount heights) shall not vary more than $\pm 20\%$ from mount-to-mount. Vibration isolated machinery shall have flexible connections for fluid, air and electrical services. Expected deflections at service connections due to extreme roll and pitch shall not exceed the allowable deflection of the flexible connection.

For all machinery listed in Table 1E - 4, the NVCC or equipment vendor shall perform vibration isolation analyses. The analyses shall show compliance with the expected static deflections at each of the mounting points and all flexible connections. The analyses shall also show that the six-degree-of-freedom (6DOF) natural frequencies do not coincide with any major forcing frequencies within $\pm 10\%$. The expected mount loading shall not exceed 80% of the total allowable loading for the selected mounts. Mount selections shall be revised if equipment weight changes. In order to perform these analyses, all vendors of vibration isolated equipment shall provide: unit weight, mounting foot locations, center-of-gravity location, unit moment of inertia (lb-in-s^2), and forcing frequencies. Results of analyses and details of the proposed mounts are to be submitted and reviewed by the Resident Engineer prior to ordering.

All equipment in Table 1E - 4 shall be inspected by the NVCC before sea trials for equal loading and sound-shorts. The Contractor shall make corrections to any improperly installed vibration isolated equipment. Once installed, no welding or burning shall be permitted near the mounts. The resilient mounts shall not be painted. Painted or damaged mounts shall be replaced at no cost to the State.

Table 1E - 4 Vibration-isolated equipment

Machinery	ID/SWBS No.	Quantity
Propulsion Diesel Generator Sets	311-01	2
Propulsion Diesel Exhaust Silencer & Piping	563-01	2
Ship Service Diesel Generator Sets	311-01	2
Ship Service Diesel Exhaust Silencer & Piping	563-02	2
Air Compressor	551-01	2
Refrigeration Plant	516-01	2
Air Conditioning Chiller Plant	514-01	2
HVAC Fans (≥ 0.75 HP)	various	28

Vibration-sensitive electrical and electronic equipment shall be installed on resilient mounts as recommended by the equipment manufacturers and as otherwise deemed appropriate.

Other components shall also be resiliently mounted as necessary to attenuate the transmission of noise and vibration to meet the requirements of the specifications.

1E.11.5 Engineer's Operating Station (EOS) Acoustic Treatment

The EOS shall be totally enclosed with steel bulkheads, overhead, and deck. These boundaries, and their openings, shall be fitted with acoustic treatments incorporating high transmission loss materials, of types and thicknesses suitable for meeting the 75 dB(A) maximum sound pressure level criterion specified herein. The EOS acoustic treatments shall be as defined below.

1. The EOS interior liner panels shall be resiliently mounted with a galvanized protective sheet on the interior face. The joiner panels shall have a surface density of 2.87 lb/ft^2 (14 kg/m^2) or greater and Sound Transmission Class (STC or R_w or I_a) of 26 dB(A) or greater.
2. The EOS dropped ceiling shall be a continuous perforated resiliently suspended acoustic ceiling panels having a mineral wool slab core and galvanized perforated sheet steel front

(visible) surface. The surface density shall be 3.48 lb/ft² (17 kg/m²) or greater and the STC (Rw or Ia) of the panels shall be 30 dB(A) or greater. Required fire treatments shall be in addition to these treatments.

3. The EOS floor shall include a “floating floor” treatment as described in Section 1E.11.12.
4. The EOS doors and frames shall have a STC (Rw or Ia) of 40 dB(A) or greater as defined in Technical Specifications Section 624.7. The rating shall be with the door and frame as a unit.
5. The EOS window(s) shall be as specified in Technical Specifications Section 625 and shall also have STC (Rw or Ia) rating of 45 dB(A) or higher.
6. All bulkheads and deck surfaces exposed to the Aft Machinery Space shall be insulated as defined in Section 1E.11.11.
7. The EOS supply and exhaust ventilation ducts and fans shall be configured as required by Technical Specifications Section 500 and, as necessary, fitted with acoustic insulation such that the HVAC noise is no greater than 70 dB(A) measured at the registers.

All boundaries and penetrations of the EOS shall be minimized and grouped. All openings around beams, stiffeners, pipes, cables and ducts passing through the boundaries of the EOS shall be filled with additional acoustical insulation or sealant. Sealant shall be applied to prevent sound leaks through panel seams, fastener holes, and other miscellaneous small openings.

Particular attention shall be paid to providing an installation that minimizes sound paths between the Aft Machinery Space and the interior of the EOS. It is essential that all panel connections to structural steel be isolated to minimize structure-borne noise transmission. Stanchions and similar structure within the EOS are prohibited.

Alternate treatments will be given consideration by the State if the alternative treatments are shown to have equal or better noise transmission loss characteristics than the treatments described herein.

1E.11.6 Noise and Vibration Control Consultant (NVCC)

During the detail design phase, the NVCC shall assess if any design features will be expected to cause noise or vibration throughout the vessel that exceeds the requirements of these specifications. The NVCC shall be responsible for all noise and vibration analyses specified in this section. This does not include the propulsion shafting analysis specified in Technical Specifications Section 200.4. The NVCC shall be consulted on the vendor, make and models (as applicable) for all noise and vibration control features. The NVCC shall confirm that selected mitigation materials are consistent with the assumptions made as part of the noise and vibration analyses. The NVCC shall be responsible for ship inspections as given in Section 1E.11.13, and the noise and vibration compliance measurements given in Technical Specifications Sections 1A.8.8.1 and 1A.8.8.2.

820 1E.11.7 Noise and Vibration Analyses

1E.11.7.1 General

Any design modifications necessary to meet the noise and vibration criteria shall be identified in the analysis reports required herein and performed by the NVCC. The necessary corrections shall be made to the vessel's final design.

825 Where hydrodynamic and machinery generated forces and torques are required for a particular analysis, it may be assumed that these forces and torques are developed with the vessel moving ahead at constant speed in deep calm seawater.

830 Analysis reports shall present analysis data, assumptions, indices and coefficients, and calculations in sufficient detail to permit independent verification of the results. These reports shall be organized, prepared, and produced by the NVCC.

1E.11.7.2 Airborne Noise Analysis

835 The NVCC shall develop and provide an Airborne Noise Analysis that provides calculations of predicted airborne noise levels in all ship spaces and weather deck locations. It shall compare noise predictions with the criteria, and fully describe acoustic treatments to be used to achieve necessary noise reductions. Where it can be shown that calculations performed for a given space closely approximate those required for similar spaces, separate calculations are not required for the other spaces.

840 HVAC noise contributions shall include duct-radiated "breakout" noise as well as noise emitted from duct openings and diffusers. Both fan and flow generated noise contributions shall be included in the HVAC system portion of the noise analysis. For the evaluation of HVAC generated sound, the noise criteria shall be those given in Table 1E - 3 minus 5 dB.

845 SNAME T&R Bulletin No. 3-37, *Design Guide for Shipboard Airborne Noise Control* (or equivalent methods/software such as DesignerNoise®) shall be used as a guide in predicting machinery and HVAC noise. For the HVAC portion of the noise analysis, information presented in ASHRAE, *Noise and Vibration Control* plus other ASHRAE publications may also be utilized, provided the Contractor fully documents publications from which data are extracted.

1E.11.7.3 Vibration Analyses

850 The NVCC shall develop and provide vibration analyses of the hull structure, superstructure, mast, and propulsion system. These analyses shall be used to affirm that the vibration criteria will be satisfied. The Analyses shall predict the low frequency response of major substructures and local structural elements to hydrodynamic and mechanical driving forces originating in the propulsion system and associated wake field. The analysis frequency range shall encompass the primary excitation frequencies of these sources, including dominant propeller blade rate frequencies and, where significant, machinery forcing frequencies. Major substructure analyses shall include, as a minimum, global structural response. Local structural element analyses shall include analyses of repeating plate panels, stiffened plate panels between web frames, and transverse beams and longitudinal girders.

The propulsion system vibration sub-analysis shall be performed by the propulsion system integrator and predict the propulsion system longitudinal, lateral, vertical, and torsional natural

860 frequencies, mode shapes, and response of the system due to propeller and engine excitations.
See Technical Specifications Section 200.4 for details.

1E.11.8 Diesel Engine Silencers

865 All of the diesel engines shall be fitted with spark arresting engine exhaust silencers as defined in Technical Specifications Section 563. The propulsion engine silencers shall be Maxim MSA44 or equal "Hospital" grade units. The SSDG silencers shall be Maxim MSA55 or equal "Hospital Plus" grade units. The EDG silencers shall be a Harco Model 5815CFHI or equal "critical" grade unit. All exhaust silencers shall provide a minimum attenuation as given in Table 1E - 5.

Table 1E - 5 Engine exhaust silencer minimum attenuation, dB

Octave Band Center Freq. [Hz]:	31.5	63	125	250	500	1,000	2,000	4,000	8,000
EDG	10	15	20	30	30	30	30	35	35
Propulsion Engines	10	20	40	50	40	35	35	35	35
SSDGs	10	20	40	45	40	40	40	40	40

870 1E.11.9 Joiner Panels

Refer to Technical Specifications Section 621.1.1 for the general requirements for joiner bulkheads and linings. All joiner bulkheads (separating compartment from compartment without a steel bulkhead) shall be a high noise reduction type.

875 To ensure acoustic privacy, all joiner bulkheads separating staterooms from staterooms and staterooms from passageways shall have the gap between the top of the joiner bulkhead and the deckhead sealed by any feasible means.

1E.11.10 Acoustically Absorptive Ceiling Systems

880 Refer to Technical Specifications Section 621.1.1 for the general specification requirements for overhead ceilings. All accommodation spaces excluding the Galley and Scullery, shall have overhead ceiling panels that are acoustically absorptive (for metal ceilings, the exposed metal must be perforated with a Mylar faced fiberglass blanket behind the panel) and have a noise reduction coefficient (NRC) of 0.70 or higher.

1E.11.11 Acoustic Insulation

885 The noise limits given in Section 1E.11.2 take into account the fire protection and thermal insulation. Any modifications to any type of insulation must be reviewed and approved by the NVCC.

Acoustic insulation shall be installed to the locations given in Section 1E.11.5, using a single layer of fiberglass or mineral wool batt, 4" thick and a nominal density of 3 lb/ft³. The acoustic insulation layer shall have an NRC of 0.70 or higher.

890 When the insulation is located behind joiner panels or overhead ceilings, it does not require any facing. When the insulation is not behind joiner panels, then material shall have an acoustically transparent facing of Mylar (or equivalent) and be covered with perforated (30% open area)

galvanized sheet steel (22-gauge), up to a height of 5' above the deck. The acoustical insulation shall be impaled on pins, faced, sealed and protected as required for other insulations specified in Technical Specifications Section 635.

1E.11.12 Floating Floors

Floating floors shall be installed in the following locations:

1. First Platform EOS.
2. First Platform Log Office.
3. Mezzanine Deck in passages and accommodation spaces.

The floating floors shall be comprised of one of two types of treatment, but whichever style is used shall be used throughout the ship.

One treatment option may be viscoelastic self-levelling vibration damping underlayment such as Pyrotek, Decidamp® SLC or equal. The damping underlayment shall be applied (poured) directly to the steel decking and shall be topped with a cement-based leveling material for steel decks. The treatment shall be installed in accordance with all manufacturers' instructions. The cement layer shall then be covered in accordance with Technical Specifications Section 634.

An alternative treatment option may be a NORAC model F-300 floating floor or equal. All locations shall use the 60 mm thick insulation (total thickness of 63 mm). The floating floor shall be laid over a smooth steel deck that has been cleaned, primer coated, and faired with underlayment. The treatment shall be installed in accordance with all manufacturers' instructions. The floating floor shall be covered in accordance with Technical Specifications Section 634.

For either treatment type there shall be no sound shorts between the ship structure (decking or bulkheads) and the top plate of the floating floor system. Where unavoidable, penetrations shall be in accordance with manufacturer's recommendations, in order to maximize the performance of the floating floor installation. Joiner bulkheads in compartments with floating floors shall be located on top of the floating floor and isolated from the ship through rubber attachments at all other points.

1E.11.13 Noise Control Treatment Inspections

The NVCC shall perform at least two (2) ship inspections. One shall be performed before launching and one shall be performed between launching and the start of dock trials. The NVCC shall inspect all noise and vibration control treatments for adequacy, condition, and load, as applicable. A report shall be prepared and supplied to the Contractor and Resident Engineer listing all noise isolation features which are improperly installed, damaged, sound shorted, or otherwise acoustically deficient and what the necessary corrective actions by the Contractor.

1E.11.14 Correction of Deficiencies

The Contractor shall locate and correct unsatisfactory vibration and/or noise arising during tests/trials or subsequently during the warranty period, and which can be attributed to the final design or construction of the vessel.

SECTION 100 GENERAL REQUIREMENTS FOR HULL AND DECKHOUSE STRUCTURE

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070-01 *General Arrangements*, AMHS Dwg. No. 14-070-001-001.

070-03 *Hull Lines*, AMHS Dwg. No. 13105.10-070-001-003.

070-04 *Hull Appendages*, AMHS Dwg. No. 14-070-001-004 [To Be Developed].

120-01 *Hull Structural Sections*, AMHS Dwg. No. 14-120-002-001 [To Be Developed].

130-01 *Hull Structural Plans*, AMHS Dwg. No. 14-130-002-001 [To Be Developed].

150-01 *Structural Elevations*, AMHS Dwg. No. 14-150-002-001 [To Be Developed].

171-01 *Hinged Mast Arrangement Design Requirements*, AMHS Dwg. No. 14-171-008-001 [To Be Developed].

441-01 *Antenna Arrangements/Helo Access*, AMHS Dwg. No. 14-441-093-001 [To Be Developed].

582-01 *Mooring Arrangement and Details*, AMHS Dwg. No. 14-582-010-001 [To Be Developed].

The vessel structure shall be designed and constructed in accordance with ABS *Steel Vessel Rules*, ABS *Shipbuilding and Repair Quality Guide*, to the attending surveyor's satisfaction, and the Specifications.

The deckhouse (Cabin Deck bulkheads and above) shall be constructed of ordinary-strength steel, longitudinally and transversely framed with a frame spacing of 24". All plating and attached framing in the deckhouse shall be minimum ABS certified Grade A steel. In lieu of Grade A steel, ASTM A36 steel otherwise tested and certified to the satisfaction of ABS may be substituted for a thickness up to and including ½" for plate, and up to and including 1.57" for sections.

Attachments of components to structural members shall not reduce the strength of the member. Brackets, margin plates, doubler plates, inserts, or special framing shall be attached to the structure, and the components mounted thereto and not directly to the structure. Drilling or tapping flanges of structural members for the purpose of attaching supports for any equipment, foundations, pipe hangers, cableways, or similar items shall be prohibited.

Strength members that are subject to high tensile stresses shall be designed so that dependence is not placed on the strength of the metal normal to its plane of rolling. Where this is impracticable, other means such as through-connections shall be provided to minimize the possibility of failure due to plate delamination.

Openings in any part of the ship's structure, including those parts that do not contribute to the strength of the ship, shall have radiused corners. The corner radius of openings in decks, shell and inner bottom tank top shall be generally one-eighth the transverse dimension of the opening, with a minimum of 6" and a maximum of 24". Cuts in non-structural bulkheads shall have at least a 1" radius. In longitudinal structural bulkheads and in deckhouse sides, the radius shall be one-eighth of the vertical dimension of the opening but need not exceed 6". In transverse structural bulkheads of considerable extent, such as main transverse bulkheads, the radius shall be one-twentieth of the vertical dimension of the opening, with a minimum of 1". In transverse bulkheads of lesser extent, such as racking webs, the radius shall be one-tenth of the vertical dimension of the opening, with a minimum of 1".

All materials, including plates, shapes, welding electrodes, etc., used in ship's structure, shall meet the requirements of ABS for Grade A or AH steel as applicable and the Buy America provisions of the Contract. Metallurgical test reports, ABS charge sheets, and manufacturer's certificates of compliance shall be obtained at the Contractor's expense and provided to the Resident Engineer.

Materials, workmanship, and welding procedures shall comply with the requirements of this section.

All completed structure areas of work shall be thoroughly cleaned, primed and finish-coated in accordance with the requirements of Technical Specification Section 631.

Sharp and ragged edges or corners of structure which are unsightly, or which could cause injury to personnel shall be removed, ground smooth or sniped. In any spaces or areas that could trap liquids, adequate limbers shall be provided to ensure effective drainage.

Proper drainage of all structural members shall be provided.

All burning of notches and holes in the structure shall be carefully laid out and shall be regular in outline with jagged edges removed and corners rounded. Semicircular "rat holes" shall be provided in framing members in way of passing welded seams or butts in the attached plating. All notches and "rat holes" shall be welded all around.

All outside corners of exterior steel bulkheads and interior bulkhead corners not covered by joiner work shall be radiused a minimum of 3" unless otherwise stated.

Where it is necessary to provide holes through structural members for passage of wiring, piping, or ductwork, compensation shall be provided where appropriate. In general, if such holes remove more than 30% of the depth of the web of a member and/or if they are unfavorably located, reinforcement shall be required. Where reinforcement is required in way of penetrations of decks, shell, bulkheads or framing members, insert plates or reinforcing rings shall be used where practical. The use of doubler plates shall be avoided if possible.

Openings in structural members shall be cut as near to the neutral axis as possible, reinforced as necessary to maintain the structural strength of the member, and well-rounded so as to reduce stress concentration.

85 All penetrations of fire boundaries shall be collared and insulated at all penetration intersections and as otherwise necessary to meet their particular classification and regulatory body requirements.

Direct attachments of fittings to oil-tight structure shall be by welding only.

90 In the fabrication and erection of hull structure, discontinuities, undercutting, notches, or other mechanical damage that might initiate or propagate cracks in the structure shall be eliminated or repaired.

Where foundations and other structural members are prefabricated in a shop or assembly area, they shall be well supported and stiffened as necessary to avoid buckled surfaces or other objectionable irregularities and to maintain the required limits of fairness delineated in ABS Shipbuilding and Repair Quality Standard for Hull Structures During Construction. Fitting
95 prefabricated structures to the vessel shall employ a proven and documented welding sequence to avoid warping and stress concentrations.

100 Clips, lugs and temporary handling fittings and pad eyes used for erection purposes shall be removed as work progresses in such a fashion so as not to damage plating or other structural members. All pitting, gouging, or other damage resulting from improper removal shall be repaired by welding and grinding. All coatings damaged shall be repaired in accordance with the paint schedule included in Technical Specification Section 631.

In the vicinity of temporary access openings, the Contractor shall prepare a drawing(s), including calculations, of temporary shoring, stiffening or intended means of load distribution as the calculations show are required to adequately support the vessel's structure.

105 The Contractor shall use insert plates in way of all foundations where the thickness of the deck or bulkhead needs to be increased. Doubler plates will not be allowed in these locations.

102 WELDING

Temporary welds incident to erection shall be carefully removed and flushed off by chipping or grinding.

110 Intermittent welding may be used where appropriate to minimize distortion and where oiltightness or watertightness is not required. However, intermittent welding shall not be used in locations exposed to the weather or moisture.

115 All structure shall be double continuously welded in way of mooring fittings, deck machinery, generator and propulsion engine foundations and other areas subject to high stress or vibration. Ballast tanks, water tanks, sewage system tanks, wet spaces, chain locker, sumps, and bilges shall be double continuously welded.

102.1 Welding Operator Qualifications

- 120 Welding operators shall be proficient in the type of welding to be performed. They shall be trained and experienced in the working of high-strength and mild steel structures in a marine environment. All welding operators shall be acceptable to ABS. The Contractor shall use welders that have been trained and certified in accordance with the standards of the AWS D1.1 and ABS, for the intended materials and positions. Records of tests and qualifications shall be kept by the Contractor and shall be made available to the Resident Engineer when requested. All welders and their certifications shall remain current and up to date throughout the project.
- 125 Any welder whose work has to be repaired by removing a portion of a weld and then re-welding the removed area as a result of an inspection by either ABS or the Resident Engineer shall have his/her name logged in a separate notebook maintained by the Contractor. The notebook shall be made available to the Resident Engineer upon request. On the second occasion where an individual welder's name is logged, the Resident Engineer shall have the option of requiring the
- 130 Contractor (with no change to the Contract) to have test coupons made by the welder and destructively tested. The test results shall be documented and evaluated by an accredited inspection company not associated with the Contractor and shall be presented to the Resident Engineer. The welder shall not be allowed to do any additional welding on the vessel until the test is judged acceptable.
- 135 The Contractor shall use a welding surveyor who shall have, as a minimum, the same credentials as the welder operators, as well as a proven record of survey experience in the welding of high-strength and mild steel, and aluminum structures in a marine environment. The Contractor shall submit the qualification of the surveyor to the Resident Engineer for approval.
- 140 The Contractor's welding surveyor shall be responsible for acceptance or rejection of material and workmanship. The basis of the surveyor's qualifications shall be documented and shall include current certification as an AWS Certified Welding Inspector in accordance with the provisions of AWS QC1, or equivalent.
- 145 When conducting radiographic testing, the Contractor shall use a technician who shall be, as a minimum, qualified in accordance with the current edition of the ASNT Recommended Practice No. SNT-TC-1A (Annex A).
- The tests shall be carried out with due care and attention to the conditions and instruments used, so that there is no doubt as to the accuracy of the results obtained.

102.2 Welding Procedures

- 150 Welding procedures shall be established by the Contractor and submitted to ABS for approval. All welding details and procedures shall be submitted to the Resident Engineer for review at least ninety (90) days prior to the start of construction. Procedures for the welding of all joints, including the type of consumables, joint preparation, and welding position shall be detailed.
- Welding procedures shall be developed to minimize distortion, bumps, and hollows in the plating.
- 155 Careful consideration shall be given to assembly sequence and the overall shrinkage of plate panels, assemblies, etc., resulting from the processes employed. Welding shall proceed

systematically with each welded joint being completed in correct sequence without undue interruption. Where practicable, welding shall commence at the center of a joint and proceed outwards or at the center of an assembly and progress outwards towards the perimeter so that each part has freedom to move in one or more directions.

Butt welds shall be finished full at the ends and cut back before welding the seams. Seams shall not be welded within 12" of an unwelded butt or across an unwelded butt joint.

Welding and silver brazing shall be done by properly trained and qualified personnel. The Contractor shall use only welders and welding operators that are qualified to the satisfaction of ABS and the Resident Engineer (at no expense to the State) for the type of material(s) and welding process(es) being used.

The Contractor shall accomplish all welding with approved welding procedures in accordance with regulatory body requirements of ABS and/or USCG. The procedures shall identify type and size of electrode or filler metal, current values, shielding gas and other details of welding and silver brazing processes and procedures as they relate to the work being addressed.

Structural welding will be carried out in such sequence as to:

1. Compensate for shrinkage as the work progresses.
2. Prevent locked in stresses
3. Hold distortion to an acceptable minimum

Structural steel may be manual or machine welded, depending on the Contractor's standard practice.

Peening of weld material will not be allowed except as specifically approved by the ABS, and the Resident Engineer. Steel to be welded shall be kept entirely free of paint or oil other than "weld-through" primers.

All welds shall be neatly finished, with all spatter and slag removed, and ground flush where required.

102.3 Preparation

The preparation of plate edges shall be accurate and free from blemishes. All joints shall be properly aligned and closed or adjusted before welding. Means shall be provided for holding the work in proper alignment without rigid restraint during welding operations. Excessive force shall not be used in fairing and closing the work. Where excessive gaps exist between surfaces or edges to be joined, the corrective measures adopted shall be to the satisfaction of the Resident Engineer and the attending ABS Inspector.

Before a manual sealing run is applied to the back of the weld, the original root run shall be cut back to sound metal.

Joint edges shall be scratch-brushed (or other acceptable method) immediately before welding to remove oxide or adhering films of dirt and filings.

102.4 Cleanliness and Environment

195 The surfaces in way of all parts to be welded shall be made clean, dry, and free from grease and other contaminants that might adversely affect weld quality, by cleaning with suitable chemicals or solvents.

200 The welding environment shall comply with the requirements of AWS D1.1, Section 5.12. Adequate protection shall be provided where welding is required to be carried out in exposed positions in wet, windy, or cold weather. Special precautions shall be taken to protect the building area from contamination by dissimilar metals (e.g., iron, steel, and copper).

102.5 Tack Welding

Consumables for tack welding shall be of the same grade as those used for the main weld.

Tack welds that are to be retained as part of the finished weld shall be clean and free from defects before being incorporated into the weld.

205 Care shall be taken when removing tack welds used for assembly to ensure that the material of the structure is not damaged.

Any defects in the structure resulting from the removal of temporary attachments shall be prepared, welded, and ground smooth so as to achieve a defect-free repair.

102.6 Alignment and Fit

210 Workmanship shall result in fair lines and smooth surfaces.

Structure shall fit tightly without excessive gaps between seams, buckles, kinks, or other surface irregularities.

215 Care shall be taken to obtain good alignment of structural members, particularly where such members oppose each other on opposite sides of bulkheads or decks. Alignment shall comply with the tolerances specified in the *ABS Shipbuilding and Repair Quality Standard for Hull Structures During Construction*. Additionally, any cases where misalignment exceeds half the thickness of the thicker member shall be considered deficient and require correction. Where discontinuities of structure are unavoidable, suitable brackets or other reinforcement shall be installed.

220 Dimensional tolerance, fit, alignment, and finish of structure shall additionally be in accordance with the approved Working Drawings and regulatory approval(s). All joints shall be prepared, aligned, and adjusted in accordance with approved joint designs.

225 The Contractor shall take every precaution to keep distortion and welding stresses to a minimum. Excessive unfairness in plating may be corrected by local spot-heating and quenching, provided such methods are approved by the regulatory bodies. Deviation and distortion of structural material shall, in general, be within the tolerances prescribed in *ABS Shipbuilding and Repair Quality Standard for Hull Structures During Construction*. Hull plating and all decks, interior and exterior, shall have a maximum deformation of $\frac{1}{8}$ " between frames.

Shims, liners, “dutchmen,” or “sleepers” shall not be used for correcting improper fit. Clamps with wedges or strong-backs used for this purpose shall be suitably arranged to allow freedom of lateral movement between adjacent elements. Welded temporary attachments used to aid construction shall be removed carefully.

See General Conditions Sections 5.4, 5.11, and 5.12 for additional workmanship requirements.

102.7 Inspection and Acceptance Criteria

All welds shall be visually inspected per the standards with additional non-destructive testing as noted in these specifications. Should ABS or the Resident Engineer deem it necessary to increase the area of inspection because of the discovery of unsatisfactory welding, all such additional inspections shall be at the Contractor’s expense.

The Resident Engineer shall require random radiography of all welds. The Contractor shall furnish these satisfactory radiographs for the project. Radiographs shall conform to ASTM E390. Repair and retesting of any defects found as a result of these tests shall be at the Contractor’s expense. Any radiographic testing requested by the attending ABS Inspector for fixed or unit price work shall be at the Contractor’s expense.

Prior to testing, the Contractor shall develop a Radiographic Testing Plan compliant with the *ABS Guide for Nondestructive Inspection of Hull Welds*, Section 2, and submitted to the Resident Engineer for review. The minimum extent and location of radiographic inspection shall meet ABS requirements for nondestructive inspection. All NDT inspection methods and interpretation shall comply with ABS rules.

The Resident Engineer may require additional inspections, including inspections more stringent than those originally employed, to prove the quality and integrity of any weld at any time there is reason to question the weld because of its appearance or the conditions under which the weld was performed. The Resident Engineer may order additional testing on a random basis. If the results of inspections requested by the Resident Engineer prove that the weld is sound, the Contractor will be compensated for the additional testing work in accordance with the Contract.

Should the testing reveal a defective weld, the testing and repair shall be wholly at the Contractor's expense. At any time that NDT reveals a defective weld, the testing shall be expanded at the Contractor's expense until a sound weld is located. All defective welds shall be removed and renewed to the satisfaction of the Resident Engineer and the attending ABS Inspector. The Contractor shall be wholly responsible for all expenses associated with the removal and replacement of defective welds.

Weld inspections shall occur prior to any painting of welds, and shall include both visual and NDTs, as required by ABS and the Resident Engineer.

All weld inspection equipment, inspection equipment operators and materials shall be furnished by the Contractor, at no expense to the Resident Engineer.

The Resident Engineer shall be allowed to witness the NDT, the repair of defective areas, and all retesting. The Resident Engineer shall be notified 24 hours (minimum) before scheduled, witnessed weld inspections. Notification of ABS for witnessed weld inspections is the responsibility of the Contractor. A minimum of 10% of the length of the exterior welds shall be

270 ND tested. A minimum length of 12" to 14" of the portion of any weld selected shall be ND tested.

If discontinuities are shown to be in the weld, then testing shall continue until the extent of the discontinuities is revealed. Such welds shall be repaired in the specified manner, at the Contractor's expense, and re-inspected. This inspection shall continue until both the Resident Engineer and ABS are satisfied.

275 The Resident Engineer reserves the right to bring in outside independent NDT personnel to perform additional NDT examinations, over and above those required by ABS and the Resident Engineer as delineated above. All costs for NDT personnel hired by the Resident Engineer shall be the Resident Engineer's responsibility. Discontinuities discovered by Resident Engineer's hired personnel shall be treated as if discovered by the Resident Engineer.

280 Any internal/external defects or other welding deficiencies found to be unsatisfactory to ABS, USCG or the Resident Engineer, will be corrected by the Contractor and re-inspected/tested (the test method to be determined by either ABS and/or the Resident Engineer), at the Contractor's expense.

102.8 Weld Repair

285 Repairs to defective welding shall be carried out using approved consumables and procedures.

Repairs shall be reexamined for further defects. Care shall be taken when repairing defects that require the application of small weld beads. Tears and scars left on plating after the removal of temporary attachments shall be built up by welding, if necessary, and dressed smooth.

290 When modifications or repairs have been made that result in openings having to be closed by welded inserts, particular care shall be given to the fit of the insert and the welding sequence. The welding shall also be subjected to non-destructive testing.

When misalignment of structural members on either side of bulkheads, decks, etc., exceeds the required tolerance, the member shall be released, realigned, and re-welded in accordance with the required repair procedure.

295 Weld splatter and arc strikes shall be repaired in accordance with the *ABS Shipbuilding and Repair Quality Standard for Hull Structures During Construction*.

110 SHELL PLATE AND SUPPORT STRUCTURE

110.1 Shell Plating

Fabrication of the hull and shell plating shall be in accordance with Reference 070-03.

300 The thickness of the shell plating shall be in accordance with ABS Rules and as shown on the Contract Drawings. Where the Contract Drawings call for plate thicknesses in excess of ABS Rules, the Contract Drawings shall govern. Seams and butts between plates of the same thickness may be located to suit the practice of the Contractor, provided that butts and seams are kept clear of bulkheads and framing by a minimum of 3". Seams shall lie in fair lines.

305 The stem bar connection to the shell plating shall be fair, well-rounded, and with welds ground smooth.

The shell shall be increased in thickness locally by means of insert plates with rounded corners in way of sea chests and other shell penetrations, as appropriate and in accordance with the requirements of the regulatory bodies. Insert plates shall be installed at all overboard piping
310 discharges in accordance with ASTM F994 Type III. All insert plates shall be set such that the exterior is flush with surrounding plating. Watertight bulkheads and tank boundaries shall be tested in accordance with regulatory requirements to demonstrate tightness.

All openings in the shell, decks, and structural bulkheads will be well rounded, in accordance with TS Section 101.

315 **110.2 Bulwarks**

Bulwarks shall be provided as shown on the Contract Drawings. The bulwarks shall include freeing ports to allow for adequate drainage in heavy seas.

114 SHELL APPENDAGES

114.1 Skeg

320 The skeg shall be of boxed plate construction as shown on the Contract Drawings, installed as an integral part of the hull structure and fit up to the flat plate keel. The structure shall be designed to withstand the loads imposed on it, including those associated with dry docking block placement.

325 The skeg shall be fitted with drain plugs located to allow for complete drainage of the skeg in dry dock.

The interior surfaces of the skeg shall be coated to the maximum extent practicable with a regulatory approved, float-coat, rust-preventative coating system.

114.2 Bilge Keels

330 Bilge keels shall be provided as shown on Reference 070-04. Bilge keels shall be discontinued in way of the fin stabilizer pockets and shall be arranged to not interfere with the fin stabilizer deployment or operation in any way. Bilge keels shall be of double plate watertight construction, have sharp edges outboard but well-rounded at front and no exposed framing. Bilge keels shall be attached to hull plate with doublers so arranged that the welding from bilge keel to doubler is weaker than the welding of doubler to hull. The bilge keels shall not extend
335 below baseline.

The interior surfaces of the bilge keels shall be coated to the maximum extent practicable with a regulatory approved, float-coat, rust-preventative coating system in accordance with Technical Specification Section 631.

114.3 Guard Plate

340 The shear strake will act as a guard plate and shall be reinforced accordingly. All welding on the guard plate and guard plate structure shall be continuous. The exposed plate guard edges shall have a generous radius and be ground smooth to prevent damage to piers.

120 HULL STRUCTURE

120.1 Hull Structural Bulkheads

345 The hull structural bulkheads shall be fabricated in accordance with the Contract Drawings.

Attachments to bulkheads for supporting local weights may not impair the strength or tightness of the bulkhead. Insert plates, margin plates, special framing, and stiffening shall be installed as necessary to distribute local stress. Where practicable, the attachments shall be made to the special framing and not directly to the bulkhead structure.

350 Interior and exterior boundaries formed by steel (with associated joiner bulkheads installed, where applicable) shall conform to regulatory requirements of USCG and ADA regulations for sufficient passage room. Particular care shall be given to stair towers and stair tower passageways to see that minimum required width, landing, and headroom dimensions are maintained.

355 120.2 Hull Decks

All weather decks shall have sheer and camber as shown on the Contract Drawings. All deck plating shall be worked with flush seams and butts. Heavy insert plates shall be provided in way of the deck machinery. Insert plates located on the Main Deck in the Vehicle Space shall be arranged with the top surface flush with the deck surface.

360 Welding of Vehicle Space deck plating to stiffeners and webs shall be continuous in way of tie down buttons, wrinkle bars, and all other highly loaded areas.

Regions subject to possible impact, such as the transom and side shell near guard, shall be designed in accordance with the ABS recommendations for vessels subject to impact.

120.3 Main Deck

365 Main Deck loading, in way of trailer access, shall be based on a design semitrailer with a maximum gross weight of 80,000 pounds and a single trailer axle maximum of 20,000 pounds.

Stiffeners shall be welded to the deck plates with full penetration, staggered intermittent welds. Double continuous welds of equal strength, may be allowed after successful demonstration and approval by the Resident Engineer that such a method can be accomplished without
370 “washboarding” of the plate.

Weather decks and all interior steel decks, coamings, and deck connections of steel bulkheads, in way of toilet/shower (T&S) modules, cleaning gear lockers, showers, scullery and refrigerated spaces shall be proven tight prior to application of any deck or bulkhead covering and after all preparatory work involving water tightness has been completed.

375 **120.4 Bulbous Bow**

The vessel shall have a bulbous bow to improve the vessel's hydrodynamic properties as shown on the Contract Drawings.

In constructing the bulbous bow section, four-way joint intersections shall be avoided. Use of such intersections must be reviewed and approved by the Resident Engineer.

380 **120.5 Tanks and Voids**

Tanks and voids shall be provided and arranged as indicated in the Contract Drawings

Limber and vent holes, 1½" radius minimum, shall be provided within tanks and voids to ensure proper venting and drainage of the spaces. Tanks shall have adequate limber holes and vent holes for full capacity flow to suction and vent lines.

385 All tanks and voids shall have adequate docking plugs so arranged to drain all liquid from all low spots at trim angles of ±0.02°. Docking plugs located in the shell shall be Type 316 stainless flush socket head. Shell opening shall be suitably reinforced with a threaded inset.

120.6 Cross Flooding Ducts

390 Non-centerline voids and the Fin Stabilizer Rooms shall be provided with cross flooding ducts arranged and sized as indicated in the Contract Drawings, and the Intact and Damage Stability Report.

120.7 Pillars and Stanchions

395 Pillars and stanchions shall be designed and provided to adequately support and transmit the imposed loads. Where additional pillars or stanchions appear necessary as the design develops, their location shall not interfere with the function of the vessel and shall be subject to approval by the Resident Engineer. Pillars shall be of steel seamless pipe, round tubing, or square structural tubing; and shall land on adequate strength members. The Contractor shall provide all necessary cap plates, bearing plates, chocks, etc. Electric resistance welded pipe **shall not** be allowed.

400 **150 DECKHOUSE STRUCTURE**

The deckhouse shall be fabricated in accordance with the Contract Drawings.

160 SPECIAL STRUCTURES (NOT USED)

162 STACK

405 The stack shall be fabricated of stiffened 3/16" steel plate and in accordance with Reference 070-01.

Provisions shall be made to keep diesel engine and diesel fired heater exhaust gases and soot from contaminating the ventilation air intakes, exterior deck areas, and exterior doorways during normal conditions of operation. The vessel's stack shall be provided with an efficient exhaust system that encloses all diesel engine exhaust gas systems except that for the EDG set. The stack

410 shall also provide space for machinery room ventilation fans and ductwork, MSD venting, and diesel fired heater exhaust gas piping. Internal insulation and sheathing shall be provided as required to meet the noise requirements of Technical Specification Section 1E.11.

Access to the top of the stack shall be provided from the port side. Access shall consist of vertical ladders and climber safety rails, as required, to service and maintain the top of the stack, 415 including after and outboard sides, and exhaust pipe covers. Stack top shall have piped deck drains to remove water.

Ladder access, lighting, and grating at all landing levels shall be provided inside stack.

163 SEA CHESTS

A total of four (4) ship service sea chests shall be provided. Two sea chests, one port and one 420 starboard, shall be provided in the Forward Machinery Room (FMR). Two sea chests, one port and one starboard, shall be provided in the Aft Machinery Room. The sea chests shall provide seawater for shipboard services as described in Technical Specification Section 520.

Sea chests shall be fabricated from pipe or plate thicker than the surrounding shell. If fabricated from pipe, thickness and insert details shall conform to ASTM F994 Type III for 24" pipe. Sea 425 chests shall be furnished with inlet strainer/guards with minimum ½" openings, removable for access to sea chest interior. Each sea chest shall have one primary opening for water intake and one vent/air blow down fitting as specified in Technical Specification Section 524. Sea chest design shall meet ABS rules and shall be sized at a minimum with double the net area of the intake connection.

430 165 HULL PENETRATIONS

All hull penetrations shall be constructed in accordance with ASTM F994 Type III.

166 SPONSONS

Sponsons shall be provided fore and aft at the sides of the ship, fairing into the guard plates, as shown on the Contract Drawings, to provide for proper fendering at docks. Sponsons shall be 435 incorporated into the side shell and form part of the watertight envelope of the vessel.

167 STRUCTURAL CLOSURES

167.1 Sliding Watertight Door Systems

A total of eight (8) sliding watertight doors shall be provided and installed as shown on the Contract Drawings. Sliding watertight door systems shall be Walz & Krenzer, or equal, power- 440 operated sliding doors configured for electro-hydraulic operation and conforming to ABS Rules and USCG regulations. Doors shall be capable of remote closure and have an accumulator or stored energy system to allow operation during loss of power.

Local controls shall be pre-mounted by the manufacturer on the door frame.

167.2 Hinged Watertight Doors

445 Hinged watertight doors shall be provided and installed as shown on the Contract Drawings and as follows: Vehicle Space to exterior at Frame 248 port and starboard. Hinged watertight doors shall be quick acting, Walz & Krenzer, Centex, PCM, or equal, conforming to the regulatory requirements of ABS and USCG.

167.3 Watertight Hatches

450 Watertight hatches shall be provided and installed as shown on the Contract. Watertight hatches shall be Walz & Krenzer, Centex, PCM, or equal, hatches conforming to the regulatory requirements of ABS and USCG. Hatches shall be quick acting, watertight, flush, spring balanced, 24" x 24" clear opening, and equivalent in strength to the surrounding deck.

167.4 Watertight and Oiltight Scuttles and Manholes

455 Scuttles and manholes shall conform to the regulatory requirements of ABS and USCG. Scuttles and manholes shall be 20" round in bulkheads and decks. Where possible, access shall be through deck in favor of bulkheads. Manholes into potable water tanks shall be through bulkheads. There shall be a minimum of two manholes per tank spaced at opposite ends.

460 Scuttles and manholes on Main Deck and in way of walkways shall be a flush design with stainless countersunk flathead socket machine screws. Remaining scuttles and manholes shall be raised on 3" coamings with stainless hex bolts.

167.5 Bolted Equipment Removal Plates (BERPs)

465 BERPs shall be provided as needed based on the Contractor's equipment removal plan, Technical Specification Section 1E.8. BERPs shall be watertight and equal in strength and material to the surrounding structure. At a minimum, the BERPs shown on the Contract Drawings shall be provided as well as those listed below:

In Decks:

1. Pump Room to Workshop above.
2. Lower MSD Room to Upper MSD Room above.
- 470 3. Overhead of Forward Machinery Room to Vehicle Space above.
4. Overhead of Aft Machinery Room to Vehicle Space above.
5. Overhead of Propulsor Equipment Room to Main Deck above.
6. Overhead of Bosun's Stores to Focsle Deck above.

475 In Bulkheads:

1. Bulkhead between MSD and FMR (1st Platform Level preferred).
2. Bulkhead between Workshop and Aft Machinery Room.

3. Inboard FMR uptake casing to the Vehicle Space.
4. Inboard Aft Machinery Room uptake casing to the Vehicle Space.

480 **167.6 Curtain Plate Access Ports**

Hinged watertight hatches shall be provided and installed in the curtain plate in way of the fueling stations port and starboard. Hatches shall be Walz & Krenzer, Centex, PCM, or equal, conforming to regulatory requirements of ABS and USCG. Hatches shall be 24" x 24", opening inboard, with dogs on inside only.

485 **169 SPECIAL PURPOSE CLOSURES AND STRUCTURES**

169.1 Vehicle Elevator and Turntable Systems with Side Doors/Ramps and Hatch

Refer to Technical Specification Section 575 for information regarding the vehicle elevator and turntable.

169.2 Stern Door

490 Refer to Technical Specification Section 573 for information regarding the stern door.

169.3 Hinged Exterior Decks

Refer to Technical Specification Section 575 for information regarding the hinged decks.

169.4 Vehicle Guards

495 Guards shall be installed on all corners of the casing and mezzanine overhangs in the Vehicle Space vulnerable to damage from vehicles. Guards shall be cut from 6" schedule 40 pipe either in one-half rounds or three-fourths rounds as appropriate. Details and extents of the guards shall be subject to approval from the Resident Engineer.

169.5 Pilothouse Maintenance Platform

500 A maintenance platform, GS METAL Corp. Heavy Duty Grip Strut, "H" Series, or equal, steel walkway channel system shall be provided at the Pilot House Deck level, forward of the Pilothouse.

A storm rail type horizontal handrail shall be provided just below the windows above the entire maintenance platform. A suitable climber rail safety system shall be provided in parallel with the handrail.

505 **171 MASTS**

The vessel shall have eight masts, arranged as shown on the Contract Drawings. The masts are designated as follows: two stub masts supporting the ship's radar scanners, a fore folding mast, a stub mast for the satellite communications system antenna, a stub mast for the GPS compass sensor, an after mast, and bow and after staffs.

510 The masts shall be suitable for mounting antennae and all navigation lights necessary to meet regulatory requirements for international service as indicated on the Contract Drawings. Structural reinforcement shall be provided for the loads imposed. The masts shall be self-supporting without the use of stays. The supporting structure, along with the mast, shall be designed to minimize blind arcs and false targets on the radars.

515 Masts and mast foundations shall be designed to minimize structural vibrations damaging to mounted equipment.

Mast rungs, climber safety rails, and tie-off pad eyes shall be provided on the after mast and after flag staff for servicing navigation lights.

171.1 Radar Masts

520 Two (2) stub masts supporting the ship's radar scanners shall be installed as detailed in the Contract Drawings.

171.2 Fore Folding Mast

525 The Contractor shall provide and install one (1) hinged mast system as shown on the Contract Drawings and described herein. The hinged mast shall be arranged for efficient handling to the satisfaction of the Resident Engineer.

170.2.1 Load Requirements

Design loads and margins are shown on Reference 171-01.

170.2.2 Functional Requirements

530 The hinged mast shall be capable of being lowered. To accomplish this requirement, the mast shall rotate around a fixed point above the Solarium House Top. The arrangements of the mast lowering mechanism shall be in accordance with Reference 171-01.

535 For helicopter operations and for mast equipment maintenance, no part of the mast system shall be greater than 10' above the Solarium House Top, when the mast is in the lowered position. In addition, when in the lowered position, no portion of the mast or attached equipment may encroach on the 15' diameter helicopter pick-up area.

The hinged mast shall be provided with a mast step (base) capable of supporting the mast while in the upright and lowered positions. The mast step shall be provided with collars to secure the mast in the upright position. All portions of the fixed mast step shall be less than 7' above Solarium House Top.

540 The hinged mast shall be provided with a mast rest capable of supporting the mast while in the lowered position.

To accommodate the required mast mounted equipment, the arrangement of the mast spars and mast top shall be in accordance with Reference 171-01.

As shown in Reference 441-01, the mast shall have space for:

- 545
1. Four (4) VHF antennas (8' in length).
 2. One (1) TV/AM/FM antenna.
 3. One (1) loudspeaker.
 4. One (1) Inmarsat C antenna.
 5. One (1) DGPS antenna.

550

 6. One (1) wireless bridge antenna.
 7. One (1) anchor light.
 8. One (1) flag.
 9. One (1) air horn..

555 The mast shall be provided with an engraved brass plate mounted on the mast step, which clearly defines the cumulative loads and cumulative wind areas of mast-mounted equipment given in the Mast Load Restrictions of Reference 171-01. A reference to an appropriate Working Drawing, containing more information, shall be provided on the engraved brass plate.

The mast shall also be capable of supporting a 4' long by 3' high flag on a halyard.

Anchor light shall not be obscured for more than 6° directly aft.

560 Equipment mounted on the mast shall be arranged to meet minimum separation distances.

The mast step shall be capable of carrying the vessel's horns on a horn bracket, as shown in Reference 171-01.

565 The hinged mast shall be arranged such that no damage to wires will occur throughout the mast range of motion. Power and data wires for mast-mounted equipment shall be arranged so disconnection of wires is not required when mast is raised or lowered. Power and data wires shall be provided with a cable loop, as shown in Reference 171-01, such that wires are not in tension during any range of mast motion.

170.2.3 Control Requirements

570 The mast shall be provided with an engraved brass plate mounted on the mast step, which clearly defines mast operating instructions for both raising and lowering the mast, as shown in Reference 171-01. Required personnel safeguards and procedures shall be clearly stated.

The hinged mast shall be capable of being changed from the full upright position to the lowered position, including securing the mast in either position, in less than 15 minutes using the effort of two vessel crew members.

575 The raising and lowering mechanism (hoist) shall be operable by one person. The second person is a spotter used to ensure safety during raising or lowering.

Mast movement shall be slow and deliberate. Mast shall be under positive control of a vessel crew member throughout the full range of motion. Positive control means that a momentary mistake by the crew member shall not result in free fall of the mast.

580 The hinged mast shall have smooth rotation throughout the range of motion without binding or jamming.

Mast raising or lowering operations shall not result in a crew member located below, or in the path of, the moving mast or any raising and lowering mechanisms, during any range of motion.

585 The mast shall have a mechanism to secure the mast in either the full upright or lowered position. Mast shall not rely on the raising and lowering mechanism to secure the mast for normal vessel operation.

171.2.4 Winch

590 One (1) Thern, or equal, Drill-Drivable 2W40-BM 4600-pound Capacity Worm Gear Hand Winch shall be provided as a winch for the vessel's hinged fore mast. Winch shall be capable of raising and lowering the mast in accordance with Reference 171-01 and the design requirements given in Section 171.2.1 of this specification.

171.2.5 Mast Rest

595 The Contractor shall install one (1) mast rest capable of supporting the mast while in the lowered position. Material for the mast rest shall be ASTM A36 Mild Steel. Height of the mast rest shall be set so that the lowered mast is horizontal.

171.3 Sat-Comm Mast

One (1) stub mast for the satellite communications system antenna radome shall be provided as shown on the Contract Drawings.

171.4 GPS Compass Mast

600 One (1) stub mast for the GPS compass shall be provided as shown on the Contract Drawings.

171.5 After Mast

One (1) secondary fixed mast shall be provided on the fore kingpost cross beam as shown on the Contract Drawings. The mast shall be fitted for navigation lights. Mast and foundations shall be designed to minimize structural vibrations damaging to mounted equipment.

605 Suitable ladders, handrails and climber safety systems shall be provided to service navigation lights on aft mast.

171.6 Fore and After Staffs

One (1) bow and one (1) stern staff shall be provided with all the necessary fittings, lights, and halyards as shown on the Contract Drawings.

610 **172 KINGPOSTS AND SUPPORT FRAME**

Refer to Technical Specification Section 575 for information regarding the kingposts.

179 SERVICE PLATFORMS

179.1 Lifeboat Service Platform

615 Port and starboard platforms shall be provided for boarding lifeboats at stern prior to davit launching. Platforms shall be well-supported and equipped with gratings, rails, and inclined ladders fabricated from steel to ABS and USCG requirements.

179.2 Helicopter Platform

620 A minimum 5m square raised platform for helicopter winching operations shall be located port side on solarium top, just aft of the main mast. Platform shall be well-supported and equipped with gratings, rails, and inclined ladder fabricated from steel to ABS and USCG requirements capable of handling a stretcher.

180 FOUNDATIONS

625 The Contractor shall design and provide foundations for all machinery and equipment. Appropriate support structure (brackets, etc.) shall be provided for all new equipment, such as electrical panels and instrumentation, regardless of weight.

The Contractor shall provide containment coamings around all equipment where oil leakage may occur.

All foundations shall meet the following criteria:

- 630 1. Foundation design shall provide adequate strength to support and maintain alignment of the mounted equipment in its operational mode. Loadings to be considered in design of foundations shall include:
- a. Dry weight of equipment.
 - b. Weight of fluids.
 - c. Dynamic loadings induced by equipment in operation.

635 d. Weights of supported ancillary components and/or systems (e.g. wiring, piping, control equipment, safety shields).

 - e. Ship motions.
 - f. In exposed locations, the loading caused by icing and snow, wave impact and wind shall be included.
- 640 2. Foundations shall be adequately supported by and braced to the vessel's structural members so that equipment loadings are properly distributed. Additional structural support members, headers, and chocks shall be provided as required. Foundations shall not be attached directly to unsupported plate.
- 645 3. Design of foundations shall provide for alignment and such other special criteria as may be specified by the equipment manufacturer or regulatory bodies.

4. Design of foundations shall permit equipment access as required, and access for maintenance of foundations and adjacent hull structure. Pockets and inaccessible places where corrosion cannot be controlled or where dirt and debris can accumulate shall be avoided.

- 650 5. Foundations shall incorporate suitable supports to prevent excessive or unusual vibration under the normal range of vessel operating conditions.

Foundations shall be arranged to provide clearance for disassembling parts, such as circulating pumps, filters, air coolers, pistons, stators, valves, and rotors, without dismantling other machinery, structure or piping.

- 655 Where machinery, such as a pump with motor, is supplied bolted to a substantial steel base, the base may be welded to the foundation, provided the machinery (including future replacements) can be aligned after welding the base and foundation together.

180.1 Design

- 660 The Contractor shall develop the details and scantlings for all equipment and machinery foundations. Requirements for rigidity and dynamic performance are specified in respective sections. Foundations, in general, are not shown on the structural Contract Drawings.

- 665 Foundations for rotating machinery, transformers, and power converters shall incorporate resilient mounts (including resilient sway mounts for equipment weighing over 500 pounds) in accordance with Technical Specification Sections 1E.11.4, 311.3, and 500.3 of these specifications. Collision chocks shall be provided for resiliently mounted equipment weighing 500 pounds or more.

- 670 The foundations for the machinery plant shall be such that the vibration levels do not exceed the limits of Technical Specification Section 1E.11. Foundations for antennas shall be such that natural resonant frequencies will not interfere with the effectiveness of the antennas. Foundations subject to cyclic or reversed loadings shall be designed to withstand fatigue.

Piping connections to machinery and equipment shall not be considered as reducing the load to foundations and supports.

- 675 Insert plates shall not be used to stiffen the deck in way of foundations if it is possible to accomplish the same by installing headers below the deck. In cases where insert plates are required to increase the section modulus of structural members in way of foundations, the insert plates shall extend past the point of maximum moment in the direction of lading. The extent of the insert shall be based on the reduction in moment and a minimum of 12" past the point of maximum moment. Exterior working deck insert plates shall be flush with the top of the adjacent deck.

- 680 Doubler plates shall not be used in foundations or to stiffen the deck in way of foundations.

- 685 Propulsion machinery and selected other foundations are shown in the drawings, based on manufacturer information currently available. The Contractor shall lay out foundations using certified drawings of the actual, selected equipment, following the Contract Drawings for design guidance. Foundation details such as bolt and shim arrangements and local girder support shall be finalized by the Contractor.

The Contractor shall design foundations for the generator sets and all other mechanical and electrical equipment and outfitting items. These foundations shall be designed in accordance with this section and with the noise treatment specifications in Technical Specification Section 1E.11.

690 **180.2 Structural Arrangement**

Continuity of structure shall be maintained along with adequate strength and rigidity so that loads are properly distributed into the hull structure. To minimize weight, structural members of the hull, reinforced as necessary to carry the additional loads, shall be used as parts of the foundations wherever practicable. Lightening holes shall be used, wherever possible, provided
695 that the required strength and rigidity is not adversely affected.

Equipment shall be supported without direct connection to the shell or other structure subject to wave impact, contact with waves, propeller excited vibrations or similar loadings where the distortion or vibration would damage the equipment or impair its performance. Machinery and equipment shall not be attached to two structures that can deflect relative to each other under
700 dynamic loadings. Equipment shall not be attached to watertight bulkheads if the deflection caused by flooding of adjacent compartments could render such equipment inoperative.

Accessibility shall be provided for inspection and maintenance of equipment.

The foundation structure shall be arranged so that under dynamic conditions, loading is distributed to all hold-down bolts.

705 Foundations shall be constructed so as not to contain pockets that could retain liquids. Complete drainage of foundations shall be provided.

180.3 Alignment

Provision shall be made for maintaining secure and accurate alignment for satisfactory operation of the machinery or equipment.

710 The rigidity of foundations and supporting structure shall be sufficient to prevent misalignment or movement that would interfere with operation of the machinery and equipment. For electronic equipment, top sway braces shall be installed if the ratio of height to the smaller base dimension is three or greater. These braces shall not restrain the equipment vertically. Bracing
715 for equipment mounted for noise and/or vibration reasons shall not produce a mechanical short between the piece of equipment and the rest of the vessel.

Foundations shall be designed to minimize misalignment or strain caused by thermal expansion under any operating condition.

Large units of machinery, weighing 500 pounds or more, that must be aligned with connected equipment shall be installed on fitted steel chocks or on cast resin chocks.

720 Small bearings (i.e., for shafts 2" outside diameter and smaller) that require permanent and accurate alignment, but which are not subject to heavy loads, may be kept in alignment with accurately fitted, tapered pins.

180.4 Attachment of Equipment to Foundations

725 Coamings, liners, gaskets, bolts, foundation blocks, and other material and fastenings shall be fitted, as required, for the attachment of machinery and equipment to foundations.

Unless otherwise specified, self-locking nuts of plastic-insert type or all-metal, self-locking nuts of distorted type, shall be provided to prevent loosening of hold-down bolts caused by shock or vibration.

730 The attachment of machinery and equipment to foundations shall accommodate thermal expansion without degrading performance.

735 In the assembly of machinery subjected to large-reversing stresses (such as independent thrust bearings, screw gear, and hydraulic cylinders of steering equipment), fitted bolts, keys, or dowel pins shall be used to withstand the forces tending to shift the unit on its foundation. Propulsion machinery and auxiliary machinery (such as windlasses, winches, and capstans) that exert heavy loadings on foundations shall be secured by means of fitted bolts.

Packing for through-bolts shall be provided, as required, to maintain tightness. Oil from machinery shall be prevented from leaking to compartments below.

740 Equipment without rotating parts, and not requiring removal for maintenance, may be secured by welding only with approval by the Resident Engineer. Main propulsion machinery and generators shall not be welded to their foundations.

Bolts, studs, lock washers, and cap nuts used to fasten aluminum components shall be of stainless steel. Threads shall be coated with a non-copper bearing, anti-seize lubricant. For aluminum components mounted in the weather, or where the possibility exists that the components may be exposed to seawater, stainless steel hardware shall be electrically isolated.

745 180.5 Requirements Specific to Equipment Exposed to Weather

750 All equipment exposed to the weather shall make use of watertight closed box foundations with removable drain plug as close to deck height as possible. The outside periphery of the box shall be flush with the base outline of the equipment so as to present a smooth, easy-to-maintain structure. Where high loads or safety make the use of studs impractical, flanges may be added to the closed sections to allow the use of other attachments suitable for the intended service.

**SECTION 200
PROPULSION MACHINERY**

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245-01 *Wake-Adapted Propeller Design*, [To Be Developed].

10 **200.1 General**

20 The propulsion plant is designed to achieve 15 knots in Sea State 4 at no more than 90% MCR on the two main diesel generator sets while supplying power to all propulsion system components and also supplying all ship service electrical power. Main propulsors shall be fully azimuthing without limitation, each with a fixed-pitch propeller in a pulling configuration and driven by a variable-speed AC motor.

All machinery requiring lubricating or hydraulic oils shall be supportable using Chevron products. Manufacturer's recommendations for lubricants shall identify the acceptable Chevron product.

The propulsion power plant shall be composed of the following major components:

- 35
1. Two (2) main diesel engines (see Technical Specification Section 311).
 2. Two (2) azimuthing electric propulsors.
 3. Two (2) propulsion switchboards (see Technical Specification Section 322).
 4. Two (2) propulsion motor drives.
 5. Two (2) propulsion transformers (if required for the type of propulsion motor drive used).
 6. Two (2) bow thrusters (see Technical Specification Section 568).
 7. Two (2) bow thruster motor drives (see Technical Specification Section 314).

40 An ISO 9001-certified organization having a demonstrated heritage of providing propulsion system integration services shall be provided by and responsible to the Contractor, to manage

and perform design integration, analyses, component selection, installation, testing, documentation, and training. The services shall also include obtaining regulatory body certifications for the propulsion system's primary machinery and equipment components and the final integration of the propulsion system. The propulsion system integrator demonstrated heritage for providing these services shall be at least 6 previous marine installations classed by either ABS, DNV, or Lloyd's.

200.3 Propulsion System Dynamic Analysis

The propulsion system integrator shall perform a propulsion system dynamic analysis with assistance from the engine manufacturer. The analysis shall predict the transient performance of the vessel and its propulsion system during open water and slow speed maneuvering (docking) operations, operations in waves, and "crash stops." The analysis shall employ representations of the salient hull characteristics (one degree of freedom), propulsion plant (engines through propellers), control systems, and the environment. The analysis shall be accomplished using computer simulations, test bed studies, other suitable techniques, or any combination of the foregoing that provides a reliable and realistic engineering basis for predicting the transient performance of the vessel and propulsion system as required above. All analysis and findings shall be submitted to the Resident Engineer for approval prior to the start of equipment procurement and fabrication.

The dynamic analysis shall be used to:

1. Support propulsion system detailed engineering, design development, testing, and evaluation, and to identify potential problems and corrective actions.
2. Aid in the orderly integration of the detailed electrical control and mechanical characteristics of selected propulsion system components.
3. Predict the adequacy of control system algorithms employed to control and protect the propulsion and electrical systems.
4. Predict that the vessel and propulsion system performance requirements given in these specifications will be satisfied.
5. Determine the dynamic characteristics of the system with respect to crash astern and crash ahead maneuvers, and corrective actions required, if any, to meet the maneuvering and other performance requirements.
6. Evaluate the dynamic performance of the diesel prime movers, including available torque versus RPM, the ability to accelerate, and factors, such as turbocharger lag, should be included.

200.4 Propulsion System Vibration Analysis

Both the generator supplier and thruster supplier shall perform a torsional vibration analysis (TVA) of provided equipment packages. The analysis and findings shall be submitted to the Resident Engineer for approval prior to the start of equipment procurement and fabrication.

The vibration analysis shall include the selection of resilient mounts (see Technical Specification Section 1E.11.4) and associated flexible couplings necessary to minimize structure-borne noise and vibration. Barred speed ranges within the normal operating speeds of the engine or

propulsion motors shall be unacceptable, as will raising the idle or lowering the maximum continuous RPM to avoid barred speeds.

200.5 Vibration Isolation

85 Each main generator set shall be mounted on resilient mounts as determined in Technical Specification Section 1E.11.4. The Contractor shall install the generator sets and mounts in accordance with manufacturers' recommendations.

90 All piping connections to the main engines and generators shall be made with ABS and USCG approved flexible connections in accordance with Technical Specification Section 505.9. Flexible connections shall have sufficient flexibility to accommodate the full range of engine and generator motion.

Torsional couplings between the engine and generator shall be designed for the maximum excursions of the main engine isolation mount system. Torsional couplings shall be provided by the engine supplier as part of the genset package.

202 PROPULSION MACHINERY CONTROL AND MONITORING

95 See Technical Specification Section 411.

233 PROPULSION INTERNAL COMBUSTION GENERATORS

The propulsion drive train shall include two (2) main diesel generator (MDG) sets. See Technical Specifications Section 311.

235 ELECTRIC PROPULSION AUXILIARIES

100 The propulsion drive train shall include two (2) 690 VAC, 3 phase, 60 hz main switchboards (See Technical Specifications Section 322), phase shifting transformers for harmonic distortion mitigation, and propulsion motor drives.

235.1 Propulsion Drives

105 The Contractor shall engineer, procure, and install two (2) new AC motor drives for the new AC propulsion motors.

The motor drives shall meet all USCG and ABS requirements for electric propulsion.

The Contractor shall provide all accessories, glands, multi-cable transit (MCT) inserts, lugs, bolts, etc. to facilitate a fully functional installation.

110 Braking resistors serving only the propulsor shall not be utilized in the propulsion drives. The propulsion drive controls shall be configured to limit the amount of regenerated power to the drive DC link if required to eliminate the need for braking resistors dedicated to each drive. See Section 314 regarding use of braking resistors utilized by major power electronics.

Propulsion Drive Salient Characteristics:

1. Input: As required based on the configuration of the propulsion switchboard.

- 115 2. Output: 690VAC, 3 phase to propulsion motor – amperage to be determined by Contractor after final equipment purchase is made.
3. All power and control cabling shall be through the top of the drive enclosure using Roxtec multicable transits. MCT packing modules shall be provided with the drives.
4. Enclosure rating shall be IP22 or greater.
- 120 5. Auxiliary power supply: 480VAC, 3P, 60Hz that provides power for the following items:
- a. Drive internal anti-condensation/standstill heater.
- b. Associated propulsion transformer standstill heater, controlled by contactors in propulsion drive.
- 125 c. Associated propulsion transformer cooling fans, controlled by contactors in propulsion drive.
- d. Associated propulsion motor standstill heater, controlled by contactors in propulsion drive.
- e. Propulsion drive DC pre-charge circuit.
- f. Internal liquid cooling circulation pumps for drive cooling.
- 130 6. Control power supplies: 2 x 120VAC, 60Hz, 1 phase, 500 Watts max.
7. Rated for 45C ambient temperature.
8. Freshwater cooled with separate integrated cooling water loop and heat exchangers.
9. Internal heat exchanger and all internal piping to be 316 stainless steel.
10. 2 x 100% capacity internal cooling pumps for redundancy.
- 135 11. Each drive to be furnished with sufficient cooling fluid for a single fill of the drive's internal liquid cooling system.
12. Each propulsion drive shall be configured for four emergency shutdown pushbutton devices, three from Pilot House stations, and one from the EOS. Each emergency shutdown shall incorporate loop monitoring using series and shunt resistors at the
- 140 pushbutton devices.
13. Each propulsion drive shall interface with the propulsion control system.

235.2 Propulsion Transformers

The Contractor shall furnish and install two (2) new transformers to feed the new propulsion motor AC motor drives if required by the type of drive front end used. If required, the

145 transformers shall be as described below.

The transformers shall each be new five winding transformers to feed the new propulsion motor drives from the 690V propulsion switchboard. A generic arrangement is shown in the figure below. The Contractor shall provide all accessories, glands, MCT inserts, lugs, bolts, etc. to facilitate a fully functional installation. The electrical power, instrumentation, and mechanical

150 piping connections for the two propulsion transformers shall be mirror images of each other, symmetric across the vessel centerline.

The new propulsion transformers shall be water-cooled with an integral water-to-air heat exchanger and dual circulation fans:

1. Suitable for use as infeed to 24 pulse diode front-end motor drive.
2. Approved for use by ABS & USCG for electric propulsion systems.
3. Copper windings, with earthed copper screen between windings.

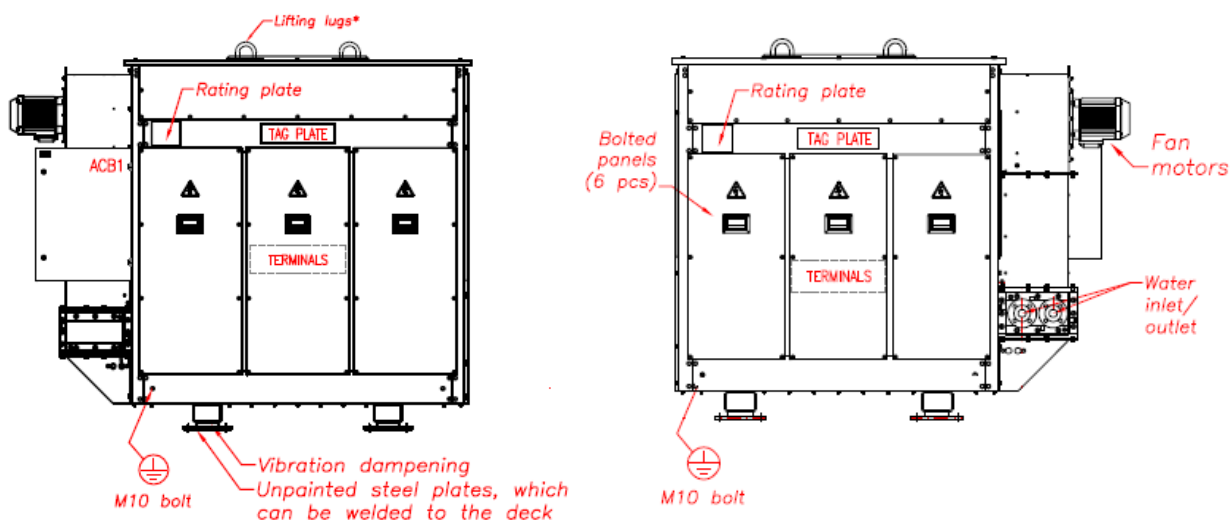


Figure 200 - 1 Preliminary generic propulsion transformer arrangement from Trafotek

249 AZIMUTHING PROPULSORS

249.1 General

The vessel shall be fitted with two (2) azimuthing electric propulsors. Each propulsor (i.e., thruster) shall be fully azimuthing without limitation, each with fixed-pitch propellers in a pulling configuration and driven by a variable-speed AC motor. Each propulsor shall be a self-contained unit with integrated auxiliaries.

Thrusters shall be ABB Azipod DO1100A, Thrustmaster T-Pod 1230PG, or L-drive configuration with factory integrated electric motors.

249.2 Propulsion Motors

Each azimuthing thruster shall utilize an integrated variable speed AC permanent magnet propulsion motor. Each motor shall be rated for unrestricted continuous output. Final motor specifications shall be confirmed by the equipment supplier prior to purchasing.

The propulsion motors shall be designed for low-vibration “quiet” operation, in order to reduce underwater radiated noise. This shall include any and all appropriate options available from the manufacturer, vibration-absorbing bearing housings, rotor balancing (balance quality grade G 2.5), encapsulation techniques, and insulation of the casing. The Contractor shall present options chosen to reduce motor vibration noise to the Resident Engineer, along with radiated

sound data, for evaluation. Each motor shall be isolated from the vessel's structure in accordance with Section 1E.11.4.

180 Each propulsion motor shall be permanent magnet type, alternating-current, three-phase,
outfitted for marine propulsion service. The motors shall be opposite turning but otherwise
identical. Each motor shall operate from a variable speed motor drive (Section 235). The motor
windings shall be insulation class F (155°C) and the enclosure and shall be provided with anti-
condensation heater or equivalent means of preventing condensation on the windings when idle.
185 In the case of crash stops, the motors shall remain spinning in their original direction and the
propulsors shall be configured to azimuth 180° in opposite directions.

Alternative motor characteristics may be acceptable if vessel performance is proven equivalent
and open Resident Engineer's review and acceptance.

249.3 Propellers

190 Each azimuthing propulsor shall utilize a fixed-pitch propeller with inwards rotation. The
propeller blade geometry shall be selected to obtain the best possible combination of efficient
propulsion and minimum vibration of the propulsion machinery and ship's hull assuming 15 knot
service speed. The propeller blades shall be manufactured in accordance with Reference 245-01.
Refer to Technical Specification Section 1E.11.7.3 for additional requirements regarding
propeller vibration analysis and control.

195 The propeller hub and blades shall be cast austenitic stainless steel in agreement with
ASTM A743, Grade CF-3.

Propellers shall be manufactured in accordance with ISO 484/1. Blade tolerances shall be in
accordance with ISO 484/1 Class I.

200 Each completed propeller's static balance shall comply with ISO 484/1. The weight of each
blade shall not deviate by more than 2% from the mean weight of all blades of the same hand. In
addition, the static unbalance of the assembled propeller shall not exceed the value determined
by:

$$U = \frac{4000W}{N^2}$$

205 where: U = Maximum residual static unbalance in ounce-inches
W = Weight of rotating part in pounds
N = Maximum operating RPM of unit

The following information shall be clearly stamped on the hub and individual blades in locations
that shall be visible after the propeller is installed:

210	Hull No. Weight	Plan No. Manufacturer	Contract No. ABS Approval	Diameter Material	Pitch - 0.7R Heat No.

249.4 Steering Modules

215 Each azimuthing propulsor shall include a dedicated full-follow-up, electric or electro-hydraulic steering system with a full-follow-up back-up system. Each steering system shall meet all regulatory body requirements, and shall include reservoir, pumps, motors, cooler, head tank, filters, instrumentation, and controls. All primary steering system components shall be integrated with the propulsor.

249.5 Cooling System

220 Each azimuthing propulsor shall include an integrated freshwater cooling system for the propulsion motor and/or auxiliaries. The system shall utilize an external freshwater source from the vessel as its heat sink.

249.6 Shaft Seal

Each azimuthing propulsor shall include a barrier fluid circulation unit to provide lubrication of the mechanical shaft seals.

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- 10 201-02 *Auxiliary Machinery and MSD Room*, AMHS Drawing No. 14-201-050-002 [To Be Developed].
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- 330-01 *Electrical Lighting Deck Plans – Interior*, AMHS Drawing No. 14-330-092-001 [To Be Developed].
- 20 330-02 *Electrical Lighting Deck Plans – Exterior*, AMHS Drawing No. 14-330-092-002 [To Be Developed].
- 430-02 *Vehicle Elevator, Door/Ramp and Hatch Block Diagram*, AMHS Drawing No. 14-430-095-002 [To Be Developed].

301 GENERAL REQUIREMENTS

- 25 The vessel electrical system shall be powered by an integrated diesel electric system consisting of a combination of two (2) main diesel generator (MDG) sets and two (2) ship service diesel generator (SSDG) sets. Propulsion power shall be low voltage and ship service power shall be 480 VAC, 3 phase, 60 Hz. During normal operation, all ship's power shall be generated by the two MDGs.
- 30 Two (2) 3,000ekW, 690VAC, 3 phase MDG sets shall be connected to the propulsion switchboards to provide propulsion and maneuvering power and shall be connected to the 480VAC ship service switchboards via transformers. 480VAC power shall serve ship service loads and the vehicle elevator and turntable system (VETS) shall be able to be powered from the SSDGs. Two (2) 550 ekW, 480 VAC, 3 phase, 60 Hz, SSDG sets shall be connected to supply
- 35 the 480 VAC ship service switchboard to provide a secondary source of ship service electrical power when required. The connection may be direct on the 480VAC ship service switchboard, or through the propulsion switchboard specified by the Electrical Integrator and approved by the Owner. One (1) 550 ekW, 480 VAC, 3 phase, 60 Hz, emergency diesel generator (EDG) set shall be installed to provide emergency power.
- 40 Propulsion and ship service switchboards shall each be separated between forward and aft machinery spaces for redundancy. Switchboard halves shall connect with bus ties and suitable bus tie breakers. The bus ties shall be through a water-tight, A-60 fire boundary.

A shore power system shall be provided for use during extended periods at dock. Shore power shall be via dual 400 Amp, 480VAC, 3 phase, 60 Hz, receptacles (800 Amp total) installed on

45 each side of the ship in the Vehicle Space, connected to the auxiliary switchboard.

The equipment and designs shall comply with the requirements of the USCG, ABS, and IEEE 45. IEC standards may be accepted as a substitute for IEEE, or other standards as allowed by the above regulations. Electrical generating and distribution equipment shall be fitted with alarms, indicators, and controls necessary to meet ABS machinery automation classification

In addition, the following guidance shall be followed:

1. USCG NVIC 2-89.
2. *ABS Guidance Notes on Control of Harmonics in Electrical Power Systems.*

The operating voltages of electrical systems shall be 690 VAC, 480 VAC, and 208Y/120 VAC, both three-phase and single-phase power. A nominal 1000 VDC bus and bus-tie in the propulsion switchboard will also be accepted. Control voltages shall be 120 VAC, 24 VDC and 12 VDC, as required. Equipment or systems requiring voltages other than those listed shall be provided with integral power conversion equipment that will accommodate power input at one of the listed voltages.

301.1 Electrical Growth Reserve

The ship service electrical system (480 VAC and below) was designed with an additional reserve of 10% in generating capacity and a growth reserve in the electrical distribution system (switchboards, motor control centers, and panelboards) of at least 20%. Cables shall be sized to support the eventual consumption of the growth reserve. The Contractor shall maintain this growth allowance throughout the design and construction period.

301.2 Power Quality and Characteristics

The AC power system characteristics shall comply with IEEE 45 Clause 4.5, as delineated in Table 300 - 1. All equipment shall accommodate the power system characteristics and tolerances shown.

Table 300 - 1 Alternating current (AC) power characteristics (from IEEE 45)

Characteristics	Limits
Frequency	
a) Nominal frequency	60 Hz
b) Frequency tolerances	± 3%
c) Frequency modulation	1/2 %
d) Frequency transient:	
1) Tolerance	± 4%
2) Recovery time	2 sec.
e) The worst-case frequency excursion from nominal frequency resulting from item b), item c) and item d) 1) combined, except under emergency conditions	5-1/2 sec.

Characteristics	Limits
Voltage	
a) User voltage tolerance:	
1) Average of the three line-to-line voltages	± 5%
2) Any one line-to-line voltage, including item a) 1) and line voltage unbalances item b), below	± 7%
b) Line voltage unbalance	3%
c) Voltage modulation	5%
d) Voltage transient:	
1) Voltage transient tolerances	± 16%
2) Voltage transient recovery time	-2 sec
e) Voltage spike (peak value includes fundamental)	± 2500 V (380-690 V) system 1000 V (120-240 V) system
f) The maximum departure voltage resulting from item a) 1) and item d) combined, except under transient or emergency conditions	± 6%
g) The worst-case voltage excursion from nominal user voltage resulting from item a) 1), item a) 2) and item d) 1) combined, except under emergency conditions	± 20%
Voltage Waveform Distortion	
a) Maximum total harmonic distortion (THD)	5%
b) Maximum single harmonic	3%
c) Maximum deviation factor	5%
Emergency Conditions	
a) Frequency excursion	-100 to +12%
b) Duration of frequency excursion	Up to 2 min.
c) Voltage excursion	-100 to +35%
d) Duration of voltage excursion:	
1) Lower limits (-100%)	Up to 2 min.
2) Upper limit (+35%)	2 min.

301.3 Harmonic Interference

The harmonic voltage distortion levels shall be maintained ≤5% THD and shall be verified by an analysis of the electrical system, performed by the Contractor. This analysis shall utilize a proven computer power system analysis program, such as SKM Power*Tools (any recognized analysis program using the principles found in IEEE 399 is acceptable), to determine the harmonic contributions, and their effects, from large motors (>50 HP), uninterruptible power supplies (UPSs), major cyclic loads, motors with variable frequency drives (VFDs), etc. The system shall be modeled in the steady state condition in several operational scenarios to include transit operations and elevator operations while operating on MDGs only, SSDGs only, and

75

80 shore power. A report detailing the results of the harmonic analysis shall be developed by the Contractor and delivered to the Resident Engineer.

Power quality shall be verified during vessel trials to ensure that the harmonic voltage distortions are in line with the predicted levels and less than the allowable limits. Harmonic measurements shall be taken at the 690VAC propulsion switchboard, 480 VAC ship service switchboard, 85 208/120 VAC load centers, and 480 VAC emergency switchboard (while connected to the main switchboard only). Harmonic measurements shall meet the recommendations of the ABS *Guidance Notes on Control of Harmonics in Electrical Power Systems*.

301.4 Electromagnetic Environmental Effects

90 All electrical and electronic systems shall not interfere with any other electrical or electronic systems electromagnetically.

Radiators and receptors of electromagnetic energy and related electronics on the vessel shall be designed and installed to ensure electromagnetic compatibility and to avoid hazards from electromagnetic radiation to personnel. Personnel at or enroute to normal operating stations, including the masts, shall not be exposed to electromagnetic energy in excess of the limits 95 established in IEEE C95.1, 3 kHz to 300 GHz.

100 All Medium Frequency (MF)/HF transmit antennas shall be installed with non-metallic personnel guards located so as to provide a minimum distance of 7.87' (2,400 mm) horizontal separation from any working areas, manned stations and personnel access areas. All areas within this region shall be designated as hazard areas, by painting the deck, and provided with warning signs in accordance with IEEE C95.2. Areas outside this region that violate the safe levels as defined in IEEE C95.1 shall be identified as personnel "no loiter" areas. Warning signs shall be provided to designate no loiter areas.

105 Automated control systems, communication systems, and electronic systems shall not respond spuriously to electromagnetic interference from radiating sources or transients on power lines. Cables interconnecting power equipment items that utilize solid-state high frequency switching devices and cables that carry high amplitude pulses shall be physically separated from more sensitive cables whose signal data would be distorted by induced interference. Table 300 - 2 provides minimum required cable separation distances. Cableway crossings shall be as nearly perpendicular as practical with maximum practical separation. Cables shall be 110 routed within the vessel structure and protected from electromagnetic radiation from on-ship transmitting antennas to the maximum extent practicable. All transducer and motor drive (e.g., VFD) cabling shall be shielded. Special attention shall be paid to manufacturers' guidance for grounding shields.

115 All cables routed in topside areas exposed to the weather shall be shielded. Shielding shall be accomplished through the selection and use of shielded cable or by routing cable through shielding conduit. Shielding conduit shall be flexible metal hose, totally enclosed metallic cableways bonded to base structure, metal pipe bonded to base structure, or totally enclosed steel cable trunks. Armored cable does not meet these shielding requirements. The outermost overall cable shield of shielded cables shall be grounded at weather deck or weather bulkhead 120 penetration points. Metal tubing and waveguides routed in topside areas shall be grounded at

deck or bulkhead penetration points. Tubing shall be grounded by welding or by a welded flange, or shall utilize the method specified for cable shield grounding.

Table 300 - 2 Cable group separation distances (inches)

Cable Group Classification		A	B	C	D	E	F	G	H	I	J	K	L	M
A	MDG Cables	--	24	24	36	36	36	36	36	36	36	36	36	36
B	VFD Power Cables	24	--	18	24	18	18	18	36	18	18	18	18	36
C	Power and Lighting	24	18	--	2	4	2	4	12	18	18	18	18	24
D	Control Cables	36	24	2	--	4	2	4	12	18	18	18	18	24
E	Receiving Antenna Cables	36	18	4	4	--	2	2	12	18	18	18	18	24
F	TV/VHF Antenna Distribution	36	18	2	2	2	--	2	12	18	18	18	18	24
G	Telephone/ Audio Distribution	36	18	4	4	2	2	--	12	18	18	18	18	24
H	Sonar Transducer	36	36	12	12	12	12	12	--	18	18	18	18	24
I	HF Transmitter/ Coupler Cables	36	18	18	18	18	18	18	18	--	18	18	18	24
J	HF Coupler/ Antenna Waveguide Cables	36	18	18	18	18	18	18	18	18	--	18	18	24
K	VHF/UHF Transmitter Cables	36	18	18	18	18	18	18	18	18	18	--	18	24
L	Radar Transceiver Coaxial or Waveguide	36	18	18	18	18	18	18	18	18	18	18	--	24
M	Digital Data Bus	36	36	24	24	24	24	24	24	24	24	24	24	--

302 ELECTRIC MOTORS AND ASSOCIATED EQUIPMENT

125 302.1 Motors

130 Main thruster and bow thruster motors shall be suitable for operation on 690 VAC, three-phase circuits. All other motors of 1 HP and larger shall be suitable for operation on 480 VAC, three-phase circuits unless otherwise specified. Three-phase motors shall be of the squirrel-cage induction type. Single-phase motors shall be high starting torque, capacitor start and shall operate satisfactorily on 120 VAC, 60 Hz. Three-phase motors shall be NEMA Design B, unless the characteristic of the driven machine requires otherwise.

Motors rated 5 HP and above, not incorporated in a vendor-supplied module or system, with the exception of the main thruster, bow thruster and elevator motors, shall be obtained from a single manufacturer.

135 Multi-speed motors shall be variable torque unless otherwise specified. Locked-rotor and breakdown torques and locked-rotor current shall be as called for in the NEMA standards for the design involved.

All motors shall meet the efficiency rating for NEMA ultra-premium efficiency motors. All motors shall be equipped with anti-friction sealed bearings of suitable design to take the required

140 thrust and radial loads. All motors shall be totally enclosed and fan cooled. Insulation shall have fungus inhibitors. Each motor shall be fitted with a nameplate of corrosion-resistant materials. Motors shall be designated as hostile environment motors having a 1.15 service factor, stainless steel shaft, Class F insulation or better and an epoxy coating on the case.

145 At a minimum, motors for use on weather decks shall be IP66, corrosion-resistant, and shall be equipped with sealed insulation. The stator winding shall be insulated and varnish-treated to provide a sealed insulation system. The insulation system shall seal the windings and connections against contaminants.

150 Enclosures of any motors serving essential loads rated 60 HP and greater located in damp areas and all motors located in weather locations shall be provided with strip heaters within the enclosures to reduce condensation when idle. Provisions shall be made to automatically disconnect the heaters when the motor is in operation.

Motors with aluminum frames shall not be used except for HVAC use where not exposed to the weather.

155 Motors intended for use with VFDs shall be classified as “inverter ready” or “inverter duty” and provided with shaft grounding, voltage spike resistant insulation systems, and insulated bearings.

302.2 Motor Controllers

160 Motor controllers shall adhere to the requirements of UL Standard 508 including marine supplement, USCG, and ABS regulations. Where “local” or “remote” operation is indicated in relation to motor control, local shall mean at the motor controller (individual or motor control center), and remote shall be anywhere but at the motor controller, e.g., in integrated monitoring, alarm, and control systems (IMACS), or at the motor (e.g. remote pushbutton station). All equipment shall have start control, latchable stop control, and run indication at the equipment, except in the case where the motor controller is located immediately adjacent.

165 Individual controllers shall have the same characteristics and shall be designed to accommodate plug-in, combination starters with internal circuit breakers, either thermal-magnetic or motor circuit protector (MCP) type, or fused disconnect switches. The disconnect handle shall be lockable in the “off” position. There shall be a provision to open the controller door with the handle in the “on” position by means of a defeater screw. The controllers shall be rated for the maximum short circuit current available at their location.

170 Controllers for single-speed or two- speed, non-reversing motors $\frac{3}{4}$ HP or less may be of the manual across-the-line type. Switches installed in motor circuits shall have a rated amperage of not less than the nameplate locked rotor current of the motor served. Where multiple fan units are fed from a single distribution panel, the fan controllers shall be collocated.

175 Controllers for all other motors shall be of the magnetic across-the-line type, unless momentary voltage drop at the ship service switchboard, with a single generator supplying power to the electrical system, requires a current limiting type starter or VFD.

The maximum voltage dip criteria for motor starting shall be 5% for a cyclical load, such as air or air-conditioning compressors, and 15% for any single motor. Solid-state reduced voltage

starters shall be used on motors of 30 HP and greater. The solid-state starter shall meet the requirements of the motor controllers, and have the following features:

1. Adjustable current limit from 150% to 425%.
2. Solid-state overload relay with test feature.
3. Phase loss protection.
4. Shorted thyristor converter detection.
5. Thermal sensor thyristor converter protection.
6. Easily replaceable power poles.
7. Plug-in logic modules.
8. LED diagnostics.
9. Rugged modular construction.
10. Bypass contactors to engage when the motor is up to speed.

Variable-speed motor controllers shall be designed to meet the speed control requirements of their respective motors and driven loads. All variable speed controllers shall be supplied with filtering circuits to minimize the effects of induced harmonics to the power system; at a minimum, all VFDs shall be provided with 5% line-side reactors or equivalent DC choke. All variable speed motor controllers shall meet the requirements of ABS, which include portions of IEC 61800 and IEC 60146.

Controllers installed in interior locations shall have, at a minimum, IP22 enclosures. Controllers in weather or damp or corrosive environments, including all machinery spaces less than 3' above the deck plate level, shall have, at a minimum, IP66, corrosion-resistant, enclosures. Controllers located in hazardous zones shall be explosion-proof.

All magnetic controllers shall be NEMA controllers and sized to the horsepower rating of the motor. All controllers shall be capable of operating under all expected conditions of vibration and roll, pitch, and trim as specified in Technical Specification Sections 1E.11.3 and 1E.9.

All motor controllers shall utilize NEMA-rated contactors. Starters shall have external manual overload reset and have ambient-compensated bimetallic or solid state thermal overload relays. Starter coils and control circuits shall be 120 VAC or lower input voltage. Individual control circuit transformers shall be provided operating at 120 VAC or lower. Control transformers shall be fused on both primary and secondary windings.

Motor controllers shall have all pushbuttons, switches, and indicator lights required for operation mounted on the face of the controller. Remote operating stations shall be provided where control from more than one location is required, when the motor starter is not located in the line of sight from the motor, or as required by other sections of the Specifications or regulatory bodies.

Each door for an enclosure containing a combination motor starter unit shall have control operators and run indicator lights mounted in it as described. Unless otherwise specified, operating controls shall be mounted in the front of the enclosure and push-to-test motor running pilot lights shall be provided. Run indicator lights shall be green for single-speed motors and variable speed motors. For two-speed motors, the indicator lights shall be blue for low speed and

green for high speed. Controllers with “hand”, “off”, and “auto” control shall be provided with amber lights indicating “auto” control. All indication lights shall be LED, push-to-test type.

220 Hour meters shall be provided at the motor controllers for all motors 5 HP and above.

Motor controllers shall have provisions to allow connection to, and operation from, the IMACS (see Technical Specification Section 431). Low voltage protection shall be provided in all motor controllers, except those specifically required to be of low voltage release type by the regulatory bodies.

225 Magnetic controllers that operate from a remote (automatic) two-wire pilot device (level switch, pressure switch, etc.) shall be provided with the additional relay necessary to provide for low voltage protection. They shall also be provided with a local manual three-position selector switch for “hand”, “off”, and “automatic” operation. Controllers that operate from pressure or level switches shall have the high-pressure or level setting stop work regardless of the mode
230 selected.

Motor controllers not incorporated in an existing vendor-supplied module or system shall be obtained from a single manufacturer.

All motor disconnect devices shall be capable of being locked in the open position. Motor controllers shall be provided with the necessary fused circuits for energizing “power on”
235 indicating lights.

Pushbutton and switch operators shall meet enclosure requirements, but be watertight/oiltight (IP55 and IP54) at a minimum, momentary for low voltage protection functions and maintained (selector switch) for low voltage release functions.

240 All controllers, operators, and indicators shall be labeled in accordance with Section 305 and Technical Specification Section 602. A fire resistant control-wiring diagram shall be installed inside the access door of each controller. This drawing shall reflect field connected signals and controls, and shall be readily legible.

245 Enclosures of controllers, local control switches, and disconnect switches, in non-climate-controlled areas, shall be provided with heaters within the enclosures. Provisions shall be made to automatically disconnect the heaters for controllers when the respective motors are in operation.

303 BONDING AND GROUNDING

The installation recommendations and wiring practices, including grounding requirements, shall comply with the practices set forth in MIL-STD-1310.

250 Large metal items attached by a low resistance connection to the vessel’s hull are considered extensions of the vessel’s hull and are at ground potential.

The following equipment shall be bonded and grounded to the vessel’s ground potential:

1. Equipment utilizing electrical power.
2. Fuel tanks and pipes.

- 255 3. Metallic standing rigging and masts.
 4. Metallic hoisting gear.
 5. Removable metallic lifeline stanchions, liferails, and all ladders.
 6. Water tanks.
 7. Metal ducts.
- 260 8. Transformers.
 9. Three-phase receptacles.
 10. Engines, main propulsion shafting.
 11. Sonar trunks and seachests.
 12. Resiliently mounted equipment shall be bonded as described herein.

265 The outermost metallic surface of equipment connected to electrical power of 30V or more shall
 be grounded. A third conductor in the power supply cable, a bond strap or a bracket shall be
 used to ground electrical and electronic equipment installed on resilient mounts. Other electrical
 and electronic equipment is considered properly grounded if it has areas of solid metal-to-metal
270 contact or installation bolts. Slide-mounted or roller-mounted equipment shall be grounded by a
 conductor within the equipment cable harness. Caution shall be exercised where dissimilar
 metals have been isolated.

Wherever possible, running rigging such as flag hoists shall be non-metallic. Metallic standing
rigging shall be bonded to ground potential through the use of bond strapping.

275 In each of the preceding grounding requirements, the resistance between each item of equipment
 and the ground point shall not exceed a DC resistance of 0.1 Ω .

280 Bonding and grounding straps shall be fabricated from appropriate braided cable. Lugs shall be
 installed on each end of the cable to facilitate bond strap installation. Lugs shall be selected to
 match the mating surface. Bond strap length shall be the minimum necessary but shall have
 sufficient length to prevent vibratory shorts on resiliently mounted equipment. Surfaces where
 bond straps and lugs are to be attached shall be prepared for installation by cleaning to bare
 metal. Bond straps placed in topside areas shall be weather sealed after installation by priming
 and painting the lugs and areas affected by welding, or by coating the bolted lugs and associated
 hardware with weather sealing compound. Bond straps shall not be painted.

304 ELECTRIC CABLES

285 304.1 Cables

The construction of cable shall be in accordance with MIL-DTL-24643, IEEE 45, or IEC 60092
for marine, low-smoke, halogen-free, PVC-free, flame-retardant cable, as allowed by the
regulations.

290 All insulation will be type LSE or LSX; halogen free and suitable for operation with 90°C
 conductors. Cable jacketing shall be halogen free, type L or TPO.

Fiber-optic cables shall meet the construction/flame propagation requirements of ABS and shall be of robust marine grade construction.

Unarmored cable shall generally be used in all locations, including in the weather. Cable shall be protected in locations where damage to the cable may occur.

- 295 Cable conductors shall be sized so that the maximum AC voltage drop does not exceed 5%. Feeder cables shall be sized to include the 20% growth at the panelboards. Voltage drop calculations shall be submitted to the Resident Engineer for review. No conductor smaller than 14-gauge AWG (2.5 mm²) shall be used for general power and lighting service. Special cable may be used for electronic equipment as recommended by the equipment manufacturer, 300 providing it is qualified for low flame propagation per IEEE 45, ABS, or equivalent.

All control cable and motor operated valve cables shall be shielded, grounded, and fire rated as per regulatory requirements.

- 305 Portable cables shall be of the UL type SOOW. Portable cables for heat-producing appliances shall be heat and flame-resistant. All portable cables shall contain an extra conductor for equipment grounding.

Cables for VFD applications shall be VFD-rated including 100% overall shield and concentric grounding conductors. Manufacturer guidance for installations and terminations shall be followed to minimize disturbances from VFDs.

304.2 Cable Installation

- 310 Cables shall be run as directly as possible consistent with practical cableway groupings, hazardous locations, etc. Cables shall be concealed in bulkheads or overhead in spaces that are lined. Where possible, cableways shall be run overhead through passageways.

- 315 Control and treatment of electrical noise shall be considered during planning of electrical distribution. A detailed cable routing and management plan shall be developed and submitted to the Resident Engineer for review prior to installation. It shall reflect the wiring level/cable separation requirements for power, signal, and control cables. This plan shall be maintained and updated throughout construction and submitted every three (3) months to the Resident Engineer.

- 320 Cableway crossings shall be as nearly perpendicular as practical with maximum practical separation. See Section 301 for electromagnetic environmental effects and cable separation distances.

Low voltage signal cables shall be separated from power cables with high content of harmonics and spikes, and shall be protected from electromagnetic interference by installation in separate cableways or in conduit as specified in Section 301.

- 325 Cables that are subjected to mechanical damage shall be suitably protected by metal guards. Likewise, cables subjected to possible moisture dripping shall be provided with sheet metal drip shields.

Cables shall be supported by either a manufactured tray system, or fabricated “open” cableways consisting of steel angle or square tube downcomers with angle crosstrees spaced in accordance

330 with regulatory requirements to minimize cable sag. Retention devices (metal and/or plastic
straps as allowed by the regulations) shall be installed in accordance with IEEE 45. Cableways
shall be designed to support all cabling required to pass through them in a single layer (per tier)
with 20% spare capacity except cableways dedicated to generator, thruster, or bus-tie cables need
not have any spare capacity. Cables may be installed two layers per tier when required;
335 however, those cables' ampacity shall be de-rated per the regulations. Cableway structure shall
be strong enough to withstand short circuit conditions.

Cables for deckhouse exterior lighting, receptacles, etc., shall be run inside the deckhouse as far
as practicable. Exterior cable runs to equipment and lighting on deck shall be located in conduit.
Cables for lights and instruments on the main and aft masts shall be run interior to the mast as far
as practicable.

340 Openings for passage of cables through non-tight bulkheads shall be edged with metal strips or
plastic bushings to prevent chafing. MCTs, Rextec or equal, shall be installed in fire-rated
and/or watertight bulkheads and decks in lieu of stuffing tube nests when there is a requirement
for three or more cable penetrations in any given location. The transits shall be readily
345 accessible from both sides of the penetration and shall have at least 30% reserve capacity for the
future installation of cables during vessel upgrades.

Where single cables penetrate decks, there shall be a 9" high kick pipe with watertight gland and
sealing compound molded to shed water, or equivalent arrangement. For locations where three
or more cables are penetrating the deck in the same vicinity the cables shall penetrate through a
MCT. The top of exterior MCT shall be raised above the deck by a minimum of 6" and the cable
350 shall be protected to prevent damage and corrosion.

Cables to flexibly mounted equipment shall be arranged with sufficient bends and slack such that
mechanical noise transmission across the cable is attenuated and the cables do not impede the
free motion of the equipment under ship slamming conditions.

355 All cable connections shall be made within equipment enclosures or standard approved
appliances with terminal blocks. Terminal blocks shall be non-combustible and moisture-proof,
with barriers between terminals. Terminal lugs shall be of the solderless type. The lugs shall be
of a type that will prevent turning. Cable terminals shall use ring-type or eyelet-type terminals to
the maximum extent possible to prevent cables from slipping out of connections while in service.

360 Cables connected to equipment in hazardous zones shall be provided with appropriately rated
fittings and glands.

305 ELECTRICAL DESIGNATION AND MARKING

Labels shall be provided and installed in accordance with Technical Specification Section 602.

311 ELECTRICAL POWER GENERATION

311.1 General

365 Two (2) MDG sets and two (2) SSDG sets shall be provided and installed to supply the
propulsion and ship service power requirements for the vessel. The MDGs and SSDGs may
either be of the constant speed, 60hz type or the variable speed type; both MDGs must be of the

same type and both SSDGs must be of the same type. One (1) constant speed EDG set shall be provided to supply emergency power for the vessel. The MDGs shall be the main electrical power source, the SSDGs shall be an auxiliary source of power for ship service loads when the MDGs are offline, and the EDG the emergency source. The MDG, SSDG, and EDG set skid assemblies and accessories shall be certified to ABS Rules, ~~AMS~~ and ~~ACCU~~.

Each MDG shall be rated for unrestricted continuous power output of minimum 3,000 ekW, and each SSDG set shall be rated for unrestricted continuous power output of minimum 550 ekW.

Unless otherwise specified, electric power consuming equipment shall be selected to have a frequency rating of 60 Hz and one of the following nominal voltage/phase ratings:

1. 690 VAC, three-phase, 3-wire.
2. 480 VAC, three-phase, 3-wire.
3. 208 VAC, single or three-phase, 3- or 4-wire (neutral included).
4. 120 VAC, single-phase, 2-wire.

Direct current shall be provided in the following nominal voltages, as required:

1. 24 VDC.
2. 12 VDC.

AC power source, distribution system conductors, and current carrying parts shall be ungrounded, except the neutral of wye-connected systems.

311.2 Main Diesel Generators

Each diesel engine and alternator shall be mounted on a common skid by the engine manufacturer/provider, and shall be isolated from the vessel's structure by resilient (vibration isolator) mounts in accordance with Technical Specification Section 1E.11.4.

311.2.1 MDG Engines

The Contractor shall furnish and install the two (2) main diesel engines. The main engines shall be Wabtec model 12V250MDC, or equal, turbo-charged and after-cooled; each rated 4,218 BHP (continuous) at 900 RPM. Power ratings shall be based on ISO 3046/1 test methods. The engines shall meet EPA Tier 4 emission requirements without the need for Diesel Exhaust Fluid.

The engines shall be provided with all manufacturer's recommended parts and components as detailed below, as well as certification and technical files demonstrating compliance with MARPOL Annex VI and EPA Tier 4 emissions requirements, and ABS certification. The engines shall be identical.

Each propulsion engine shall be configured with the following engine-driven pumps:

1. Diesel oil feed pump.
2. High-temperature cooling pump.
3. Low-temperature cooling pump.
4. Lubricating oil circulating pump(s).

405 Shipped-loose components provided with the engine shall be installed and plumbed in accordance with the manufacturer's recommendations.

Propulsion engine safety controls shall be provided as required to obtain regulatory body approvals and certifications. Engine safety controls shall not automatically alter the propulsion power output; i.e., shutdown engine, reduce engine speed, disengage clutch or reduce propeller pitch, unless mandatory for regulatory approval.

410 The propulsion engine local control, alarm, and instrument panels shall provide for clear access to the engine for performing maintenance tasks without removing the panels.

415 The propulsion engine combustion exhaust manifold shall include provisions (i.e., safety screen) for preventing turbocharger damage in the event of a combustion chamber component failure such as an exhaust valve. The manufacturer shall account for this requirement when stating engine power and performance characteristics.

Each engine-generator set shall be provided with the controls necessary to allow auto-paralleling with the other engine, and the ability to be remotely started and stopped.

Each main engine shall be provided with the following loose-shipped accessories installed by the Contractor:

- 420 1. 90° exhaust turning elbow.
- 2. Exhaust stack sensor.
- 3. Double chamber jacket water expansion tank (for high and low temp circuits).
- 4. Kim Hotstart, or equal, for jacket water and oil heating, with circulating pumps for both "keep warm" and "pre-lube" capability.
- 425 5. Water Separator Filter, Racor model 79812 or equal.
- 6. Stage 1 fuel oil filter.
- 7. Fuel oil hand pump.
- 8. Local engine control panel with HMI for engine control and monitoring, see Section 311.2.2.
- 430 9. Power supply unit for control and monitoring.
- 10. Interconnect box for control and monitoring.

311.2.2 Local MGD Engine Control Panel

435 A stand-alone local control, instrumentation, and alarm indication shall be provided and installed on a vibration-dampened panel mounted adjacent to each engine. All data available within the panel shall be capable of being displayed to the operator. This shall include, as a minimum, the following:

- 1. Start/Stop and speed regulation.
- 2. Start/Stop keep-warm system.
- 3. Start/Stop pre-lube oil system.
- 440 4. Engine lube oil pressure and temperature.

5. Engine lube oil sump level.
6. Engine jacket water inlet and outlet temperature.
7. Fuel pump discharge pressure.
8. Fuel manifold pressure.
- 445 9. Engine jacket water pump discharge pressure.
10. Engine raw water pump discharge pressure.
11. Air manifold pressure.
12. Engine RPM.
13. Hour meter (rollover after 99,999.9 hours or greater).
- 450 14. Cylinder exhaust temperature.
15. Turbocharger inlet and outlet exhaust temperatures.
16. Fuel consumption rate.
17. Crankcase pressure (-5" to +5" water gauge).
18. Start air pressure.

455 Each of the control panels shall be provided with an engine manufacturer-supplied computerized controller to interface with the diesel engines for IMACS and power management control.

The Contractor shall provide and install the necessary communication equipment and wiring for integrating with the IMACS and power management system.

460 An interconnect box and power supply shall be provided to facilitate local control station connections.

311.2.3 MDG Alternators

465 Two identical alternators shall be provided and connected to their respective main diesel engine on a common skid. Each alternator shall be rated for 3,000 ekW at 900 rpm, 690 VAC, 3 phase, 60 Hertz and 0.8 power factor. Each alternator shall be capable of a 10% overload at rated power factor for 1 hour in 12 hours of operation. Each alternator shall be marine-rated, totally enclosed, freshwater-cooled, self-regulating, brushless, three-phase synchronous with salient pole rotor, built-in exciter machine.

470 The main machine and exciter rotors shall be fitted together with rotating rectifier and fan on the same shaft. The rotor itself shall be supported by two sleeve type bearings and extended at the drive end. It shall be press-fitted on the shaft and excited by an integrated exciter. The exciter rotor with plain poles shall be mounted on the machine on the non-drive end. The exciter rotor shall be accessible after dismantling the rectifier cooler.

475 The stator shall consist of a welded chassis in which the stator bundle is press-fitted and locked against rotating. The stator bundle shall have a stator-sheet core, a main and auxiliary winding. The exciter stator shall be mounted in the end shield on the non-drive end of the machine and shall be of a pole type. The stator shall be provided with permanent magnets intended to excite the machine during starting.

The generator bearings shall be of the antifriction type with relubrication and grease amount regulator. The bearings shall be fitted in the end shields.

480 A terminal box shall be fitted on the top of the generator stator box. The terminal box shall contain all equipment necessary for generator connection and operation.

The generator shall be equipped with temperature sensors in the stator winding. Bearing thermometers shall be provided in the bearing caps.

485 The generators shall be freshwater cooled in accordance with Technical Specification Section 532 and shall be provided with anti-condensation heater or equivalent means of preventing condensation on the windings when not in use

Each generator shall be complete with separate excitation, load sharing and voltage/frequency regulation control modules, and each generator shall include local monitoring and control (at the switchboard – see Section 322.2).

490 The generator excitation shall be switched off when the generator protective device trips due to overload or actuation of one of the protective relays.

When operated under automatic control, a generator shall be capable of assuming full load upon closure of its main circuit breaker.

495 The generator voltage, frequency, stability, harmonics and waveform characteristics shall be suitable for powering the various electronic equipment and other equipment provided with electronic controllers without affecting the operation of the controllers. See Section 301 above for power quality requirements.

311.3 SSDG Set Design and Configuration

311.3.1 SSDG Engines

500 The Contractor shall provide and install diesel engines for the two SSDG sets. The diesel engines shall be Caterpillar Model C18 ACERT generator set package, or equal, each rated for unrestricted continuous power output of 599 bkW. The generators shall be Caterpillar type SR4B, or equal, rated at 550 ekW, with 10% percent overload operation for 2 hours every 24 hours. The diesel engines shall be provided with EPA Tier 3 and ABS certification. The two
505 engines shall be identical.

Each diesel engine and alternator shall be mounted on a common skid by the engine manufacturer/provider and shall be isolated from the vessel's structure by resilient (vibration isolator) mounts in accordance with Technical Specification Section 1E.11.4.

510 Each SSDG engine shall have all necessary auxiliary system and components provided for normal operation, as specified in Technical Specification Section 500.

Each engine-generator set shall be provided with the controls necessary to allow auto-paralleling with the other engine, and the ability to be remotely started and stopped.

Each generator set shall be provided with the following manufacturer provided components:

1. Engine mounted fuel return cooler connected to the on-engine low temperature cooling circuit.
2. Heating element installed at the engine oil cooler and heater thermostat installed at the right rear location of engine head.

311.3.3 Local SSDG Engine Control Panel

A stand-alone local control, instrumentation, and alarm indication shall be installed on a vibration-dampened panel mounted adjacent to each SSDG engine. All data available within the panel shall be capable of being displayed to the operator. This shall include, as a minimum, the following:

1. Start/stop and speed regulation.
2. Start/stop keep-warm system.
3. Start/stop pre-lube oil system.
4. Engine lube oil pressure and temperature.
5. Engine lube oil sump level.
6. Engine jacket water inlet and outlet temperature.
7. Fuel pump discharge pressure.
8. Fuel manifold pressure.
9. Engine jacket water pump discharge pressure.
10. Engine raw water pump discharge pressure.
11. Air manifold pressure.
12. Engine RPM.
13. Hour meter (rollover after 99,999.9 hours or greater).
14. Cylinder exhaust temperature.
15. Turbocharger inlet and outlet exhaust temperatures.
16. Fuel consumption rate.
17. Crankcase pressure (-5" to +5" water gauge).
18. Start air pressure.

Each of the control panels shall be provided with an engine manufacturer-supplied programmable logic controller (PLC) to interface with the diesel engines and alternators for IMACS functions and for power management.

311.3.2 SSDG Alternators

The alternators shall be marine-rated, self-regulating, brushless, three-phase synchronous with salient pole rotor, built-in exciter machine and electronic voltage regulator, capable of being operated at 1,800 RPM with a marine-rated diesel engine. Each of the alternators shall be rated for continuous unrestricted output at 550 kW with a 0.8 power factor.

The alternators shall consist of main stator, main field, and internally implemented exciter, with an auxiliary winding for the power supply to the automatic voltage regulator.

The stator housing shall be of welded design. The stator core pack shall consist of hydraulically pressed, low-loss dynamo laminations, pressed together with the housing via pressure plates to form a compact unit. The stator winding shall be insulated in accordance with appropriate insulation class according to IEC 60034, Part 18. The winding heads and wiring shall be supported by suitable fastening elements and firmly linked together by mechanical means to guard against electrodynamic loads caused by current forces.

The rotor shall consist of the shaft, the main revolving field, exciter rotor, and rotating rectifier with rectifier protection elements. The main revolving field in a salient pole design shall be constructed with hydraulically pressed lamination sheets or steel plates. A damper cage shall be installed, with the bars electrically connected within the pole shoes, as well as from pole to pole. The main rotor windings shall be flat copper and protected against centrifugal forces by suitable components. The rotor shall be dynamically balanced with half key in accordance with IEC 60034, Part 14.

Bearing plates shall be welded. The alternator feet shall be integrated in the bearing plates or located as near as possible to the bearing plates in order to grant optimum vibration stiffness.

Each of the alternators shall have the following technical ratings and features:

1. Three-phase, 480 VAC, synchronous alternator.
2. Degree of protection IP44, lesser IP rating down to IP22 may be considered provided ABS approves the suitability of the alternator enclosure for use in the local area firefighting (LAFF) zone.
3. Insulation class H (180°C).
4. Single-bearing design.
5. Individual acceptance by ABS (essential service).
6. Steady state voltage performance from $\pm 0.5\%$ to 1% at: No load to rated load.
7. Power factor 0.8.
8. Parallel operation – alternators suitable for automatic parallel operation.
9. Electronic voltage regulator with voltage drop device for parallel operation, to be mounted in the main switchboard.
10. Anti-condensation heater or equivalent means of preventing condensation on the windings when not in use.

Passive insulation monitors shall be provided for the alternators. The monitors shall alarm locally and through the IMACS for low insulation conditions.

312 EMERGENCY GENERATOR SET (EDG)

An EDG shall be provided and installed. The EDG prime mover shall be Caterpillar Model C18 ACERT generator set package, turbo-charged, four-cycle diesel engine of sufficient power to

drive a continuous-rated generator of 525 kW. The engine shall be radiator cooled and provided with EPA Tier 3, and ABS, certifications.

590 The engine shall be close-coupled to a 480 VAC, three-phase, 60 Hz generator, continuously rated and sized to meet applicable USCG and ABS requirements, at 1,800 RPM, with a 0.8 power factor providing for a 10% growth margin. The generator shall additionally be rated for 10% overload operation for 2 hours every 24 hours. The generator shall be a Caterpillar, type SR4B. The EDG shall be connected to the ship's emergency electrical distribution system as described in Section 323.

595 The generator shall comply with the applicable requirements of EPA, ABS and USCG, the recommendations of IEEE 45, NEMA MG-1, and/or the IEC. The generator skid assembly shall be isolated from the vessel's structure by resilient (vibration isolator) mounts in accordance with Technical Specification Section 1E.11.4.

600 The generator shall be equipped with a PMG excitation system. Both the PMG and the rotating brushless exciter shall be mounted outboard of the bearing. The system shall supply a minimum short circuit current of 300% of the rating for 10 seconds.

605 The voltage regulator shall be solid state with no voltage build-up relay or other relays acceptable. The unit shall be encapsulated for humidity and abrasion protection. The regulator shall include true volts per Hertz operation with adjustable cut-in, loss of sensing continuity shutdown, over-excitation shutdown with inverse time characteristic and three-phase rms sensing. The voltage regulator shall be factory wired and tested with the generator.

The EDG set shall be monitored by the IMACS. For required monitoring points, see Technical Specification Section 431.

The EDG engine shall have all necessary auxiliary systems and components provided for normal operation. Auxiliary system information can be found in Technical Specification Section 500.

610 A stand-alone local control, instrumentation, and alarm indication shall be installed on a vibration-dampened panel mounted adjacent to the engine. All data available within the panel shall be capable of being displayed to the operator. This shall include, as a minimum, the following:

1. Start/stop and speed regulation.
- 615 2. Start/stop keep-warm system.
3. Start/stop pre-lube oil system.
4. Engine lube oil pressure and temperature.
5. Engine lube oil sump level.
6. Engine jacket water inlet and outlet temperature.
- 620 7. Fuel pump discharge pressure.
8. Engine jacket water pump discharge pressure.
9. Air manifold pressure.
10. Engine RPM.

11. Hour meter (rollover after 99,999.9 hours or greater).

625 12. Cylinder exhaust temperature.

13. Fuel consumption rate.

14. Crankcase pressure (-5" to +5" water gauge).

The control panel shall be provided with an engine manufacturer-supplied PLC to interface with the diesel engine and alternator for IMACS functions and for power management.

630 The EDG set shall be provided with the following optional components:

1. Engine mounted fuel return cooler connected to the on-engine low temperature cooling circuit.

2. Heating element installed at the engine oil cooler and heater thermostat installed at the right rear location of engine head.

635 3. Skid mounted radiator cooling with engine driven fan. Radiator shall be coated with Heresite protective coating to prevent corrosion.

313 STORAGE BATTERIES AND CHARGING EQUIPMENT

640 The Contractor shall provide and install battery/charger systems to furnish 24 VDC power to engine starting and control systems as delineated in this Section. Battery/charger systems shall be installed in accordance with ABS rules and USCG regulations, and shall include:

1. Emergency Generator Starting and Control.

2. Emergency Switchboard Control.

3. SSDG Set Control and 480 VAC Ship Service Switchboard Control.

4. Propulsion Control and Monitoring.

645 Batteries shall be sealed, maintenance free gel cell or absorbent glass mat (AGM) type. All batteries shall be of the same type. Battery charging equipment shall be in accordance with IEEE 45.

650 Batteries shall be provided, as well as storage racks, interconnecting wiring, transfer and disconnect switches, chargers, and monitoring instrumentation to make complete and fully operational battery systems as required herein and by the regulatory bodies.

Each battery system shall be fitted with a regulated, constant voltage, automatic float charger, LaMarche type A41 (type A46 for engine starting batteries) marine battery charger, or equal, sized to maintain fully charged batteries and carry full load.

655 Battery chargers shall be equipped with DC voltmeter and ammeter. Output ripple shall be filtered to 1% of the rated output voltage. USCG approved switches shall be installed for each system to allow safe disconnection of the chargers from both supply and load voltages. Battery chargers shall be monitored/alarmed by the IMACS as required by the regulatory agencies.

660 Batteries shall be stored in boxes or enclosures constructed and ventilated in accordance with USCG regulations. Battery boxes located in the weather, or other non-heated space, shall be provided with a space heater.

313.1 Emergency Diesel Starting and Control Battery System

A 24 VDC engine starting system with the configuration and battery capacity to comply with ABS/USCG Regulations shall be provided and installed to automatically start the EDG set. The control circuits shall monitor starting to prevent overcrank and to assure battery reserve capacity in accordance with regulations.

This battery system shall also provide 24 VDC power to the engine control panel, as required by the engine manufacturer. The Contractor shall provide and install appropriate distribution circuit protection for the starting and control circuits. The battery/charger system shall be sized to start the emergency diesel engine as required by the regulations, supply engine control power for 30 minutes, and shall be fed from the emergency power system.

The batteries and charger shall be installed in the Emergency Generator Room. The batteries shall be stored in a dedicated battery box(es) and firmly secured in a position where excessive movement is prevented.

313.2 Emergency Switchboard Control Battery System

A 24 VDC emergency switchboard control battery system shall be provided and installed by the Contractor. This system shall provide all required control/alarm/indication power to the switchgear system and switchboard-mounted power management, engine regulation, control, and monitoring equipment, as required. The battery/charger system shall be sized to supply full switchboard control power for 30 minutes and shall be fed from the emergency power system.

The batteries and charger shall be installed in the Emergency Generator Room. The batteries shall be stored in a dedicated battery box(es) and firmly secured in a position where excessive movement is prevented.

313.3 Ship Service Generator Set and 480 VAC Ship Service Switchboard Control Battery System

A 24 VDC battery system shall be provided and installed by the Contractor serving the SSDG generators and 480 VAC ship service switchboard control. This system shall provide all required control/alarm/indication power to the two SSDGs and the 480 VAC ship service switchgear, including the switchboard-mounted power management, engine regulation, control, and monitoring equipment, for each engine, as required. The battery/charger system shall be sized to supply full switchboard control power for 30 minutes and shall be fed from the emergency power system.

Two sets of batteries and charger shall be installed, one in each machinery space (forward and aft), adjacent to the associated 480 VAC ship service switchboard. The batteries shall be stored in a dedicated battery box(es) and firmly secured in a position where excessive movement is prevented.

Alternate configurations and voltages meeting the backup duration may be used if approved by the Owner.

313.4 Main Generator Set and 690 VAC Main Switchboard Control Battery System

A 24 VDC battery system shall be provided and installed by the Contractor serving the main generators (MDGs) and main switchboard control system. This system shall provide all required control/alarm/indication power to the two MDGs and the 690 VAC main switchgear. The battery/charger system shall be sized to supply full switchboard control power for 30 minutes and shall be fed from the emergency power system.

Two sets of batteries and charger shall be installed, one in each machinery space (forward and aft), adjacent to the associated 690V propulsion switchboard. The batteries shall be stored in a dedicated battery box(es) and firmly secured in a position where excessive movement is prevented.

Alternate configurations and voltages meeting the backup duration may be used if approved by the Owner.

314 POWER CONVERSION EQUIPMENT

314.1 Bow Thruster Motor Power Conversion Drives

The Contractor shall furnish and install two new AC motor drives for the new AC bow thruster motors, one each. Selection of the drives and specific requirements shall be informed by the final chosen thruster supplier and the propulsion switchboard configurations. The Contractor shall provide all accessories, glands, MCT inserts, lugs, bolts, etc. to facilitate a fully functional installation. The motor drives shall meet all USCG and ABS requirements for electric propulsion.

Computer control of each drive shall provide the necessary motor current to maintain the set thrust reference. The computer control shall also limit power if demand exceeds the capacity of the generators operating at the time or the power or torque limit of the bow thrusters. Regenerated power associated with quick reversals and emergency stopping shall be absorbed to the greatest extent by other online loads supplemented by a braking resistor bank for when regenerated power exceeds the capacity of the supply system to absorb it.

AC and DC filters shall be provided as required to protect against line voltage spikes, switching surges and electrical noise. Instruments and control switches shall be mounted on front hinged doors.

314.2 Vehicle Elevator & Turntable System

The Contractor shall furnish and install a comprehensive electrical power and control system for the Vehicle Elevator and Turntable System (VETS). The system shall take 480VAC electrical power from either section of ship service switchboards (forward or aft) and power various electric motor loads and controls in the VETS. See Technical Specification Section 575 for additional VETS requirements.

314.3 Dynamic Braking Resistors

The Contractor shall provide and install, if required, dynamic braking resistors to absorb the regenerative power produced by the two stern propulsors, two bow thrusters and VETS. The

resistors shall be sized in consultation with the propulsor, thruster and drive manufacturers and shall account for the power generated by the worst-case dynamic braking scenario: both stern propulsors together in a crash stop situation. The braking resistors shall be either fresh water-cooled or air-cooled.

740 **314.4 Transformers**

All transformers shall be constructed in accordance with IEEE 45, with copper windings, and be of an energy-efficient design. Transformer banks rated below 25 kVA shall have two 5% full capacity below normal (FCBN) primary winding taps. Banks rated 25 kVA and greater shall have two 2.5% full capacity above normal (FCAN) primary winding taps.

745 All low-voltage transformers shall be rated for 115°C rise, maximum. Transformers located in spaces other than machinery spaces, shall have an IP protection rating as required by ABS and an ambient temperature rating of 45°C. Transformers located in machinery spaces shall have a minimum protection level of IP22, and shall be rated for an ambient temperature of 50°C.

Transformers shall be located in well-ventilated areas, as near as possible to their service loads.

750 Transformers shall be electrostatically shielded between windings to divert primary electrical noise to ground, except when the transformer is part of a commercially available item.

Required drive and distribution transformers shall be provided as shown on Reference 301-01.

314.5 Uninterruptible Power Systems

Two major UPS systems shall be provided, a vital systems UPS and a non-vital systems UPS.

755 The vital systems UPS shall provide power to critical vessel systems to meet the transitional and final emergency power supply requirements of the regulatory bodies. The non-vital systems UPS shall provide power to additional systems as defined below.

Means shall be provided to monitor both the vital and non-vital UPS status within the IMACS. Voltage regulation shall be $\pm 1\%$ steady state, and $\pm 6\%$ for a 100% step load. Voltage recovery time shall be $\sim 16.6\text{ms}$ (one cycle). Voltage distortion shall be $< 2\%$ THD for linear loads, $< 5\%$ THD for non-linear loads. The batteries shall be firmly secured in a position where excessive movement is prevented during operations.

765 UPSs shall be provided with bypass capability. UPSs shall be provided with means to be disconnected from both supply sources and loads served. UPSs that are located in the same compartment as equipment they serve shall be provided with remote disconnect(s) for loads served. UPSs shall be standardized whenever practicable. The equipment manufacturer shall provide any UPSs integral to the use of their equipment.

314.5.1 Vital Systems UPS

770 The vital systems UPS shall be from the same manufacturer as the non-vital systems UPS to minimize different spare parts. The vital systems UPS shall be sized to provide power to the following loads for 30 minutes, with 20% capacity reserved for future installations.

1. IMACS.

2. Area lighting for muster stations.
3. Floodlighting for lifeboat and liferaft embarkation.
- 775 4. Navigation lighting alternate power feed.
5. Whistle control.
6. Watertight door controls.
7. Fire door holdback and release systems.
8. Helicopter pick-up area lighting.
- 780 9. Firefighting/damage control station.
10. Other loads as indicated on Reference 301-01.

Systems specified to be provided with integral battery backup, or vendor-provided UPS (e.g. fire detection/alarm, interior communications, Global Maritime Distress and Safety System [GMDSS]), are not required to be powered from the vital systems UPS.

785 314.5.2 Non-vital Systems UPS

The non-vital systems UPS shall be from the same manufacturer as the vital systems UPS to minimize different spare parts. The non-vital systems UPS shall be sized to provide power to the following loads for approximately 30 minutes, with 20% capacity reserved for future installations.

- 790 1. CCTV system.
2. Satellite communications system.
3. Shipboard network switches and routers.
4. Shipboard point-of-sale (POS) system.

314.6 Pilothouse Electronics 24 VDC Power Systems

795 The Contractor shall provide and install a 24 VDC conversion/distribution system for the Pilothouse navigation electronics and radios (other than GMDSS), as required. The system shall consist of a 120 VAC/24 VDC power supply, NewMar, or equal, and an appropriately-rated and -sized distribution panelboard. The power supply and panelboard shall feed loads in the center, and bridge wing, consoles, and also the internal lighting for the binnacle-mounted
800 magnetic compass (see Section 421.3). The power supply shall be fed from the vital systems UPS, 208Y/120 VAC Pilothouse UPS Panel EP-01 (see Reference 301-01).

315 SHORE POWER CONNECTION

805 Two (2) shore power connection stations, one port and one starboard, shall be provided and installed on the Main Deck in a location approved by the Resident Engineer. For each station, two dead front, interlocked, 480 VAC, three-phase, 400A, receptacles shall be provided in an 800A capacity station as determined by the maximum load from the shore power load condition shown in the required load analysis (see Technical Specification Section 1D.6). Receptacles and enclosures shall be IP66 and corrosion-resistant, and shall have a bottom entrance, for the shore connection cable, as required by USCG regulation 46 CFR 111.83-5.

810 Each shore power connection station shall contain two 400A, current-limiting, molded case, circuit breakers, one connected to each receptacle to protect the fixed cable between the shore power connection station, and the 480V ship service switchboard. External white LED pilot lights to indicate “Shore Power Available” shall be provided on the enclosure for each receptacle.

815 Shore power emergency disconnect pushbuttons shall be provided at each shore power station and in the EOS. These pushbuttons shall trip the shore power circuit breakers.

The 480 VAC ship service switchboard shall be provided with shore power voltmeter, ammeter, phase-check relay with indication, and synchronizing equipment to allow seamless transfer to and from the shore power connection. “Shore Power Available” and “Breaker Closed” lights shall be provided on the switchboard. Shore power breakers shall be interlocked, such that closing a shore power breaker will open the incoming circuit breakers from transformers T1, T2, and SSDGs (see Reference 301-01). An interlock shall be provided to allow automatic shore power breaker closure only when both shore power plugs are energized and both circuit breakers at the shore power box are closed. If one of the shore power plugs is removed, or a circuit breaker at the shore power box trips, the main shore power breaker for that connection at the switchboard shall open. Shore power circuit breakers in the main switchboard shall be interlocked to allow only a single shore power connection to the switchboard.

When the ship is on shore power, means shall be provided to prevent inadvertent paralleling of ship’s generators with shore power upon loss of shore power.

830 Two (2) flexible shore power cables with appropriate terminations shall be provided. Each cable shall consist of a mating plug, for the vessel’s shore power receptacle, with a 100' length of UL Type W, 350MCM, four-conductor cable, lugged for the onshore connection at the free end.

A grounding lug shall be provided at each shore power station for grounding the vessel while in drydock. The lug shall be sized for the full rating of a shore power conductor.

835 **320 ELECTRIC POWER DISTRIBUTION SYSTEMS**

All electrical equipment and materials shall be of types suitable for the services intended and shall operate under all expected conditions of vibration and roll, pitch and trim as specified in Technical Specification Section 1E.11.3 and Section 1E.9. Generally, equipment shall be designed and installed to operate under the conditions outlined in this section.

840 In accordance with USCG regulations, equipment shall be manufactured to operate at ambient temperatures of 40°C in non-machinery spaces, and 45°C in machinery spaces and on weather decks. Rotating electrical machinery shall be rated for 50°C in machinery spaces and on weather decks. Circuit breakers, constructed to UL489 (w/marine supplement) shall be rated at 40°C.

845 Electric machinery, equipment, and wiring shall be located to ensure adequate natural cooling to avoid exceeding rated temperatures. Equipment designed based on the standard 40°C or 45°C ambient temperatures shall require no special design considerations to compensate for short duration shutdown of ventilation systems.

Electrical installations shall be of non-watertight construction unless noted otherwise. Non-watertight boxes, cabinets, and enclosures shall meet regulatory requirements and shall be, at a

850 minimum, of IP22 construction. Cable entries to enclosures shall be provided with cable glands. Any unused entries shall be sealed.

Equipment shall operate such that when power is interrupted and restored, no damage will result to any component or part of the equipment.

855 All electrical equipment shall be appropriately protected or shielded to prevent the equipment from being damaged. The equipment shall be flush mounted when installed in sheathed bulkheads and ceilings and the electric cables shall be concealed.

Power consuming equipment shall operate as specified with a steady state voltage tolerance and frequency tolerance described in Section 301.

860 IP66 rated, waterproof, corrosion-resistant enclosures and impervious sheathed cables shall be used in all locations subject to condensation of vapors and in locations either temporarily or permanently exposed to the weather or subjected to routine washing down. All electrical equipment located in the Vehicle Space or vehicle elevator locations shall be IP66 rated, waterproof, and corrosion resistant.

865 All electrical equipment and wiring, including spare parts, shall be treated and otherwise suitably protected against corrosion, moisture, salt, mold, or other destructive agents to which they may be exposed under climatic conditions during normal operation in marine environments.

All electrical equipment requiring external wiring shall be provided with suitable terminal boards or blocks equipped with solderless terminals to which the Contractor shall make all necessary connections.

870 Electrical equipment and cabling located in hazardous zones shall be appropriately rated.

Circuit breakers shall adhere to the requirements of UL Standard 489 including the marine supplement, and applicable regulations. Circuit breakers shall be rated for 40°C, and shall comply with UL Standard 489, including the marine supplement.

324 SWITCHGEAR AND PANELS FOR ELECTRIC POWER AND LIGHTING

875 324.1 Switchboards

324.1.1 General

Switchboards shall be constructed, configured, and located in accordance with the requirements outlined in IEEE 45, and/or IEC 60092, and ABS Rules. General locations shall be in accordance with Reference 201-01, 201-02, and 201-03.

880 In the general design and arrangement of the switchboards, particular attention shall be given to the equipment's overall dimensions to ensure an installation with adequate overhead clearances, deck space, safe operation, maintenance, and troubleshooting access.

885 The equipment shall be designed for continuous operation at the maximum ambient temperature to which the equipment and/or any part is exposed. All parts and subassemblies that could require servicing, repair or replacement during the life of the equipment shall be accessible.

Potential transformers shall be used for indicators, instruments, meters, and relays connected to AC circuits over 230V. Transformers for voltage regulators shall not be used for other purposes.

890 The switchboard metering shall be sized and positioned for an unobstructed view. For analog metering, the scales shall be of a range such that the normal value reading shall appear between $\frac{1}{2}$ and $\frac{3}{4}$ scale. The accuracy of all instruments and the precision of the scale graduation shall be within 2% of full scale. Readings for safe and prudent operations shall be available on separate displays. In general, meters shall only display a single parameter. Switchboard metering shall be Yokogawa, or equal. Meters depictions on PLC screens shall not include glare.

895 The switchboards shall be designed and built to provide ready front access for installation, inspection, maintenance and repair, and shall include hinged panels with door stops and holding devices to secure them in the open position. Covered terminals shall be provided for any equipment (switches, fuses, meters, etc.) mounted on the doors that carry voltage 120 VAC or greater.

900 Smooth non-conductive handrails shall be mounted on the front of the switchboards. The rails shall be attached in such a manner that panels can be removed or opened without rail removal, and they shall not extend more than 4" from the surface of the switchboard. Handrails shall run the entire horizontal length of the switchboard, with appropriate breaks for door access. The switchboards shall be provided with drip shields extending from the top edge.

905 Switchboard lighting shall be provided to adequately illuminate the switchboard without excessive glare. The lighting shall be LED and consist of a row of lamps with lenses that are mounted integral to the drip shields and extend the full length of the switchboard. The fixtures shall be connected to the emergency lighting system (there shall be no switch controls for switchboard lighting).

910 All indicator/pilot lights in the switchboards shall be LED and provided with momentary push-to-test capability.

Cable shall enter the switchboard from either top or bottom; bottom entry is preferred. All cable penetrations to the switchboard shall be sealed to prevent dust ingress. Cable penetrations through the top of the switchboard shall also be watertight using cable glands or MCTs.

915 The generator and switchboard main distribution buses shall be provided with vacuum, air, and/or molded case circuit breakers of the quantity, frame size, interrupting capacity, and trip element ratings indicated on the Contract Drawings. Fuse protection shall be restricted to instrumentation, very low current devices, and power electronics. Where fuse protection is used above 24VDC, it shall be provided with fuse blown indication to alert the operator without opening the enclosure.

920 Air circuit breakers, if used, shall be separated by horizontal metal partitions from instrumentation and control equipment within the same section.

925 Current transformers associated with the ground fault detection system shall be installed in the wiring gutters serving the transformers. A suitably rated metal oxide varistor or similar type over-voltage protection device shall be located in the vicinity of, and installed across the leads of, each current transformer. All bus work shall be hard-drawn, commercially pure copper with the bars and connections provided with silver surfaced contacts. The bars and fastenings shall be

braced to withstand the maximum available short circuit current as determined by the Contractor's short circuit analysis.

930 The switchboard distribution sections shall be designed and sized for at least 20% future expansion in capacity. Positions within the switchboard designated for future breakers shall include fully insulated and braced connections and all other parts/features necessary to accept the breakers. Spare circuit breakers, with frame sizes generally as shown on Reference 301-01, shall be provided in the ship service switchboard and emergency switchboard.

935 Where space is provided for the future installation of a circuit breaker, it shall be complete in all respects with the exception of the circuit breaker and lugs. All necessary circuit breaker studs and mounting hardware shall be provided. The front panel shall be cut out and fitted with a suitable cover plate.

Switchboards, including the emergency switchboard, shall be provided by the same manufacturer.

940 **324.1.2 Propulsion Switchboard**

The generator control and propulsion switchboards shall be integrated units, with main bus, circuit breakers input and output protection, and diesel-generator controls and protections. Two identical switchboards shall be provided for redundancy, connected with suitable bus tie breakers. Each switchboard shall be rated IP22 and rated for 45°C ambient temperature.

945 If the propulsion switchboards are designed with a 690VAC main bus then it shall be rated for 4,000A maximum continuous current, 100kA short circuit current, with major breakers in accordance with Table 300-3, and with rear access. Each switchboard shall be provided with these nominal features: All circuit breakers shall be draw out type, 100kA @ 690VAC, LSI trip, electrically operated.

950 **Table 300 - 3 Main Switchboard Configuration**

Service	Frame (A)	Trip (A)
Main Diesel Generator	4,000	4,000
Bus Tie	4,000	4,000
Main Propulsor Drive	3,200	3,200
Bow Thruster	2,000	1,200
Ship Service Transformer	2,000	1,200

955 If the propulsion switchboards are designed with a DC main bus then it shall be suitably rated in accordance with the design requirements, include rectifiers for the connected generators, include variable speed drives for thruster drives in accordance Technical Specification Sections 235.1 and 314.1, include braking resistors, include grid converters to supply the 480V Ship Service Switchboard, be freshwater cooled in accordance with Technical Specification Section 532, and be front access only.

All circuit breaker sizes shall be verified by the Contractor based on final equipment selections.

The Contractor shall provide all other required components to meet the requirements. This shall include, at minimum, the following items:

- 960 1. Transformers.
- 2. Grounding devices.
- 3. Meters, switches, pilot devices.
- 4. Automation controls.
- 5. Enclosure devices.
- 965 6. Governor and voltage regulator equipment.

Needed instrumentation and controls for local operation and connections for remote operation, both manual and automatic, shall be provided to meet ABS ✕ACCU Rules. The switchboard shall be constructed to withstand the peak short-circuit current indicated in the Contractor's short-circuit analysis.

- 970 This switchboard shall be provided with the required interfaces to the IMACS as specified in Technical Specification Section 431.

324.1.3 480 VAC Ship Service Switchboard

- The 480 VAC power distribution shall be integrated into two (2) multi-section ship service switchboards, one located in each machinery space (forward and aft). The switchboard shall
- 975 include the SSDG controls, indications, and main circuit breakers, supply from the propulsion switchboard, shore power circuit breakers, bus tie arrangements, emergency bus-tie circuit breaker, and appropriate circuit breakers for 480 VAC ship service distribution loads and 208Y/120 VAC system supply transformers. Needed instrumentation and controls for local operation and connections for remote operation, both manual and automatic, including
 - 980 synchronizing the SSDGs with each other and synchronizing shore power with the 480 VAC ship service switchboard, shall be provided to meet ABS ✕ACCU Rules. The switchboard shall be constructed to withstand the peak short-circuit current indicated in the required short-current analysis. The ship service switchboard configuration shall be as illustrated on Reference 301-01.

- 985 The 480 VAC ship service switchboard shall be provided with a bus tie circuit breaker, which shall include protective logic to only close to a dead bus or through automatic synchronization.

An "Emergency Generator Running" indicator light (amber) shall be located on the face of the synchronization section of the switchboard.

This switchboard shall be provided with the required interfaces to the IMACS as specified in Technical Specification Section 431.

990 324.1.4 Ship Service 208Y/120 VAC Switchboard Section

- The 208Y/120 VAC ship service power distribution system shall be supplied from a three-phase, four-wire switchboard section. The switchboard section shall meet all pertinent requirements of the USCG, ABS, and the general requirements outlined above. Molded case circuit breakers, with appropriate trip settings and short circuit capacities to power the loads shown on the
- 995 drawings shall be provided.

This switchboard section shall require interface with the IMACS as specified in Technical Specification Section 431.

324.1.5 EMERGENCY SWITCHBOARD

1000 An emergency switchboard shall be provided in accordance with ABS and USCG requirements, and the Contract Drawings. The emergency switchboard shall be constructed in accordance with Technical Specification Section 322. In addition to the required components and instrumentation, the switchboard shall include the EDG circuit protection, emergency switchboard bus tie, ship service-to-emergency power transfer arrangement, the EDG engine starting controls, and engine hour meter. The power transfer arrangement shall function in
1005 accordance with the regulatory agency requirements to connect the emergency switchboard to the emergency source (EDG) upon failure of the normal source (ship service), but only after the time and voltage limits have taken place. Automatic controls shall initiate engine starting, cool down, and stopping in addition to transfer function.

1010 The emergency switchboard shall be provided with an EDG ready light (amber) to indicate that all controls are in proper configuration for auto start/run. This indication shall be integrated in to IMACS.

324.2 Energy Management System (EMS)

1015 An integrated EMS shall be supplied, for the MDGs, SSDGs, and associated switchboards and controlgear. The systems shall be integrated to function as a whole. The EMS shall be supplied power from a Contractor-provided battery backup system, with 30-minute capacity at full-rated power and a feed from the ship's emergency power system.

1020 The EMS shall be configured to monitor and alarm the status of the electrical power generation and distribution systems and to automatically control the generator selection and switchboard operation to suit the power requirements of the ship and to restore power or maintain power during engine or generator loss or overloading condition. The control of the bus tie switches, distribution circuit breakers, and load shedding and load limiting features shall be incorporated into the EMS controls to ensure the integrity of the electrical power distribution systems without requiring system adjustments or operator intervention.

1025 Alarm and monitoring of the MDGs and SSDG sets shall link to the IMACS. Primary control and emergency shutdowns integral to the generator control system shall not be compromised by the EMS. The EMS shall provide these nominal functions:

1. Load dependent and fault dependent start-stop of the MDG and SSDG engines.
2. Individual selection of standby sequence.
3. Automatic load limiting and shedding.
- 1030 4. Power plant control with status and alarm presentation to the touch-screen panel in the switchboards and EOS.
5. Communication to the IMACS for indication of power plant status and alarm presentation.

1035 Power limit on the thrust shall be over-ridable by the operator as noted in Technical Specification Section 411. Actuation of the power limit override shall initiate the electrical power load shed functions to reduce load on the MDG and provide propulsion thrust capacity.

The generating plant EMS shall provide all monitoring, alarm, and control functions required by the regulations for the generating plant and main switchboards to other vessel monitoring, alarm and control systems.

1040 **324.3 Automatic Transfer Switches**

ATSs, of appropriate ratings, shall be provided and installed for the IMACS, emergency lighting panels, and accommodations sprinkling pump power feeds. The ATSs shall conform to the requirements of UL1008.

1045 The ATSs shall be provided with a microprocessor controller with membrane interface panel, shall be capable of adjustable voltage and frequency sensing, and shall have provisions for connecting to the IMACS to monitor ATS functions.

The voltage of each phase of the normal source shall be monitored, with pickup adjustable to 95% of nominal and dropout adjustable from 70% to 90% of pickup setting. Voltage and frequency sensing shall be provided for each phase of the emergency source.

1050 An adjustable time delay shall be provided on transfer to emergency, adjustable from 0 to 5 minutes for controlled timing of transfer of loads to emergency. An adjustable time delay shall be provided on retransfer to normal, adjustable from 0 to 30 minutes. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable. A 5-minute cool down time delay shall be provided on shutdown of engine generator. All adjustable time
1055 delays shall be field adjustable without the use of tools.

An in-phase monitor shall be provided to control transfer so that motor inrush currents do not exceed normal starting currents. The in-phase monitor shall not require external control of power circuits.

324.4 Distribution Panelboards

1060 Power distribution panelboards shall be provided for auxiliary systems, ventilation and heaters, Galley equipment, hotel services, power receptacles, and lighting as required. The lighting and power distribution panelboards shall consist of thermal-magnetic circuit breakers assembled into a single interior unit, which shall be mounted in a sheet-steel enclosure consisting of a box and front designed to be mounted on a bulkhead. In spaces that are lined the panelboards shall be
1065 flush mounted. The panelboards shall be of the dead-front type.

Panelboards shall be in accordance with UL 67, including the Marine Supplement. There shall be no knockouts.

1070 Each distribution panel shall have hinged trim meeting door-in-door specifications. Each panel shall have a door with lock. All door locks shall be keyed the same. All panelboards shall have suitable ratings for the location installed with a minimum rating of IP22. Each panel shall be identified by name with embossed metal or engraved plastic plates inside as well as outside each

box. Pockets shall be provided in each unit for circuit cards, printed with circuit designations and service.

1075 All bus bars shall be made of hard-drawn commercially pure copper, and shall be sized according to the IEEE standards for panelboards. Buses shall be arranged to maintain sequence phasing throughout; that is, adjacent poles shall be of unlike polarity and rotated in sequence. Panelboards shall be provided with main-lug-only bus configurations unless otherwise noted. Dual-voltage panelboards shall be provided with a neutral bus.

1080 All panelboards shall have a 20% spare breakers, but no less than two spare breakers per panel. Spare circuit breakers shall be sized equal to the most common size in the panel. Cables supplying panelboards shall be sized to provide for the eventual usage of the spare breakers, in accordance with USCG regulations.

Loads shall be balanced between phases. Single-phase loads shall be distributed between phases such that the load on any one phase is within $\pm 15\%$ of the average load of all three phases.

1085 As far as practicable, panelboards shall be located on the same deck as the loads that they serve. Panelboards serving the weather decks shall be located in interior spaces.

330 LIGHTING SYSTEM

330.1 General

1090 All lighting systems (except the searchlights, as required) shall be powered with 120 VAC, 60 Hz, single-phase via distribution panelboards located throughout the vessel. Lighting shall be provided to maintain the illumination values indicated in *ABS Guide for Crew Habitability on Ships* and as specified in this section.

1095 General lighting LED color temperature shall be 3000°K to 3500°K (soft white). In spaces such as the Galley, Scullery, Served, machinery spaces, workshops, and offices, the color temperature shall be 5000°K (cool white).

Light switches shall be provided and installed inside the space served (except where required outside the space, e.g., refrigerated spaces), near each door entering the space. Light switches for the Paint Locker shall be explosion-proof or located directly outside the space.

1100 Switching for lighting in public spaces (e.g., Side Lounges, Observation Lounge) shall be located for access only by the crew. Switches and dimmers may be located behind locked, hinged, panels in joinerwork, or in adjacent, crew-only spaces (e.g., local fan rooms and lockers).

Connection boxes, cabling and all required accessories shall be provided and installed to make a complete, operational, lighting system.

330.2 Illumination Requirements

1105 Lighting shall be provided to maintain, at a minimum, the lux values indicated in *ABS Guide for Crew Habitability on Ships*, as excerpted below and as shown on Reference 330-01.

330.2.1 Lighting Criteria for Accommodation Spaces

Table 300 - 4 indicates the illuminance level criteria for accommodation spaces.

Table 300 - 4 Lighting criteria for accommodation spaces

Space	Illuminance Level in Lux	Space	Illuminance Level in Lux
Entrances and Passageways			
Interior Walkways, Passageways, Stairways and Access Ways	100	Exterior Walkways, Passageways, Stairways and Access Ways (Night)	100
Corridors in Living	100	Stairs	150
Muster Area	200		
Cabins, Staterooms, and Sanitary Spaces			
General Lighting	150	Bath/Shower (General Lighting)	150
Reading and Writing (Desk or Bunk Light)	500	All other Areas within Sanitary Space (e.g., Toilets)	200
Mirrors (Personal Grooming)	500	Light During Sleep Periods	<30
Dining Spaces			
Mess Room and Cafeteria	300	Snack or Coffee Area	150
Recreation Spaces			
Lounges	200	Exercise Rooms	300
Bulletin Boards/Display Areas	150	All other Recreation Spaces (e.g., Game Rooms)	200
Theater (when not showing films)	150	Training Room Office/Meeting Rooms	500
Medical and First Aid Centers			
Wards	150	Reading Hospital/Ward	500
General Lighting	500	Critical Examination	500

1110 330.2.2 Lighting Criteria for Navigation and Control Spaces

Table 300 - 5 indicates the illuminance level criteria for navigation and control spaces.

Table 300 - 5 Lighting criteria for navigation and control spaces

Space	Illuminance Level in Lux	Space	Illuminance Level in Lux
Navigation Spaces			
Wheelhouse, Pilothouse, Bridge	300		
Offices			
General Lighting	300	Computer Work	300
Service Counters	300		
Chart Area			
General Lighting	300	On Chart Table	500
Control Stations			
General Lighting	300	Control Consoles and Boards, Panels, Instruments	300
Switchboards	500	Log Desk	500
Local Instrument Room	400		
Gyro Room			
Elex and Copy Room	200		

330.2.3 Lighting Criteria for Service Spaces

Table 300 - 6 indicates the illuminance level criteria for service spaces.

1115 **Table 300 - 6 Lighting criteria for service spaces**

Space	Illuminance Level in Lux	Space	Illuminance Level in Lux
Food Preparation			
General Lighting	500	Galley	500
Pantry	300	Working Surfaces, Food Preparation Counter and Range Tops	750
Food Serving Lines	300	Scullery (Dishwashing)	300
Laundries			
General Lighting	300		
Storerooms			

Space	Illuminance Level in Lux	Space	Illuminance Level in Lux
Large Parts	200	Small Parts	300
Chemical Storage			
Chemical Storage	300		
Elevators			
Elevators	150		
Food Storage			
Non-refrigerated	200	Refrigerated	100

330.2.4 Lighting Criteria for Operating and Maintenance Spaces/Areas

Table 300 - 7 indicates the illuminance level criteria for operating and maintenance spaces.

Table 300 - 7 Lighting criteria for operating and maintenance space/areas

Space	Illuminance Level in Lux	Space	Illuminance Level in Lux
Machinery Spaces			
General Lighting	200	Unmanned Machinery Spaces	200
Fan Room	200	HVAC Room	200
Pump Room, Fire Pump Room	200	Steering Gear Room	200
Windlass Rooms	200	Battery Room	200
Emergency Generator Room	100		
Engine Room			
Engine Room	300		
Switchboards			
Generator and Switchboard	300	Switchboard, Transformer Room	500
Main Generator Room/Switchgear	200		
Inspection and Repair Tasks			
Rough	300	Medium	500
Fine	750	Extra Fine	1000
Workshops			
Paint Shop	300	Workshop Office	750
Mechanical Workshop	500	Inst/Electrical Workshop	500

Space	Illuminance Level in Lux	Space	Illuminance Level in Lux
Bilge/Void Spaces	75	Shaft Alley	100
Escape Trunks	50	Muster/Embarkation Area	200
Cargo Handling (Weather Decks) Lay Down Area	200	General Process and Utility Area	200
Loading Ramps/Bays	200	Cargo Storage and Maneuvering Areas	350

1120 330.2.5 Lighting for Red or Low-Level White Illuminance

Table 300 - 8 indicates the illuminance level criteria for red or low level illuminance.

Table 300 - 8 Lighting for red or low-level white illuminance

Space	Illuminance Level in Lux	Space	Illuminance Level in Lux
Where seeing is essential for charts and instruments	1 to 20	Interiors or Spaces	5 to 20
Bridge areas (including chart tables, obstacles and adjacent corridors and spaces)	0 to 20 (Continuously Variable)	Stairways	5 to 20
Corridors	5 to 20	Repair work (with smaller to larger size detail)	5 to 55

1125 The Contractor shall perform a photometric lighting survey upon completion of the lighting system. The survey shall be in accordance with the methods in the IESNA RP-12-97 (as referenced by the *ABS Guide for Crew Habitability on Ships*). The lighting survey shall be witnessed by the Resident Engineer, and a survey report, by the Contractor, shall be submitted for review and approval.

330.2.6 Special Illumination

330.2.6.1 Crew Staterooms

1130 Staterooms shall be provided with overhead lighting to meet the lighting levels shown on Reference 330-01. Stateroom overhead lighting shall be provided with dimmers. Each bunk shall be equipped with a low profile, berth light including a simplex receptacle. Bunk lights shall be located to avoid creating head-knockers for the stateroom occupants. Each sink shall be equipped with a mirror light, with built-in simplex receptacle, located to avoid creating a head-knocker when using the sink. Fluorescent desk lamps shall be provided and installed at each desk.

1135

All staterooms shall be provided with LED emergency escape lighting that illuminates upon loss of main power to the normal lighting circuits.

330.2.6.2 Navigation Spaces

1140 The Pilothouse and all adjacent spaces, and the vehicle elevator control cab, shall be equipped with red illumination for use at night in addition to the standard fixtures. Chart table, GMDSS console, and console lamps shall be dimmable, and equipped with a red lens/LED.

Emergency light fixtures in the Pilothouse shall be red, and not be equipped with emergency batteries. These lighting circuits shall be fitted with a relay to automatically turn on the
1145 emergency lights should main power fail.

330.2.6.3 Passenger Staterooms and Cabins

Staterooms shall be provided with overhead lighting to meet the lighting levels shown on Reference 330-01. Stateroom overhead lighting shall be provided with dimmers. Each bunk shall be equipped with a low profile, berth light including a simplex receptacle. Bunk lights shall
1150 be located to avoid creating head-knockers for the stateroom occupants. Each sink shall be equipped with a mirror light, with built-in simplex receptacle, located to avoid creating a head-knocker when using the sink. Sink receptacles shall be provided with GFCI protection.

All staterooms and cabins shall be provided with LED emergency escape lighting that illuminates upon loss of main power to the normal lighting circuits.

1155 332 LIGHT FIXTURES

Emergency lighting with transitional-power battery units, as required by the regulations, shall be provided and installed as shown on the Contract Drawings.

General lighting fixtures shall be linear LED for the open overheads and for the finished (suspended) overheads. Lighting in public areas shall be dimmable to provide lower lighting
1160 levels throughout the space.

Linear LED lighting fixtures with one red LED lamp module, configured to allow switching for night lighting, shall be provided in the approaches to the Pilothouse (Solarium Deck Passage, FR70-140) to accustom the eye for night vision. Three-position toggle switches, indicating “on”, “off”, and “red”, shall be provided and installed to control the red lighting. Emergency
1165 lighting in these areas shall be switchable between red and white, with no “off” switch to meet regulatory requirements.

LED globe and guard style lighting fixtures shall be provided and installed as required around the perimeter of the weather decks to provide general night lighting. Exterior fixtures other than globe and guard style shall be flush-mount style. Exterior lights that could cause interference
1170 with navigating the vessel shall have control switches located in the Pilothouse.

LED explosion-proof lighting fixtures, shall be provided and installed in the Paint Locker.

Detail lighting such as desk, berth, and mirror lights shall be provided and installed in all staterooms. Desk, berth, and mirror lighting shall be LED with convenience receptacle (GFCI where required).

1175 Lighting fixtures shall be provided and installed in toilet/shower units and water closets. The fixtures shall be LED, recessed and designed for damp/wet locations, IP44 or higher.

Emergency exit lights, with internal battery back-up, shall be installed at all required escape route doors and other areas as required by the regulations. Exit lights shall be LED and surface mounted (vertically or horizontally). Emergency exit lights shall be connected to the emergency power system.

Watertight LED floodlights shall be provided and installed to illuminate the exterior working deck areas (including the mooring stations and dock areas). Deck floodlights shall be controlled via a dedicated switch panel in the Pilothouse.

Floodlights, to illuminate the exterior muster stations, lifeboat, life raft, and rescue boat stations, and the water area below them, shall be provided and installed per the regulations. Survival craft floodlights shall be LED with watertight, corrosion-resistant enclosures. These floodlights shall be connected to the emergency power system with the panelboard located in the Pilothouse or otherwise controllable from the Pilothouse.

333 RECEPTACLES

333.1 Convenience Receptacles

Convenience duplex receptacles shall be provided in the accommodations, workspaces, storerooms, passages, and machinery spaces. Convenience receptacles shall be rated for 15 amps, 125V, with NEMA 5-15R configuration. All backboxes and enclosures shall be standard NEMA configurations and dimensions unless otherwise specified. Where bulkheads are lined, convenience receptacles shall be flush mounted. Receptacles in dry locations shall be Pauluhn ProConnect 27R/mw, or equal.

Convenience receptacles in potentially damp locations such as machinery spaces shall be weatherproof, Pauluhn ProConnect 24/mw, or equal. Convenience receptacles in potentially wet locations such as exterior areas, Galley, laundries, etc. shall be watertight, Pauluhn ProConnect 25B/mw (mating plugs required to maintain the receptacle watertight integrity shall be provided and installed on appliances intended for use in the affected spaces, i.e., portable food processors in the galley). Receptacles in wet spaces shall be provided with GFCI protection at the receptacle or the circuit breaker.

Watertight plugs shall be of the pin-protected type with an appropriate shell completely covering the pins.

A minimum of three ship service 120 VAC duplex receptacles shall be provided in each space and passage, evenly spaced throughout. Exceptions and additional requirements are indicated below.

333.1.1 Officer and Crew Mess

Duplex, convenience receptacles shall be provided around the perimeter of the Officer and Crew Mess, located approximately every 6' and on each side of all doorways.

Three additional duplex receptacles shall be provided in way of the serving bar.

333.1.2 Officer and Crew Staterooms/Toilet Shower Modules

1215 Duplex convenience receptacles shall be provided around the perimeter of each stateroom located approximately every 6' and on each side of all doorways, a minimum of one duplex receptacle shall be provided on each athwartship bulkhead. Additionally, four convenience receptacles (two duplexes or one quadplex) with surge protector shall be provided at each desk. Receptacles shall be centered on the desk, located just above the desktop. A GFCI protected, duplex convenience receptacle shall be located adjacent to each sink. Berthing lights, and desk
1220 lamps, shall include simplex convenience receptacles.

333.1.3 Public Spaces

Duplex convenience receptacles shall be provided around the perimeter of public spaces as follows:

- 1225 1. Observation Lounge – at each booth and every 6' of bulkhead length, including partial height bulkheads.
2. Side Lounges – at each booth and every 6' of bulkhead length, including partial height bulkheads.
3. Dining areas – at each booth and bulkhead-adjacent table. Every 6' of counter length.

333.1.4 Passenger Staterooms (including Roomettes)/Toilet Shower Modules

1230 Duplex convenience receptacles shall be provided around the perimeter of each stateroom located approximately every 6' and on each side of all doorways, a minimum of one duplex receptacle shall be provided on each athwartship bulkhead. A GFCI protected, duplex convenience receptacle shall be located adjacent to each sink. Berth lights shall include simplex convenience receptacles.

1235 333.1.5 Galley and Scullery

Duplex, watertight, receptacles shall be provided around the perimeter of the Galley and Scullery, located approximately every 4'. Receptacles shall be located 4" above the countertop. Additional, dedicated receptacles shall be provided to power installed Galley equipment. Duplex receptacles shall be provided at either end of the island in the Galley. Island receptacles are to be
1240 centered on the end of the island, located 4" below the countertop flush with the cabinet side.

333.1.6 Laundries

Weatherproof duplex convenience receptacles shall be provided around the perimeter of the laundries approximately every 4' and on each side of all doorways.

333.1.7 Lockers

1245 One quad convenience receptacle shall be provided in each locker.

333.1.8 Machinery Spaces and Storerooms

In machinery spaces, including Fan Rooms, and Bosun's Stores/Shop, receptacles shall be located not fewer than two per bulkhead, and so as to be able to reach any part of the outfitted machinery spaces with a 25' extension cord. One duplex receptacle shall be provided in the
1250 vehicle elevator control cab.

In the Workshop and storerooms, receptacles shall be located approximately every 4' in convenient locations. Workbench receptacle circuits shall be provided with a cut-off switch at the workbench. Receptacles shall be rated for 20A, 125V, with NEMA 5-20R configuration.

333.1.8 Weather Decks

- 1255 On the weather decks, including house top, watertight receptacles shall be located to reach any part of the deck using a 20' extension cord. Receptacles located in the weather shall not be connected in the same circuit as any interior receptacle (including those in the Solarium).

In the Solarium, weathertight duplex receptacles shall be located every 10' of bulkhead length, with the first located 6' from the aft opening.

- 1260 One weathertight receptacle shall be located adjacent to the folding mast winch foundation on the Pilothouse top.

333.1.9 Navigation Spaces

- 1265 Duplex receptacles shall be located every 6' around the perimeter of the Pilothouse. Two duplex receptacles shall also be located at each end of the MCC, and at the end of each bridge wing console.

- 1270 The Electronics & Copy Room shall be provided with receptacle strips located around the perimeter. The receptacle strips shall consist of 6' raceway units with single, 15A receptacles spaced 12" apart. Receptacle strips shall be Hubbell model HBL24GB612GY or equal. Each strip shall be fed with its own circuit. Duplex receptacles shall also be located every 6' around the perimeter of the space.

333.1.10 EOS

- 1275 The EOS shall be provided with receptacle strips located around the perimeter. The receptacle strips shall consist of 6' raceway units with single, 15A receptacles spaced 12" apart. Receptacle strips shall be Hubbell model HBL24GB612GY or equal. Each strip shall be powered with its own circuit. Duplex receptacles shall also be located every 6' around the perimeter of the space. A quad receptacle shall be located at the desk.

333.2 Power Receptacles

333.2.1 Refrigerated Van Receptacles

- 1280 Fourteen (14) 32A, 480V integrated receptacles shall be provided and installed in the Vehicle Space for refrigerated vans. All receptacles shall be three-phase with grounding conductor. The receptacles shall be ESL Power Systems, item number 2203-22ANPP, or equal with watertight crew cover attached by thin cord or chain. The Contractor shall install the receptacles in locations approved by the Resident Engineer.

- 1285 The Contractor shall assemble and provide to the Resident Engineer twelve 50' lengths of flexible 4-conductor 10-gauge AWG cable, with a plug, ESL Power Systems item number 1800-03P1A or equal, at each end.

Refrigerated van receptacles shall be powered as indicated on Reference 301-01.

334 HEAT TRACE SYSTEM

1290 Heat tracing shall be provided and installed for those piping systems/segments indicated in Technical Specification Section 505.3.

Heat trace shall be designed, manufactured, and tested in accordance with the applicable requirements of the latest edition of the following:

1. Factory Mutual Research Corporation (FM).
2. IEEE 515.
- 1295 3. NFPA 70.
4. NEMA.
5. UL 746B.
6. ANSI.
7. ABS.

1300 The heating cable shall have the following third party approvals: UL listed, CSA certified, FM approved.

All heat-tracing systems shall use a self-regulating heating cable. Self-regulating heating cable shall vary its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.

1305 All cables shall be capable of passing a 1.6kV dielectric test for 1 minute after undergoing a 10 ft-lb. impact (IEEE 515 Test 4.1.8).

1310 The heating cable shall consist of two 16-gauge AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) without the use of thermostats of 5 W/ft for T5 (T-rating) and a maximum temperature of 212°F.

1315 The heating cable shall have a tinned copper braid with a resistance less than 8 mΩ/ft as determined by metallic covering conductivity test (IEEE 515 Test 4.1.13). On pipes exposed to corrosive or organic materials such as sewage or salt, the braid shall be protected from chemical attack and mechanical abuse by a polyolefin or fluoropolymer outer jacket.

Heat tracing shall be attached to metal pipes with fiberglass tape. Heat trace attachment to non-metal pipe shall be with aluminum tape for better heat transfer.

1320 All connection components used to terminate self-regulating heating cables, including power connectors, splices, tees, and connectors, shall be approved for the respective area classification and approved as a system with the particular type of heating cable in use. Under no circumstances shall terminations be used which are manufactured by a vendor other than the cable manufacture.

In order to keep connections dry, components shall be rated NEMA 4. Components located in the weather shall be rated NEMA 4X.

SECTION 400
INTERIOR COMMUNICATIONS

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SECTION 400 INTERIOR COMMUNICATIONS

REFERENCES

- 411-01 *Propulsion Control System Block Diagram*, AMHS Drawing No. 14-411-091-001 [To Be Developed]
- 10 430-01 *IT and Computer Network Block Diagram*, AMHS Drawing No. 14-430-095-001 [To Be Developed]
- 436-01 *Machinery Alarm and Monitoring Block Diagram*, AMHS Drawing No. 14-436-071-001 [To Be Developed]
- 436-02 *Machinery Control System Points List*, AMHS Drawing No. 14-436-071-002 [To Be Developed]
- 15 441-01 *Antenna Arrangements/Helo Access*, AMHS Drawing No. 14-441-093-001 [To Be Developed]
- 663-01 *Pilothouse Arrangement and Details*, AMHS Drawing No. 14-663-015-001 [To Be Developed]

20 **410 VESSEL CONTROL AND MANEUVERING**

The vessel shall be equipped with controls to meet the requirements of ABS classification and the requirements listed below. Control shall be transferred between stations using a “send control/accept control” transfer system. A single send/accept control shall be provided for all propulsors and bow thrusters.

25 **411 PROPULSION & BOW THRUSTER CONTROLS**

Propulsion and bow thruster speed and direction control shall be provided at the following four control stations

1. Pilothouse MCC – steering stand included.
2. Starboard Bridge Wing Console.
- 30 3. Port Bridge Wing Console.
4. Engineers Control Room.

Propulsion speed and direction control shall be provided at all four stations. Individual, combination type levers combining both speed and steering into a single unit for each podded propulsor shall be provided. RPM shall read in propeller RPM. A meter shall be provided to indicate available spinning reserve. Propulsor control shall be either with both propulsors synchronized, using one of the two levers, or both acting independently. The mode shall be selectable with a lighted pushbutton switch and interconnected between the two lever assemblies. The rate of turn of the propulsors shall be tunable based on vessel speed. Steering shall also be possible from the separate steering stand.

40 Selectable manual combined control of all four thrusters (2 stern propulsors and 2 bow thrusters) shall be provided through a single joystick. See Section 412. In this mode it shall be possible to tag out individual thrusters.

Individual bow thruster control heads shall be provided for each bow thruster. Control heads shall combine thruster speed and direction (port/starboard). See Section 413.

45 Propulsion motor and bow thruster motor emergency shutdowns and power limit override shall be provided at each console in the Pilothouse and at the motor. All indications and alarms shall also be provided in the IMACS.

411.1 Steering Stand

50 The Contractor shall provide an independent steering stand behind the MCC from where steering of the two stern propulsors may also be controlled. The system shall be supplied by the stern propulsor manufacturer and shall have all the monitoring, alarm and control points required by the regulations. All alarms shall be passed through the IMACS.

The steering control and feedback shall be integrated into the VDR to meet regulatory requirements.

55 411.2 Emergency Steering Control

Emergency steering control shall be provided for each hydraulic power unit in the Propulsor Equipment Room. Propulsor angle and thrust indication shall be provided at these stations.

60 Centralized emergency steering control shall also be provided in the Propulsor Equipment Room either with both propulsors synchronized, using one of the two levers, or both acting independently. The mode shall be selectable with a lighted pushbutton switch and interconnected between the two lever assemblies.

411.3 Independent Autopilot Steering Control System

65 A self-tuning, adaptive heading and track controller-type autopilot system shall be provided and installed. The autopilot system shall be capable of maintaining a set course and steering the vessel through a non-automatic integrated control system, using input from either the vessel's gyrocompass or the DGPS. The system shall have the following features:

1. Full adaptive control.
2. Precision and economy modes.
3. Pilothouse user interface.
- 70 4. Ability to be combined with ECDIS.
5. Rate-of-turn and turn radius control modes.
6. Maximum operator or program defined steering angle based on vessel speed.
7. Ability to operate with azimuth propulsion.
- 75 8. Ability to selectively lock either stern propulsor straight ahead and steer with the other propulsor.

The autopilot shall automatically control the vessel's heading within 2.5° of the selected course at speeds from 0.5 knots to maximum. Propeller RPM shall be manually controlled at the thruster speed controls. This system shall allow course corrections without coming out of this mode.

80 The main autopilot control shall be located in the Pilothouse. System control shall be from the BCC.

412 INTEGRATED JOYSTICK

85 All vessel maneuvering and control equipment shall be integrated with a joystick control system. The integrated control system shall provide manual operator control of heading and speed, and integrated control of propulsion motors, stern propulsors, and bow thrusters through a single joystick. The system shall be able to compensate for the unavailability of any two of the four units and shall work within the power management and propulsion motor limiting systems. The joystick control system shall be provided at each of the Pilothouse control stations.

90 This mode is manual to the extent that navigational input from the DGPS is not used. Integrated manual mode control shall be by dual axis joystick at the BCC and Bridge Wing Consoles. The joystick shall include automatic heading capability. Joystick control response shall be squared curve. The joystick shall be capable of low and high speed precision. All joystick input shall be linear. At each control station, the joystick controls shall be configured such that the control motion is referenced to ship direction.

95 In the integrated manual mode, reduced thrust as well as full thrust shall be operator selectable and available for each thruster.

413 BOW THRUSTER CONTROLS

The Contractor shall provide and install a bow thruster speed and control system.

100 Bow thruster motor speed ramp rates shall be controlled by the EMS and shall be set to allow a good motor response without negative voltage impact to the power plant. Ramp rates shall be confirmed with an analysis conducted by the manufacturer and shall be, as close as practicable:

1. 0 to 100% in ≤ 10 seconds,
2. 100 to 0% in ≤ 5 seconds,
3. +100 to -100% in ≤ 15 seconds.

105 Pushbutton controls shall be located near each dual transverse throttle for bow thruster on/off. When pushing a bow thruster “on” control, the EMS shall bring additional generation capacity online until there is sufficient reserve to accommodate the full bow thruster load. Indication shall be provided at the station to indicate that full bow thruster capacity is allowed based on power reserve availability. If insufficient power reserve for the full bow thruster capacity is present, indication shall be provided at the maneuvering stations to indicate limited bow thruster capacity. If the bow thruster is in limited capacity, and a request for bow thruster control above the available power is given, visual indication shall be provided at the maneuvering stations that the bow thruster is in power limit.

115 Bow thruster controls shall be located at the Pilothouse MCC, and at each bridge wing console. Each control location shall be provided with directional indications, thruster motor power (kW) indications, emergency stop pushbuttons, and required alarms.

416 CONTROL STATIONS

416.1 Main Navigation Station

The MCC located forward on centerline in the Pilothouse shall be the main navigation station.

120 This station shall contain the following:

1. Instrumentation and control as required for ABS NIBS notation as a workstation for navigation and traffic surveillance/maneuvering as well as to function as the manual steering station.
2. CCTV monitoring display.
- 125 3. Vessel combinator controls for stern propulsors (propulsion motors and steering), bow thrusters, and integrated DP joystick controls.
4. Auto-pilot.
5. Electronic navigation systems, including radar and ECDIS displays.
6. Aircraft scanner.
- 130 7. Two (2) centralized machinery control and monitoring system stations.
8. Writing surface with fiddles to a hold 11" x 17" log book inside chart hood. Chart hood shall be provided with individually switched, interior red light.

Fiddleboards located above the console shall be used to display information where appropriate.

135 Means for reaching controls on the fiddleboards shall be provided to accommodate the entire range of anticipated crew height.

416.2 Bridge Wing Consoles

The Port and Starboard Bridge Wings shall, at a minimum, contain the following:

1. Instrumentation and control as required for ABS NIBS notation as a workstation for docking.
- 140 2. Vessel propulsion and steering control for the stern propulsors and bow thrusters through combinators and through integrated DP joystick controls.
3. Speed log displays: showing speed in the fore/aft and athwart ships directions. Speed shall be displayed in STW while at sea and SOG alongside a dock.
4. Wind speed.
- 145 5. CCTV display.
6. Searchlight controls.
7. IBS multi-function display showing electronic navigation systems, including radar and ECDIS.

Fiddleboards located above the console shall be used to display information where appropriate.

150 Means for reaching the fiddleboards shall be provided to accommodate the entire range of anticipated crew height.

416.3 Aft Bridge Consoles

The Aft Bridge shall provide sufficient navigational equipment to navigate the vessel in the event of total loss of bridge and all primary navigational equipment. It shall be co-located with the elevator control station on the aft cabin deck. Aft Bridge Equipment shall be independent of primary navigation equipment and have two separate power sources. It shall, at a minimum, contain the following:

1. DSC VHF Radio.
2. Air Band distress radio.
3. Satcom C.
4. GPS.
5. AIS.
6. Magnetic Compass.
7. 9GHz Radar.
8. ECDIS.
9. Ship's Whistle control.
10. Navigation Controls.
11. Sound Powered Phone.
12. Back-up Gyro with heading display.
13. Pelorus.

416.4 Safety Center

The Vessel shall have a Safety Center in full compliance with SOLAS Chapter II-2 Regulation 23. The Safety Center shall be part of the bridge, aft and to Port. It shall be curtained off to minimize light and sound interference with normal navigation functions. The Safety Center shall, at a minimum, contain the following:

1. Sound Powered Phone.
2. Intercom station.
3. PA System
4. Powered ventilation control and indication and monitoring.
5. Fire Door releases
6. General Alarm actuator
7. Watertight Door control and indication
8. Side Doors, Stern Door, Side deck, Fueling Ports status and leakage monitoring
9. CCTV system control and monitoring
10. Fire detection and alarm system
11. Fixed Firefighting systems.
12. Sprinkler and deluge control and monitoring systems.

13. Crew alarm.

14. Flooding detection.

190 15. Fire pump control and monitoring.

417 CONTROL CONSOLES

Control consoles shall be arranged to facilitate the ergonomic usage of presented data and controls. All components installed in consoles shall be mounted flush or inset to provide a clean and integrated appearance.

195 Each component with an illuminated surface that is integrated into the pilothouse shall have dimming capability. This dimming control shall provide capability to dim the illumination from full display brightness to no illumination in a continuous, analog-type control. Drop-in type control modules shall have a single dimmer control for the module.

200 Control consoles shall be provided with cabinets below. The cabinets shall be provided with removable, lockable hinged doors that latch open at minimum of 90°. Cables shall be brought into the cabinets through MCTs and landed on terminal blocks.

All control cabinets shall be furnished with silent type cooling fans with filters to facilitate cooling of installed components.

420 INTEGRATED NAVIGATION SYSTEMS & IBS

205 The Contractor shall provide integrated propulsion machinery controls, control/monitoring functions, and navigation instrumentation, with appropriate interfaces to the IMACS, in an ergonomically correct configuration to maximize the effective utilization of the installed equipment.

210 Displays shall be 27" minimum flat screen MFDs. At a minimum, displays shall be provided in the quantities required by ABS at each control station. One additional MFD shall be provided for the route planning at the chart table. The MFDs shall display navigation data, required steering and propulsion data, and alarms on operator selected data display graphic pages. The displays shall be daylight visible with physical dimmer knobs for night operations. Each display and operating station shall be provided with keyboard and trackball. Power supplies, internal
215 power distribution, and UPSs shall be included as required.

MFDs shall be provided as the interface and be capable of displaying the following information:

1. CCTV.
2. IMACS.
3. Sonar helm display.
- 220 4. Radar display.
5. ECDIS.

Each MFD shall include a minimum of five separate programmable memory configurations. The protocol and interface necessary to display additional user selected information shall be provided with the system.

225 The system shall be designed for redundancy and resistance to vibration, dampness, and humidity in consideration of the vessel operating areas.

421 NAVIGATION AIDS

421.1 Ship's Whistle

The Contractor shall provide and install two (2) air-driven tri-horn ship's whistles in compliance with the USCG Navigation Rules (72 Colregs, COMDTINST M16672.2D), and with the following features:

1. Pushbutton controls from the Pilothouse MCC and each bridge wing control station.
2. Pushbutton control of the secondary whistle from the Aft Pilot House.
3. Automatic fog and maneuvering signal controller for the Primary whistle.

The primary whistle shall be mounted, in accordance with manufacturer's instructions, on the House Top. The secondary whistle shall be mounted, in accordance with manufacturer's instructions, on the Aft bridge Top.

The ship's whistles shall be a Kahlenberg model T-4A, with model M-611 control unit, and model V-152L electric and manual control valve, or equal.

The M-611 control units, and V-152L control valves, shall be provided with 120V emergency power. The whistle shall be provided with compressed air from the ship service air system.

421.2 Fog Bell/Gong System

The Contractor shall provide a ship's bell and gong system with electronic and manual control to satisfy the restricted visibility rules in the USCG Navigation Rules (72 Colregs, COMDTINST M16672.2D).

The ship bell system shall be a Kahlenberg model KB-12E, or equal, and shall consist of a manual bell, model KB-12, or equal, and an electronic bell, model KB-E, or equal. The electronic ship bell shall be interfaced with the Kahlenberg model M-611 signal controller provided in Section 421.1.

The ship gong system shall be a Kahlenberg model KG-15E, or equal, and shall consist of a manual gong, model KG-15, or equal, and an electronic gong, model KG-E, or equal. The electronic ship gong shall be interfaced with the Kahlenberg model M-611 signal controller provided in Section 421.1.

The ship electronic bell and gong shall be provided with 120V emergency power.

421.3 Non-Electric Navigation Aids

The Contractor shall provide and install the following equipment:

1. One (1) binnacle-mounted magnetic plate compass, Ritchie Navigation model B-463, or equal, installed in front of the Pilothouse steering stand (with regard to power sources that may affect the compass). The compass shall be provided with 24VDC power for red night lighting.
2. One (1) Spherical yoke-mounted magnetic compass, Ritchie Navigation model YB-600, or equal, installed in the Aft Pilothouse (with regard to power sources that may affect the compass). The compass shall be provided with 24VDC power for red night lighting.
3. Four (4) pairs of clinometers (one for trim and one for heel) of the bubble-in-tube type, graduated in degrees. One pair shall be located in the Pilothouse, one pair in the EOS,

and two pairs in the Vehicle Space, as directed by the Resident Engineer, to assist in vehicle loading.

a) Clinometers for heel shall be dual-tube and indicate 45° each side of vertical in 1/2° divisions and 20° each side of vertical in 1/4° divisions. The clinometers shall be Moeller, No. 458, or equal.

b) Clinometers for trim shall be dual-tube and indicate 5° each side of vertical in 1/10° divisions and 15° each side of vertical in 1/4° divisions. The clinometers shall be Moeller, No. 455, or equal.

4. One (1), large, pendulum-style, clinometer shall be fabricated and installed in a Vehicle Space location designated by the Resident Engineer. The clinometer shall indicate 25° each side of vertical, in 1° divisions. The clinometer shall measure 4' from the vertex to the bottom of the scale at 0°. The pendulum and scale shall be contrasted to be easily readable from up to 100' away in the lighted Vehicle Space.

5. Six (6) 6" quartz movement, solid brass, flanged case, screw bezel clocks. One shall be located in the Pilothouse, one at the Purser's Counter, one each in the officer and crew mess, one in the Galley, and one in the EOS. The clocks shall be Chelsea, or equal.

6. Three (3) 6" solid brass flanged case, screw bezel barometers. One shall be installed adjacent to the Pilothouse clock and one adjacent to each of the officer and crew mess clocks. The barometers shall be Chelsea, or equal.

All navigational shapes and associated rigging as required by the USCG. Shapes shall coincide with the navigation light conditions described in Section 422.1, as required.

A set of international code flags as required by USCG, stowed in the flag locker in the Pilothouse.

422 NAVIGATION LIGHTS, SIGNAL LIGHTS, SEARCHLIGHTS, AND NIGHT FLIGHT OPERATIONS LIGHTS

422.1 Navigation Lights

The Contractor shall provide and install navigation lights in accordance with the USCG Navigation Rules (72 Colregs, COMDTINST M16672.2D). These shall include forward and aft masthead lights, stern light, sidelights, anchor lights, NUC lights, RAM lights, and an aircraft warning light.

Masthead, stern, and sidelights shall be equipped with dual light sources powered by isolated circuits, as required by USCG regulations – all other lights shall be single light sources. Fixtures shall operate with 120V LED lamps. Each fixture shall be permanently mounted and wired to the navigation light panels via watertight junction boxes located at the light. Light visible ranges shall be in accordance with the USCG Navigation Rules. The navigation lights shall be Aqua Signal Series 75D Arctic, or equal.

The Contractor shall provide and install screens, for side, stern, and masthead lights, as required.

The lights and control panels shall be configured to be controlled from either the forward or aft control panels. Supervised navigation light switch panels shall be provided and installed by the Contractor, in the MCC in the Pilothouse and in the Aft Pilothouse. The navigation light panels shall be a Glamox, or equal, configured as required for the navigation light arrangement, and to

control series 75D LED navigation lights. Each navigation light panel shall be fed from two separate power sources, primary and emergency, as required by the regulations.

422.2 Searchlights

310 The Contractor shall provide and install two (2), 1000 W Xenon searchlights: Carlisle & Finch model XE9666-RF, or equal, one on each side of the House Top above the Pilothouse. Each searchlight shall use an electric joystick control lever mounted in the Pilothouse MCC (both searchlights), and in each bridge wing control console (the respective side searchlights). Each searchlight shall be provided with an anti-icing heater.

315 The Contractor shall fabricate and install appropriate foundations for each searchlight and their power supplies. The power supplies shall be located in the Electronics/Copy Room, just aft of the Pilothouse, on the Solarium Deck.

424 ELECTRONIC AND ACOUSTIC NAVIGATION SYSTEMS

424.1 Automatic Identification System (AIS)

320 The Contractor shall provide and install two (2) SAAB model R5 Supreme, or equal, AIS. The systems shall be independent and each consist of:

1. One main display, located at the Pilothouse MCC or Aft pilothouse.
2. One AIS transponder unit.
3. One DGPS antenna.
- 325 4. One AIS VHF antenna.

Each systems shall be powered from a 24 VDC source, as required.

424.2 Global Positioning Systems (GPS)

424.2.1 Primary GPS

330 The Contractor shall provide and install two (2) complete Saab R5 Supreme Nav, or equal, global positioning GPS systems. The systems shall be DGPS and DGLONASS capable. Each system shall consist of a main display, navigation sensor, and antenna. One main display shall be located at the Pilothouse MCC, and the other at the chart table. One repeater display shall be located at each bridge wing console. One antenna shall be located on the House Top, and the other on the forward (hinged) mast.

335 The GPS systems shall be interfaced to all radar display units and the electronic charting system, to provide primary and secondary position input, time, speed over ground, course over ground, heading, and latitude/longitude information to these items. The GPS systems shall integrate with the VDR to provide required position, course, date, and time information.

Each unit shall be powered from a 24 VDC source, as required.

424.2.2 Secondary GPS

340 The Contractor shall provide and install one (1) complete Saab R5 Supreme Nav, or equal, global positioning GPS system. The systems shall be DGPS and DGLONASS capable. System shall consist of a main display, navigation sensor, and antenna and powered from a 24 VDC source, as required. Display shall be in the Aft Pilothouse, and the other at the chart table.

345 Antenna shall be located on the Aft Pilothouse Top.

The GPS systems shall be interfaced to radar display unit and the electronic charting system in the Aft Pilothouse position input, time, speed over ground, course over ground, heading, and latitude/longitude information to these items.

424.3 Satellite Compass

350 The Contractor shall provide and install one (1) DGPS satellite compass system, JRC model JLR-21, or equal.

The system shall consist of:

1. Five (5) displays, one each at the:
 - a) Pilothouse MCC.
 - 355 b) Steering stand.
 - c) Chart table.
 - d) Master's Office.
 - e) Emergency steering station (Thruster Room).
2. One (1) "tricorn" DGPS antenna, to be located on the House Top at ~Frame 130 center
360 line.

The DGPS compass shall be capable of interfacing with the radar(s), ECS, gyrocompass heading management system, autopilot, and VDR.

Power shall be from a 24 VDC source.

424.4 Doppler Speed Log

365 The Contractor shall provide and install a Sperry Marine NAVIKNOT 450D, or equal, single-axis Doppler speed log system in the Pilothouse MCC.

Components of this system shall include:

1. Two (2) primary control and display units
 - a) One (1) mounted in the Pilothouse MCC.
 - 370 b) One (1) at the chart table.
2. Pre-amplifier that powers and connects the display(s) to the transducer and provides data output to ARPA/radar, ECS, AIS, and VDR; electronics unit.
3. Transducer unit (NF Type 2829).
4. Gate valve (or tank) for transducer installation.

375 The speed log shall be capable of providing speed data signals to navigation data display(s) (see Section 424.6).

Power supply shall be from a 24 VDC source.

424.5 Navigation Echo Sounder

380 The Contractor shall provide and install an echo sounder system, Furuno model FE800, or equal. The main displays and controls shall be located at the Pilothouse MCC, with a slave readout at

the chart table, and the other locations indicated, via a navigation data display, in Section 424.6 below.

The echo sounder system shall be provided with all cables and ancillary equipment required, including:

- 385 1. Transceiver unit (model FE-8020).
 2. 200 kHz transducer (model 200B-8B).
 3. Matching box (model MB-504).
 4. Transducer tank (model TTF-2000).

The echo sounder shall be interfaced with the VDR, ECS, ARPA radar, and DGPS.

390 Power supply to the system shall be 120 V.

424.6 Navigation Data Displays

395 The Contractor shall provide and install a Furuno RD-30, or equal, remote display units at the Pilothouse MCC, both wing consoles, and at the chart table. The units shall be interfaced with respective navigation electronics to display ship's position, speed, course, water depth, and wind speed and direction.

Furuno RD-30 display units shall also be located in the EOS, and Master, Chief Engineer, and Chief Mate offices.

Power supply to each unit shall be from a 24 VDC source.

424.7 Anemometer

400 The Contractor shall provide and install a wind speed and direction sensing system. The main display shall be mounted at the Pilothouse MCC and both wing control consoles, with data connections run to the navigation display units provided in Section 424.6, and to the voyage data recorder (VDR; see Section 444).

405 The anemometer system shall be one (1) R.M. Young Company, model 86004 ultrasonic wind monitor (w/heater), or equal, with three (3) model 06206 marine wind tracker as the main displays. Additional components, as required to provide data output to all displays and systems requiring the data, shall be provided and installed by the Contractor.

Power supplies shall be from a 24 VDC source.

424.8 Navtex Receiver

410 The Contractor shall provide and install one (1) Navtex receiver, Furuno model NX-700A, or equal, adjacent to the GMDSS in the Pilothouse.

The Navtex system shall consist of:

1. Display/printer unit (model NX-700A).
 2. Receiver unit (model NX-7001) located adjacent to the display unit.
415 3. Antenna unit (model NX-7H), mounted on the House Top.

Power supplies shall be from 24 VDC sources.

426 ELECTRONIC CHART SYSTEMS (ECS)

The Contractor shall provide and install two (2) complete ECS. Each ECS shall be a Transas Navi-Sailor 4000 ECS MFD, or equal, and shall include a compatible desktop-style computer, with hardware and software/OS required by Transas, power conditioning/UPS equipment (as required) and capability to interface with the radar, gyrocompass, DGPS, and AIS. All required electronic charts for the proposed delivery route and the following areas of operation shall be included:

1. Coastal Oregon.
2. Coastal Washington, including Puget Sound, Straits of Juan de Fuca to Seattle.
3. Coastal British Columbia.
4. Alaska, from Bellingham (WA) to Dutch Harbor.
5. The Columbia River, from the Pacific Ocean to Portland, including the Port of Portland.
6. The Willamette River to the Swan Island Basin

The ECS chart system shall also provide the following features:

1. Variable brilliance and contrast controls at each display.
2. Vessel's information display including: vessel speed and heading, DGPS position and course-made-good, time, and date.
3. Universal chart manager, capable of displaying IMO ECS charts as well as Admiralty Raster Chart Service (ARCS) and Seafarer charts.
4. ARPA target data receiving/display capability.

427 GYROCOMPASS AND REPEATERS

427.1 Primary Gyro

The Contractor shall provide and install a gyrocompass system, Northrop Grumman/Sperry Marine current-modification model NAVIGAT X Mk 1, or equal. The configuration shall provide for distribution to repeaters, radars, autopilot, VDR, DGPS, and other installed peripheral appliances, as required. The system configuration shall incorporate:

1. The necessary switch-over units.
2. Static and dynamic north speed error correction.
3. Splitter box(es).
4. NAVITWIN IV, or equal, gyrocompass heading management system (control and display unit).
5. Visual and audible status indications and alarms:
 - a) Heading difference.
 - b) Adjustable maximum rate of turn.
 - c) Off heading.

- d) General.
- e) Power failure.

455 The gyrocompass shall have a built-in electronic power control unit and be certified for reliable operation with concurrent roll and pitch freedom to $\pm 40^\circ$.

Five (5) Sperry Marine universal digital repeaters, or equal, shall be provided and installed by the Contractor: one each at:

- 1. The Pilothouse MCC.
- 2. Both wing consoles.
- 460 3. The chart table.
- 4. The emergency steering station in the Thruster Room.

Power for the gyrocompass unit shall be from a UPS-backed 120V emergency power source. The power for each universal digital repeater, and the switchover unit, shall be 24 VDC.

465 The Contractor shall provide and install two (2) bearing repeaters, with column stands and gimbal brackets, to be located beside each bridge wing station (or at other locations approved by the Resident Engineer). The bearing repeaters shall be Sperry Marine model DBR-600 (with control panel) and column stand, Sperry Marine part # 1812783, or equal, and shall be interfaced with the compass systems via the switchover unit.

427.2 Secondary Gyro

470 The Contractor shall provide and install a gyrocompass system, Northrop Grumman/Sperry Marine current-modification model NAVIGAT X Mk 1, or equal. The configuration shall provide for distribution to repeater, radar, DGPS, and other installed peripheral appliances, as required. The system configuration shall incorporate:

- 1. The necessary switch-over units.
- 475 2. Static and dynamic north speed error correction.
- 3. Splitter box(es).
- 4. NAVITWIN IV, or equal, gyrocompass heading management system (control and display unit).
- 5. Visual and audible status indications and alarms:
 - 480 a) Heading difference.
 - b) Adjustable maximum rate of turn.
 - c) Off heading.
 - d) General.
 - e) Power failure.

485 The gyrocompass shall have a built-in electronic power control unit and be certified for reliable operation with concurrent roll and pitch freedom to $\pm 40^\circ$.

Two (2) Sperry Marine universal digital repeaters, or equal, shall be provided and installed by the Contractor: one each at:

1. The Aft Pilothouse.

490 2. The emergency steering station in the Thruster Room.

Power for the gyrocompass unit shall be from a UPS-backed 120V emergency power source. The power for each universal digital repeater, and the switchover unit, shall be 24 VDC.

495 The Contractor shall provide and install one (1) bearing repeaters, with column stand and gimbal brackets, to be located on the Aft Pilothouse top (or at other locations approved by the Resident Engineer). The bearing repeater shall be Sperry Marine model DBR-600 (with control panel) and column stand, Sperry Marine part # 1812783, or equal.

430 INTERIOR COMMUNICATIONS

431 INTEGRATED MACHINERY ALARM AND CONTROL SYSTEM (IMACS)

431.1 General

500 A comprehensive, computerized, IMACS shall be provided and installed to monitor the data points and furnish the control functions outlined in these Specifications. It shall be configured as required by ABS ~~✕~~ ACCU Classification, and USCG regulations, 46 CFR 62, for a periodically unattended propulsion machinery space.

505 The Contractor shall follow the Standards of IEEE 45-2002, Clause 9, when integrating IMACS into the overall control and monitoring system. The system shall integrate the requirements of the regulatory bodies, the ship electrical power and propulsion systems, the fire control station and the hotel and accommodation systems. The central control and monitoring system design and microprocessor-based equipment shall be under the general description of IMACS, which includes hardware and software specifically designed for shipboard applications. Additional
510 tools shall be provided that make use of IMACS data including an IMS, providing historical and trend analysis. The system shall also provide data acquisition and performance monitoring for logging.

515 Centralized control shall be provided for the monitoring of all vital temperatures, pressures, levels, and electric load characteristics. Abnormal conditions shall be sensed and shall activate alarms to warn of the condition, and the system shall advise of corrective action in the case of certain serious malfunctions.

The centralized control and monitoring system shall be a computer-based system utilizing touch screen, computer mouse and/or keyboard input to acknowledge alarms, open/close valves, start/stop pumps and fans, and monitor the vessel's machinery plant.

520 In addition to the requirements of the rules and regulations, the centralized control and monitoring system shall include, but not be limited to, the following:

1. Centralized TLI readouts for all fuel, ballast, and various other tanks.
2. Centralized control of fuel transfer operations, including tank selection, pump start/stop and all valve operations.

3. Centralized control of trim and ballast operations, including tank selection, pump start/stop and all valve operations.
4. Remote start/stop and paralleling of the MDGs and SSDGs.

A list of regulatory and State-required (non-regulatory) IMACS points is shown on Reference 436-02. This list shall be used by the Contractor, as guidance, for bidding and planning.

The Contractor shall develop a final IMACS points list, indicating all control, monitoring and alarm points required to satisfy the 49CFR regulations, as well as non-regulatory requirements outlined herein. The points list shall be delivered to the Resident Engineer for review and approval.

431.2 System Configuration

IMACS shall consist of two independent networks: a control network, which shall connect all field I/O devices to the control network processors, and a supervisory network, which shall provide the operator interface to the system. Both networks shall be redundant in terms of processing, cabling, and communications.

Redundancy of the entire system shall be arranged to meet the criteria for SRtP with redundant processors and control stations located in separate fire zones and cable arranged such that network and other functions in one fire zone are not degraded by a casualty in another fire zone.

431.2.1 Control Network

IMACS shall perform its stated functions by reading input signals from various control transmitters, devices, and systems, processing these signals, and delivering processed output signals to supervisory workstations, alarm annunciation equipment, and other field devices. All I/O signals shall connect to IMACS at one or more main controllers, or at remote I/O stations that shall be installed in various locations about the vessel. The remote I/O stations (RIOs) shall communicate with the main IMACS controllers via digital communications arranged in a device level ring or similarly redundant arrangement that makes the communication network impervious to any single point of equipment or cable failure.

The IMACS main controllers shall feature redundant processing. The controllers shall include internal fault monitoring that will automatically transfer to the backup processor when a fault or failure is registered on the primary processor. Automatic transfer from one processor to the other shall register and annunciate an alarm. Systems that manually transfer from the primary to the backup processor shall also be acceptable provided they generate and annunciate an alarm on processor fault and include manual controls allowing operators to manually transfer to the backup processor from the primary and from the backup processor back to the primary. Such manual controls, if they are provided, shall be readily accessible at the EOS main console.

431.2.2 Supervisory Network

Operators shall interface with IMACS through one of the multiple IMACS workstations. Three IMACS workstations shall be installed on the control console in the EOS, two IMACS workstations shall be installed in the pilothouse, and one workstation shall be located in the Chief Engineer's office. The workstations shall be connected to each other and to the main IMACS controllers via a digital communications network arranged in device level ring or other redundant configuration that is impervious to any single point of equipment or cable failure. The type and protocol of this network may be of the Contractor's choosing (e.g., Ethernet, Fieldbus,

copper, or fiber optic) provided the network supports all system requirements when installed on the vessel.

570 431.2.3 IMAC System Operator Workstations

Three (3) IMACS operator workstations shall be located in the EOS console. Two (2) IMACS operator workstations shall be located in the Pilothouse. The workstations shall be composed of a console-mounted display, processing unit, and keyboard/mouse unit.

575 The display shall be a 24" diagonal (minimum) color, low glare, thin film transistor (TFT) touchscreen.

The keyboard/mouse unit shall be a combined standard QWERTY keyboard and integrated trackball mouse mounted flush to the console desktop.

The processing units shall be mounted inside the EOS on slide out marine mounts, Mariner, or equal, behind hinged accesses.

580 A printer shall be located inside the EOS console for printing alarm list, alarm logs, HMI screen shots, and trend displays.

585 An IMACS workstation shall be located in the Chief Engineer's office and connected to the IMACS interface servers via the redundant supervisory network. The workstation shall include a processing unit, keyboard, mouse, printer, and minimum 24" color monitor (LCD type). The Chief Engineer's office workstation shall be capable of all monitoring and control functions inherent to the EOS operator workstations, but shall also have the capability to operate in reduced function mode, whereby users may monitor any aspects of the IMAC, but lack any control capabilities. The display in the Chief Engineer's office shall incorporate dimming via a dial or buttons and selectable color palettes to allow easy viewing during daylight and night watches.

590 Workstation process images (screens) shall graphically present the monitored functions with, for example, simplified system diagrams, and deck and/or space arrangements. Consideration shall be given for the practical number of controls and indicators for each screen, limited size of computer type monitors, and the rule for clear and intelligent presentation of information. The number of screens and presentation of each shall be as mutually agreed upon between the Contractor and the Resident Engineer, but shall generally follow the guidance presented in Table 400 - 1. The IMACS supplier shall utilize modern control system industry guidance for effective HMI design when designing the screen layouts.

600 The IMACS supplier shall work closely with the Resident Engineer when developing the layout of information and graphics of the IMACS interface screens. Interface development shall proceed as a collaborative effort between the Resident Engineer and the Contractor, and shall include a minimum of three iterations of review and feedback from initial submittal to final interface screen design. Sample screen captures from similar control integration efforts completed by the Contractor shall be included with the Contractor's proposal for review by the Resident Engineer. Screen development iterations shall begin once the IMACS system design is substantially complete. Final proofs of the screens shall be presented to the Resident Engineer for review and approval prior to IMACS commissioning.

Table 400 - 1 Process image guidance

Screen	Description
Power System Overview	Power system one-line showing status of breakers, power flow, voltage, frequency, thruster motors, etc., generator start/stop control, parallel/disconnect control, with selectable trend displays for all process data represented on the mimic screen.
Generator Set Detail (x4)	Mimic display of the generator set with status, RPM, exhaust temps per cylinder, temp deviations, fuel oil pressure, lube oil pressure, lube oil temperature, jacket water pressure, jacket water temperature, power, current, with trending of all analog process data.
Main Propulsion Overview	Engine status, thruster status, auxiliary system status, summary of active alarms.
Main Propulsion Engine Detail (x2)	Showing engine status, RPM, exhaust temps per cylinder, temp deviations, fuel oil pressure, lube oil pressure, lube oil temperature, jacket water pressure, jacket water temperature, seawater cooling temperature and pressure, other process data.
Propulsion Detail (x2)	Thruster RPM, bearing temperatures, status, with trending of all analog process data.
Tank Level Summary 1	All tanks grouped by type shown as gauges with normal and abnormal ranges shown in green and red, respectively.
Tank Level Summary 2	All tanks superimposed on a simplified vessel outline diagram showing tank level.
Chilled Water P&ID	Monitoring of all temperatures, pressures, and levels overlaid on a P&ID diagram.
Waste Heat P&ID	Monitoring of all temperatures, pressures, and levels overlaid on a P&ID diagram.
Seawater Cooling P&ID	Monitoring of all temperatures, pressures, and levels overlaid on a P&ID diagram.
Sanitary Flushing P&ID	Monitoring of all pressures and levels overlaid on a P&ID diagram.
Bilge P&ID	Monitoring of all pressures and levels overlaid on a P&ID diagram.
Fresh Water Cooling P&ID	Monitoring of all temperatures, pressures, and levels overlaid on a P&ID diagram.
Fuel Oil P&ID	Monitoring of all temperatures, pressures, levels, and instantaneous fuel consumption overlaid on a P&ID diagram. Tank level shown (% , ft-in, and gallons) for all fuel tanks and trending plots for user-selectable time period.
Trim & Ballast P&ID	Monitoring of all pressures, and levels overlaid on a P&ID diagram. Tank level shown (% , ft-in, and gallons) for all trim and ballast tanks.

Screen	Description
Potable Water P&ID	Monitoring of all temperatures, pressures and levels overlaid on a P&ID diagram. Tank level shown (% , ft-in, and gallons) for all potable water tanks and trending plots for user-selectable time periods.
Ventilation	Ventilation fans start/stop control and run indication with controls for starting groups of fans with a single action.
MSD System	MSD status, effluent, lift, and sewage tank level with trending plots for user-selectable time period.
System Status	Representation of IMACS indicating status of all communication, power supplies, and active processors.
Active Alarm Page	All active alarms listed in reverse chronological order, with an alarm time stamp for each alarm.
Alarm History Page	All alarm events (alarm register, alarm acknowledge, alarm clear) shown in reverse chronological order. Timestamps shall be provided for each event.

431.2.4 IMACS Alarm Annunciation

610 Alarm annunciation is a primary function of IMACS. Alarm annunciation function shall be in accordance with ABS Rules 4-9-2/7. Alarm annunciation shall include audible alerts, visual alerts, IMACS screen visual indication, and alarm event logging.

615 All analog signals included in the IMACS points list shall be assigned scaling factors, alarm set points (in engineering units), reset points (or hysteresis values), alarm configuration (low, high, etc.), alarm category, and on/off time delay. More than one alarm may be associated with a single analog input channel. All digital signals shall be assigned an alarm configuration (open to alarm or close to alarm), and alarm category, and an on/off time delay.

All alarm configuration settings shall be changeable but this changeability shall be secure and access controlled with credentialed login.

620 IMACS shall distinguish between a plant alarm condition and sensor circuit failure where the present sensor circuit allows supervision. IMACS shall address each signal input and check any available circuit failure information such as over-range, under-range, or open circuit signal attribute.

IMACS shall feature two alarm categories:

- 625 1. Vital Alarms dealing with propulsion equipment, IMACS, generators, and vital auxiliaries.
2. Non-Vital Alarms dealing with non-propulsion related equipment such as air-conditioning systems, ventilation fans, etc.

630 All alarms shall have visual and audible indications at the alarm locations. Not all alarms are activated at all consoles and panels. Alarm horns can be silenced at all alarm locations using an alarm silence pushbutton at that location.

635 Alarms shall be displayed by a colored indicator on the IMACS visual display unit. Alarm/status indication colors shall be in accordance with IEEE 45-2002, Clause 9, Table 13. Alarms shall be displayed until the alarm condition is corrected. Once the engineer acknowledges an alarm, visual (blinking) and audible (horn) should cease. A summary of the previous two alarms shall

always be visible on the display screen regardless of view state. All alarms and abnormal operations shall be designated by alarm category, alarm network address, alarm description (plain English language, no coding), and date/time.

640 To the degree practical and allowed by the regulations, IMACS shall inhibit alarms based on operator intention. Alarm logic shall correctly identify routine machinery plant state changes such as equipment start/stop and preclude display and logging of associated alarm conditions, such as low pressure when a pump is commanded to stop.

645 The alarm list and settings shall conform to ABS and USCG requirements. The list shall be presented to the Resident Engineer for review. Alarms shall be logged for future review. Alarm logs shall be stored for a period of sixty (60) months.

431.3 System Functions

It is intended to integrate as many of the vessel vital monitoring and control functions as practical and allowed by rules and regulations. In this regard, the features outlined in Sections 431.3.1 through 431.3.9, as a minimum, shall be included.

650 431.3.1 ✕ACCU Required Control and Monitoring

IMACS shall provide control and monitoring of vessel systems as required by the rules and regulations. The controls required at the fire control station, located in the Pilothouse, and monitoring and control of watertight doors shall be included in these functions.

431.3.2 Energy Management System (EMS) Interface

655 The system shall provide full monitoring, control and set-point adjustment interface with the EMS located in the main switchboards where electrical power is automatically controlled utilizing control of the diesel generators and switchboard components. See Technical Specification Section 322.

431.3.3 Propulsion System Interface

660 IMACS shall interface with the propulsion system, including the stern thrusters and bow thrusters. This shall include the following functions:

1. Receive all alarm and monitoring outputs required by the regulations.
2. Receive ready-for-control indication from a propulsion control selector switch.

665 A detailed system FMEA shall be performed, which demonstrates that any single failure in IMACS will not have an impact on more than one propulsion train.

431.3.4 Firefighting Station

IMACS shall provide the capabilities required by the rules and regulations for the firefighting station. The firefighting station shall be located in the Pilothouse. See Section 431.11.

431.3.5 Auxiliary Systems Monitoring and Control

670 IMACS shall provide for utilities in addition to those required by the rules. This includes remote transfer control of fuel; monitoring and control of fuel, lube, and ballast tank filling; remote control of seawater pumps and hull valves; TLIs of fuel and potable systems, and summary alarms from air-conditioning chillers and refrigeration. See Reference 436-02 for auxiliary systems monitoring points required by the State.

675 431.3.6 Tank Level Indicators (TLIs)

Tank levels, with high and/or low alarms as required, shall be integrated into IMACS. See Section 431.4.

431.3.7 Bilge Level Indication

Bilge high-level alarms shall be integrated into IMACS. See Section 431.5.

680 431.3.8 Navigation Suite Interface

IMACS shall provide an interface with the vessel navigation suite, as required, for relevant navigation instrument data.

431.3.9 Information Management System (IMS)

685 An IMS (Data Historian) shall be provided to assist in evaluating machinery performance in real-time and in performing trend analysis and data storage for future analysis and maintenance planning. This shall include a redundant interface from the IMS server to the vessel's LAN system.

690 The IMS shall collect and store all IMACS incoming and outgoing data (events) in a date/time sequence format. The data shall be easily formatted for reading on-screen or printing. The IMS shall be capable of storing the specified data for 60 months. Historical condition data viewing/printing parameters shall be developed by the Contractor and delivered to the State for approval.

431.4 Tank Level Indicator (TLI) System

695 The Contractor shall provide and install a remote TLI system, level alarm system, and visual TLIs.

700 The TLI system, via associated level sensors, shall provide continuous measurement of the liquid level in the vessel tankage for interface with IMACS. The system shall monitor fuel oil storage tanks, fuel oil settling and day tanks, the EDG fuel tank, any trim & ballast tanks, potable water tanks, and sewage tank(s). The TLI outputs shall be accessible from IMACS, which shall have the ability to activate level alarms.

Remote TLI systems of a type designed for marine service shall be provided to serve the tanks listed in Table 400 - 2.

Table 400 - 2 Remote TLIs for IMACS

Quantity	Tank Type	IMACS Alarm
6	Fuel Oil Storage	High Level
1	Fuel Overflow	High/High High Level
1	Sprinkling Tank	High/Low Level
4	Jacket Water Expansion	Low Level
1	Jacket Water Holding	Level
1	Sewage Holding	High Level
1	Aft Lift Station	High Level
1	Effluent Tank	Level
6	Trim & Ballast	Level

Quantity	Tank Type	IMACS Alarm
4	Fuel Oil Day	Low/Low Low Levels
1	Oil Processing	High/Low Levels
1	Waste Oil	High Level
2	Fuel Oil Settling	High/Low Levels
1	Fuel Oil Leak-Off	High Level
1	Oily Water Holding	High Level
3	Lube Oil	High/Low Levels
1	Deck Wash Holding	High Level
1	Miscellaneous, as needed	High/Low Levels

705 TLI and high/low level alarms for all tanks shall be displayed in IMACS. Fuel oil storage tanks shall also have level displays and high level alarms at the transfer manifolds.

All tank level alarms and level switches shall be provided with a built-in adjustable time delay to avoid inadvertent nuisance alarms caused by tank fluid sloshing in heavy seas.

710 Level switches shall be float type, Gems series LS-800, or equal, with intrinsically-safe relays as required. Local monitoring/level display equipment shall be Gems series 163000 digital bar graph display receiver(s), or equal.

431.5 Bilge High Level Alarms

The Contractor shall provide and install a bilge high level alarm system, which shall be arranged to detect an excessive rise of water in the bilges or bilge wells of the compartments listed below:

- 715
1. Bow Thruster Room (2 sensors).
 2. Lower MSD Room (2 sensors).
 3. Forward Machinery Room (4 sensors).
 4. Aft Machinery Room (4 sensors).
 5. Pump Room (4 sensors).
 - 720 6. Vehicle Elevator Machinery Room (2 sensors).
 7. Thruster Rooms, Stern (2 sensors, each room).

725 Sensors shall be positioned in each compartment in such a way as to detect high levels of water in the bilges at various angles of heel or trim. The estimated number of sensors required for each space are included in the compartment list above. The Contractor shall determine the final number of sensors required. These sensors shall be the float type, with protective covers or housings. The level sensors shall activate high level alarms in IMACS.

Bilge level float switches shall be Gems Sensors, model LS-270, or equal.

431.6 Fire Detection and Alarm System

730 The Contractor shall provide and install a smoke and fire detection system in accordance with regulatory body requirements and ASTM F1198. The system shall be as provided by Consilium Marine & Safety AB (Salweco), or equal. The system shall be provided with the central

control/repeater panel (M4.3 Cruise, or equal) located on the aft bulkhead of the Pilothouse, adjacent to the firefighting/damage control station (see Section 431.11). A second control and indication panel (Repeater M4.3, or equal) shall be located in the EOS. The central
735 control/repeater panel shall be integrated with the firefighting station to provide general arrangement mimic indication of fire locations.

The system shall be equipped to be powered from both the main and emergency electrical distribution systems, with switchover between the systems being automatic. The system shall
740 also be supplied with an internal battery backup capable of supplying the system for at least 30 minutes in standby mode and 5 minutes in alarm mode.

The system shall be designed and installed to meet the redundancy and separation requirements of SRtP.

The system shall use addressable detectors and call points, connected to the central control panel with looped circuits. Detectors shall be located to monitor spaces as required by ABS and
745 USCG. Detectors need not be placed on the vessel exterior, except in the Solarium. Detectors shall generally be smoke. Thermal and/or optical flame detectors shall be installed in spaces such as the Galley, the Paint Locker, machinery rooms, and electrical equipment rooms. Optical flame detectors shall be installed in the Solarium.

Manual call points shall be located along primary egress routes to the stair towers from the major
750 spaces on each deck as required by the regulations.

The Contractor shall be responsible for the definition, location, and arrangement of all detectors, cables, junction boxes, enclosures, processors, power supplies, batteries, displays, fasteners, and other appurtenances to create a fully functional and compliant system. Detector locations near
755 bulkheads, beams, ventilation outlets, or other positions where patterns of air flow could adversely affect performance, and where physical damage is likely to occur, shall be avoided. Detection system components located in public spaces shall be integrated into the surrounding decor as far as practical.

431.7 General Alarm

See Section 432.1.

431.8 Engineer's Assistance-Needed Alarm

An engineer's assistance-needed alarm system shall be provided and installed, in accordance with USCG and ABS regulations. This system shall be operated from the EOS, with
760 annunciators in each engineer's stateroom or office and the mess. The system shall also be operated automatically if an alarm is not acknowledged within a specified duration or if the alarm system normal power fails. The system shall have separate alarms for fire and high bilge water, as well as a summary alarm for all other vital alarms.

431.9 Steering Status Indicators and Alarms

Azimuthing propulsor status indicators and function alarms shall be provided per regulatory requirements. Alarms shall independently sense each propulsor steering system. Steering failure
770 alarms shall be provided per USCG regulations.

431.10 Refrigerated Spaces Alarm

The Contractor shall provide and install a refrigerated spaces alarm system, in accordance with USCG regulations, for each walk-in refrigerated storage compartment. Activation switches shall be located adjacent to the exit from the refrigerated space (inside the refrigerated space), with an alarm actuated in the EOS. This system shall be integrated into IMACS.

431.11 Safety Center

An integrated firefighting/damage control station (Safety Center) shall be provided and installed on the aft bulkhead of the Pilothouse. The station shall integrate the functions and systems listed below in a PLC-based system, with touch-screen mimics and controls, where allowed by the regulations. Required indications, controls, and alarms, including silencing, shall be integrated into the mimic displays. The station panel shall be dimmable for night operations. Power for the station shall be from the emergency system, via the vital UPS.

431.11.1 Ventilation Shutdown Systems

Ventilation emergency shutdown systems shall be provided and installed as per the regulations. The emergency pushbuttons indicated shall be located in the integrated firefighting/damage control station, and shall be hard-wired, in accordance with the regulations.

1. Engine room ventilation shall be tripped with individual pushbuttons in the firefighting control station. The pushbutton shall trip the associated machinery space ventilation circuit breaker(s). Pushbutton stations shall also be located at the top of the stairway, on the Main Deck, leading out of the respective machinery space.
2. Vehicle Space ventilation shall be provided with an emergency shutdown pushbutton configured like the machinery space ventilation shutdown. This system shall serve only the Vehicle Space ventilation.
3. Accommodations, and navigation spaces (Mezzanine Deck accommodation spaces, and all spaces Cabin Deck and above) shall be provided with a ventilation shutdown system configured similarly to those above.

Ventilation fan shutdown and fire damper closure shall be automatically triggered for the space served when the fire suppression system is actuated. Each space shall have individual controls as described in Technical Specification Section 555.

431.11.2 Fire Door Holding and Release Systems

The Contractor shall provide and install electro-magnetic holdbacks on all fire screen doors. The holdback and release system shall be configured in accordance with SOLAS regulations (by reference from 46 CFR 111.99-5).

The circuit shall hold the doors back (open) when energized, and release the doors upon interruption of the power to the circuit. Spring operated door closers shall close the doors upon release of the holdbacks. The system shall be equipped with a button or switch, on both sides of the door, to de-energize the holdbacks. Fire door magnetic holdbacks shall be Elomek, model GPM, or equal, provided with a microswitch for door indication. The Contractor shall verify the magnet hold strength (holdpower) requirements.

A fire door control and indication mimic shall be provided in the Pilothouse, as part of the firefighting/damage control station. The station shall be provided with a single button or switch to close all fire doors simultaneously. This button/switch will de-energize the system so that

positive action is required to re-energize it. The mimic shall include a visual representation of the areas of the ship where fire doors are located, with indication of the status of the door(s).

815 The system shall be powered with 24 VDC via power supply (NewMar, or equal) connected to the emergency power system.

431.11.3 Sliding Watertight Door Remote Control and Indication Systems

820 The Contractor shall provide and install a sliding watertight door control and indication display in the Pilothouse, as part of the firefighting/damage control station, that shall allow remote closing of each, and all, sliding watertight doors, as well as status indication (open or closed) for each door. The display shall include a visual representation (mimic) of the deck(s) on which the doors, and associated watertight bulkheads through which the doors provide access, are located. Indication shall be provided at each mimic door location to indicate status.

431.11.4 Shell Door Closed Indicating Systems

825 The Contractor shall provide and install a shell door closed indicating system. The two shell side doors, and stern door shall be fitted with sensors that will indicate, to the firefighting/damage control station, that each door securing dog is fully closed, as required. Should a dog remain not fully closed, an indication shall be via a mimic display on the station touchscreen, and an alarm shall sound at the station.

830 A summary panel, indicating which shell door is not fully closed, shall be provided and installed in the Vehicle Space, in a location approved by the Resident Engineer.

431.11.5 Vehicle Space Leak Detection Systems

835 A Vehicle Space leak detection system shall be provided and installed. This system shall consist of float switches located adjacent to, and on either side of, the three shell doors, in a location that will collect water leaked through the doors (e.g., in the corner of web frames).

Float switches shall also be located in the deck sumps adjacent to the shell doors and in four additional locations, two each port and starboard, along the shell, as approved by the Resident Engineer.

840 The leak detection system shall be integrated into the firefighting/damage control station, with mimic indication of which float is activated, and an alarm.

The leak detection float switches shall be Gems Sensors, model LS-270, or equal.

431.11.6 Fire/Sprinkler Pump Start/Stop Controls

845 Pushbutton start/stop controls, and status indication, for each fire and sprinkling pump, shall be provided in the firefighting/damage control station panel. These controls may be integrated into the touch-screen display.

850 Each sprinkler system alarm and indication, at the integrated fire/damage control station, shall be in accordance with ABS and SOLAS Rules, as follows: a visual and audible alarm signal shall be given at the central safety station to indicate when the sprinkler system is in operation or when a condition that would impair the satisfactory operation of the system exists. Alarm signals shall be provided for:

1. Monitoring position of control valves.
2. Fire pump power supplies and operating condition.
3. Water tank levels and temperatures.

4. Zone water flow alarms.
5. Pressure of tanks.
6. Air pressure on dry-pipe valves.

Alarms shall give a distinct indication for each individual system component monitored. This information shall be taken from IMACS, and shown on the touch-screen display.

431.11.8 Fuel and Lube Oil Systems Shut-Downs

Fuel oil pumps, lube oil service pumps, and fuel purifiers shall be configured to be shut down at the firefighting/damage control station. A single pushbutton system, configured to trip all such pumps and purifiers at once, shall be provided and installed in the firefighting station panel. This pushbutton shall be hard-wired, as an emergency shutdown, in accordance with the regulations. In addition, controls of oil piping positive shutoff valves shall be provided.

431.11.9 Bilge Level Alarm System

See Sections 431.3.7 and 431.5. The bilge level alarm system shall be depicted in the Firefighting/Damage Control panel display as a ship general arrangement mimic, indicating which level switch(es) have activated in what space. An alarm shall sound upon activation of any level switch.

431.11.10 Control of Fixed Gas Fire Extinguishing Systems

See Sections 555.2. Separate controls and monitoring shall be provided for each system.

431.12 Vehicle Space Gas Detection System

The Contractor shall provide and install a Vehicle Space gas detection system. Fourteen (14) gas monitors (detectors), MSA Ultima XE, or equal, calibrated (7) for gasoline vapor, and (7) for carbon monoxide, shall be installed in pairs with one of each type, distributed evenly about the Main Deck Vehicle Space:

The gas detectors shall be located not-higher-than 18" above the deck and shall be provided with appropriate explosion-proof cable entry glands, and other connection equipment, as required for a C11, Div1 hazardous zone environment.

The gas detectors shall be configured for 4-20mA output and integrated into IMACS via the nearest remote I/O cabinet. Detectors shall be calibrated to alarm at the low explosion limit (LEL) of gasoline (~1.4% by volume - Contractor to verify), and carbon monoxide (~12% by volume – Contractor to verify).

432 INTERIOR COMMUNICATIONS

The interior communications systems described below shall be an IP-based integrated platform consisting of controllers and switches connected with fiber-optic cables, and endpoints (speakers, telephones, etc.) connected to the switches with Ethernet, CAT 5e (Marine-grade STP) copper cabling. The main cabinets that contain the controllers, switches, patch panels, PBX, etc., shall be provided with 30-minute back-up UPSs and shall be fully installed in shock-mounted racks.

The main rack(s) shall be located in the Electronics/Copy Room. The interior communications systems shall be as provided by Vingtor, or equal.

432.1 Public Address and General Alarm System

The Contractor shall provide and install an integrated public address / general alarm / talkback / entertainment system that complies with USCG and ABS regulations. The system shall be complete with steel enclosure(s), shock mounts, and wired for 120 V power input. The system shall be provided with battery backup as required for 30 minutes of operation.

The system shall include tone generators for the general alarm as allowed by the regulatory bodies. Contact makers (2), shall be provided, and installed by the Contractor, one each in the Pilothouse, and the EOS.

The system shall be designed and installed to meet the redundancy and separation requirements of SRtP.

PA/GA system control panels shall be located in the Pilothouse MCC, in the EOS, and at the Purser's Counter. The panel shall provide the user with a series of touch menus displayed on a high-resolution color LCD screen with resistive touch panel. PBX, alarm activation, fog signaling, public address and talkback shall be integrated together through the panel in an ABS type-approved system.

The PA system shall be interfaced with the entertainment system to allow broadcast (music, etc.) to selectable zones.

The entertainment system shall be provided with, at minimum, the following features:

1. CD player.
2. DVD (Blu Ray) player.
3. MP3 input.
4. Auxiliary inputs.
5. AM/FM tuner.
6. All-band omni-directional shipboard antenna for TV and radio reception.
7. Power supplies and ancillary devices to make a complete, operational, system.
8. Two (2) 42" color flat-screen television monitors (one each in the Crew Mess and Officer Mess).
9. Computer projector, overhead mounted (installed in the Theater).
10. Fixed movie screen, forward bulkhead of Theater.

In adherence to the regulations, the entertainment system shall be configured to mute during PA announcements.

PA speakers in the lounges shall be configured to serve only their respective space, and shall be integrated with the entertainment system and the television(s) in that space.

FM/TV outlets, complete with connectors and cabling, shall be located in each crew stateroom, each office, the Observation Lounge (3), each Side Lounge, the Theater, Crew Mess, and Officer Mess.

Final locations for the PA/GA/Entertainment system components shall be approved by the Resident Engineer.

930 Table 400 - 3 summarizes the equipment requirements and approximate quantities of the public address/general alarm/talkback/entertainment system.

Table 400 - 3 Public address system equipment list

Location	Equipment
Mainmast	(1) Loudhailer
Hold Level	(11) Interior horns (4) Rotating Beacon (red – for general alarm in machinery spaces)
1st Platform	(1) Master station (EOS) (10) Interior horns (12) PA speakers (4) Rotating Beacon (red – for general alarm in machinery spaces) (3) TV outlets
Main Deck	(6) Exterior horns (Vehicle Space) (5) PA speakers (2) PA speakers (one in each elevator)
Mezzanine Level	(40) PA speakers (17) TV outlet
Cabin Deck, Interior	(1) Master station (Purser Office) (42) PA speakers (1) Interior horns (Emergency Generator Room) (4) TV outlets
Cabin Deck, Exterior	(6) Exterior horns
Boat Deck, Interior	(31) PA speakers (9) TV outlets
Boat Deck, Exterior	(5) Exterior horns
Solarium Deck, Interior	(1) Master station (Pilothouse) (21) PA speakers (10) TV outlets
Solarium Deck, Exterior	(2) Exterior horns
Solarium House Top, Exterior	(1) Exterior horn (Helicopter ops area)

Public address speakers/horns listed above shall be divided into “groups” as shown in Table 400 - 4 (“All Call” is included separately).

935 **Table 400 - 4 PA speaker equipment grouping**

PA Group 1	Passenger Accommodations & Public Spaces (including Vehicle Space)
PA Group 2	Crew Working Spaces (including Machinery Spaces)
PA Group 3	Vehicle Space
PA Group 4	Crew Accommodations
PA Group 5	Exterior Speaker Horns
PA Group 6	Loudhailer (Mainmast)

The integral talkback speaker system shall consist of NEMA-4X-rated speaker horns with integral, sealed, call-in signal pushbutton (except loudhailer location – see Table 400 - 3 for loudhailer equipment).

Talkback circuits shall be located as shown in Table 400 - 5.

940 **Table 400 - 5 Talkback speaker circuits**

TB1	Pilothouse MCC (This station is integral with the PA system control panel, installed as part of the PA/GA system)
TB2	Pilothouse, Port Bridge Wing Console
TB3	Pilothouse, Starboard Bridge Wing Console
TB4	Forward Lookout (Bullnose)
TB5	Anchor Windlass
TB6	Forward Mooring Station (Cabin Deck, starboard)
TB7	Forward Mooring Station (Cabin Deck, port)
TB8	Liferaft Station (Solarium Deck, starboard)
TB9	Liferaft Station (Solarium Deck, port)
TB10	Lifeboat Station (Boat Deck, starboard)
TB11	Lifeboat Station (Boat Deck, port)
TB12	Aft Mooring Station (Cabin Deck, starboard)
TB13	Aft Mooring Station (Cabin Deck, port)
TB14	Lifeboat Embarkation Station (Boat Deck, starboard)
TB15	Lifeboat Embarkation Station (Boat Deck, port)
TB16	Aft Mooring Station /Work Boat Davit (Cabin Deck, center line)
TB17	Elevator Control Cab (Cabin Deck,)
TB18	Turntable Control Station (Main Deck, port)

432.2 IP Dial Telephone System

The Contractor shall provide and install a VoIP-based dial telephone system complying with the ABS requirements for voice communication and configured as an emergency communications system. The telephone system shall be as provided by Vingtor, or equal.

945 Cabling, telephone jacks, patch panels, etc. as needed to achieve a functioning telephone system meeting the requirements of these Specifications shall be provided and installed.

The telephone system shall be suitable for marine installation and shall be capable of handling inputs from approximately 80 phone extensions installed throughout the vessel.

950 The system shall interface with the satellite telephone system (see Section 494.2), such that satellite phone calls may be directed to any ship's dial telephone.

The dial telephone system equipment is outlined in Table 400 - 6.

Table 400 - 6 Dial telephone system equipment list

Location	Equipment
Hold Level Fin Stabilizer Room (P) Fin Stabilizer Room (S)	Bulkhead-Mounted Telephone
Hold Level Pump Room	Bulkhead-Mounted Telephone Acoustic Booth Visual Signaling Beacon
1st Platform Bow Thruster Room Upper MSD Room Laundry & Shower Workshop Refer Machy & Engineer's Stores Log Office Thruster Room Athwartship Passage, Frame 240	Bulkhead-Mounted Telephone
1st Platform Forward Machinery Room Aft Machinery Room Vehicle Elevator Machinery Room	Bulkhead-Mounted Telephone Acoustic Booth Visual Signaling Beacon (Blue)
1st Platform EOS	6-Button Speakerphone
Main Deck Bosun Storeroom	Bulkhead-Mounted Telephone
Turntable Control Station	(2) Shoreside Line Terminal Boxes (configured for 8 lines each)
Mezzanine Level Bosun's Stores SR (21) Training Room Crew Laundry Crew Day Room Exercise Room	Bulkhead-Mounted Telephone

Location	Equipment
Cabin Deck Purser SR First Aid Room Network Room Electrical Room Elevator Control Cab	Bulkhead-Mounted Telephone
Cabin Deck Aft Pilot House	6-Button IP Speakerphone
Cabin Deck Purser Office	6-Button IP Speakerphone
Cabin Deck Emergency Generator Room	Bulkhead-Mounted Telephone Acoustic Booth Visual Signaling Beacon (Blue)
Cabin Deck Accessible SR (3)	Bulkhead-Mounted Telephone (configured in compliance with the ADA)
Boat Deck Steward's Office	6-Button IP Speakerphone
Boat Deck Serving (at Cashier's stand) Galley Crew Mess Officer Mess	Bulkhead-Mounted Telephone
Solarium Deck Pilothouse (2) Master SR Master Office Chief Mate SR Chief Mate Office Chief Engineer SR Chief Engineer Office 1 st Asst Engineer SR 1st Asst Engineer Office	6-Button IP Speakerphone
Solarium Deck Officer SR (6) Electronics & Copy Room	Bulkhead-Mounted Telephone

955 The system shall be self-contained and integrated with the satellite communications systems. The system shall manage extension-to-extension call routing and shall record off-vessel phone time (both at sea and in port). The primary reception phone, located in the Purser's Office, shall be a multi-line featured phone capable of receiving incoming satellite calls and transferring the calls to the appropriate extension.

960 Eight shoreside line terminals (port and starboard) shall be provided and installed for use when
the vessel moored alongside a pier. The shore connection locations shall be approved by the
Resident Engineer.

432.3 Sound Powered Phones

965 The Contractor shall provide and install sound-powered telephone systems as required by the
regulations and as outlined below. The sound-powered telephone system shall be as provided by
Vingtor, or equal.

All sound powered phones in a space with multiple sound powered phone circuits (e.g. EOS,
Chief Engineer's office, Pilothouse) shall be provided with an indication light and latching relay
to indicate which sound powered phone circuit is ringing.

432.3.1 Ship Control and Maneuvering System (Circuit 1JV)

970 A ship control and maneuvering sound-powered telephone system (circuit 1JV) shall be provided
and installed to communicate between the following stations:

1. Pilothouse MCC.
2. Pilothouse, adjacent to the Safety Center
3. Aft pilothouse
- 975 4. Thruster (Propulsor) Rooms.
5. EOS.
6. Bow Lookout Station (with Cut-Out Switch located in the Pilothouse).
7. Master Office.
8. Chief Engineer Office.
- 980 9. Elevator Control Cab.
10. Emergency Gear Locker (Main Deck, Frame 122 port).
11. Emergency Gear Locker (Cabin Deck, Frame 110 starboard).
12. Emergency Gear Locker (Boat Deck, Frame 110 starboard).

432.3.2 Engineering System (Circuit 2JV)

985 An engineering sound-powered telephone system (circuit 2JV) shall be provided and installed to
communicate between the following stations:

1. Pilothouse.
2. Chief Engineer Office.
3. Elevator Control Cab.
- 990 4. Turntable Control Station.
5. Forward Machinery Room.
6. Aft Machinery Room.
7. EOS.
8. Vehicle Elevator Machinery Room.

- 995 9. Pump Room.
10. Bow Thruster Room.
11. Thruster (Propulsor) Room.
12. Emergency Generator Room.

1000 Provisions shall be made for high ambient noise areas. In the machinery spaces, including Forward and Aft Machinery Rooms, Bow Thruster Room, and Emergency Generator Room, a blue, rotating beacon shall be installed to alert personnel to incoming calls. (Machinery space sound-powered telephones may be located in acoustic booths provided as part of the dial telephone system.)

432.3.3 Fueling System (Circuit 3JV)

1005 An intrinsically safe sound-powered telephone system (circuit 3JV) shall be provided and installed to communicate between the following spaces:

1. Fueling Station (Main Deck Frame 224 port).
2. Fueling Station (Main Deck, Frame 224 starboard).
3. Fueling Manifold.
- 1010 4. EOS.
5. Chief Engineer Office.

Sound-powered telephone units at the fueling stations shall be intrinsically safe.

432.4 Engine Order Telegraph (EOT)

1015 The Contractor shall provide and install an EOT system as part of the propulsion control system. See Section 411.

The propulsion order telegraph system shall be a Prime Mover Controls series 8202-2000, for twin azimuth thrusters, or equal.

EOT locations shall be provided in the following locations for each stern thruster (Propulsor):

1. Pilothouse MCC.
- 1020 2. EOS console.
3. Thruster (Propulsor) Equipment Rooms

432.5 Steering Position Indication System

1025 The Contractor shall provide and install a steering position indication system, in accordance with USCG regulations. The system shall consist of angle feedback units, angle calibrator(s), and propulsor angle indicators. The feedback units shall be mechanically connected to the propulsors, the calibrator(s) located in the Thruster Room, and angle indicators shall be located at the Pilothouse steering stand, Pilothouse wing stations, overhead above the Pilothouse Captain's chairs, and at the emergency steering station in the Thruster Room. An additional, panoramic-style steering angle indicator shall be located in the Pilothouse, on centerline, directly
1030 above the MCC.

The system shall be as supplied by Sperry Marine, or equal.

432.6 Elevator Intercom System

1035 The Contractor shall provide and install an intercom system in each elevator (passenger and service), connected only with the EOS for emergency communications. The intercom shall be operable from all elevator positions. The intercom system shall be from the same manufacturer as the PA/GA system (Vingtor, or equal).

434 PASSENGER INFORMATION DISPLAY SYSTEM (PIDS)

1040 The Contractor shall provide and install a PIDS. This audio-visual system will provide passengers with useful travel, ship's navigation, and other information that can be displayed on various LCD monitors located in selected public areas throughout the ship.

The system shall consist of:

1. Nine (9) display stations.
2. One (1) PIDS server.
- 1045 3. Network hardware and cabling necessary to interface the display stations with the server and entertainment system.

Each display station shall include a 42" high-definition monitor, capable of supporting a multi-window format as well as all equipment necessary to deliver content. The display stations shall be located as follows:

1. Two (2) in the Boat Deck Observation Lounge (forward, port and starboard).
- 1050 2. Two (2) in the Boat Deck Passages inboard of the Side Lounges (~Frame 100 port and starboard).
3. One (1) in the Boat Deck Foyer (~Frame 128, centerline).
4. Two (2) in the Boat Deck dining areas (1 each, main and side).
5. One (1) on the Cabin Deck Foyer (~Frame 140, centerline).
- 1055 6. One (1) in the athwartship passage (aft bulkhead) on the Solarium Deck at ~Frame 148.

The PIDS server shall be located in the network rack in the Network Room.

Operating systems, and PIDS software, will be provided, installed, and configured by the State.

1060 The PIDS server shall be interfaced with the ship's State-furnished computer network (see Section 493). The Contractor shall provide and install, to the PIDS, the required cabling for the interface, but shall not connect the network side. Cabling shall include one CAT6 cable from each display station to a patch panel in the Network Room.

1065 The PIDS server shall be interfaced with the ship's entertainment system (see Section 432.1). The Contractor shall provide and install the required cabling for the interface to both systems. Cabling shall include one CAT6 cable from each Ethernet capable device to a patch panel in the Network Room.

1070 Navigation information available from the ship's electronic navigation equipment shall be interfaced with the system to provide the information needed to display the ship's charted position, ship's speed, and other navigation information of interest to passengers. The Contractor shall provide and install cabling required to interface the navigation electronic chart system (ECS – see Section 426 above) with the PIDS. Cabling shall include one CAT6 cable from each Ethernet capable device to a patch panel in the Network Room.

Detail design of this system shall be coordinated with the design of the ship's entertainment and network systems, such that proper selections are made for crossover components such as video-audio matrix switchers, the electronics cabinet UPS, and common cable runs.

- 1075 Power supply for system components shall generally be from 120V normal (non-emergency) power source via the non-vital UPS system.

439 CLOSED CIRCUIT TELEVISION SYSTEM (CCTV)

- 1080 The Contractor shall provide and install a CCTV system, to monitor the machinery spaces, the Vehicle Space, interior public spaces, and exterior areas of the ship. All cameras shall have remote zoom and focus controls; those in the weather and in the Vehicle Space shall be suitably protected and heated. The location of all cameras shall be approved by the Resident Engineer. Monitors, and camera control stations, shall be located in the Pilothouse, Purser Office, and EOS.

- 1085 The system shall be equipped with channel selection, multiple channel viewing, and view identification capability. The system shall have continuous-loop, 1-2 hour, DVR recording capability, with the ability to archive thirty (30) days of recording for all cameras. The surveillance monitors shall be 19" LCDs with up to 16-screen display, or any camera single image display capability.

- 1090 The system shall function on an IP network, which shall be integrated with the ship's computer network. The system shall include:

1. CCTV cameras.
2. Control equipment including matrix switchers.
3. Digital video recorder.
4. Operator interfaces including monitors, keyboards.
- 1095 5. All other items necessary to create a complete functional system.

The CCTV server(s) shall be mounted in an equipment rack in the Network Room.

Generally, cameras shall be located to view the areas listed in Sections 439.1 through 439.3 below (locations are approximate).

439.1 Exterior CCTV - Fixed, Wide Angle

- 1100 The Contractor shall provide and install approximately seven (7) cameras in the exterior locations listed below:

1. Solarium Deck, Frame 102 port – Aft along weather deck, including liferaft stowage.
2. Solarium Deck, Frame 102 starboard – Aft along weather deck, including liferaft stowage.
- 1105 3. House Top, Fwd Folding Mast – Helicopter operations area (aft-looking).
4. Solarium Housetop, Elevator Kingpost:
 - a) View down into elevator hoistway (two [2] cameras: one each port and starboard).
 - b) View down to shore ramp (two [2] cameras: one each port and starboard).

439.2 Interior CCTV – Fixed, Wide Angle

- 1110 The Contractor shall provide and install approximately twenty eight (28) cameras in the interior spaces/locations listed below:
1. Hold Level, Lower MSD Room, (1 camera).
 2. Hold Level, Forward Machinery Room (2 cameras).
 3. Hold Level, Aft Machinery Room (2 cameras).
 - 1115 4. Hold Level, Pump Room (1 camera).
 5. Hold Level, Fin Stabilizer Room, starboard (1 camera).
 6. Hold Level, Fin Stabilizer Room, port (1 camera).
 7. 1st Platform, Upper MSD Room (1 camera).
 8. 1st Platform, Forward Machinery Room (1 camera).
 - 1120 9. 1st Platform, Aft Machinery Room (1 camera).
 10. 1st Platform, Vehicle Elevator Machinery Space (1 camera).
 11. 1st Platform, Thruster Room (1 camera).
 12. Main Deck, Vehicle Space ~Frame 85 port (1 camera).
 13. Main Deck, Vehicle Space ~Frame 90 starboard (1 camera).
 - 1125 14. Main Deck, Vehicle Space, ~Frame 230 port and starboard (2 cameras).
 15. Mezzanine Deck, Vehicle Space, ~Frame 90 port and starboard (2 cameras).
 16. Mezzanine Deck, Vehicle Space, ~Frame 280 port and starboard – viewing shell doors, including deck at bottom of door (3 cameras).
 17. Mezzanine Deck, Vehicle Space, ~Frame 215 port (1 camera).
 - 1130 18. Cabin Deck, Emergency Generator Room, (1 camera).
 19. Solarium Deck, Frame 148 port (1 camera).
 20. Solarium Deck, Frame 140 port – athwart across Foyer, to port (1 camera).
 21. Solarium Deck, Solarium port and starboard, ~Frame 178 (2 cameras).

439.3 Cameras and Equipment

- 1135 Exterior, Vehicle Space, and Solarium cameras shall be Pelco model FH-LIXP31-12, or equal, with IP control system, adaptive motion detection, and low-temperature enclosure (NEMA 4X [IP66] with heater).

- 1140 Interior cameras, installed in suspended overheads, shall be Pelco model IME319-1VI (vandal-resistant), with IP control system, adaptive motion detection, and vandal-resistant mini-dome enclosure, or equal.

Interior cameras, installed in machinery spaces, and spaces without suspended overheads, shall be Pelco model IME319-1EP (environmental), with IP control system, adaptive motion detection, and environmental (NEMA 4X [IP66]), pendant-style enclosure, or equal.

1145 Video management system shall be a Pelco Digital Sentry, or equal, with 18Tb internal storage, 24 TB of external storage, necessary software for 64 cameras.

Monitors shall be Pelco model PMCL319BL, or equal.

Switcher(s) of sufficient capacity to enable viewing of camera positions either sequentially or individually shall be provided and installed.

1150 All equipment shall be powered with 120 V, 60 Hz, single-phase; transformers or power supplies will be required to provide 24VAC to the exterior cameras.

Control and display locations for the CCTV system shall be located in the Pilothouse, EOS, and the Purser's Office.

441 RADIO COMMUNICATIONS SYSTEMS

1155 Specific references to some vessel equipment are intended to define State requirements and are not meant to be limiting. The requirements of the regulatory bodies shall be met in all cases.

The Contractor shall provide and install all radio communication system equipment that is required by the regulatory bodies, as well as the equipment described herein. Each piece of equipment shall be installed according to the manufacturer's recommendations.

1160 All equipment shall be FCC type-approved and located in the Pilothouse unless specifically indicated otherwise.

The Contractor shall require that the navigation and exterior communications vendors contribute to a Contractor-developed topside antenna arrangement, indicating locations of the various antennas so that interference is minimized between the antennas.

1165 Information on the vessel's position shall be continuously and automatically provided to all relevant radio communication equipment to be included in the initial distress alert when the button on the distress panel (see below) is pressed.

441.1 Ancillary Radio Equipment

1170 In addition to the radio equipment required for GMDSS (see Section 442), to satisfy the bridge-to-bridge requirements of the FCC, and local communications equipment (tugs, shore, etc.), the Contractor shall provide and install the following radio equipment:

1. Three (3) Furuno FM8900S, or equal, semi-duplex 25-watt VHF radiotelephones. Provided with a 6dB gain antenna.
2. Three (3) IMO GMDSS-approved portable VHF radios (provided as part of the GMDSS suite).
- 1175 3. One (1) distress panel installed in the Pilothouse MCC. This panel shall contain one single button that, when pressed, initiates a distress alert using all radio communication installations required on board for that purpose. The panel shall clearly and visually indicate whenever the button has been pressed. Means shall be provided to prevent inadvertent activation of the button.
- 1180 4. One (1) distress alarm panel installed in the Pilothouse MCC. The distress alarm panel shall provide visual and audible indication of any distress alert or alerts received on board and shall also indicate through which radio communication service the distress alerts have been received.

Note: The two distress panels described above may be included as part of the GMDSS suite.

- 1185 1. Two (2) commercial VHF aircraft scanner, operating in the 118-136.975 MHz frequency range. The scanner shall be an Icom IC-A110, or equal, VHF transceiver, one located in the Aft Pilothouse.
- 1190 2. Twenty-five (25) marine grade hand-held VHF radios shall be provided, to be used by crewmembers for communicating between various locations on the vessel and to/from dockside. Charging stations shall be supplied for each radio to provide for storage and charging at specified locations such as the Pilothouse, EOS, and/or Purser's Counter. Hand-held VHF radios shall be Icom, model IC-M36, or equal.

441.2 Antenna Systems

- 1195 A complete system of receiving, receive/transmit, and DSC antennas shall be provided for all communications and navigation equipment, as required. The electromagnetic interference requirements outlined in Technical Specification Section 301.4 shall be adhered to. All relevant vendors and the navigation equipment supplier(s) shall be consulted to ensure integration and compatibility of all systems. Radio antennas shall be Shakespeare Marine, or equal.

442 GMDSS

- 1200 The Contractor shall provide and install a pre-packaged, pre-wired GMDSS console system. This system shall conform to USCG and IMO/SOLAS requirements for GMDSS Sea Area A3. The Contractor shall provide and install a Furuno model RC1815, or equal, GMDSS console system. The system shall consist of:
- 1205 1. One (1) Furuno Felcom 18, or equal, Inmarsat-C mobile earth station.
2. One (1) Furuno FS2575, or equal, 250 watt MF/HF radiotelephone with integrated DSC transceiver/DSC watch receiver.
3. Two (2) Furuno FM8900S, or equal, semi-duplex 25W VHF radiotelephones, each with built-in Class-A DSC and CH70 watch receiver.
4. Two (2) Furuno PP520, or equal, GMDSS-compliant dot matrix printers.
- 1210 5. One (1) Furuno PR850A, or equal, external rectifier, 115 V to 24 VDC, with automatic power switch (switching from primary power source to secondary back-up battery system upon failure of primary power source).
6. One (1) Furuno IB585, or equal, NBDP telex terminal display unit (10.4" color LCD display), supplied with keyboard and secure digital (SD) storage cards.
- 1215 7. One (1) Furuno FUSA 1800 GMDSS console rack.
8. One (1) Analytic Systems, or equal, 24 VDC, 60 A GMDSS-qualified battery charger.
9. One (1) metal GMDSS operator's table, with back panel for mounting GMDSS equipment.
10. Battery bank/back-up power supply system.
- 1220 11. Power and coaxial cabling, as needed.
12. Antennas and/or related couplers/pre-amplifiers, as needed.

The Contractor shall provide and install this emergency response electronic equipment as part of the GMDSS installation:

1. Two (2) 9 GHz SART radar transponders, as required by regulatory bodies.
- 1225 2. One (1) 406 MHz EPIRB and one (1) INMARSAT, or equal, L-Band (1.6 GHz) EPIRB, both with remote activation capability.

The GMDSS shall be configured with long-range identification and tracking equipment to meet 33 CFR 169.

443 SRTP RADIO COMMUNICATIONS

- 1230 The Contractor shall provide and install equipment in Aft pilothouse to provide back-up communications capability in case of loss of Pilothouse. Equipment shall comply with minimum requirements as defined in SOLAS regulations for Safe Return to Port.

The system shall consist of:

1. One (1) Furuno Felcom 18, or equal, Inmarsat-C mobile earth station.
- 1235 2. One (1) Furuno FM8900S, or equal, semi-duplex 25W VHF radiotelephone, with built-in Class-A DSC and CH70 watch receiver.
3. One (1) Furuno PR850A, or equal, external rectifier, 115 V to 24 VDC
4. Power and coaxial cabling, as needed.
5. Antennas and/or related couplers/pre-amplifiers, as needed.

1240 444 VOYAGE DATA RECORDER

The Contractor shall provide and install a complete, IMO-approved VDR, with features and capabilities in accordance with IMO Resolution A.861(20) as amended. The VDR shall be capable of interfacing with IMACS and navigation systems to record the information required by the regulatory bodies (see below). The VDR shall record 48 hours of data in a continuous loop.

- 1245 The VDR shall be a Furuno VR-7000, or equal, complete with data collection unit, fixed and float-free data recording units, remote alarm panel, up to six (6) microphones, and a laptop PC for live play/playback of VDR information.

In addition, the VDR system shall have the following features:

1. Memory capable of storing 48 hours of data in the data recording units, and
- 1250 2. thirty (30) days in the data collection unit.
2. VDR playback software.

The VDR shall be capable of recording the following data:

1. Date and Time – Referenced from a source external to the vessel or from an internal system source (i.e., GPS).
- 1255 2. Vessel Position – Latitude and longitude and datum used.
3. Speed – Through water.
4. Heading – From gyrocompass and/or GPS.
5. Pilothouse Audio – Microphones at the MCC, bridge wing consoles and chart table.

6. Communications Audio – VHF communications relating to vessel operations.
- 1260 7. Radar Data – As it appears on the master radar display during the recording period.
8. Echo Sounder – Depth under keel, depth scale, and status information.
9. Main Alarms – Status of all mandatory bridge alarms.
10. Stern Thruster (Propulsor) Position and Response – Include status and settings of autopilot.
- 1265 11. Propulsion Order and Response – Direct engine and propulsion motor controls and feedback indications. Include status and power levels of bow thruster.
12. Watertight and Fire Door Status – Include all mandatory status information required at the Pilothouse.
13. Wind Speed and Direction – Either relative or true, with an indication of which.

1270 Data may be derived from the individual indicating/alarm equipment or, as practicable, from IMACS.

The data recording units (“black box”) shall be located in a clear section of the housetop to allow access by a diver or ROV, and such that the float-free unit will clear the ship. The data collection unit shall be located in the Electronics/Copy Room.

1275 **451 RADARS**

451.1 Primary Radars

The Contractor shall provide and install two (2) complete radar systems as described below.

Additional system components and materials, such as pedestal stands, additional circuit boards, junction boxes, terminal strips, cabling, and data cable connectors, shall be furnished and
 1280 installed, as needed, to provide a complete and fully operational and interfaced system. The radar systems shall be configured with a 6-way inter-switch device, mounted separately from the radars. The inter-switch device shall afford the operator at each radar display the ability to switch between any transceiver signals at that radar and to switch the radar display to the slave unit if preferred. This shall provide for full scanner redundancy at each radar, and full “master”
 1285 radar redundancy at any display unit.

The radar installation shall comply with the regulatory agencies. Two (2) complete radar systems shall be provided and installed:

1. One (1) 10 kW X-Band radar system shall be Sperry Marine VisionMaster FT , or equal, with ARPA capabilities, one (1) 6' antennas, turning units (with heaters), turning unit-mounted TX/RXs, and one (1) deck standing 25.5" color flat-screen display (VMFT 340).
- 1290 2. One (1) 30 kW S-Band radar system shall be a similar Sperry Marine VisionMaster FT, or equal, complete with 12' antenna, turning unit (with heater), bulkhead-mounted TX/RX unit, a deck standing 25.5" color flat-screen display (VMFT 340).

The radars shall accept inputs from the gyrocompass, the speed log, AIS, and the DGPS system.

1295 The systems shall be integrated via an inter-switch unit. The navigation radar and ECS (see Section 426) shall be compatible and shall be tightly integrated in functionality. Correlation of AIS and ARPA targets shall be performed by the radar and ECS. All targets shall have the same reference designation on both the ECS and the radar displays so that there is no confusion on

1300 target identification for the operator. The radar plotting system shall have the capability of operating in both the sea and the ground stabilized mode.

The radar systems shall also provide the following features:

1. Radar controls mounted on the deck standing display unit.
2. Multiple means of data communication (NMEA, MITS or PICIES Ethernet) as required for communication with other navigation equipment.
- 1305 3. Outputs of ARPA tracked target data to the ECS and VDR.
4. ARPA capability to track targets respectively at relative speeds of up to 150 knots.
5. Manual and automatic clutter suppression.
6. Communication link to the ECS for receiving and displaying chart and/or route data (radar overlay).
- 1310 7. Remote control of autopilot in heading, course, and track control modes.
8. Electrical supply via a UPS.

1315 Each radar scanner shall be mounted on its own stub mast, two X-band, and one S-band located on the House Top above the Pilothouse, in accordance with Reference 441-01. The stub masts, in conjunction with their connections to ship's structure, shall be suitably stiffened to avoid vibration.

The two deck-standing displays shall be located adjacent to the Pilothouse MCC. A third, desktop-style display, shall be mounted on a swivel base and pedestal, and located adjacent to the starboard captain's chair, as shown on Reference 663-01.

451.2 Secondary Radar

1320 The Contractor shall provide and install one (1) complete radar system as described below.

The radar installation shall comply with the regulatory agencies. Two (2) complete radar systems shall be provided and installed:

1. One (1) 10 kW X-Band radar system shall be Sperry Marine VisionMaster FT , or equal, with ARPA capabilities, one (1) 6' antenna, turning unit (with heater), turning unit-mounted TX/RX, and one (1) desktop-style display.

1325 The radar shall accept inputs from the gyrocompass, the speed log, AIS, and the DGPS system.

Correlation of AIS and ARPA targets shall be performed by the radar and ECS. All targets shall have the same reference designation on both the ECS and the radar displays so that there is no confusion on target identification for the operator. The radar plotting system shall have the capability of operating in both the sea and the ground stabilized mode.

1330 The radar system shall also provide the following features:

1. Radar controls mounted on the display unit.
2. Multiple means of data communication (NMEA, MITS or PICIES Ethernet) as required for communication with other navigation equipment.
- 1335 3. Outputs of ARPA tracked target data to the ECS.
4. ARPA capability to track targets respectively at relative speeds of up to 150 knots.

5. Manual and automatic clutter suppression.
6. Communication link to the ECS for receiving and displaying chart and/or route data (radar overlay).
- 1340 7. Electrical supply via a UPS.

Radar scanner shall be mounted on its own stub mast, located on an Elevator Kingpost cross beam, in accordance with Reference 441-01. The stub masts, in conjunction with their connections to ship's structure, shall be suitably stiffened to avoid vibration.

493 SHIPS COMPUTER NETWORK

- 1345 The vessel shall have a computer network/satellite communications system, to be interfaced with the PIDS described separately in Section 434.

The Contractor shall be responsible for providing and installing network server racks, cable, power supplies, power receptacles, and terminations for the network and satcomm systems; all ship's network computers, printers, and servers are to be State-furnished equipment, and will be
1350 installed by the State after vessel delivery.

The Contractor shall install the power and data cabling between the satcomm system and network equipment, but final connections to the network equipment cabinet will be made by the State after vessel delivery.

- 1355 The ship's network (wireless bridge) antenna shall be State-furnished and installed by the Contractor. The Contractor shall install a State-furnished NEMA 4X enclosure at a prescribed location on the House Top, and install a power cable from the non-vital UPS power distribution panel in the Electrical Equipment Room to a NEMA 5-15 receptacle mounted in this NEMA 4X enclosure. The Contractor shall provide and install four (4) Cat-6 cables from the NEMA 4X enclosure to the network server rack in the Network Room.

- 1360 The Contractor shall install the network server racks in the Network Room on the Cabin Deck. They shall be secured to the deck and other adjoining structure with welded studs. The rack layout shall be provided by the State and shall be selected to provide front and rear access, and allow free air circulation on all sides.

- 1365 The Contractor shall provide and install the necessary fiber-optic and Cat-6 cables for this system. Cable runs shall be made from the various spaces on the vessel served by the network to the network server rack in the Network Room via State-furnished switches and patch panels. Such runs shall include those required at intended wireless access points and any installed ATM and point-of-sale locations. See Reference 430-01 for cabling guidance.

- 1370 All network cable shall be shielded (Cat 6 only) and plenum rated, low smoke, flame retardant PVC, conforming to regulatory body requirements. The cable shall be run in continuous lengths without splices or junctions. Network cable shall be routed separately from power cables.

494 SATELLITE COMMUNICATIONS

494.1 Ku-Band Communications System

- 1375 The Contractor shall provide and install a Ku-band very small aperture terminal (VSAT) system, Sea Tel model 6012, 1.93m (~6'-6") radome, or equal, on the House Top in the location shown on Reference 441-01. The radome shall be mounted on shipyard-fabricated and installed pipe stub mast foundations capped with plate, in accordance with the manufacturer's requirements.

The below-decks equipment shall be installed in the Network Room server racks, installed above.

1380 **494.2 SatPhone (Broadband Voice/Data) System**

1385 The Contractor shall provide and install an Iridium Pilot, or equal, satellite broadband voice/data system. The antenna radome shall be located on the vehicle elevator kingpost, ~Frame 250 port, as shown on Reference 441-01. The below-decks equipment shall be located in the Network Room on the Cabin Deck. Three (3) handsets shall be provided and installed: one in the
1385 Pilothouse, one in the First Aid Room, and one in the Purser's Office. The system shall be interfaced with the ship's computer network, as indicated on Reference 430-01, and with the ship's dial telephone system, to enable satellite phone calls to be routed to any ship's telephone (see Section 432.2). The Contractor shall route the Ethernet cabling, from the ship's network computer, to the below-deck equipment, to the antenna radome, such that the total length of the
1390 Ethernet cabling does not exceed 100 m (~328'), in accordance with the manufacturer's installation manual.

The Contractor shall provide and install, in the Master's Office, a portable, hand-held satellite telephone, Iridium Extreme, or equal, complete with charging station.

494.3 Cellular Booster System

1395 The Contractor shall provide and install a cellular booster system, Shakespeare, or equal, consisting of a cellular signal booster, internal shared access points, splitters, and an exterior antenna required to provide cellular phone service to officer and crew areas. These areas are to include the crew accommodations, Mezzanine Deck (port and starboard); Cabin Deck, adjacent to the Purser's Stateroom and Purser's Office; Officer Mess and Crew Mess; officer
1400 accommodations and Pilothouse, Solarium Deck. The system shall be capable of sending/receiving 3G and 4G LTE service signals, and handling no fewer than 10 users simultaneously. Cable, between the booster and internal shared access points, shall be LMR-400, or equal, in accordance with manufacturer's recommendations.

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85 **500 MACHINERY – GENERAL**

500.1 Arrangements

Machinery, equipment, compartments, walkways, and accesses shall be arranged in accordance with References 070-01, 201-01, 201-02, 201-03, 201-04, 201-05, 201-06, 243-01, and 568-01.

500.2 Maintenance Access, Shipping Access, and Service Routes

- 90 Refer to Technical Specification Sections 1E.8.3 and 1E.8.4 for maintenance access, shipping access, and service routes.

500.3 Vibration and Noise Control Features

To meet the noise and vibration requirements, selected rotating, vibrating, and reciprocating equipment shall be mounted on vibration isolators in accordance with Technical Specification
95 Section 1E.11.4. Vibration-sensitive electrical and electronic equipment shall be installed on resilient mounts as recommended by the equipment manufacturers.

All piping serving resiliently isolated equipment shall be mounted to ship structure with isolated pipe clamps for a minimum of the first three piping supports. Clamps shall include a minimum
100 ½" thick rubber insert made from rubber, with a 40 to 45 Shore A Durometer. All pipe clamps shall be attached to stiffened areas of the vessel. No pipe clamps shall be located to the center of bulkhead or deck plating. Final connections to resiliently mounted equipment shall be made with expansion joints, flexible couplings, or hoses.

All fans and air handling units (AHUs) shall be installed on rubber-in-shear vibration isolation mountings in accordance with Technical Specification Section 1E.11.4. All fans and AHUs shall
105 be connected to ductwork with flexible elements as described in Section 505.9.

500.4 Machine Guarding

Removable guards shall be provided for all rotating machinery, power-transmission machinery, and other machinery where necessary to prevent personnel from contacting moving parts.

Equipment hazards to be guarded shall include, but are not limited to, flywheels, couplings
110 between motors and pumps, chain and sprockets, propulsion shafting, any rotating shafts, and V-belt drives.

Guards shall be bolted to the machine bases or foundations utilizing Type 316 stainless steel studs, bolts, nylon insert lock nuts, and washers.

503 PUMPS

503.1 Selection of Equipment

Pumps shall be of commercial standard marine grade and built in accordance with Standards of the Hydraulic Institute, *Design Practices for Marine Application*, and shall meet all regulatory requirements. Rotary pumps shall be in accordance with ASTM F1718 and ASTM F1510.
120 Centrifugal pumps shall be in accordance with ASTM F998. Pumps shall be selected for intended service and shall operate at the maximum efficiency point in the head-capacity curve at design conditions and shall have non-overloading power characteristics. Pump connections shall be in accordance with ANSI B16.5. The Contractor shall verify, through hydraulic calculations, that the pump head and capacity specified will work properly with the detailed piping design.

Pumps shall have mechanical seals in accordance with ASTM F1511. Black water pumps shall
125 be provided with packed glands.

Pump components with large mating surfaces shall be properly doweled and provided with jacking bolts for breaking joints. When available from the manufacturer, a vent shall be located at the top of the casing and a drain at the bottom.

Pumps for fuel oil and lubricating oil shall be positive displacement gear type. Alternative
130 positive displacement style pumps may be used where specifically specified.

The number of different types and manufacturers of pumps shall be minimized. Pumps for the same service and capacity shall be identical. Pumps of identical design shall have the same rotation and be to the same hand.

Pumps in seawater systems shall be all bronze construction.

- 135 Where possible, pumps shall be balanced hydraulically. All pumps shall be equipped with suitable thrust bearings to absorb any thrust that may occur during operation.

- In general, pumps shall be equipped with oil reservoir type bearings or with sealed ball bearings contained in housings, and removable as a unit with the pump shaft. Sleeve-type bearings may be used with oil or grease lubrication only. Where water jacketing is supplied, jackets shall be formed by cored casting, with no joints to allow water leakage into the bearings. Bearing water shields or slingers shall be provided.
- 140

Attached pumps furnished with diesel engines and with other unitized equipment shall be of the manufacturers' standard marine models, suitable for the services intended.

503.2 Installation

- 145 Location of pumps, together with piping design and arrangement, shall provide the highest practicable NPSH available for the pumps. Pumps shall be designed and installed to have positive suction through either submergence, foot valves, suction check valves, or priming systems, as appropriate, in order that pump operation is immediate and positive.

- Pumps and motors shall be mounted above the floor plates, where practical, and shall have clear access for repair and removal of the units with appropriate rigging. Heavy pump components shall be made such that lifting gear can be attached.
- 150

- For cast iron parts of pumps in corrosive services, which require disassembly when pumps are being serviced, stainless steel through-bolts or studs shall be used instead of tapped bolts. In general, the use of stainless steel through-bolts or studs shall be used for securing pump parts when thread corrosion or seizure may be expected in service.
- 155

Vertical pumps mounted below the floor plate level shall have means to prevent bilge water from splashing into the bearings.

Shafts of horizontal pumps shall be oriented fore and aft, whenever practicable.

- All pumps handling oil, oily water or sewage, shall be provided with drip pans. Drip pans shall be fabricated from 14-gage stainless steel plate with a 2" high coaming, and an approximately 6" wide open area around the pump base. Drains shall be hard piped to a waste oil collection tank in each machinery space, which in turn shall be drained by the waste oil system. In the Forward Machinery Room (FMR) and Aft Machinery Room (AMR), the drains may lead directly to the waste oil tank.
- 160

- 165 Means shall be provided for venting seawater and freshwater pumps into the bilge.

Each pump, except black water pumps, shall be provided with suction and discharge pressure gauges, and they shall be mounted on or near the pump. The gauges shall be readily visible to the pump's local control and installed in accordance with Section 504. Suitable provisions shall be made for using a portable tachometer to determine the speed of motor-driven pumps.

- 170 In addition to the remote controls and automation required by Technical Specification Section 431, all independent pumps shall be fitted with local start/stop controls, within sight of the pumps.

All pumps shall be provided with appropriate electrical power. Pumps shall be aligned with their associated motor. Pump motors, controls, and circuit protection shall be in accordance with Technical Specification Section 300.

503.3 Centrifugal Pumps

Pumps shall be selected to operate at or near the maximum efficiency point on the head-capacity curve and shall have non-overloading power characteristics. The motor horsepower rating shall at least equal the maximum power requirement of the pump at rated speed.

Unless otherwise specified, centrifugal pumps shall be close-coupled. All coupled pumps shall be directly connected to drivers through flexible couplings for horizontal units, and flexible or rigid couplings for vertical pumps.

Each pump/motor set shall be mounted on a common shaft, fully protected against wear and corrosion. Suction piping connected to this type of pump shall be arranged so that the impeller can be removed without disturbing the suction cutout valve.

Centrifugal pumps that will operate at or near shut-off during a service condition shall have means for recirculation. As a minimum, the fire pumps shall be furnished with recirculation. The amount of recirculation shall be sufficient to prevent overheating of the pump when operating at shutoff and to prevent vaporization of the liquid being pumped.

503.4 Positive Displacement Pumps

Preferably, positive displacement pumps shall be direct-coupled to motors; however, where necessary, they may be provided with reduction gears, flexible couplings, and supports for drives. The entire unit shall be a rigid assembly to ensure close and permanent alignment. Where the pump is internally lubricated by the fluid pumped, wearing parts shall be of design and materials such that the pump may be operated safely when pumping liquids without lubricating characteristics.

Casings shall be designed so that operating parts may be dismantled without disturbing the suction or discharge connections. All connecting suction parts requiring alignment shall be taper-doweled.

Relief valves shall be provided of sufficient capacity to relieve maximum pump flow on the discharge side of all positive displacement pumps that do not have built-in relief valves, and as necessary to protect piping and equipment from possible over-pressure.

504 INSTRUMENTS AND INSTRUMENT BOARDS, MECHANICAL

504.1 General

Instrumentation shall be provided for the proper and safe operation of machinery, equipment, and systems under normal and emergency operating conditions.

Instruments directly exposed to weather shall have corrosion-resistant enclosures and shall be flush mounted on panels to provide protection to operating personnel and to instruments from accidental damage.

Instrumentation shall have scales identified using United States Customary Units (also known as 'English' or 'Standard' units), unless specifically authorized by the Resident Engineer.

Local instrumentation furnished by manufacturers integral with machinery and equipment shall be the manufacturer's standard, except that the scale range and accuracy requirements stated herein shall be satisfied.

- 215 Failure of any instrument shall not cause the system to be inoperable; for example, gauge piping shall have root valves and thermometers shall be installed in thermowells. Gauge piping materials and installation guidelines shall be in accordance with ASTM F721.

- 220 Connection ports with isolation valves or fittings shall be provided in instrument piping systems for the temporary installation of calibrated temperature and pressure gauges to facilitate maintenance, testing, and troubleshooting of machinery/equipment and systems.

Heat exchangers shall have inlet/outlet thermometers near their primary and secondary fluid piping connections. Multiplex strainers and filters shall have differential pressure gauges. Pressure reducing stations shall have pressure gauges to indicate both the system's supply and reduced pressures.

- 225 Instrument accuracy from source to readout shall be within $\pm 5\%$ of the full-scale range. Instrumentation shall be calibrated and fitted, with labels identifying the date of calibration.

504.2 Instrumentation

Dial thermometers shall have at least a 3" diameter dial size.

- 230 Remote-reading thermometers shall be installed wherever the location of a direct-reading type prevents it from being easily accessible for reading and replacement.

Remote-reading thermometers shall include a manually adjustable, red-colored pointer to be set at the maximum normal operating temperature for the applicable system. Generally, thermometers shall be selected with the system's normal operating temperature within the middle third of the scale's full range.

- 235 Pressure, vacuum, differential pressure, and compound gauges shall have at least a 3" diameter dial size. Pressure gauges shall have a manually adjustable, red-colored pointer to be set at the maximum (or minimum) normal operating pressure, as appropriate for the system.

Generally, gauges shall be selected with the maximum normal system operating parameter at approximately 60% of the full-scale range.

- 240 A pressure snubber or damping shall be included with all instruments that are susceptible to shocks and pulsations. All gauges shall be glycerin filled.

See Technical Specification Section 431 for details of the engineer's control console that is located in the EOS.

504.3 Gauge Boards

- 245 Gauge boards shall be provided to consolidate instrumentation throughout the machinery spaces, particularly where several instruments are located in close proximity to, and associated with, a given piece of equipment. Gauge board instrumentation shall have a mirrored arrangement when serving two units and an identical arrangement when serving three or more units. Gauge board arrangements shall be reviewed by the Resident Engineer.

- 250 All exposed and visible portions of instrumentation and gauge boards shall provide a uniform and coordinated appearance. Gauge boards containing electrical devices shall provide for IP22

protection of the electrical devices. Instruments shall be clearly visible from a standing position in an access walkway.

Gauge board material and installation guidelines shall be in accordance with ASTM F707.

255 **504.4 Tank Level Indicators**

A tank level indicator (TLI) system shall be provided, as described in Technical Specification Section 431.

505 GENERAL REQUIREMENTS FOR HULL AND MACHINERY PIPING SYSTEMS

260 **505.1 General**

265 This section contains the requirements for the design, fabrication, arrangement, installation, and cleaning of shipboard piping systems and piping components. Requirements peculiar or supplemental to a specific system are covered by the section of these Specifications governing that system. Where supplemental or differing requirements are given in the section governing the system, they will take precedence. All piping shall conform to the requirements of the regulatory agencies.

270 The Contract Drawings are not intended to provide the exact routing, length, or size and type of piping or fittings, or the exact location of such items and devices. Equipment and piping shown on the Contract Drawings are generally laid out schematically and do not indicate all fittings, interferences, hardware, or appurtenances that are required for a complete operating installation or intended final locations. Except where specifically noted in these Specifications, the final selection of pipe sizes shall be the responsibility of the Contractor considering the particular system and service requirements.

275 Final system design, routing, and size selection shall be determined by the Contractor to suit requirements, such as allowable pressure drop, length of pipe run, pump characteristics; and to avoid cavitation, erosion, water hammer, and noise. The Contractor shall use the design and maximum pipe velocities in Section 505.2 during the detailed design process. System design changes made by the Contractor shall maintain the existing pump horsepower unless modifications specifically prevent this, such as increased capacity or static head.

280 **505.2 System Design**

Piping shall be led as directly as practicable with a minimum number of bends and fittings and with sufficient joints to provide for removal, inspection, servicing, and replacement of equipment.

285 Fluid velocity in piping systems shall be based on inside pipe diameter as shown in Table 500 - 1.

Table 500 - 1 Fluid velocity in piping systems (diameter in inches)

Service	Fluid Velocity, fps	
	Nominal	Limit
Saltwater	$5\sqrt{\phi_{Inside}}$	12
Hot/Chilled Water, Mains	-	12
Hot/Chilled Water, Branches	-	9
Fresh Water	$5\sqrt{\phi_{Inside}}$	12
Lube Oil, Suction	$\sqrt{\phi_{Inside}}$	4
Fuel Oil, Suction	$2\sqrt{\phi_{Inside}}$	7
Fuel Oil, Discharge	$5\sqrt{\phi_{Inside}}$	12
Fuel Oil, Bunkering	-	25
Hydraulic Oil, Suction	$1.5\sqrt{\phi_{Inside}}$	8
Hydraulic Oil, Discharge	$8\sqrt{\phi_{Inside}}$	20
Inlet Nozzles & Heat Exchangers	-	6

Pipe bends or long radius elbows shall be used in place of short radius elbows wherever possible. Piping shall be run so as to avoid cutting of the vessel structure where possible. Structural penetrations shall be reinforced where required in accordance with Technical Specification Section 100. Piping systems shall be designed and installed for easy access to valves and components for both operation, inspection, and maintenance.

Care shall be exercised to ensure that piping system design and installations permit:

1. Free passage along walkways and ladder ways.
2. Free access to perform operational and routine maintenance of machinery and equipment.
3. Free access to all doors, hatches, and openings.
4. As much as is practicable, freedom from interference to the ready removal of the vessel's equipment and of system components.

System piping and associated components shall be designed and installed to provide adequate flow to all equipment served under all normal operating conditions. The use of automatic regulators or restrictive devices in lines servicing auxiliary components is permissible for obtaining and maintaining operational conditions, provided they do not impose undue restrictions, cause destructive erosion conditions, or produce excessive noise in noise critical systems.

Unless noted otherwise, overboard discharges shall be located above the deepest load waterline. Overboard discharges for black water, gray water, and food waste shall be located below the lightship waterline.

High points in piping systems shall be avoided where practical. Unavoidable high points shall be provided with vent valves for air or gas removal. High point vent valves shall be accessible for service and inspection. Automatic vent valves shall be fitted with drains or located such that leakage will not damage insulation, linings, or equipment.

Piping in each system shall have provisions for draining of low points.

In order to prevent damage to piping and joints at bulkheads and decks, there shall be expansion bends sufficient to accommodate piping thermal growth, as well as movement due to working of the vessel's structure. Expansion joints shall not be used in lieu of expansion bends.

In systems containing automatic control valves, strainers shall be incorporated upstream of the control valves. Y-type strainers, except those for fuel and lubricating oil services, shall have accessible valved blow-off lines to the bilge or suitable "blow down" containment when not installed in an area accessible to the bilge. Blow-off lines to the bilge shall terminate no less than 12" from the shell or associated structure.

With the exception of combustion exhaust systems, the use of mitered joints or mitered fittings in piping systems shall not be permitted, unless specifically approved in writing.

Pipe welding and brazing shall comply with regulatory requirements. Joint design shall comply with regulatory requirements, except as limited by these Specifications. ASTM F722 may be used as a guide.

Unless specifically approved, all backing rings used for pipe welding shall be of the consumable insert type. Permanent type backing rings may only be used on the diesel engine and oil fired heater exhaust systems.

Flow turbulence in the piping systems shall be minimized by restricting the velocities to within the specified limits listed above. In addition, the following shall be applied where practicable:

1. Abrupt changes of pipe diameters in piping runs and connections shall be avoided.
2. Transitions for diametrical changes shall be gradual.
3. Where feasible, long-radius bends and fittings, sweep tees and wyes, and lateral type fittings shall be used.

505.3 Installation

During the fabrication, installation, and testing of all piping systems, openings shall be kept tightly sealed to ensure foreign matter and moisture exclusion, including components such as valves, pumps, coolers, heaters, and instruments. Metal, wood, or plastic caps, plugs, and blanks shall be used, as appropriate, to limit system and component contamination.

All piping shall fit without springing or forcing into place. Flange faces shall fit parallel and concentric before bolting. Piping shall be held close to deck beams and, wherever possible, behind the face of the bulkhead stiffeners.

Where piping penetrates bulkheads or decks, flanged heavy weight spool pieces or reinforcing sleeves shall be fitted per ASTM F682. In some cases, such as penetrations by galvanized sections, a collar shall also be used.

Where CPVC (chlorinated polyvinyl chloride) piping is required to penetrate watertight bulkheads a USCG approved penetration shall be used. Penetrations shall utilize RISE/ULTRA

Crusher sleeves and Slipsil plugs on both sides of the penetration, or equal, and be installed based on the manufacture's recommendation using qualified personnel.

350 Where CPVC piping is required to penetrate firetight, A-class boundaries a USCG approved penetration shall be used. Penetrations shall utilize RISE/ULTRA Crusher sleeves, or equal, and be installed based on the manufacture's recommendation using qualified personnel.

Flanged connections between metallic and non-metallic piping shall be made use flat faced flanges with full-face gaskets.

355 Pipe bends shall conform to the ASME B31.1, in addition to applicable regulatory requirements, with due regard being given to erosion, head losses, bent pipe wall thickness, and other salient characteristics of the installed system. In general, pipe bend radii shall not be less than five times the size of the nominal pipe diameter and tubing bend radii shall not be less than three times the nominal tubing diameter.

The amount of piping exposed to weather shall be minimized.

360 In addition to the weight effects of piping components, consideration shall be given in the selection of pipe hangers to other load effects such as those introduced by maximum operating pressure, thermal expansion, shock, vibration, and vessel motion, as applicable. Hangers shall be chosen to permit the movement of piping caused by external forces or by thermal strain. Anchors and/or guides shall be provided, as required, to restrain, direct, or absorb piping
365 movements accounting for the dynamic effects of vessel motion, internal pressure, and expansion and contraction of the pipe under full range of operating conditions.

All gasket material shall be certified asbestos free.

370 Where piping is below floor plates, the hand wheels shall be close to, but below the floor plates, with floor plate access provided over the hand wheels. Reach rods shall be securely attached to valves that would otherwise be difficult to reach. Reach rods shall be fitted with intermediate supports.

Piping in way of pumps shall be provided with suitable takedown fittings to allow easy removal of the pump for servicing. Piping and/or tubing is not permitted in or on electrical cableway hangers, nor may they share deck and/or bulkhead penetrations.

375 There shall be no unions installed in piping systems behind linings, or in inaccessible locations.

When reducers are required at pump inlets, eccentric type reducers shall be provided where practical in a horizontal plane with the straight side on top to prevent air-binding of the pump.

Discharge piping connected to self-priming pumps shall rise vertically not less than 30° from the horizontal plane to permit self-venting of air and/or gas where the installation permits.

380 To facilitate inspection and maintenance of equipment (including tube or tube bundle withdrawal on components having removable heads), the piping connection thereto shall be designed and installed to permit access without breaking more than the connecting flanges.

All plate type heat exchangers shall be fitted with a 1" chemical cleaning connection on the freshwater side and a 1½" back flush connection on the seawater side.

385 Sounding tubes, air escapes, valve operating rods, etc., shall be kept behind the face of stiffeners and frames where practicable.

Pipes shall, in general, not be installed where the system fluid is subject to freezing. This includes uninsulated exterior bulkheads and locations within or adjacent to unheated spaces

subject to freezing conditions. Where the routing of pipe subject to freezing is unavoidable, piping shall be insulated and heat traced to prevent the system fluid from freezing. All piping passing through the Vehicle Space that is subject to freezing shall be insulated and heat traced in accordance with Technical Specification Section 334.

505.4 Materials

Materials for the various piping systems shall be as shown on the Contract Drawings and/or as described in these Specifications. Where piping system materials are not addressed in either the Contract Drawings or these Specifications, ABS and USCG rules, in conjunction with ASTM F1155, shall be used in selecting materials. Should there be conflict between the requirements of ASTM F1155 and these Specifications or Contract Drawings, the Specifications and Contract Drawings shall prevail.

Copper-nickel piping shall be used for all seawater systems below the main deck. Approved CPVC pipe shall be used for seawater systems above the main deck where specified.

Unless specifically noted otherwise, all CPVC piping shall be from a single vendor, SeaCor™ or equal, and shall carry USCG and ABS approval for having met the applicable ABS and USCG requirements for flame spread and smoke and toxicity. Any substitutes for SeaCor shall meet the ABS and USCG requirements for all pipe sizes utilized in the system. SeaCor piping shall be installed in accordance with the requirements and restriction noted on ABS and USCG type approval certificate using personnel qualified in the SeaCor system and using SeaCor approved adhesives and installation techniques. CPVC piping shall be used in interior spaces only. See Section 505.3 for penetrations using CPVC.

All hydraulic piping shall be Type 316 stainless steel pipe or Type 316 stainless steel tubing, as appropriate for system pressure.

The threads of all bolts shall be coated with an appropriate anti-seize compound prior to assembly.

505.5 Restrictions

Fuel and lubricating oil piping shall be kept away from engine exhaust pipes and the hot water heater uptake. All pipes shall be located away from electrical equipment as much as possible, and flanges or joints shall not be located over electrical equipment. In particular, piping shall not be run over the switchboards, motor control centers, distribution panels, etc.

Piping systems containing combustible or flammable liquids under pressure shall be designed and installed so that flanged connections and valves are remotely located from exposed surfaces having a temperature in excess of 450°F. Protective spray shields, selected in accordance with ASTM F1138, shall be provided around flanged connections and valves where necessary to prevent the possibility of spray onto exposed hot surfaces.

Lubricating oil systems shall be located at least 18" away from surfaces which have temperatures in excess of 650°F under the insulation or lagging of that surface. All other systems containing combustible and/or flammable liquid shall be located at least 18" away from surfaces which have temperatures in excess of 650°F under the insulation or lagging of that surface.

Precautions shall be taken to preclude personnel hazard from the bulkhead or deck penetrated by hot water piping (both heating water and domestic hot water) if surface temperature of the

430 bulkhead or deck exceeds 125°F. Piping systems shall be insulated in accordance with
Section 508.

435 Unless directly associated with equipment installed in those spaces, piping shall not pass through
the Galley or food service areas, or through spaces predominantly equipped with electrical
equipment or components. When it is necessary to pass through or enter such spaces, pipe joints
shall be minimized.

Drains from piping and equipment shall not be less than ¾" IPS.

Pipe joint compound shall be used for sealing threaded joints. Teflon™ tape shall not be used
for sealing threaded joints.

505.6 Corrosion Precautions

440 Piping conveying corrosive media shall be designed and installed to be protected from the effects
of corrosion and/or corrosion erosion by:

505.6.1 Proper Materials

445 Valves and fittings (except resilient-seated butterfly valves and other approved lined or liner type
valves and fittings) in nonferrous piping runs shall be either of bronze or of a material
comparable to and compatible with the applicable piping material. Pumps, heat exchangers,
valves, and fittings in seawater service shall be non-ferrous/non-aluminum except where steel
valves and fittings are required by regulation.

505.6.2 Proper Isolation of Dissimilar Metals

450 Joints of ferrous and nonferrous metallic materials shall be avoided. Where such joints cannot be
avoided, a flanged "waster piece," length two to three times the pipe diameter, constructed of
seamless, extra strong, carbon steel pipe and fittings shall be provided. The waster piece shall be
galvanically isolated from the hull and all other piping. In piping 2" and below, dielectric unions
may be substituted for the flanged waster piece between the dissimilar metal lines. However, no
waster piece or dielectric union is required where a nonferrous line connects to a ferrous line
455 having a diameter two or more times larger. Waster pieces shall be designed for easy
replacement and shall be incorporated in readily accessible locations, never behind joiner or in
overheads behind ceiling panels. The interior of waster pieces shall not be galvanized or painted.
All waster pieces shall be clearly indicated on piping arrangements and final as-built drawings.

505.6.3 Minimize Flow Turbulence

460 See Section 505.2 for guidance on proper design velocities for piping. Abrupt changes in
direction of flow shall be avoided. Gradual transitions in changes of piping runs and connections
shall be provided by using long-radius bends and/or fittings, sweep tees, and Y and lateral type
fittings. Flanges shall be properly aligned and pipes shall be finished flush with the flange face.
Pipe internals shall be free of protruding jointing material, weld bead or braze bead.

505.6.4 Proper Design and Installation of Throttling Devices

Body passages in throttling devices shall be designed to provide gradual changes in flow
direction. In addition, the downstream cavity shall be as large as practicable to permit
dissipation of the issuing jet before making wall contact. At points where direct impingement at
close range does occur and cannot be avoided, section thickness shall be increased to provide

adequate material to withstand the additional erosive effect. Piping downstream of throttling devices shall have a straight run at least ten times the inside pipe diameter where practical, or at the manufacturer's required distance.

505.7 Valves, Fittings, and Instrument Piping

Spindles, seats, and disks of valves shall be of corrosion-resisting materials, except as may be specifically noted in these specifications or the Contract Drawings. Stop, throttling, and check valves shall have renewable disks, gates, and balls, and re-grindable seats for valves greater than 2".

Valves 2½" and over, except for butterfly valves, fire station hose valves and ball valves, shall be commercially (ANSI) flanged with bolted bonnets and stuffing boxes. Unless otherwise specified, valves 2" and under shall have NPT or union ends or the equivalent, or soldered ends with suitable joints for system takedown, and bonnets as indicated in the system Material Schedule.

Butterfly valve body and disk materials shall be as noted in the system Material Schedule. Butterfly valves used for shell valves shall be the lugged type and be USCG category A. Valve stems shall be Monel or Type 316 stainless steel. Valve seats shall be Buna N in water service, Viton in diesel oil and lubricating service, or as required to suit the service intended. Butterfly valves shall be fitted between weld-neck flanges wherever possible. To allow for disconnection of piping for maintenance, lug style valves shall be used. Wafer valves may be used where disconnection for maintenance is not required.

Ball valves shall be full port, with three-piece bolted body construction. Seats and seals shall be Teflon (TFE) or Nitrile (Buna N) in water service; Viton in diesel oil and lubricating oil; reinforced TFE in compressed air unless otherwise specifically called out on the Contract Drawings, or as required to suit the service intended.

Hand wheels for sea valves shall be designed and installed above the deck plates and/or grating levels in accordance with Section 505.11. These hand wheels shall be easily accessible and identifiable.

Unless it can be demonstrated to be impractical by reason of access or interference, manually operated valve stems shall be installed with the valve stem on or above the horizontal plane. Ball and butterfly valves shall be installed in such a manner that the valve opens and the handle points with the media flow under normal conditions of operation.

Relief valves shall be provided of sufficient capacity to relieve maximum pump flow on the discharge side of all positive displacement pumps that do not have built-in relief valves, and as necessary to protect piping and equipment from possible over-pressure.

Check valves or approved back-flow prevention devices shall be provided wherever flow reversals would be detrimental to operational requirements or required by the regulatory bodies. Backflow preventers in potable water systems shall be reduced pressure zone type with relief valves drained to the nearest deck drain.

Automatic control valves shall be designed and installed to meet full operational requirements and to permit field adjustments, inspection and maintenance without removal from the line. They shall also be designed to assume a fail-safe position that will satisfy the requirements of system safety while affording continued operation.

All globe valves shall be incorporated with the system's pressure under the disc. Sea valves shall be installed with sea pressure under the disc.

Valve locking devices shall be in accordance with ASTM F993.

515 Except where otherwise specified, the designation of valve trim includes the following: stem, disc (or gate or ball), nut, seat, back-seating bushing and guides.

The use of cocks in place of valves is not permitted, except on small bore sizes for instrumentation or low point drains, etc.

505.8 Takedown Joints

520 Flanges in piping shall conform to ANSI standards for the appropriate service.

Suitable takedown joints shall be provided in piping to allow access to and/or removal of piping system components such as pumps, pressure regulators, valves and strainers (and their baskets), and to remove unavoidable piping interferences to the ready removal of vessel equipment and/or system components.

505.9 Flexible Connections and Expansion Joints

Flexible connections shall be provided between piping assemblies and all resiliently mounted equipment listed in Technical Specification Section 1E.11.4. Piping connected to reciprocating machinery shall have flexible connections, located as close to the machines as is practicable. Fire sleeves shall be provided where required in accordance with USCG and ABS requirements.

530 Flexible connections shall not be used to compensate for misaligned piping or to carry the weight of the attached piping. Great care shall be taken that flexible connections are installed in accordance with the manufacturer's specifications including but not limited to tolerances for angular, lateral, and torsional alignment and flange-to-flange dimensions in the neutral position. Flexible connections shall be installed as close as possible to pipe anchor points. Flexible
535 connections shall be selected such that maximum excursions of resiliently mounted equipment and piping is within the manufacturer's specification for movement capability of flexible connection.

Initial installation of piping sections that make use of flexible connections shall be fitted with template spool pieces matching the neutral dimensions of the flexible connections to ensure
540 proper final alignment and spacing of flexible connections.

Hose clamps shall not be permitted in flexible connections or takedown joints of rubber or neoprene hose.

All flexible connections shall be identified with metal tags that indicate manufacturer, size, model, date of manufacture, and material, and comply with USCG and ABS requirements for
545 flexible connections.

Flexible connections to pumps, tanks, etc., with a nominal diameter of 2½" and above shall be flanged. Flexible connections of 2" nominal diameter and below may be threaded with sufficient unions to permit removal of equipment.

550 Expansion bends shall not be used in lieu of expansion joints. Expansion joints shall be of a standard size for equal diameter pipe, and targeted for use so that any joint of the same pipe diameter can be exchanged with any other joint on the vessel.

Flexible connections shall be standard stock catalog sizes (diameter and length) and readily available from manufacturers. Special made, custom fit connections shall not be used.

All mechanical expansion joints and flexible connections shall remain unpainted.

555 **505.10 Cleaning and Flushing**

505.10.1 General

560 All piping, piping appurtenances, and applicable equipment shall be thoroughly cleaned after fabrication and prior to shipboard installation. After complete shipboard installation, each system shall be thoroughly cleaned and flushed of all foreign matter with the applicable system's medium, or an approved substitute. System flushing shall be conducted at the applicable system's maximum operating pressure and at 150%-200% above normal line velocity, utilizing temporary strainers. Line vibrators, or the temporary in-line and/or portable hand types, shall be employed. However, prior to flushing operations, units such as heat exchangers and control valves, having in-line mechanisms capable of trapping, or affected by the carryover of foreign matter, shall either be removed or blanked-off and bypassed.

570 Temporary strainers shall be lined with 10-micron filter bags (5-micron for fuel and hydraulic systems) and shall be inspected every 2 hours during flushing activities. Temporary strainers shall be cleaned periodically while changing filter bags, and flushing shall be continued until it is demonstrated that two consecutive bags show no signs of dirt, scale, and/or foreign material. Sumps, tanks, and equipment that cannot be adequately flushed shall be hand-cleaned and inspected prior to service.

505.10.2 Fuel Oil Piping

575 Fuel oil piping shall be cleaned after fabrication or assembly and before installation by pickling in hot acid, after which the piping shall be washed, acid neutralized, washed again, dried, and coated with oil to the satisfaction of the Resident Engineer.

After installation is complete, the entire system shall be cleaned by continuously circulating hot oil at 150%-200% above normal design velocity at not less than 140°F, using temporary strainers and filters until a clean system is obtained. The flushing oil shall be removed.

580 The system shall be flooded again using the normal system fluid and a lint-free cloth bag shall be placed over the temporary strainer, and flushed for at least 1 hour, or longer if necessary, until a clean bag is obtained. After cleaning, the system shall be drained and refilled with new, normal system fluid. Line vibrators, of the temporary in-line and/or portable hand types, shall be employed during the installation cleaning process.

585 After system flushing, all fuel oil used for flushing shall be drained. Affected sumps and tanks shall be opened and manually cleaned with lint-free rags or other suitable wiping material, to remove all traces of residual contamination and oil. The sumps and tanks shall be closed utilizing new gaskets and shall be filled with new, clean oil.

505.10.3 Lubricating Oil and Hydraulic Piping

590 Lubricating oil piping shall be cleaned after fabrication or assembly and before installation by pickling in hot acid, after which the piping shall be washed, acid neutralized, washed again, dried, and coated with oil to the satisfaction of the Resident Engineer.

Hydraulic oil piping (stainless steel) shall be cleaned after fabrication or assembly.

After installation is complete, the entire lube oil or hydraulic oil system shall be cleaned by continuously circulating hot oil at 150%-200% above normal design velocity at not less than 140°F, using temporary strainers and filters until a clean system is obtained. Line vibrators, of the temporary in-line and/or portable hand types, shall be employed during the installation cleaning process. The flushing oil shall be removed.

The system shall be flooded again using the normal system fluid and a lint-free cloth bag shall be placed over the temporary strainer, and flushed for at least 1 hour, or longer if necessary.

Flushing shall continue until the oil at a minimum meets the characteristics of ISO 4406 17/15/12 or equipment manufacturer's requirements if more stringent.

After system flushing, all fuel oil used for flushing shall be drained. Affected lube oil or hydraulic oil sumps and tanks shall be opened and manually cleaned with lint-free rags or other suitable wiping material, to remove all traces of residual contamination and oil. The sumps and tanks shall be closed utilizing new gaskets.

505.10.4 Potable Water Piping

Before being put into service, the entire potable water portion of the fresh water system shall be cleaned, disinfected, and flushed in strict accordance with the requirements of the USPHS and WHO. Certificates of disinfection shall be provided to the Resident Engineer prior to the system being placed in service. Should it be necessary to reopen the potable water system prior to redelivery, the system shall be re-cleaned and disinfected.

505.10.5 Refrigeration Piping

Prior to installation, all refrigeration piping shall have all foreign or loose particles removed and shall be thoroughly cleaned and degreased. Upon completion of the cleaning operation, all open ends shall be plugged or capped. Open ends shall be kept closed until final installation. Condensers, coolers, compressors, and other equipment that have been opened shall be inspected and, if necessary, cleaned.

After installation and before the system is put in operation, the refrigerant circuit shall be thoroughly cleaned and flushed internally with an approved fluid utilizing the temporary installation of a dirt interceptor. After installation and leak testing, and before charging with refrigerant, the system shall be purged and dehydrated by a vacuum method.

505.11 Valve Operating Gear

Manually operated valves shall be readily operable by one person directly or through mechanical advantage type remote valve operators or permanently fixed reach rods. All valves above 2½" shall have mechanical advantage type operators. The valve control operator handles or hand wheels shall be easily accessible to operating personnel without the need for lifting floor plates and/or gratings, climbing over or through machinery and/or piping, and reaching higher than 6'-6" above deck plate/grating levels.

Where piping is below floor plates, hinged access doors through floor plates and/or gratings shall be used to reach valve operators and hand wheels. For piping below floor plates, valve operators and hand wheels shall be located no more than 6" below floor plates and/or gratings.

Reach rods shall be provided and securely attached to valves that would otherwise be difficult to reach. Reach rods shall be fitted with intermediate supports.

635 All valve motor-operators shall be operable, with status indication, locally at the valve, and from the IMACS (see Technical Specification Section 431). Valve actuators shall be equipped with a manual hand wheel.

505.12 Pipe Hangers

640 Piping shall be supported by hangers suitable for the material and service in accordance with ASTM F708 supplemented by ANSI/MSS SP-69. Hangers shall be welded to basic structure such as beams, frames, bulkhead stiffeners or plate that is opposite support structure. Hangers for nonferrous pipe or tube and for hydraulic systems shall be synthetic rubber lined. Hangers for hot water and engine exhaust piping shall be lined, or, in some other appropriate manner, be thermally isolated from structure. Hangers in the bilges shall be galvanized.

645 Piping hangers exposed to weather shall be configured, and 100% welded out, to minimize maintenance due to "running rust," and include the use of corrosion-resistant material where practical.

650 In addition to the weight effects of piping components, consideration shall be given in the selection of pipe hangers to other load effects such as those introduced by maximum operating pressure, thermal expansion, shock, vibration and motion of the vessel as applicable. Hangers shall be chosen to permit the movement of piping caused by external forces or by thermal strain. Anchors and/or guides shall be provided, as required, to restrain, direct or absorb piping movements accounting for the dynamic effects of vessel motion, internal pressure and expansion and contraction of the pipe under full range of operating conditions.

655 CPVC piping is particularly susceptible to variations in temperature. Thermal growth characteristics vary greatly from metallic pipe, therefore ASTM F708 spacing is not always appropriate for CPVC. Precautions shall be taken to adequately support CPVC in accordance with the manufacturer's recommendations.

Piping to resiliently mounted equipment shall be supported by means of resiliently mounted pipe hangers, see Section 500.3.

660 If spring type hangers are needed in conjunction with the resilient mounting of piping or to accommodate thermal or mechanical strains, they shall be suitable for the maximum loads imposed.

506 OVERFLOWS, VENTS, FILLS, AND SOUNDINGS

506.1 General

665 All tanks and compartments fitted with arrangements for filling, flooding, pumping, or drainage and void spaces through which pressure piping passes, shall be vented. Flanged take-down connections shall be provided in vent/overflow lines for fitting of blanks to allow tank air testing.

506.2 Sounding and Sight Glasses

670 All tanks and voids, except hydraulic, lube oil, potable water, and small independent tanks, shall be fitted with sounding tubes. Sounding tubes shall be of not less than 1½" inside diameter. Each sounding tube shall be lead as straight and vertically as practicable from approximately 2" above the lowest point in the tank or void to a location that is always accessible. Sounding tubes shall in no case have a slope greater than 45° or a radius of curvature less than 20'.

Sounding pipes shall not terminate in staterooms, or in locked or inaccessible spaces.

675 Sounding pipes terminating on the Main Deck or above shall be closed with flush-fitting deck plugs. A tee wrench, or similar, shall be provided and mounted near each grouping of flush deck plugs. All deck plugs shall use the same size wrench. Location of pipes shall be such as to not be covered by equipment on deck or typical car parking arrangements if possible.

680 Sounding pipes terminating below the Main Deck shall be fitted with self-closing gate valves at the upper end and shall be in accessible locations.

685 All sounding pipes shall be labeled with the name, number, and maximum sounding of the tank or compartment they serve. Label plates shall be located in a readily readable position on the adjacent structure as close as practicable to the sounding tube termination. In the case of sounding tubes fitted with self-closing gate valves the label plate may be securely attached to the valve.

Striker plates shall be fitted at the bottom of all sounding pipes to prevent damage to the tank by sounding bobs.

Where portability is required to permit removal of equipment, flange joints shall be provided in sounding tubes. Flanges shall not be located in accommodation spaces.

690 Hydraulic, lube oil, and potable water tanks shall have ABS approved magnetic flag type level indication. Fuel oil day tanks and the emergency diesel generator (EDG) fuel oil tank shall have ABS approved flat glass type level indication. Small independent tanks shall have sight glasses with self-closing valves.

506.3 Vent Pipes

695 As far as possible, tank vents shall be located in the highest part of the tank. Special care shall be taken to provide air escape passages and holes in way of any structure that prevents proper venting to the pipe. Vent piping runs shall be continuously upward sloping, whenever possible, to prevent accumulation of moisture in the piping.

700 Vents for small independent tanks in the machinery spaces shall terminate in the space where they are located and away from machinery.

Potable water tank vents shall terminate 4' above the Main Deck in order to prevent contamination from other fluids. Potable water vent piping shall be of Type 316 stainless steel.

705 A powered vent system shall be installed for the sewage holding tank and sewage lift station tank. The vent system shall be of adequate capacity to keep the sewage tanks from going anaerobic. Non-sparking corrosion-resistant blowers shall be used with air ejectors to vent tanks via piping leading to and out the top of the stack.

710 The internal cross-sectional area of each vent pipe shall be not less than 125% of the size of the internal cross-sectional area of the fill line. When necessary, the size of vent pipes shall be increased to compensate for long runs, bends and/or combined branches. Some void vents shall be oversized to meet cross-flooding requirements.

506.4 Fuel Oil Overflow Piping and Tank

The fuel oil settling tanks and storage tanks shall overflow into the fuel overflow tank through a common overflow system as shown on Reference 506-01. Flow sensors shall be provided in each fuel storage tank overflow line and shall be located as close as practicable to the tank that

715 they serve. Whenever flow is detected in an overflow pipe, there shall be an alarm at the EOS identifying the tank in the overflow condition as well as a summary overflow condition alarm at the bunkering connection.

720 The vent for the overflow tank shall be terminated in a watertight enclosure above the Main Deck, in a protected location that minimizes the risk of water ingress through a vent check positioned overboard. The watertight enclosure shall act as a containment coaming and have a separate vent, which terminates in the weather on the Cabin Deck.

506.5 Vent Terminals

725 Vent terminals above the freeboard deck (Main Deck) shall terminate to the exterior or Vehicle Space at least 30" above the deck, and with approved gooseneck fittings. Terminals shall be located at the deckhouse side or under the bulwark cap if located on the open foredeck. The number of vent terminals above the Cabin Deck shall be kept to a minimum.

730 Automatic vent check valves, in general, shall be fitted to all vent pipes from spaces below the Main Deck unless otherwise approved. Flame screens shall be stainless steel and fitted where required by the regulations. Potable water tank vents shall be fitted with an insect screen. Vent terminals shall be located such that the automatic vent check valves and the ship structure in way of the vent can be readily maintained without removal of the vent terminal.

735 Fuel oil service, settling, and storage tank vent terminals shall consist of flanged vent check valves with flame screen. Vent piping shall turn overboard through the side shell and prevent any ingress of water. Vent terminals for fuel tanks shall not terminate into the Vehicle Space or other enclosed space. Vents for settling and storage tanks shall be high enough to prevent spilling during system overflow. A minimum height of five feet above the Main Deck shall be maintained before turning down and overboard.

740 Vent terminals for the processing tank, oily water tank, fuel leak-off tank and waste oil tank shall terminate in containment stations. Containment coamings shall be sized in accordance with regulations. No vent, fill, or discharge connection from any hazardous system shall be located within 3' of any opening into living quarters, or any ventilation system intakes or discharges.

506.6 Fill Station

745 Dedicated fill stations shall be provided both port and starboard on the Main Deck, forward of the elevator, and in accordance with Reference 506-01. Each fill station shall consist of permanently installed piping and valves to fill or discharge all associated tanks on the vessel. Fill stations shall include:

1. Potable Water (Port/Starboard).
2. Ballast/Trim (Port/Starboard).
3. Jacket Water (Port only).
- 750 4. Vehicle Space Drain Tank (Port only).
5. Sewage w/ Flushing Connection (Port/Starboard).
6. Lube Oil (3 stations) (Port only).
7. Waste Oil/Oily Water (Port/Starboard).
8. Fuel Oil (Port/Starboard).

- 755 9. International Shore Connection (Port/Starboard).
10. Local Fire Department Connection (Port/Starboard).
11. Compressed Air (Port/Starboard).
12. Hydraulic Oil (3 stations) (Starboard only).
13. Waste Heat Water Connection (2 stations) (Starboard only).

760 Each fill station shall be provided with a nearby hinged watertight hatch in accordance with Technical Specification Section 167.

507 MACHINERY PIPING DESIGNATION AND MARKING

Label plates for piping, mechanical and HVAC systems shall be provided and installed in accordance with Technical Specification Section 602.

765 508 INSULATION AND LAGGING FOR PIPING, EQUIPMENT AND MACHINERY

In general, piping insulation shall be applied as follows:

1. All piping running in spaces with joiner linings shall be insulated with thermal insulation with anti-sweat capabilities.
- 770 2. All piping systems with surface temperatures over 125°F shall be thermally insulated to protect personnel.
3. All piping systems adversely affected by heat transfer to their surroundings shall be thermally insulated.
- 775 4. All piping passing through fire boundaries requiring structural fire protection insulation shall be insulated for 18" (450 mm return) on the insulation side of the boundary to meet ABS and SOLAS.

Unless necessary to meet one of the four requirements stated above, insulation shall be applied to the following piping systems using materials and methods approved by ASTM F683:

1. Machinery Exhaust Systems. Thermal insulation on all surfaces over 125°F.
- 780 2. Chilled Water System: Closed cell foam, thermal insulation on all piping.
3. Firemain System: Closed cell foam, anti-sweat insulation through any air-conditioned space.
4. General Seawater Systems: Closed cell foam, anti-sweat insulation through the accommodation spaces.
- 785 5. Plumbing, Interior, and Deck Drain System: Closed cell foam, anti-sweat insulation through the accommodation spaces. Closed cell foam, thermal insulation through Vehicle Space.
6. Sanitary Flushing System: Closed cell foam, anti-sweat insulation through the accommodation spaces.
- 790 7. Bilge System: No insulation.
8. Ballast System: No insulation.

9. Freshwater Cooling Systems: Thermal insulation on all surfaces over 125°F.
10. Hot Potable Water System: Closed cell foam, thermal insulation on all piping.
11. Cold Potable Water System: Closed cell foam, anti-sweat insulation on all piping.
- 795 12. Waste Heat Recovery and Hot Water Heating Systems: Thermal insulation on all piping.
13. Fuel Oil Systems: If required.
14. Lube Oil Systems: If required.
15. Hydraulic Oil Systems: If required.
- 800 16. Compressed Air Systems: Closed cell foam, anti-sweat insulation through accommodation spaces.
17. Vents and Overflows: If required.
18. MSD and Sewage Transfer System: Closed cell foam, anti-sweat insulation through the accommodation spaces.
19. Oily Water Separator System: If required.
- 805 20. Refrigeration Systems: Thermal insulation on all piping.

Protective sheet metal lagging shall be installed wherever necessary to protect insulation from damage. Protective lagging shall also be installed where insulation can become oil- or water-soaked, and in areas of heavy traffic. A surface treatment or covering shall be installed where necessary for the protection of personnel against cuts, abrasions, or from hot surfaces.

- 810 Required testing of piping shall be complete before pipe covering is installed over mechanical joints.

Coverings shall be installed so that movement of enclosed components will not damage the coverings. Fastenings shall not crush or otherwise reduce the insulating value of the insulation.

- 815 A vapor barrier shall be applied to all insulation to prevent penetration of moisture except where closed cell foam insulation provides low vapor permeability and low water absorption. Vapor barriers shall remain intact and continuous over the areas protected by means of sealed joints and edges.

All piping to be insulated shall be properly coated prior to application of insulation, see Technical Specification Section 631.

- 820 Piping in voids and cofferdams shall have thermal or anti-sweat insulation in cases where omitting insulation may be detrimental to system operation or where condensation would promote corrosion or other damage.

- 825 Anti-sweat insulation shall be provided on all components where it is necessary to limit absorption of heat from an external source where it would be detrimental to the system, and to prevent formation of condensation that may drip on personnel or on such items as electrical equipment and machinery, stores and supplies.

For anti-sweat and refrigerant insulated piping, clamps shall be to the exterior of the insulation on a wrap of metal lagging or isolated from the pipe by a $\frac{1}{8}$ " thick rubber sheet.

509 THERMAL INSULATION AND ACOUSTIC TREATMENT FOR DUCTS AND TRUNKS

509.1 Vibration Isolation

Refer to Technical Specification Section 1E.11.4 for information regarding resilient mounting of fans. All fans with horsepower greater than or equal to 0.75 HP shall be vibration isolated. Resilient mounts shall be selected in accordance with the requirements of Section 1E.11.4.

To decrease transmission of noise through ducts, and to allow for relative motion between the resiliently mounted ventilation fans and the ducts, flexible joints shall be installed at the suction and discharge of all ventilation fans and blowers. Flexible duct connections shall be flanged rubber spools of 40 durometer hardness maximum.

509.2 Acoustic Treatment for HVAC Ducting

509.2.1 Medium Velocity Ductwork (<2500 fpm Air Velocity)

Acoustic treatment and insulation treatments shall be provided in the ventilation system as required to limit noise in the accommodation spaces to the levels required by Technical Specification Section 1E.11.2. Internal duct lining shall consist of 1" or 2" fibrous glass insulation, as appropriate, faced with reinforced Mylar exposed to the air flow. The treatment shall be covered on the air side with 16-gage perforated sheet metal. As alternates, commercial duct silencers in fan suctions/discharges and/or approved sound trap boxes at diffuser terminals may be installed.

509.2.2 High Velocity Ductwork (>2500 fpm Air Velocity)

Ductwork for high velocity systems shall be double wall construction with perforated inner liner (wall) and acoustic insulation between walls. The inner liner shall have 0.125" perforations on staggered centers corresponding to an overall open area of 23%. Insulation shall be 1" thick glass fiber insulation with a minimum density of 1 lb/ft³. A Mylar retaining fabric shall line the perforated inner shell exposed to air flow. Outside ducting shall be galvanized steel meeting Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) standards.

509.2.3 Weather Terminals

Weather terminals shall be fitted with acoustic louvers or otherwise treated for airborne noise, as necessary to meeting the noise levels required by Technical Specification Section 1E.11.2.

509.3 Thermal Insulation

All insulation materials shall conform to the requirements of the regulatory bodies.

All parts of HVAC systems (including equipment, access covers, flanges, and recirculation ducts) shall be covered with the type of insulation required to prevent sweating and external heat transfer, as follows:

509.3.1 Air-Conditioning Systems (Including Return Air)

Insulate, vapor seal, and lag completely.

865 509.3.2 All Ventilation Supply Systems (Concealed or Exposed)

Insulate, except where the ducting passes through the space that it serves.

509.3.3 Ventilation Exhaust Systems (Concealed or Exposed)

Where exhaust ducts for unheated spaces pass through heated spaces, the duct shall be insulated.
870 Where exhaust ducts for heat-producing spaces pass through other heated or air-conditioned spaces, the duct shall be insulated.

509.3.4 Supply, Air-Conditioning, and Recirculation Systems Passing through Machinery Spaces and Hooded Areas

875 Insulate ducts, except exposed ducts, within the space that they serve. Trunks and ducts in the casings and uptakes shall be insulated. Vapor sealing and lagging shall be provided as required in this section.

Insulation on rectangular ducts carrying conditioned air shall be fibrous glass board, with minimum density of 3 lb/ft³, and with a factory-applied aluminum foil vapor barrier. Insulation on round and flat oval ducts, and on bends, shall be the same as required for rectangular ducts, except it may be a flexible type with a minimum density of 1½ lb/ft³.

880 Air-conditioning preheaters, ducts, cooling coils, and other equipment carrying chilled or recirculated air shall be completely insulated and installed with an approved vapor seal, unless condensation can be controlled by other means.

Insulation for ventilating and heating ducts in exposed areas shall be installed the same as for chilled air and recirculating ducts.

885 In areas where insulation may be subject to damage, protection such as galvanized metal, or lightweight aluminum sheathing, or guards, shall be provided as required. Insulation installed in way of deck penetrations shall be cut back 4" (100mm) on the top side to avoid wicking.

Insulation (both thermal and acoustic) shall be secured to duct with an approved adhesive. Adhesive shall be chemically compatible with the insulation surface.

890 Where both thermal and acoustic insulation is applied, credit may be taken for the thermal value of the acoustic insulation.

509.4 HVAC Silencers

895 HVAC silencers shall be used in the following systems/situations given below. The silencers shall have the minimum attenuation performance as given in Table 500 - 2 or as demonstrated by the NVCC to achieve the noise limits for each space.

Table 500 - 2 Minimum silencer attenuation values (dB) for supply and exhaust fans

Octave Band Center Frequency	31.5	62	125	250	500	1,000	2,000	4,000	8,000
Small	1	4	7	9	12	15	16	14	9
Medium	2	8	12	14	16	19	20	18	14
Large	3	10	15	19	20	22	24	22	18

509.4.1 Accommodation Spaces

900 HVAC silencers shall be used in the HVAC systems serving the accommodation spaces. The silencers shall have the minimum attenuation performance for a medium silencer as given in Table 500 - 2 or as demonstrated by the NVCC to achieve the noise limits for each space. Alternate approaches for noise treatment may be used, if they are demonstrated by the NVCC to achieve the noise limits for applicable spaces.

509.4.2 EOS Supply and Exhaust Fans

905 HVAC silencers shall be used in the HVAC systems serving the EOS Supply System and the EOS Exhaust System. Alternate approaches for noise treatment may be used, if they are demonstrated by the NVCC to achieve the noise limits for applicable spaces.

509.4.3 Vehicle Space Ventilation Systems

910 HVAC silencers shall be installed in the ventilation systems serving the Vehicle Space. Alternate treatment approaches may be used, if they are demonstrated by the NVCC to achieve the noise limits for the Vehicle Space.

510 CLIMATE CONTROL AND GENERAL HVAC REQUIREMENTS

510.1 Cooling Season Design

915 The interior spaces of the vessel shall be capable of being cooled to the corresponding requirements when the exterior conditions are as follows:

1. Outside air dry bulb: 85°F.
2. Outside air wet bulb: 74°F (60% relative humidity).
3. Seawater: 85°F.

Accommodations and living spaces:

- 920
1. Inside air dry bulb: 75°F.
 2. Inside air wet bulb: 62°F (50% relative humidity).

510.2 Heating Season Design

The interior spaces of the vessel shall be capable of being heated to the corresponding requirements when the exterior conditions are as follows:

- 925
1. Outside air dry bulb: -20°F.
 2. Seawater: 28°F.

Accommodations and living spaces: Inside air dry bulb: 70°F.

510.3 General HVAC System Design

930 The HVAC system designs shall be in accordance with the SNAME T&R Bulletin No. 4-16 except where design criteria are modified by this Specification.

Acoustic treatments shall be provided for fans, ductwork and/or louvers, as described in Section 509.

Particular attention shall be directed toward designing and installing a HVAC system with minimal airborne and structure-borne sound transmission. Acoustic dampening shall be accomplished by a combination of equipment layout, insulation, sound isolation and absorption devices, and proper balancing of air flows in the various spaces.

The systems' design and all equipment shall be suitable for the extreme motions, vibrations and corrosive environments imposed by a shipboard installation.

Heating shall be a combination of hot water and electric resistance heaters. Heaters over 3 kW shall typically be hot water heated and shall be supplied by the waste heat and hot water supply system as described in Section 517. Heaters below 3 kW shall be electric. Air-conditioning shall be provided by a centralized chilled water system as described in Sections 514 and 516.

In accommodations spaces, HVAC mechanical equipment, ducts, and trunks, except for terminals and thermostats, shall be located behind bulkhead linings, suspended ceilings, and in fan rooms, so as not to be visible. HVAC ductwork and equipment shall not adversely affect ceiling heights, without case-by-case approval by the Resident Engineer. The location of weather air intakes shall be carefully considered to avoid short circuiting with exhaust air outlets; to avoid tank vents, engine exhausts and other contamination sources; and to avoid ingestion of rain and sea spray.

HVAC systems and controls shall be automated (i.e., shall require a minimum of operator interaction for proper operation). However, controls shall be manually adjustable to allow the vessel operating personnel to compensate for unforeseen circumstances.

See Technical Specification Section 431 for IMACS interfaces with HVAC systems.

510.4 Balancing Tests

All systems shall be balanced such that the delivered quantity of air at each terminal and to each compartment shall be $\pm 10\%$ of the quantity shown on the HVAC drawings.

510.5 Equipment

510.5.1 Electrical Duct Heaters

Electric duct heaters, in general, shall be of good commercial marine quality and constructed with corrosion resistant materials in accordance with the regulatory body requirements. Heating elements shall be of the fin tube type. Heating banks shall consist of shockproof sheath-enclosed heating elements of high quality wire, centered within the sheath and imbedded in electrical-insulating and heat-conducting refractory material. Each terminal end shall be sealed to prevent the entrance of moisture. Heating element support flanges and fins shall be permanently attached to the sheath for rigid support and rapid heat transfer. Each sheath and fin shall be continuously coated with a suitable material capable of resisting corrosion from high humidity or saltwater environment without cracking, checking, or spalling under all design operating conditions.

510.5.2 Electric Unit Heaters

Electric unit heaters shall be of commercial marine quality with casings of galvanized or stainless steel. Heaters shall be the horizontal discharge type, with individually adjustable, rattle-free louvers. The fan motors shall be thermostatically controlled, single speed, and meet the requirements of Technical Specification Section 302. Unit heaters shall have a final maximum

air temperature of 125°F. Unit heaters shall not be installed in accommodation spaces. The installation of unit heaters in finished spaces shall have a finished appearance consistent with the fit and finish of the space.

510.5.3 Hot Water Duct Heaters

Hot water duct heaters, in general, shall be of good commercial marine quality and constructed in accordance with the regulatory body requirements. Heaters shall be provided with copper tubes, copper or aluminum fins, and casings of galvanized or stainless steel.

510.5.4 Hot Water Unit Heaters

Hot water unit heaters shall be of commercial marine quality, with copper tubes, copper or aluminum fins, and casings of galvanized or stainless steel. Heaters shall be the horizontal discharge type, with individually adjustable, rattle-free louvers. The fan motors shall be single speed and shall meet the requirements of Technical Specification Section 302. Unit heaters shall have a final maximum air temperature of 125°F.

510.5.5 Air Handling Units

AHUs shall be dual wall and constructed of marine grade materials such as galvanized steel or stainless steel. Heating and cooling coils shall be constructed with copper fins and tubes. Aluminum coils may be used if coated with Heresite baked phenolic, or equal. A single selectable thermostat shall control the supply air temperature to a temperature between 55°F and 60°F. System design and component sizing has assumed a 55°F off coil temperature during the cooling season and a 60°F off coil temperature during the heating season. For information regarding resilient mounting see Technical Specification Section 1E.11.4.

AHUs shall have condensate collection pans of corrosion resistant materials, of adequate depth and design to prevent sloshing and spillage caused by rolling and pitching of the vessel, and shall have antifungal coatings. Condensate drains shall be minimum ¾" diameter, provided with traps or seals, and routed to a nearby plumbing drain or deck drain. AHUs shall be insulated to prevent secondary condensation.

AHUs shall also be provided with water spray humidifiers to maintain the desired humidity control of 50% relative humidity in each air-conditioned space. The humidifiers shall utilize compressed air and potable water and be installed in a control cabinet per the manufacturer's recommendations. All controls for maintaining humidity shall be automatic and be incorporated as part of the AHU controls.

510.5.6 Fan Coil Units

Fan coil units (FCUs) shall be of commercial marine quality, constructed of corrosion resistant materials, and equipped with quiet variable speed blowers, condensate collection pans, and drains. Condensate collection pans shall be of a corrosion resistant material, of adequate depth and design to prevent sloshing and spillage caused by rolling and pitching of the vessel and shall have antifungal coatings. Condensate drains shall be minimum ¾" diameter, provided with traps or seals, and routed to a nearby plumbing drain, deck drain, or the bilge. Condensate pumps shall not be used. FCUs shall be insulated to prevent secondary condensation.

All FCUs shall have integral electric reheaters capable of maintaining the space at 70°F under heating design conditions and cooling coils capable of maintaining the space at 75°F under cooling design conditions, unless otherwise specified.

FCUs in accommodation spaces shall generally heat or cool a combination of the make-up air supplied to the unit and recirculated air, as needed.

1020 FCUs shall be provided with adjustable, programmable bulkhead mounted thermostats for meeting the comfort requirements of the occupants. FCUs shall be located such that they are easily accessible for maintenance through removable access panels in suspended ceilings or joiner linings. For information regarding resilient mounting, see Technical Specification Section 1E.11.4.

1025 In general, FCUs shall be ceiling mounted shall not extend below the finished ceiling. Where ceiling mounting is not practicable, alternative installation arrangements shall be subject approval by the Resident Engineer. The installation of FCUs in finished spaces shall have a finished appearance consistent with the fit and finish of the space.

All FCUs shall have SPLs at least 5 decibels below the noise limit for the compartment in which it is located as given in Technical Specification Section 1E.11.2.

510.5.7 Fans and Motors

1030 Fans shall be marine duty and, in general, shall be selected with low noise and vibration characteristics. Fan types and sizes shall be standardized and provided by the same manufacturer wherever possible. Resilient mounting of fans shall be as described in Technical Specification Section 1E.11.4.

1035 Fans, in general, shall be of the vaneaxial type, directly driven. Fan construction shall consist of ¼" thick housing or greater, fully welded construction, with marine coating or hot dip galvanizing. Heavy-duty motor shall be supplied fully welded to fan housing and IEEE 45 compliant. Propellers shall be marine rated with epoxy coating or of a material suitable for use in marine environment.

1040 Fans with total pressure greater than 3¾" water gauge shall meet Air Movement and Control Association (AMCA) Class II or III construction requirements as applicable.

Non-sparking type fans shall conform to the requirements of the AMCA and ABS.

Standard bell mouths shall be provided on all fans when the inlet is from free air or a plenum.

510.5.8 Weather Terminals

1045 Intakes for the Vehicle Space ventilation and FMR and AMR ventilation shall have mist-eliminating louvers with integrated weathertight closures. Mist eliminators shall be heated as necessary to prevent build-up of ice on the louvers as well as the drain line. Heat tracing shall be capable of preventing ice build-up under the ambient conditions at the rated flowrate for the louver. Mist eliminating louvers shall be Type 316L stainless steel construction.

1050 Vehicle space exhaust louvers shall be operable and act as weather closures controlled from a remote location. Louvers shall pass an ABS approved hose test when closed.

All other intakes not served by mist eliminators shall be standard louvers with integrated mechanical weathertight closures suitable for operation by a single person.

All exhaust terminals shall be provided with integrated mechanical weathertight closures suitable for operation by a single person.

1055 510.5.9 Trunks, Ducts, Accesses & Hoods

Design duct air velocities shall be as follows in Table 500 - 3.

Table 500 - 3 Air duct velocities

Location	Requirement (fpm)
Machinery space ventilation systems (supply/exhaust)	2,500
Combustion air intake inside FMR or AMR (not trunk)	4,000
Natural vent ducts serving mechanically ventilation spaces (supply/exhaust)	1,500
Low velocity air-conditioning systems (accommodations and working areas)	2,000
High velocity air-conditioning systems (accommodations and working areas)	3,500

1060 Mechanical ventilation systems shall be kept to 2,000 fpm in areas where quiet operation is essential. Velocities up to a maximum of 2,500 fpm will be acceptable if quiet operation can be maintained. Further decreases in velocity may be necessary in areas where quiet operation of system is necessary.

Exhaust terminals shall use manufacturer recommended face velocities, especially where air terminals lead to open deck areas where low noise requirements apply.

1065 Trunks, ducts, closures, louvers, etc., exposed to weather shall not be less than 16-gage stainless steel plate, and shall be watertight. All ducts in machinery spaces shall not be less than 16-gage in thickness. Trunks or ducts in stores and other locations where ducts are subject to damage shall not be less than 16-gage, unless they are adequately protected.

All ductwork shall be sealed airtight with mastic duct sealant. Sheet metal ducts shall be made of hot-dipped, galvanized steel unless otherwise specified.

1070 Circular or flat oval duct sections shall be used instead of rectangular when passing through beams, girders, or other strength members.

Ducts, if possible, shall not be located above electrical equipment. All ducts that must pass over electrical equipment shall be made watertight, and shall be insulated to prevent condensation from dripping on electrical equipment.

1075 Sufficient flange or approved clamp connections shall be provided to make ducts portable when required for servicing. Slip joints shall not be used.

High velocity ducting shall be double wall, insulated construction with perforated inner liner, as described in Section 509.

1080 Fittings for high velocity systems shall meet the same insulation criteria as the double wall duct and have connections and joint sealing per manufacturer's recommendations.

510.5.10 Duct Access Doors

Access holes of 12" x 12" minimum opening, with access doors consisting of bolted plates or quick-acting covers, shall be provided as follows:

1. Axial flow fans, heaters, and cooling coils, both sides.
- 1085 2. Centrifugal fans and multi-blade dampers, inlet side.
3. Fire dampers (either supply or exhaust), one side.
4. Galley exhaust ducts, 4'-0" maximum spacing.
5. Supply and exhaust ducts (other than galley exhaust), 8'-0" maximum spacing.
6. Trunks and non-removable ducts, 8'-0" maximum spacing.
- 1090 7. Duct and trunk drains.
8. Bottom of vertical trunks and non-removable ducts.

Plenums in the Vehicle Space shall have gasketed and bolted access covers. Size and location shall be adequate to perform maintenance and inspection of the louvers and mechanical operators. Manholes may be used for access into large plenums provided they be of the quick acting type.

1095

Fire damper access covers shall be hinged panels to allow verification of damper position without removal. All damper actuators are to be provided with maintenance access. Damper installation shall permit actuator removal without removal of the damper.

510.5.11 Terminals, Grilles, and Wire Mesh Screens

- 1100 All air terminals shall meet USPHS requirements. Diffusers for the various compartments shall be selected to fit within the compartment ceiling configurations. All supply terminals, except directional types, shall be capable of properly ventilating the space involved without creating drafts. Diffusers in high-velocity systems shall be fitted with noise traps to maintain acoustic performance within specified levels. Diffusing/blast terminals shall be used in the galley and
- 1105 similar ventilated heat producing spaces with joiner ceilings.

Machinery space supply terminals shall be of the adjustable directional type with integral throttling damper, similar to a MARAD Type E terminal.

- 1110 Ventilation space supply terminals serving working spaces shall have integral or separate throttling dampers for manually controlling the volume of airflow. Air velocity in air-conditioned spaces shall not exceed 35 fpm at heads of berths, and 50 fpm elsewhere.

Registers shall be used for exhausting the toilets and showers. Grilles or registers shall be used for exhaust or return air from passageways, etc.

Guards shall be provided in way of terminals in storage spaces, to prevent blocking terminals and interference with airflow.

1115 510.5.12 Silencers

The acoustic treatment and silencer installation shall meet the requirements outlined in Section 509.

511 VEHICLE SPACE HEATING AND VENTILATION

511.1 General

- 1120 The HVAC systems serving the Vehicle Space shall be a ducted ventilation system consisting of 100% outside air as shown on Reference 511-01. Fans, plenums and weather louvers shall be acoustically treated as required to maintain noise levels within the limits specified in Technical Specification Section 1E.11.2.

511.2 Detailed Space Design

- 1125 Vehicle Space ventilation shall be designed to provide a minimum of 10 air changes per hour based on the empty volume space. The Vehicle Space ventilation system shall be entirely independent from other ventilation systems.

- The supply fans shall draw outside air from the forward Mezzanine Deck Fan Room through water excluding louvers. The intakes shall be designed for minimum entrance loss and minimum moisture carry over. Louvers shall be located to avoid short-circuiting with other ventilation intakes when the fans are operating in reverse. The fans shall distribute the supply air throughout the space through horizontal and vertical branches and supply terminals.

- The four (4) supply fans shall be single speed and of a type suitable for operating in reverse. The fans shall be fitted with reversing controllers, which allow them to operate as exhaust fans while the ship is loading and unloading. The Vehicle Space side and stern doors shall remain open while fans are operating in reverse to provide natural supply air.

- The five (5) exhaust fans shall draw air through ductwork from terminals located low in the Main Deck (within 450 mm) and discharge to the atmosphere through louvered openings in the sides of the upper curtain plate, port and starboard. The louvered opening shall be remotely operable and be ABS approved to pass a hose test when closed.

The EOS shall be equipped with remote start/stop and reversing controls and status indicators for all ventilation fans through IMACS.

511.2.1 Fire Dampers

- 1145 Fire dampers shall be provided in the ductwork in accordance with regulatory requirements. The fire dampers shall be motor operated and controllable from the fire control station or main Vehicle Space access. Activation of the fire dampers shall shutdown the associated ventilation fan(s).

- Fire dampers are not required where ducts pass through spaces surrounded by A-class and B-class divisions, without serving those spaces, provided those ducts have the same fire integrity as the divisions which they pierce.

511.2.2 Heating

- 1155 Hot water unit heaters shall be provided in the Vehicle Space to maintain a 32°F minimum compartment temperature when ambient temperatures drop to 10°F. The heaters shall not be required to heat the Vehicle Space during loading and unloading operations. Hot water shall be provided by the waste heat system, see Section 517.

All exterior bulkheads shall be thermally insulated in accordance with Section 509 excluding side doors/ramps in order to achieve heating requirements.

512 PASSENGER SPACES HVAC SYSTEMS

512.1 General

1160 The HVAC systems serving the accommodation spaces shall be a combination of ducted medium-velocity and high-velocity, terminal reheat systems as shown on Reference 512-01. High velocity systems typically serve staterooms and smaller compartments. Medium velocity systems typically serve large public compartments.

1165 In general, large accommodation spaces (dining room, lounges, etc) shall utilize centralized ducted systems. Outside make-up air shall be mixed with recirculated air, filtered, heated or cooled to a selectable temperature between 55°F and 60°F, and distributed through the ventilation systems. Individual reheaters shall be provided in the ductwork to each compartment served, with adjustable, programmable bulkhead mounted thermostats for meeting the comfort requirements of the occupants. All reheaters are sized for centralized AHUs to utilize 60°F during heating season and 55°F during cooling season.

1170 In general, small accommodation spaces (staterooms, offices, etc) shall utilize in-compartment FCUs. Space temperature shall be maintained by recirculating air through the FCU and shall be controlled by adjustable, programmable bulkhead mounted thermostats. Fresh air to each space shall be supplied by a centralized outside air system and shall be removed by a centralized exhaust air system, typically one for each deck. Outside air shall be conditioned by filtering and heating or cooling to maintain the system design setpoint.

Thermostats shall be located within the compartments they control and mounted on a nearby bulkhead.

The laundry dryers shall vent to the atmosphere through the ventilation ductwork with lint traps.

1180 Supply and return ducting serving the high velocity AHUs (AHU-5 and AHU-6) shall be double wall. All other ducting shall be medium velocity. System routing and space constraints shown on Reference 512-01 may require the use of double wall, insulated, flat oval duct and fittings for specific sections of high velocity ducting. This duct shall meet the same standards outlined in Section 510.5.9 for high velocity duct.

1185 512.2 Detailed Space Design

512.2.1 Galley

One (1) dedicated AHU and dedicated ductwork system shall be provided for the Galley. Exhaust hoods shall be provided over the hot cooking line (range, deep fryers, etc.) and dishwasher. The range hood shall be of commercial marine quality and shall have an integral grease extractor, grease collection, wash system, and fire extinguishing system. See Section 555 for fire extinguishing details.

1195 The range hood exhaust fan shall have two-speed control. The Galley AHU shall be balanced with the range hood on full with roller curtain door open. If the range hood is at half-speed the Galley AHU shall be secured with roller curtain door open to provide necessary air. A manual selection switch located near the range hood shall be provided to control between two settings; low speed of range hood fan and Galley AHU off, or high speed of range hood fan and Galley AHU on. The Galley HVAC shall be balanced with a slight under pressure during all modes of operation.

512.2.2 Solarium

- 1200 The Solarium shall be treated as an exterior space and be naturally ventilated from the openings in the aft part of the space. Electric radiant heaters shall be positioned throughout the space to provide nominal heating capacity. The heaters are not designed to maintain interior design temperatures.

513 MACHINERY SPACES HVAC SYSTEMS

1205 513.1 General

The HVAC systems serving the machinery spaces shall be a combination of ducted ventilation and local fan coils as shown on Reference 513-01.

- 1210 Both forward and aft machinery rooms shall be mechanically ventilated to ensure that the spaces do not exceed 113°F (45°C) with equipment operating at maximum ambient conditions from Section 510. Remaining spaces shall be ventilated based on temperature rise dictated by SNAME T&R Bulletin No. 4-16.

Fans, plenums and weather louvers shall be acoustically treated as required to maintain noise levels within the limits specified in Technical Specification Section 1E.11.2.

Ductwork passing through the Vehicle Space, but not serving the space, shall be structural steel.

1215 513.2 Detailed Space Design

513.2.1 Forward Machinery Room (FMR)

The FMR shall be mechanically ventilated with 100% outdoor air for cooling and for providing combustion air to the main and auxiliary diesel engines.

- 1220 The supply system shall consist of two (2) supply fans drawing air through screened, water excluding louvers and fire dampers. The supply fans shall be two-speed with dual winding motors. Motors shall have full and two-thirds speed windings. Supply air shall be distributed through the FMR via ductwork and supply terminals as shown on Reference 513-01.

- 1225 The mechanical exhaust system shall consist of two (2) variable speed exhaust fans drawing air from the FMR and discharging it on the port side of the stack, above the Solarium Deck, through fire dampers and exhaust louvers. The exhaust fans shall be automatically controlled by a proportional integral derivative (PID) loop to maintain a slight negative pressure approximately - 0.125" water gauge in the space.

The fans and fire dampers shall be interlocked with the fire extinguishing system and shall automatically shut down and close upon activation of the fire extinguishing system.

- 1230 Capability for manual override of the exhaust fan speed shall be provided. The FMR fan speed controls shall be located in the EOS through IMACS. An FMR air temperature readout shall be located adjacent to the controls.

Heating shall be provided by unit heaters supplied by the hot water system. Unit heaters shall be sized based on the ventilation system secured and only combustion air provided to the space.

1235 513.2.2 Aft Machinery Room

The AMR shall be mechanically ventilated with 100% outdoor air for cooling and for providing combustion air to the main and auxiliary diesel engines.

1240 The supply system shall consist of two (2) supply fans drawing air through screened, water excluding louvers and fire dampers. The supply fans shall be two-speed with dual winding motors. Motors shall have full and two-thirds speed windings. Supply air shall be distributed through the AMR via ductwork and supply terminals as shown on Reference 513-01.

1245 The mechanical exhaust system shall consist of two (2) variable speed exhaust fans drawing air from the AMR and discharging it on the port side of the stack, above the Solarium Deck, through fire dampers and exhaust louvers. The exhaust fans shall be automatically controlled by a proportional integral derivative (PID) loop to maintain a slight negative pressure approximately - 0.125" water gauge in the space.

The fans and fire dampers shall be interlocked with the fire extinguishing system and shall automatically shut down and close upon activation of the fire extinguishing system.

1250 Capability for manual override of the exhaust fan speed shall be provided. The AMR fan speed controls shall be located in the EOS through IMACS. An AMR air temperature readout shall be located adjacent to the controls.

Heating shall be provided by unit heaters supplied by the hot water system. Unit heaters shall be sized based on the ventilation system secured and only combustion air provided to the space.

513.2.3 EOS & Aft Passage

1255 Local FCUs shall be provided for the EOS as well as the office and passage aft of the AMR. The FCUs in each space shall have the capacity to maintain that space at design conditions in Section 510.

1260 Two (2) chilled water FCUs shall separately cool the EOS and the passage aft of the AMR. Air shall be exhausted and replaced with outdoor make-up air as required to maintain the indoor air quality of the compartment. The FCUs shall filter outside make-up air, mix with recirculated air, and heat or cool as necessary to maintain space set-point temperatures.

1265 Ductwork serving the supply system (SF-07) and exhaust system (EF-03) of the EOS shall have exterior insulation for sound absorption between the HVAC silencer located in the AMR (see Technical Specification Sections 513.2.1 and 1E.11.5) and the EOS bulkhead penetration. Insulation shall be 2" thick glass fiber insulation with a minimum density of 3 lb/ft³ with a Mylar facing.

During the heating season, electric heaters incorporated into the FCUs shall provide heat to maintain a minimum temperature of 70°F in the spaces served.

513.2.4 MSD Space, Shaft Alley & Pump Room, and Bow Thruster Room

1270 The MSD Space, Shaft Alley & Pump Room, and Bow Thruster Room shall all be mechanically ventilated with 100% outdoor air for cooling.

1275 Each shall have a single supply fan which shall be two-speed with a dual winding motor. Motors shall have full and half-speed windings. Each space shall also have a dedicated exhaust fan which shall be an identical two-speed with a dual winding motor. Supply and exhaust air shall be distributed through each space via ductwork and supply terminals as shown on Reference 513-01.

During the heating season, unit heaters, normally hot water, shall provide heat to maintain a minimum temperature of 40°F in all machinery spaces with all ventilation at reduced speed and no equipment running.

1280 513.2.5 Auxiliary Machinery Spaces

The various auxiliary machinery spaces not listed shall be mechanically ventilated with 100% outdoor air for cooling in accordance with Reference 513-01. Heating shall generally be provided by unit heaters. Fans shall have local and remote controls at the motor control centers and in the EOS.

1285 During the heating season, unit heaters, normally hot water, shall provide heat to maintain a minimum temperature of 40°F in all machinery spaces with all ventilation at reduced speed and no equipment running.

514 CHILLED WATER SYSTEM

514.1 General

1290 Cooling for the vessel's air conditioning shall be provided by means of circulating fresh (chilled) water from the water chiller(s) to the air cooling coils located in each of the vessel's HVAC/fan rooms and in-compartment FCUs. The chilled water system shall be designed and installed in accordance with Reference 514-01.

1295 The system shall be designed for a 42°F chilled water temperature from the water chillers with a 10°F minimum temperature rise through the air-conditioning coils. The chiller refrigeration plants shall use an EPA approved, non-ozone depleting refrigerant. Refrigerants on the EPA phase out list of ozone depleting substances will not be accepted.

1300 The chilled water system shall be a variable primary flow, two-pipe direct-return type system. Two-way modulating type thermostatic control valves shall be provided at each cooling coil. Solenoid valves will not be allowed. The pump speed shall be controlled to maintain the required set-point differential pressure across the cooling loads to maintain properly balanced flow to the cooling loads. The system shall be configured with a bypass valve, controlled such as to maintain the flow through the chillers within the manufacturer's recommended range whenever a chiller is online. Chiller lead and lag functions shall be controlled through a temperature transducer positioned after the combined outlet from the chillers.

1305 The chilled water system shall be designed for a 50% propylene glycol solution with corrosion inhibitors. The system may be exposed to ambient air at -20°F and therefore must be prevented from icing inside the piping. Chilled water component sizing shall be based on de-rating equipment for glycol solution.

1310 See Technical Specification Section 431 for IMACS interfaces with the chilled water system.

514.2 Equipment

514.2.1 Pumps

1315 Two (2) identical circulating pumps each sized for the entire system capacity shall be provided in accordance with Section 503. Each pump shall be an identical centrifugal-type pump rated in accordance with Reference 514-01. The pumps shall be VFD controlled and shall be configured for primary/standby operation. Designation of the primary and standby pump shall be user selectable. The pump speed shall be controlled to maintain the required set point differential pressure across the cooling coils.

514.2.2 Expansion Tank

1320 One (1) freshwater expansion tank sized to accommodate the system fluid expansion shall be installed with a minimum capacity of 40 gallons at the highest point in the system. The expansion tank shall have a sight glass, vent, overflow, drain and a funnel for fill and water treatment. The tank shall be provided with a low-level alarm function by the IMACS in the EOS.

514.2.3 Chillers

1325 Two (2) identical, packaged water chilling air conditioning plants shall be provided. Each unit shall be sized to provide 50% of the complete air-conditioning system requirements. Each chiller shall be a 90-ton Carrier 30HXS116 standard 2-pass configuration, or equal.

1330 Each condenser/receiver shall have adequate capacity to provide a liquid seal and to hold the entire charge of refrigerant during system pump-down. The receiver shall store 120% of the total system refrigerant charge. Chillers shall be provided with inlet and outlet thermometers.

1335 The condensers shall be sized for the maximum seawater cooling water temperature of 85°F, supplied from the seawater system. Chiller skids shall be provided with a three-way modulating bypass valve to prevent sub-cooling of the refrigerant loop. Bypass valve shall be bronze construction and refrigerant pressure actuated.

1340 The units or stages shall be configured for fully automatic operation. Units or stages shall be brought online or offline in response to varying cooling load demand. Actuated isolation valves for the units or stages shall be slow opening/closing and coordinated with the circulating pump controls to avoid sudden changes to the system operation. The system shall be configured such that the operator may manually select the order in which units or stages are brought online. Each unit shall be provided with independent controllers.

516 REFRIGERATION MACHINERY, EQUIPMENT AND PIPING

516.1 General

1345 Central (piped) refrigeration systems shall be provided and installed to serve the following spaces:

1. 2-224-0 Meat, Seafood, & Poultry Refrigeration.
2. 2-224-2 Vegetable Refrigeration.
3. 2-224-4 Dairy Refrigeration.
4. 2-224-1 Frozen Stores.
- 1350 5. 03-192-2 Galley Walk-In.

The central refrigeration system shall be designed and installed in accordance with Reference 516-01. All countertop galley equipment shall have individual refrigeration circuits and not be served by the centralized system.

1355 The central refrigeration system shall use an EPA approved, non-ozone depleting refrigerant. Refrigerants on the EPA phase out list of ozone depleting substances will not be accepted.

516.2 System Design

1360 Separate refrigerant circuits shall serve each refrigerated storage space. The pressure drop through any cooling coil circuit shall not exceed 2 psi. If necessary to reduce pressure losses or to ensure satisfactory refrigerant return, coils within a space may be in parallel circuits. If parallel coils are used, separate liquid control equipment and thermostatic switches shall be installed for each circuit. Evaporators used to cool walk-in refrigeration storage spaces shall be unit cooler type. Gravity coils shall not be used for walk-in spaces.

516.3 Condensing Units

1365 Two (2) identical 2.75-ton (each) condensing units shall be installed to provide cooling for the vessel's walk-in refrigerators and freezer. The condensing units shall be packaged, freshwater-cooled, and shall be skid-mounted. Each unit shall include a compressor and motor, pressure control switches, a relief valve, crankcase heater, low ambient pressure control, and condenser/receiver. The compressors shall be semi-hermetic reciprocating type. The compressors shall be hard mounted to the skid, and the skid shall be resiliently mounted to the vessel. For information regarding resilient mounting, see Technical Specification Section 1E.11.4. Each packaged unit shall include all necessary interconnecting piping and wiring for fully automatic operation. Each package shall include gauges and switches mounted on centralized gauge boards.

1375 The refrigeration system shall be designed such that one condensing assembly will operate during normal conditions with the second assembly for standby service. For pull-down, the compressors shall be capable of parallel operation. Selection of the lead unit and/or parallel operation shall be manual. The refrigeration plants shall be sized to maintain the conditions given in Table 500 - 4 (below).

Table 500 - 4 Space design temperatures

Compartment	Design Temperature	Loading Temperature
Meat, Seafood, & Poultry	30°F	55°F
Vegetables	38°F	55°F
Dairy	38°F	55°F
Frozen Stores	-10°F	15°F
Galley Walk-In	38°F	55°F

1380 A red indicator shall be installed on each dial thermometer for walk-in refrigerated compartments to show the maximum temperature allowed for each compartment.

516.4 Evaporators

1385 One or more low profile unit coolers shall be installed inside each refrigerated space and sized to maintain the design temperatures of each space. Sizing shall be based on the maximum heat transfer surface required for pull-down or normal conditions, whichever is greatest. Fans, and housing shall be constructed of corrosion resistant materials such as galvanized steel or stainless steel. Coils shall be seamless copper tubes with aluminum fins.

Each evaporator shall be provided with electric defrost options and designed for rapid and efficient defrost.

1390 **516.5 Controls**

Control components shall be arranged in accordance with Reference 516-01. The following additional automatic control equipment shall be provided and installed.

1. Two (2) dual pressure stats, or two (2) sets of separate high- and low-pressure switches that are adjustable.
- 1395 2. Necessary controls for unloading and reduced capacity operation.
3. One (1) oil-pressure failure switch for each compressor.
4. One (1) automatic water-regulating valve for each condenser with manual bypass.
5. One (1) liquid line king solenoid valve for each compressor.
- 1400 6. One (1) liquid solenoid valve and contact maker with thermostatic element for each piece of refrigerated space.
7. One (1) externally adjustable thermostatic expansion valve for each piece of refrigerated equipment with manual bypass.
8. One (1) remote reading temperature gauge and high temperature alarm for each Chilled Stores and Frozen Stores room.
- 1405 9. One (1) local reading temperature gauge and remote indication in the IMACS for each walk-in Chilled Stores and Frozen Stores room. Automatic controls and electric elements for defrost cycles.

See Technical Specification Section 431 for IMACS interfaces with the refrigeration system.

517 WASTE HEAT AND HYDRONIC HEATING SYSTEM

1410 **517.1 General**

Hot water shall be heated by a combination of waste heat recovered from the main diesel engine jacket water and an auxiliary diesel-fired hot water heater. This system shall be designed and installed in accordance with Reference 517-01. The hot water shall be distributed through a closed loop system to the following components:

- 1415 1. HVAC preheaters, reheaters, and unit heaters (above 3kW).
2. Potable water heat exchanger.
3. Tank heating coils (oily water holding tank [OWHT], waste oil tank, and processing water tank).

The system shall be designed for 175°F supply water and 155°F return water temperatures.

1420 After startup, the system shall be fully automatic with no input required by the operators. The primary source of heat for the hot water heating system shall be waste heat recovered from the jacket water cooling systems of the two main diesel engines. The jacket water system is described in detail in Section 532. The waste heat recovery system shall not impact engine performance in any way. The waste heat recovery systems shall be automatically supplemented

1425 as required by the diesel-fired water heater to meet the vessel's heating requirements.

The system shall be a variable primary flow, two-pipe direct-return type system. Two-way modulating type thermostatic control valves shall be provided at each heating coil. Solenoid

valves will not be allowed. The pump speed shall be controlled to maintain the required set-point differential pressure across the heating coils.

1430 The system shall be configured and controlled such as to maintain the flow through the hot water heater within the manufacturer's recommended range whenever the heater is online. This will require a heater bypass valve to modulate based on maximum flow allowed through the heater as well as a system minimum flow control set provided by the hot water heater manufacturer.

1435 The waste heat recovery and hot water heating and distribution system shall be designed for a 50% propylene glycol solution. The system may be exposed to ambient air at -20°F and, therefore, must be prevented from icing inside the piping.

See Technical Specification Section 431 for IMACS interfaces with the waste heat system.

517.2 Equipment

517.2.1 Pumps

1440 Two (2) identical circulating pumps each sized for the entire system capacity shall be provided in accordance with Section 503. Each pump shall be an identical centrifugal-type pump rated in accordance with Reference 517-01. The pumps shall be VFD controlled and shall be configured for primary/standby operation. Designation of the primary and standby pump shall be user selectable. The pump speed shall be controlled to maintain the required set-point differential
1445 pressure across the heating loads.

517.2.2 Expansion Tank

One (1) freshwater expansion tank sized to accommodate the system fluid expansion shall be installed with a minimum capacity of 80 gallons at the highest point in the system. The expansion tank shall have a sight glass, vent, overflow, drain and a funnel for fill and water
1450 treatment. The tank shall be provided with a low-level alarm function by the IMACS in the EOS.

517.2.3 Diesel-Fired Hot Water Heater

One (1) packaged type instantaneous electric circulation diesel-fired hot water heater shall be provided to supplement the waste heat recovery system but be capable of producing enough heat
1455 for the full system capacity. The heater shall be configured to only fire when the waste heat system is not able to meet the heating system demands, and shall have a capacity of 2,000 kW, or equal.

The hot water heater shall be completely automatic in operation with ASME and
1460 USCG/ABS-approval. The heater shall be provided with a flow switch so that no heating will occur without flow through the unit. The heater shall have automatic proportioning of the fuel and air mixtures to maintain constant temperatures as the unit modulates from 20% to 100% of rated output. Other controls shall include safety pressure relief valve, high temperature cutout, and low water level cutoff. The heater shall be supplied with a fuel filter, and low air, flame failure, and low fuel alarms. A steam injection type hot water boiler shall not be acceptable.

1465 The hot water heater shall draw combustion air from within the FMR. Fuel for the heater shall be in accordance with Section 541, exhaust in accordance with Section 563, and piping materials in accordance with Section 505.

1470 The hot water heater shall be provided with control and safety equipment as necessary to ensure safe and reliable operation of the unit. A control panel shall be provided which will have local monitoring and control of all applicable system alarms and equipment. The unit shall also be supplied with a minimum flow control set and dew point control shipped loose. The shipped loose components shall operate to maintain minimum flow through the heater as well as modulate flow to maintain adequate flue gas temperature.

517.2.4 Water Treatment Unit

1475 One (1) self-regulating water treatment system shall be provided for the hydronic heating water. The treatment unit shall perform degassing of the water, anodic protection, and contain a magnetic filter for sludge removal and cleaning.

The treatment system shall be appropriately sized for the full system demand and be mounted near the hot water heater for maintenance purposes.

1480 517.3 Oil Tank Heating Coils

Hot water heating coils shall be provided in the bottom of the OWHT, waste oil tank, and processing water tank to promote oil/water separation and to allow high viscosity contents to be easily transferred.

1485 Piping shall be extra heavy steel and length of piping shall be adequate to ensure up to 15kW of heat transfer to the oil/water mixture in each tank. A minimum surface area of 10 ft² shall be provided in each tank with the heating pipes in each tank configured for parallel operation.

520 SEAWATER SYSTEMS

This section describes the design requirements for seawater piping systems that serve the functions of machinery and equipment cooling, dewatering, firefighting, and sanitary flushing.

1490 See Section 505 for general piping and material requirements and Section 508 for insulation and lagging requirements.

See Technical Specification Section 431 for IMACS interfaces with seawater systems.

521 FIREMAIN SYSTEM

1495 The firemain system shall be provided and installed as shown on Reference 521-01 and in accordance with regulatory body requirements described in ABS Rules and SOLAS. Three (3) identical pumps shall be provided, one each in the FMR, AMR, and Pump Room. Each fire pump shall draw seawater from the nearest sea chest crossover header, through a duplex strainer, and discharge to the firemain manifold. The firemain manifold shall be located on the Mezzanine deck, in the forward casing stairwell at approximately Frame 99. The firemain shall be of the “dry” type, with all piping sloping back to the pump discharge, where a drain valve shall be installed.

1500 The fire pumps shall be identical centrifugal-type pumps rated in accordance with Reference 521-01. The fire pumps in the Pump Room and AMR shall each be supplied with power from the emergency switchboard, and the fire pump in the AMR shall have a normally closed crossover valve to provide emergency cooling to the main engines. The firemain manifold shall be connected to both the Vehicle Space deluge system and the accommodation sprinkling system for emergency backup using any fire pump.

1510 Fire stations shall be installed in quantity and location as required by the regulatory bodies, and shall permit reaching any weather deck area and below deck area from at least two stations. Fire stations shall be fitted with fire hydrants, hoses, nozzles, and accessory equipment in accordance with the regulatory body requirements. Fire station cabinets, hose racks, and outfitting shall be free of sharp edges that could cut or chafe hoses. Fire station cabinets in public spaces shall be fitted with hinged glass enclosures to discourage tampering by passengers. Fire stations shall be fitted with retainers to secure nozzles and minimize banging and rattling from ship motions.

1515 Piping exposed to weather shall be provided with local drains and isolation valves at the nearest accessible heated location to provide freeze protection.

1520 Fire stations in exterior locations and the Vehicle Space shall be 2½" stations. Fire stations in interior locations shall be 2½" x 1½" x 1½" Siamese connections with 50' hoses, where allowed by the regulations. International shore connections shall be provided port and starboard in accordance with the regulations.

The firemain system shall be remotely operable through the IMACS from the fire control station, located in the Pilothouse, and the EOS, including all primary valve controls, low-pressure alarm, and pump start/stop.

The firemain shall also serve as the anchor chain washing system (see Section 581).

1525 **522 VEHICLE SPACE DELUGE AND DRAIN SYSTEM**

522.1 Vehicle Space Deluge System

A manual deluge system shall be provided and installed in the Vehicle Space as shown on Reference 522-01 and in accordance with ABS Rules and SOLAS, and all other regulatory requirements.

1530 The system shall have one (1) dedicated pump, sized to supply the two largest adjacent sprinkler zones simultaneously and shall be a centrifugal-type pump rated in accordance with Reference 522-01. The pump shall take suction from the sea chest crossover header located in the AMR, downstream of a duplex strainer. The deluge system shall be capable of being backed-up by the firemain pumps as described in Section 521. The pump shall be remotely operable through the

1535 IMACS, from both the fire control station (located in the Pilothouse) and the EOS.

1540 The sprinkling system shall be divided into seven approximately equal zones with a central valve manifold in the casing located on the Main Deck, in the aft casing stairwell at approximately Frame 182. Each zone shall have sprinklers placed as necessary but at no time may any part of the overhead be more than 7' from a sprinkler head. Each sprinkler head shall be a USCG approved, open pendant style with 3.2 nominal K-factor.

1545 Sprinkler heads shall be located no lower than the 15'-6" line of clear area above the Main Deck Vehicle Space to avoid interfering with van loading and unloading for the center three lanes. Sprinkler heads shall be kept as high as practicable under the Mezzanine Deck to avoid interfering with vehicle loading and unloading. Horizontally mounted sprinklers heads protecting the vehicle elevator opening shall be flush with the elevator coaming to ensure adequate clearance for vehicles. The system shall be of the "dry" type, with all piping sloping back to the pump discharge, where a drain valve shall be installed leading to the bilge. Piping exposed to weather shall be provided with local drains and isolation valves at the manifold to provide freeze protection.

1550 An overboard discharge shall be provided for system testing and operational verification. A connection to the vessel's service compressed air system shall be provided to blow down the deluge system after testing or use.

522.2 Vehicle Space Drain System

1555 A drain collection and processing system shall be provided and installed in the vehicle space as shown on Reference 522-02 and in accordance with USCG and ABS regulations. The system shall provide adequate drainage during both deck washing and firefighting events.

1560 A total of twelve (12) drain sumps shall be provided in the Vehicle Space on the Main Deck to allow adequate drainage. The top of each sump shall be flush with the Main Deck and provided with an angled screen for catching debris. Each sump shall have two drain lines: one (1) small 2-1/2" drain led from the sump bottom to a drain tank and one (1) large 6" drain leading directly overboard via a butterfly valve and check valve.

1565 During deck washing, the system shall be manually configured to route water to a drain tank in the double-bottom of the AMR through a gravity drain header. One (1) positive displacement diaphragm pump shall be provided to pump contents of the Vehicle Space drain tank to a shore connection and rated in accordance with Reference 522-02. One (1) oily water separator (OWS) shall also be provided for processing the contents of the drain tank and discharging the effluent overboard. The OWS shall be USCG approved and identical to the one described in Section 594. A filter and a strainer shall be provided on the OWS suction in accordance with Reference 522-02.

1570 During a firefighting event, each sump will be capable of dewatering the space through the overboard line.

523 ACCOMMODATION SPACES SPRINKLER SYSTEM

523.1 General

1575 A wet automatic sprinkler system shall be provided in all accommodation and service spaces as shown on Reference 523-01 and in accordance with the SOLAS regulations.

1580 The system shall have one (1) independent, dedicated pump, sized to supply the largest zone flow requirement per the regulations and shall be a centrifugal-type pump rated in accordance with Reference 523-01. The pump shall take suction from the sea chest crossover header located in the AMR, downstream of a duplex strainer. The sprinkler system shall be capable of being backed-up by the firemain pumps as described in Section 521. Commonality of pump casing size and parts shall be maintained with the firemain pumps if at all possible.

1585 The system shall be divided into nine zones. A central automatic valve manifold shall be located in the casing on the Mezzanine Deck, in the aft casing stairwell at approximately Frame 198. Each zone shall have sprinklers placed as necessary, but at no time may any part of the overhead be more than 7' from a sprinkler head. Each overhead sprinkler head shall be upright or pendant style with 4.2 nominal k-factor, USCG approved. Window protection sprinkler heads shall be USCG approved and installed along egress routes.

A dry pipe valve assembly shall be provided to allow "dry" type piping for all spaces which are subject to freezing. The dry pipe valve assemblies shall be supplied with air from the

1590 Compressed Air System described in Section 551. Dry pipe valves shall serve the following areas:

1. Zone 2, the aft Solarium Deck.
2. Walk-in refrigerated space in the Galley.
3. Port and starboard Cabin Deck promenades.

- 1595
4. Three refrigerated spaces on 1st Platform.
 5. Freezer on 1st Platform.
 6. Main Deck locker.

1600 The automatic sprinkling systems shall have adequate provisions for periodic inspections and testing without wetting the protected spaces or compartments. An overboard discharge line with flow meter for testing required flowrates shall be provided. The low-points of the sprinkler system shall drain to the bilge and a flushing line provided from the potable water system shall be installed for recharging the system with fresh water if necessary.

International shore connections and local fire department connections shall be provided on the Main Deck near the fill stations, as shown on Reference 506-01.

1605 **523.2 Pressure Tank**

The system shall be fitted with hydro-pneumatic epoxy-lined tanks capable of supplying the required flow to the area of highest demand for 60 seconds, in accordance with the regulations. Total tank volume shall have a minimum capacity of 1250 gallons with total water level of 560 gallons to achieve sizing requirements. Tanks shall be manifolded and act as a single tank when in operation. The number of tanks is based on tank geometry and accessibility. Three (3) tanks constitute the baseline design, as shown on Reference 523-01.

1610 The tanks shall each be fitted with a pressure relief valve, temperature gauge, as well as connection for compressed air supply on the top. Tank manifold shall be supplied with

1. A sight glass.
- 1615 2. TLI.
3. High-level alarm.
4. Low-level alarm.
5. Pressure gauge.

The hydro-pneumatic tanks shall be ASME and ABS approved.

1620 **523.3 Alarm and Monitoring**

Alarm and monitoring for the sprinkler system shall be installed per ABS and SOLAS regulations. See Technical Specification Section 431 for details on Fire Control Station monitoring through IMACS. The following conditions shall be provided with alarms at a minimum:

- 1625
1. Position of supervised valves.
 2. Pump power supply and operation condition.

3. Water tank high level, low level, temperature, and pressure.
4. Water flow alarm for each zone.
5. Dry pipe valve air pressure.

1630 524 SEAWATER COOLING SYSTEMS

524.1 General

The seawater cooling system shall consist of propulsion engine cooling, ship service diesel generator (SSDG) cooling, A/C chiller cooling, hot water heat pump heating, and the auxiliary system cooling, as shown on Reference 524-01.

1635 Maximum seawater temperature used for sizing equipment and flowrates shall be 85°F.

524.2 Seawater Supply Header

A total of four (4) sea chests shall be provided for the shipboard seawater services:

1. Two (2) sea chests shall be positioned port and starboard in the FMR and connected with a 12" crossover header.
- 1640 2. Two (2) sea chests shall be positioned port and starboard in the AMR and connected with a 12" crossover header.

Each sea chest shall be fitted with a lugged positive-closing butterfly valve suitable as a shell valve operable from above the grating level, and with a 12" simplex basket strainer. A waster piece at the bimetallic transition shall be flanged to transition the crossover pipe to copper-nickel.

1645

A compressed air blowdown connection shall be fitted to the vent of each sea chest using isolation valves in the vent line.

The seawater header shall provide seawater for the firemain, deluge, accommodation sprinkling, seawater cooling, local area firefighting, and the sanitary flushing system (see Sections 521, 522, 523, 524, 555 and 528). Each system shall take suction from the sea chest crossover header downstream of the simplex strainers. The sea chests, strainers and crossover header shall be sized such that all seawater demands can simultaneously be met by drawing water from either the port or starboard sea chest, alone.

1650

524.3 Propulsion Engine Cooling

1655 Cooling for both the port and starboard main diesel generator engines shall be provided by three (3) identical electrically driven centrifugal pumps operating in parallel. Each of the three pumps shall be sized for the full cooling load of one main engine and be rated in accordance with Reference 524-01. The cooling load for each engine shall consist of seawater flow requirements of the high temperature and low temperature heat exchangers, see Section 532. The pumps shall

1660 be sized such that two pumps meet full system demand (both main engines at 100% MCR) with the third pump provided for redundancy. The pumps shall be separated between each machinery space for redundancy with one (1) pump in the forward machinery space and two (2) in the aft machinery space. Pumps shall take suction through duplex strainers. Pumps in the aft machinery space shall share a common strainer.

- 1665 All four (4) seawater coolers (one (1) high temperature cooler and one (1) low temperature cooler for each main engine) shall be shipboard mounted, see Section 532. After cooling water passes through the coolers for each main engine, it shall be combined and discharged overboard, port and starboard. Coolers shall be divided between the forward and aft machinery spaces.
- 1670 The main engine cooling systems and design shall satisfy all the requirements of the diesel engine manufacturer as to cooling requirements and other restrictions in order to ensure that diesel engine performance and long system component life are not compromised. Cooling water systems for the engines shall be kept independent of cooling water systems for the alternators.

524.4 Ship Service Diesel Generator Cooling

- 1675 Each SSDG shall have seawater circulated by an engine-driven seawater-cooling pump through an engine mounted seawater/jacket water heat exchanger (jacket water cooler). Each pump shall take suction from the nearest sea chest crossover header through a dedicated duplex strainer. The SSDG engines shall be resiliently mounted and all piping connections to the engine shall be flexible connections.
- 1680 The SSDG engine cooling systems and design shall satisfy all the requirements of the diesel engine manufacturer as to cooling requirements and other restrictions in order to ensure that diesel engine performance and long system component life are not compromised.

524.5 A/C Chiller Cooling

- 1685 The system shall have two (2) identical centrifugal pumps, each sized for the seawater demand of one A/C chiller condenser and be rated in accordance with Reference 524-01. Each pump shall take suction from the forward sea chest crossover header in the AMR through a dedicated duplex strainer. A crossover shall be provided downstream of each pump allowing either pump to serve either chiller or both chillers at a reduced flow. The seawater pumps shall be segregated between the FMR and AMR.

524.6 Auxiliary Seawater Service Cooling

- 1690 The system shall have two (2) identical centrifugal pumps, each capable of satisfying the entire seawater service system demand and be rated in accordance with Reference 524-01. The pumps shall take suction from the forward sea chest crossover header in the AMR through a duplex strainer sized for the entire system demand. The seawater pumps shall be installed in the AMR.
- The seawater service system shall provide water to the following services:
- 1695
1. Propulsion freshwater cooling system heat exchangers.
 2. Auxiliary freshwater cooling system heat exchangers.
 3. Bilge system for pump priming.
 4. Sewage tank flushing connection.
 5. Aft lift tank-flushing connection.
- 1700
6. Effluent tank flushing connection.
 7. MSD system supply (x2).

524.7 Anti-Fouling System

1705 A seawater pipework anti-fouling system shall be installed to protect the piping in the vessel from excessive marine growth. The system shall be arranged for continuous operation and be ABS approved.

Each of the four (4) pipe sea chests shall have a copper and aluminum anode installed in accordance with the manufacturer's recommendations. These anodes shall be wired to the control panel mounted on the bulkhead near each sea chest.

1710 The system shall be designed for 120VAC power and shall be capable of preventing marine growth continuously. Sizing of the system shall be based on approximately 1,000 GPM seawater flow through each sea chest. Service intervals for the system shall not be less than five (5) years.

526 PLUMBING AND DECK DRAIN SYSTEM

526.1 General

1715 The plumbing and deck drain system shall be provided to collect water from all plumbing fixtures and interior deck drains aboard the vessel.

All drain pipes shall be led as directly as possible.

The drain system shall not allow gas odors in any compartment, working deck area, or weather deck areas of the vessel.

1720 Deck and fixture drain lines shall be arranged so as to provide positive drainage when the vessel is under design conditions of list and trim, or rolling and pitching of the vessel.

Gravity drains shall have maximum possible slope, but not less than ¼" per foot transversely and ⅛" per foot longitudinally. Plumbing drain piping shall be sized to carry expected flow rates and account for possible buildup.

1725 All drain piping shall be approved CPVC piping in accordance with Section 505. In cases where piping is exposed to weather or passes through a void, copper-nickel piping shall be used in lieu of CPVC. CPVC piping passing through the Vehicle Space shall be insulated and heat traced in accordance with Technical Specification Section 334. Heat tracing shall at a minimum cover traps, cleanouts, and horizontal runs in the Vehicle Space.

1730 Where drain lines are joined with other drain lines into common headers, the headers shall be increased in size for the expected flow capacity.

Where drains are combined with other drains, "Y" branches or sweet tees shall be used to facilitate flow. Standard 90° "T" fittings or short radius "L" fittings will not be permitted in the plumbing drain lines.

Interior deck drains shall be kept separate from exterior deck drains.

1735 All pipe runs between watertight bulkheads shall have at least one expansion bend.

All valves in the plumbing and deck drain system shall be of non-clog design, such as ball, plug, or gate valves. Ball and plug valves shall be full-port.

1740 Where drain lines are led through the Vehicle Space, drain lines shall be kept as close to the ship's structure as possible. Intrusions into the Vehicle Space shall be kept to a minimum in order to limit possible mechanical damage from vehicles.

526.2 Plumbing Drains (Graywater)

The graywater system shall collect water from service sinks, lavatories, showers, drinking fountains, interior deck drains, laundry equipment, and galley equipment. The graywater system shall be designed and installed in accordance with Reference 526-01.

- 1745 All graywater systems shall drain via gravity to either the sewage holding tank or aft lift tank. All graywater drains originating from aft of the Main Vertical Zone (MVZ) shall be directed to the aft lift tank. All graywater drains originating from forward of the MVZ shall be directed to the sewage holding tank.

- 1750 Drain pipes from plumbing fixtures or deck drains combined with other drains located at higher elevation may be joined; however, where such connections are made, they shall be at least 6' below the lowest drain to prevent back-flooding under design conditions of list and trim, and under the rolling and pitching of the vessel.

- 1755 Drains from the Galley sinks, range hood, and dishwashers shall have grease traps located on the Main Deck conforming to USPHS standards for grease removal. All drains leading from the Galley shall remain independent of any other gray water drain connections and shall be routed directly to the aft lift tank.

526.3 Plumbing Drains (Blackwater)

The blackwater system shall collect water from all water closets and urinals. The blackwater system shall be designed and installed in accordance with Reference 526-02.

- 1760 Blackwater drains shall be kept separate from all other drains. All blackwater systems shall drain via gravity to either the sewage holding tank or aft lift tank. All blackwater drains originating from aft of the MVZ shall be directed to the aft lift tank. All blackwater drains originating from forward of the MVZ shall be directed to the sewage holding tank.

526.4 Interior Deck Drains

- 1765 Deck drains shall be provided to prevent accumulation of water on decks under conditions of list to either side and through the possible range of trim under service conditions. Interior deck drains shall gravity drain to the sewage holding tank or aft lift tank.

- 1770 Deck drains shall be installed in all spaces where water may accumulate, such as laundry rooms, fan rooms, cleaning gear lockers, any spaces fitted with a drinking fountain or sink, storage spaces containing liquids, galley scullery, messes, high-use passageways, and sanitary spaces.

Spaces with openings to weather shall be provided with sufficient deck drains installed near the water source, which shall quickly remove intruding seawater inside exterior doors and other wet areas.

- 1775 Interior deck drains that combine with plumbing drains shall be fitted with air gaps and funnels as well as traps.

Deck drain strainers shall be fitted with removable bronze or stainless steel strainer plates having a free area of at least twice the area of the drain pipe. Deck drain strainers shall be positively secured and flush with the finished deck.

Trough drains shall be provided throughout the Galley and near the entrances to the space.

1780 526.5 Weather Deck Drains

Deck drains shall be installed for all weather areas, including the working decks and the superstructure. Weather deck drains shall be independent of all other drains. Drains shall be located and sized to ensure that there is no standing water left on the deck. However, drains shall be no smaller than 1½". Drain scuppers shall be located to facilitate adequate drainage from
1785 decks. Gravity drains shall have maximum possible slope, but not less than ¼" per foot transversely and ⅛" per foot longitudinally.

Drains from the Cabin Deck and above shall combine with drains from the lower decks where practical. Where drains are combined with other drains 'Y' branches or swept tees shall be used to facilitate flow. Weather deck drain piping through staterooms shall be minimized to the
1790 greatest extent practicable.

All flush exterior hatches shall be fitted with drains and tied into the adjacent weather deck drain piping. All plenums and fan rooms not fitted with interior deck drains shall be fitted with exterior drains and tied into the adjacent weather deck drain piping.

Chain lockers shall be served by gravity drains to the overboard. The gravity drains shall have a non-return valve and terminate above the waterline.
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The Main Deck Vehicle Space drains will require special consideration and are outlined in Section 522.

526.6 Traps and Cleanouts

A water-seal trap shall be installed for each plumbing fixture, or for a collection of no more than three fixtures. Each trap shall be located as close to the fixture as possible, and the maximum vertical distance between fixture outlet and trap shall not exceed 24". P-type traps shall be used. Each trap shall have a readily accessible means for cleaning. Traps shall be installed in a fore-and-aft direction. All drains shall have traps deep enough to prevent siphoning and backflow from the pitching and rolling of the vessel, usually between 2" and 4". Additional 20" deep p-traps shall be installed in the gray water and black water lines connecting to the sewage collection tank and the aft lift tank.
1800
1805

Cleanouts shall be provided in horizontal drain piping for every cumulative change in direction of 135° or greater, and not more than 50 linear-feet apart. Where permitted, cleanout fittings shall be installed in accessible locations for all drains to permit cleaning of drain pipes. Cleanout fittings shall be installed in each vent pipe serving a drain from a plumbing fixture. Cleanouts shall be installed so that the cleanout opens in a direction opposite to the flow of the drainage.
1810

Cleanouts and traps shall be positioned to allow for at least 12" of open access to the opening to the trap or cleanout with sufficient space for the easy entry and removal of a cleanout rod or plumbing snake. Clean-out connections shall not be less than 1½" NPS, for clearing the drain pipes by use of plumber's snake or water hose.
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No clean-out connections shall be installed in the overhead of the galley or messes.

526.7 Plumbing Vents

Individual and combined drains shall be vented. Interior drain and sink vents may be fitted with vacuum break valve terminals in lieu of running vent piping. Vacuum break valve terminals

1820 shall be located such that they are accessible for inspection and repair such as through access panels or removable ceilings.

528 SANITARY FLUSHING SYSTEM

1825 The sanitary flushing system shall utilize seawater to provide flushing water to the water closets and urinals. The sanitary flushing system shall be designed and installed in accordance with Reference 528-01.

The sanitary flushing system shall be sized to deliver a minimum pressure of 30 psi at all plumbing fixtures. Pressure reducing valves shall be placed in each branch to allow adequate pressure control at each deck. Pressure reducing valves shall be easily accessible and shall not be located behind ceilings in the overhead or behind any joiner bulkheads.

1830 Three (3) identical centrifugal circulating pumps shall be provided, each rated in accordance with Reference 528-01. The pumps shall be sized such that two pumps are able meet full system demand; the third pump shall be provided for redundancy. The pumps shall take suction from the forward sea chest crossover header located in the AMR, and through a duplex strainer sized for the entire system demand. The pumps shall be configured for lead/lag/standby operation.
1835 Designation of the lead, lag, and standby pump shall be user-selectable.

One (1) hydro-pneumatic bladder style pressure tank shall be configured to supply the system during low demand periods. The tank shall be a minimum of 100 gallons and capable of providing water for up to 10 flushes without the need to start the circulating pumps. The tank shall be fitted with a pressure relief as connection for compressed air supply to the top. The tank
1840 shall be AMSE and ABS approved.

Sanitary flushing system branches and loops shall be configured with due regard to limiting adverse effects on services should a particular section of piping need to be isolated for maintenance or repair. The system shall be subdivided amidships at the MVZ, with isolation of each forward and aft header possible for maintenance, without disrupting service to the other
1845 header. Additional isolation valves shall be installed to provide the ability to secure and service small groups of water closets or urinals without taking the entire system offline.

Each deck shall be provided with a system branch isolation valve. Each water closet or urinal shall be fitted with cutout valves in the supply line so that water service can be secured at the fixture for maintenance, repair, or replacement of the fixture.

1850 No piping in the sanitary flushing system shall be exposed to weather. Routing through the Main Deck shall be accomplished in the casing where freezing temperatures are not present.

529 BILGE SYSTEM

529.1 General

1855 The bilge system shall be provided and installed as shown on Reference 529-01 and in accordance with ABS Rules and SOLAS. The bilge system shall be provided to dewater all compartments not drained overboard by gravity, to the oily water holding tank, or gray water to the sewage tank. This includes all spaces located below the water line, double-bottoms, voids, and trunks. The bilge system shall normally be configured to discharge to the oily water holding tank(s), but in case of emergency shall be able to discharge directly overboard.

1860 The Vehicle Space drains will require special consideration and are outlined in Section 522.

529.2 Bilge Wells and Suction Lines

1865 All machinery spaces shall be fitted with bilge wells (except MSD space which is fitted on the 7' ABL tank top) and ball float type high level alarms. Bilge suction lines shall also be fitted at the low points of all double bottom voids and trunks. A complete list of high level alarms is given in Technical Specification Section 431. The bilge system shall be a hybrid system with a combination of common bilge mains and independent suctions lead to one of the bilge manifolds. All common bilge mains shall be located inboard of 20% of the breadth of the vessel.

1870 All bilge suction lines forward of Frame 116 shall run independently to the bilge manifold located within the Lower MSD Room. All spaces within Frame 116 – Frame 152 shall be run independently to the bilge suction manifold in the FMR. All spaces within Frame 152 – Frame 200 shall be run independently to the bilge suction manifold in the AMR. A common bilge main shall be provided for all spaces aft of Frame 200.

Each bilge branch connection shall have a suction rose box strainer.

529.3 Bilge Suction Valves and Manifolds

1875 All bilge suctions shall be fitted with a foot valve. All bilge branches leading to the common main shall have motorized stop-check type control valves that are accessible at all times. Bilge manifold valves shall be manual stop check type. Bilge system valve motor-operators shall have an enclosure tightness rating of IP67. Electric operators shall be operable through IMACS.

529.4 Bilge Pumps

1880 Two (2) identical bilge pumps shall be self-priming centrifugal-type and capable of each dewatering all the bilge compartments. Each pump shall be rated in accordance with Reference 529-01 and regulatory requirements. The bilge pumps shall normally discharge to the OWHT, but may be used for direct overboard discharge in flooding situations. The bilge pumps shall have a priming line from the seawater system.

1885 The bilge system shall be integrated with the waste oil system (see Section 543) and oily water system (see Section 594) by crossover lines between the system pumps.

The two ballast pumps (see Section 534) shall be cross-connected to the bilge main for emergency use as a third and fourth bilge pump.

529.5 Flooding and Emergency De-Watering

1890 The FMR shall have emergency de-watering capabilities. This space shall be fitted with a direct bilge suction utilizing the bilge pump. This suction shall draw water through a rosebox located in the FMR bilge, pass through the main bilge pump, and discharge directly overboard.

1895 The largest SW pump in the FMR, the main engine seawater cooling pump (see Section 524), will serve as the emergency bilge pump. The pump shall be capable of drawing water through a rosebox located in the FMR bilge and discharging directly overboard, utilizing valves readily operable from above the grating level.

530 FRESHWATER SYSTEMS

1900 The below sections describe the design requirements for freshwater piping systems that serve the functions of machinery and equipment cooling, potable water distribution, and adjustments for trim conditions.

See Section 505 for general piping and material requirements, and Section 508 for insulation and lagging requirements.

See Technical Specification Section 431 for IMACS interfaces with freshwater systems.

532 FRESHWATER COOLING SYSTEMS

1905 532.1 General

The diesel engine cooling systems and design shall satisfy all the requirements of the diesel engine manufacturer as to pipe size, bends and other restrictions in order to ensure that diesel engine performance and long system component life is not compromised.

1910 The freshwater cooling systems shall all be designed for a 35% ethylene glycol solution with corrosion inhibitors. The system may be exposed to freezing temperatures during vessel layup, therefore, must be protected from freezing. The freshwater cooling systems shall be installed in accordance with equipment manufacturer's specifications.

Antifreeze, corrosion inhibitors, and other jacket water additives shall be as specified by the engine manufacturer and shall be the same for all engines, if practicable.

1915 532.2 Propulsion Engine Cooling

1920 The propulsion engine jacket water shall be cooled by a closed loop freshwater cooling system, as shown on Reference 532-02. This system shall be independent of the alternator freshwater cooling system. Each diesel engine shall be provided with an independent, closed loop, dual circuit (high temperature and low temperature) freshwater cooling system. The high temperature circuit shall provide cooling for the engine jacket water and exhaust gas recirculation (EGR) cooler. The low temperature circuit shall provide cooling for the intercooler, aftercooler, and lube oil cooler.

Respective high temperature and low temperature cooling pumps shall be provided by the manufacturer, engine-mounted, and driven by the engine's power take-off system.

1925 Each main engine shall be provided by the manufacturer with an electric jacket water heater and controls to automatically maintain engine block temperature when the engine is not operating. The heater shall be provided with a circulating pump, and be remotely mounted and connected to the high temperature heater outlet/inlet provided on the engine.

1930 Waste heat shall be utilized from the high temperature circuit of each main engine. The high temperature cooling water from each engine shall pass through dedicated waste heat recovery heat exchangers, which will be the primary heat sink, and shall each be sized for 3,552,000 BTU/hr (1050 kW) of heat rejection at the design conditions. These two (2) heat exchangers shall be of Type 316 stainless steel plate. Two (2) high temperature seawater cooled heat exchangers, one dedicated to each engine, shall provide a secondary heat sink to dissipate excess heat beyond the demand of the waste heat system.

1935

1940 The high temperature seawater-cooled heat exchangers shall be sized for the full load of the engines to maintain 165°F cooling water at the return to the engines. The heat exchangers shall be titanium plate type and capable of rejecting a minimum of 6,512,000 BTU/hr (1900 kW) at the design conditions. A three way modulating valve will bypass as much cooling water as necessary to maintain proper inlet temperature to the engine. The waste heat recovery system shall be fully automatic to the extent the operator assistance is not required to maintain proper diesel engine operating temperatures and recover waste heat when an engine is placed in or taken out-of-service. See Section 517 for details on the waste heat recovery system.

1945 Two (2) low temperature seawater heat exchangers shall be provided, one for each respective circuit, independent of the high temperature circuit. Each low temperature, seawater-cooled heat exchanger, shall be sized for the full load of the engines to maintain 100°F cooling water at the return to the engines. The heat exchangers shall be titanium plate type and capable of rejecting a minimum of 4,785,000 BTU/hr (1400 kW) at the design conditions.

1950 A double-chamber expansion tank shall be provided for each engine, by the engine manufacturer, and shipped loose for Contractor installation. Each expansion tank shall be sized to accommodate the system fluid expansion for the engine and shall be installed in accordance with the manufacturer's recommendations. Each expansion tank shall have a minimum total volume of 97 gallons, and include a sightglass, 10 psi vent/overflow, and a port or method of refilling treatment chemicals to the cooling water circuits per chamber of the expansion tank.

1955 **532.3 Ship Service Diesel Generator Cooling**

1960 The SSDG jacket water shall be cooled by a closed loop freshwater cooling system, as shown on Reference 532-02 and in accordance with the manufacturer's recommendations. The entire cooling system shall be mounted on the SSDG skid. The cooling system shall utilize an engine-driven jacket water pump and a skid-mounted heat exchanger to cool the engine jacket water. A jacket water heater shall be provided to maintain engine block temperature when the engine is not operating. Filling shall be via the potable water system through an air gap. See Section 524.4 for discussion of the engine mounted seawater cooling system components.

532.4 Emergency Diesel Generator Cooling

1965 The EDG jacket water shall be cooled by a closed loop freshwater cooling system, as shown on Reference 532-02. The EDG set cooling system shall be in accordance with the manufacturer's recommendations. The entire cooling system shall be mounted on the EDG skid. Filling shall be via the potable water system through an air gap. The cooling system shall utilize an engine-driven jacket water pump, a skid-mounted radiator and engine-driven radiator fan to cool the engine jacket water. A jacket water heater shall be provided to maintain engine block temperature when the engine is not operating.

532.5 Jacket Water Holding and Transfer System

Jacket water holding and transfer systems shall be installed for draining the following systems during repairs and overhauls:

1. Main generator cooling
- 1975 2. Auxiliary generator engine cooling

3. Propulsion auxiliary cooling
4. Auxiliary cooling

The jacket water holding tank shall be located in the double bottom near the FMR/AMR bulkhead to permit gravity drainage of the propulsion and generator engine cooling systems.

1980 The capacity of the holding tank shall be approximately 2,000 gallons and integral in the vessel double-bottom. Sizing shall be adequate to contain the jacket water from all engine or auxiliary cooling systems (engine block, piping and heat exchangers).

One (1) jacket water transfer pump shall be provided and arranged to transfer cooling water from the holding tank back to the engine cooling system and to a main deck discharge station. The transfer pump shall include a recirculation line with globe valve for regulating the flow rate to the expansion tanks. The pump shall be centrifugal-type rated in accordance with Reference 532-02.

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532.6 Propulsion Auxiliary Freshwater Cooling

The following auxiliary machinery and equipment related to the propulsion plant shall be cooled by a closed loop freshwater cooling system, as shown on Reference 532-01:

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1. Propulsion Alternator #1.
2. Propulsion Transformer #1.
3. Propulsion Drive #1.
4. Stern Propulsor Oil Cooler #1.
5. Propulsion Alternator #2.
6. Propulsion Transformer #2.
7. Propulsion Drive #2.
8. Stern Propulsor Oil Cooler #2.
9. Bow Thruster Motor #1.
10. Bow Thruster Motor Drive #1.
11. Bow Thruster Motor #2.
12. Bow Thruster Motor Drive #2.

1995

2000

Two (2) identical centrifugal-type circulating pumps, each sized for the entire system capacity, shall be provided. The pumps shall each be rated in accordance with Reference 532-01.

2005

Two (2) centralized freshwater/seawater heat exchangers shall be provided and sized to provide the required freshwater flows and pressures at all operating conditions with one heat exchanger on standby. The heat exchangers shall be titanium plate type.

A freshwater expansion tank sized to accommodate the system fluid expansion shall be installed for the system with a minimum capacity of 20 gallons. The expansion tank shall have a sight glass, vent, overflow, drain and a funnel for fill and water treatment. The tank shall be provided with a low-level alarm function by the IMACS in the EOS.

2010

Isolation valves shall be provided at the freshwater supply and outlet connections of each piece of equipment served for system isolation for maintenance and repair purposes. Circuit balancing valves shall be provided on the return side of all cooling loads.

2015 **532.7 Auxiliary Freshwater Cooling**

The following auxiliary machinery and equipment not related to the propulsion plant shall be cooled by a closed loop freshwater cooling system, as shown on Reference 532-01:

1. Fuel Oil Cooler #1.
2. Fuel Oil Cooler #2.
- 2020 3. Fin Stabilizer Hydraulic Oil Heat Exchanger #1.
4. Fin Stabilizer Hydraulic Oil Heat Exchanger #2.
5. Chilled/Frozen Stores Condenser #1.
6. Chilled/Frozen Stores Condenser #2.

2025 Two (2) identical centrifugal-type circulating pumps, each sized for the entire system capacity, shall be provided. The pumps shall each be rated in accordance with Reference 532-01.

Two (2) centralized freshwater/seawater heat exchangers shall be provided and sized to provide the required freshwater flows and pressures at all operating conditions with one heat exchanger on standby. The heat exchangers shall be titanium plate type.

2030 A freshwater expansion tank sized to accommodate the system fluid expansion shall be installed for the system with a minimum capacity of 20 gallons. The expansion tank shall have a sight glass, vent, overflow, drain and a funnel for fill and water treatment. The tank shall be provided with a low-level alarm function by the IMACS in the EOS.

2035 Isolation valves shall be provided at the freshwater supply and outlet connections of each piece of equipment served for system isolation for maintenance and repair purposes. Circuit balancing valves shall be provided on the return side of all cooling loads.

533 POTABLE WATER SERVICE SYSTEM

533.1 General

2040 The potable water system shall provide continuous hot and cold potable water supply to sinks, showers, galley equipment, drinking fountains, and other service points throughout the vessel. The potable water system shall be provided and installed as shown on Reference 533-01. The potable water system shall also provide potable water to the accommodations sprinklers system (for flushing), the water mist system, freshwater expansion tanks, the oily water separators, the fuel oil purifiers, and the sanitary flushing system (for back-flushing).

2045 Hot and cold potable water shall be supplied to the lavatories, sinks, and showers. Supply pipes to fixtures shall be outside diameter tube size, with chromium-plated brass stop valves fitted in the supplies adjacent to the fixtures, except for fixtures with integral stops. Water hammer arrestors shall also be installed in the supply lines to the plumbing fixtures.

533.2 Potable Water Storage and Transfer

2050 Two tanks shall be provided to store potable water, sized for a combined capacity of four (4) days of use by a full complement of passengers and crew (approximately 36,000 gallons total capacity). The tanks shall not share boundaries with tanks containing non-potable liquid or with the sea. The tanks shall have local TLIs (sight glasses), high-level alarms, and low-level alarms.

2055 The tanks shall be filled from a potable water tank supply header. The supply header shall have an in-line wye strainer for filtering incoming water before it is stored in the potable tanks. Water to the supply header shall be provided from the Main Deck hose connections. The supply header shall direct water to either potable water tank or to both tanks simultaneously.

533.3 Cold Potable Water System

2060 The cold potable water system shall be sized to deliver a minimum pressure of 40 psi at all fixtures. Pressure reducing valves shall be placed in each branch to allow adequate pressure control at each deck. Pressure reducing valves shall be easily accessible and not behind ceilings or other joiner bulkheads.

2065 Three (3) pumps shall be provided as part of a vendor provided, engineered, and factory tested pump station for potable water service in accordance with Section 503. Each pump shall be identical and rated so two of three pumps in parallel operation can maintain the design requirement in accordance with Reference 533-01. The pumps shall be of stainless steel construction compliant to ANSI/NSF Standard 61. The engineered pump station shall operate with VFD controls and configured for lead/lag operation. Pump speed shall be controlled to maintain the required set point pressure of 70 psi at the pump station discharge. The pumps and VFD assembly shall be a skid mounted piece of equipment.

2070 A hydro-pneumatic bladder style pressure tank shall be configured to supply the system during low demand periods. The tank shall be sized by the engineered pump station manufacturer to supplement system demands. The tank shall have a minimum capacity of 26 gallons and capable of providing water to the system without the need to start the circulating pumps. The tank shall be fitted with a pressure relief valve and a connection for compressed air supply at the top. The tank shall be AMSE and ABS approved.

2075 Water shall pass through one (1) bag filter sized for the entire system demand before reaching any consumers. The filter shall have a 10-micron polypropylene filter bag and have ANSI/NSF 61 certification.

2080 Potable water system branches and loops shall be configured with isolation valves for maintenance and repair. The system shall be subdivided by deck and amidships at the MVZ, with isolation of each forward and aft deck header possible for maintenance, without disrupting service to the other headers. Additional isolation valves shall be installed to provide the ability to secure and service small groups of fixtures without taking the entire system offline.

2085 The system shall serve showers, sinks, lavatories, galley equipment, drinking fountains, and hose bibs. Each plumbing fixture shall be fitted with cutout valves in the supply lines so that water service can be secured at the fixture for maintenance, repair, or replacement. The cold potable water shall also supply make-up water to all closed loop freshwater systems. Cold potable water spigots shall be located in all machinery spaces. A cold potable water service connection shall be provided to the oily water separators and fuel oil purifiers.

- 2090 Backflow preventers shall be used in the connections between potable and non-potable systems to prevent contamination from make-up water connections, spigots in machinery spaces, the freshwater expansion tanks, the water mist system, the oily water separators, and fuel oil purifiers. Where suitable, air gaps may be used as an alternative to backflow preventers. Backflow preventers in potable water systems shall be reduced pressure zone type with relief valves drained to the nearest deck drain or bilge.
- 2095

533.4 Hot Potable Water System

- The hot potable water system shall be configured as a continuously circulating hot water loop system so that each service point has access to hot water within 10 seconds. Return loops at each deck shall have balance valves to ensure adequate flow throughout the system. Pressure reducing valves shall be placed in each branch to allow adequate pressure control at each deck. Pressure reducing valves shall be easily accessible and not in overheads, behind ceilings or other joiner bulkheads.
- 2100

- The circulating hot water return and cold water feed to the hot water heaters shall be heated by the hot water heating system of Section 517, through one (1) potable water heat exchanger to minimize electric heating requirements. The heat exchanger shall be an air gap plate type sized for a minimum of 1,534,000 BTU/hr (450 kW) of heat transfer and shall be of stainless steel construction, double wall with leak detection and shall be intended for use in drinking water systems. A thermostatically operated valve shall provide bypass around the heat exchanger as necessary to maintain 125°F at the electric hot water tank heaters.
- 2105

- For periods when adequate waste heat is not available to heat the potable water, two (2) 250-gallon electric hot water heaters shall be provided, installed and set to supply water at 125°F at fixtures on all decks. Each electric hot water heater shall have a 225 kW modulating heating element or three staged heating elements totaling a minimum of 225 kW, sized for a temperature change of 85°F (40°F to 125°F). Together the two tank heaters shall be sized for the peak system demand heat and shall maintain a 1-hour peak demand capacity.
- 2110
- 2115

- The hot potable water system branches and loops shall be configured with isolation valves for system maintenance and repair. The system shall be subdivided by deck and amidships at the MVZ, with isolation of each forward and aft deck header possible for maintenance, without disrupting service to the other headers. Additional isolation valves shall be installed to provide the ability to secure and service small groups of fixtures without taking the entire system offline. Temperature gauges shall be supplied in the header for each deck or level.
- 2120

The system shall serve showers, sinks, lavatories, and galley equipment. Each plumbing fixture shall be fitted with cutout valves in the supply lines so that water service may be secured at the fixture for maintenance, repair, or replacement of the fixture.

533.5 Water Wash Stations

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Exterior hose bibs shall be supplied from the cold water supply headers throughout the vessel. Hose bibs for washdown shall be located in order for all open deck/machinery to be reached with a single 50' hose.

- Exterior hose bibs shall be of the frost-free type and shall be fitted with an isolation valve and drain for freeze protection.
- 2130

Eye wash stations shall be provided in all areas where hazardous chemicals may be present. At a minimum an eye wash station shall be provided in the Workshop, FMR, AMR, and MSD space. Type and location of eye wash stations shall be approved by the Resident Engineer prior to installation.

2135 **533.6 Humidification**

Each AHU described in Section 512 shall have potable water provided to the water mist units for air humidification. The water mist units shall be supplied from the cold water supply headers through a backflow preventer in each fan room.

533.7 Cleaning and Disinfecting

2140 All tanks, piping, fixtures, pumps, etc., through which potable water can flow, or is stored, shall be cleaned and disinfected in accordance with WHO, *Guide to Ship Sanitation*.

Potable water treatment of storage tanks shall occur based on WHO, *Guide to Ship Sanitation* and *Guidelines for Drinking-water Quality*. Dosing for water treatment shall be done through tank manholes as necessary.

2145 **534 TRIM AND BALLAST SYSTEM**

534.1 Water Storage and Transfer

2150 A locked in freshwater ballast system shall be provided as shown on Reference 534-01. Ballast tanks shall be configured for fixed freshwater filling and be positioned for use in trim and heel adjustments of the vessel. Freshwater filling/discharge shall be via a shore connection located port and starboard of the vessel.

The ballast piping system shall be arranged to permit transferring of ballast from any ballast tank to any other ballast tank by the ballast pumps. The suction and discharge valves shall be arranged in manifolds.

2155 Two (2) identical ballast pumps shall be provided for the system. Each pump shall be a self-priming centrifugal-type, and each be sized based on bilge pump sizing regulations. The pumps shall be identical to the bilge pumps. Each pump shall be rated in accordance with Reference 534-01 and be positioned in the AMR.

2160 In addition to serving the trim and ballast system, the ballast pumps shall be configured to serve as the third and fourth bilge pumps. A crossover shall be provided to the bilge system and a dedicated overboard provided.

A locked closed suction from the forward sea chest crossover in the AMR shall be provided for both pumps and function for emergency list/trim modifications.

To meet the regulations in ABS Section 4-4-1/9.11.1, the forepeak ballast tank penetration shall be fitted with a butterfly valve with a reach rod to the Main Deck.

2165 **534.2 Trim Adjustments**

The ballast system shall have both local and remote control, and monitoring via IMACS in the EOS. Remote-controlled valves shall be arranged so they will close and remain closed upon loss of control power, or will remain in their last position and are provided with a readily accessible

2170 manual means of operation in case of loss of power to the valve control system. Remote control of ballast valves shall be clearly marked in the EOS and means shall be provided to indicate whether the valve is open or closed.

540 FUELS AND LUBRICANTS, HANDLING AND STORAGE

541 FUEL OIL SYSTEMS

541.1 General

2175 Fuel oil systems shall be designed for transferring and processing ASTM D975 Grade 2-D, ISO 8217 F-DMA, and DFM (NATO Code F-76) diesel oil. The fuel oil systems shall be provided and installed as shown on Reference 541-01. Built-in containment coamings shall be provided for all oil equipment foundations. In addition, drip pans shall be permanently installed beneath such items as strainers and filters.

2180 See Technical Specification Section 431 for IMACS interfaces with fuel and lubricant systems.

541.2 Tanks

2185 Valves used for storage and day tanks which are subjected to a static head of fuel shall be constructed of materials that are not rendered ineffective by heat and shall pass a recognized fire test acceptable to ABS and be certified USCG positive shut-off. Valves required to be operable locally and outside the space shall have remote hydraulic operators as a secondary means of closure. All hydraulic actuators shall be led to a single control station cabinet outside the space.

541.2.1 Storage Tanks

2190 The fuel oil storage tanks shall be sized to meet the minimum range requirements of Technical Specification Section 0.2 without exceeding the 95% full level in any tank, with a 10% reserve. The tanks shall be integral with the vessel's structure and shall have a sounding tube, vent/overflow, and TLI with integral alarm settings.

541.2.2 Day Tanks

2195 Four day tanks shall be arranged between the two main machinery spaces. One pair of day tanks shall be cross-connected with a normally closed valve and serve the main engine fuel oil service system. The second pair of day tanks shall be cross-connected with a normally closed valve and serve the auxiliary fuel oil service system.

2200 The day tank segregation is necessary due to the varying requirements by engine manufacturers. The General Electric main engines require a positive head pressure supplied to the engine while the Caterpillar C18 SSDGs require no fuel to be stored above the fuel injectors. To fulfill these requirements, the main engine day tanks shall be located above the auxiliary day tanks.

Each day tank shall be sized to meet the regulations, with a minimum capacity of 8 hours of operation from tank suction to high level alarm, with a 10% reserve. Main engine day tanks are each sized with both main engines at full load, while auxiliary day tanks are each sized with two SSDGs and the hot water heater at 75% load.

2205 All day tanks shall be integral with the vessel's structure and shall have a sight glass, vent, TLI, and alarm indication with low level at 85% and low-low level alarm at 30%.

2210 The service system shall be arranged to permit the propulsion engines and SSDGs to be supplied by either of the associated day tank pairs. Interlocks shall be provided to ensure fuel supply/return is from the same day tank. Fuel oil service return piping to the day tanks shall terminate high within the tanks in a manner that minimizes fuel aeration.

541.2.3 Settling Tanks

A pair of settling tanks shall be cross-connected and each sized to have a minimum capacity equal to the largest day tank.

2215 Settling tanks shall be integral with the vessel's structure and shall have a sounding tube, vent, overflow, TLI, and alarm indication with low level at 30%, and high level at 95%.

541.2.4 Emergency Diesel Generator Tank

2220 A dedicated fuel tank shall be provided for the EDG. The tank shall be sized to provide fuel to the EDG for a duration of 36 hours with the generator operating at MCR power, including a 10% reserve, without exceeding 95% full level in the tank. ABS regulations permit a 12-hour tank endurance for vessels on short duration voyages but tank size shall be based on 36-hour endurance if at all practicable. The tank shall be integral with the vessel's structure and shall have a sounding tube, vent/overflow, sight glass, low-level alarm with 800 gallons remaining, low-low-level alarm at 10%, and high level alarm at 95%.

541.2.5 Overflow Tank

2225 One fuel oil overflow tank shall be provided. Fuel oil overflow piping shall be in accordance with Section 506. The fuel oil overflow tank shall be integral with the vessel's structure and shall have a sounding tube, vent, TLI, and a level alarm indicating presence of liquid in the tank at 10% full as well as a high-level alarm.

541.2.6 Leak-Off Tank

2230 One fuel oil leak-off tank shall be provided integral to the vessel's structure in the double bottom of the Aft Machinery Room (AMR) to serve both main engines. The fuel oil leak-off tank shall have a sounding tube, vent, TLI, and a high level alarm. Liquid level switches shall be arranged to automatically start the gravity tank pump back to the day tank at 70% and stop at 10% liquid level.

2235 The engine manufacturer has indicated future models of the General Electric 12V250 engines may be provided without a leak-off tank configuration. If the engine does not require this feature, the Contractor shall not install associated pumps and piping for this configuration. The tank currently associated with this function shall be converted to a void and left free of any liquid.

2240 541.3 Fuel Fill and Transfer System

The fuel fill and transfer system shall provide a means to:

1. Purify fuel via the purifier.
2. Strip fuel tanks.
3. Transfer fuel between fuel storage and settling tanks (independent of purifier).
- 2245 4. Fill storage tanks and off-load fuel to shore.

5. Transfer fuel from storage tanks to settling tank via transfer pump.
6. Continuously fill day tanks from the settling tank via the purifier.
7. Fill the EDG tank from the settling tank via the purifier.
8. Provide fuel to the work boat or on deck equipment via fuel transfer from the EDG tank with gas station style dispenser and additional stop valve.

541.4 Transfer Pumps

Transfer operations shall be performed using two (2) identical, positive displacement fuel oil transfer pumps. The pumps shall be gear type pumps and shall be horizontally mounted in the AMR. Each pump shall be sized in accordance with Reference 541-01 and shall be configured for both individual and parallel operation.

The pumps and controls shall be configured to remotely or locally transfer fuel to the fuel oil settling tanks through the IMACS. Selection of the storage tank supplying the settling tanks via the transfer pump(s) shall be manually configured at the fuel transfer manifold.

An emergency stop station shall be provided at both Main Deck fill/discharge stations.

The transfer pump suction piping shall include a simplex basket strainer with 50 mesh perforations per square inch, or greater, for removing contaminants.

541.5 Fueling/Transfer Piping

Fueling/transfer system suction and discharge valves shall be manifolded. The manifold shall be located in the AMR.

Fueling shall be accomplished using shore-side pressure. Line sizes and flow rates shall assume 200 GPM at 40 psig deck pressure. Tanks shall be assumed to be filled in pairs after entering the manifold.

The Main Deck shall have a fill/discharge station port and starboard which shall terminate in a gate valve, and shall include a cam-lock connecting fitting suitable for joining to the fuel facility's hose. Each fill/discharge station shall include a compressed air hose fitting for fueling hose blow-down, a test valve for sampling the fuel and bleeding off pressure after fuel hose blow-down, and a gauge to monitor fuel pressure at the station. Each fill/discharge station shall be located within a containment coaming.

541.6 Purification System

A fuel purification system shall be provided to remove water and dense contaminants from fuel being transferred between the settling tanks and day tanks. The system shall incorporate two (2) fuel oil purifiers that can be aligned to take suction directly from their respective settling tank or from the fuel transfer manifold.

Purification shall have an auto recirculation/transfer. The system has been designed to continuously circulate fuel oil to the fuel oil day tanks using the purifying units. Each purifier will take suction from one of the settling tanks and discharge to the associated main day tank where it will cascade down to the auxiliary day tank then back to the settling tank.

Each purifier shall be a belt-driven self-cleaning separator including a gravity disc for the manual adjustment of the water/oil interface and be an Alfa Laval P605, or equal. Each purifier shall be

2285 sized to provide an output of at least 10 GPM of clean fuel oil. The heavy phase of water and contaminants shall discharge from the purifier to the oily water holding tank. Each purifier shall be furnished with a water seal failure alarm, run indication, and common (summary) alarm with output to IMACS.

2290 Either purifier shall also be capable of filling the EDG day tank by taking suction from their respective settling tank. The purifiers shall be cross-connected on both the suction and discharge sides for redundancy (i.e., either purifier can take suction from either settling tank and discharge to the day tank).

541.7 Fuel Oil Service System

541.7.1 Main Engine Service System

2295 The main engine fuel oil service system shall consist of two day tanks described above, and supply/return piping systems serving the main engines. The service system shall be arranged to permit either main engine to be supplied by either day tank. Fuel oil service return piping to the corresponding day tanks shall terminate high within the tanks in a manner that minimizes fuel aeration.

2300 Two (2) fuel oil return cooler shall be provided, one with each main engine, to prevent the temperature of the day tanks increasing beyond acceptable levels for engine performance. These coolers shall be double wall, air-gap type plate heat exchangers of stainless steel construction and shall be freshwater cooled as described in Section 532. The coolers shall be sized for a minimum heat rejection of 85,000 BTU/hr (25 kW) each.

2305 Small amounts of fuel may be returned from the engine through the gravity leak-off system. See requirements in Section 541.2.6.

The main engine fuel systems and design shall satisfy all the requirements of the diesel engine manufacturer as to pipe size, bends and other restrictions in order to ensure that diesel engine performance and long system component life is not compromised.

541.7.2 Auxiliary Service System

2310 The auxiliary fuel oil service system shall consist of two day tanks described above, and supply/return piping systems serving the SSDG sets and diesel fired water heater. The service system shall be arranged to permit the SSDGs and water heater to be supplied by either day tank. Fuel oil service return piping to the corresponding day tanks shall terminate high within the tanks in a manner that minimizes fuel aeration.

2315 Two (2) fuel oil return coolers, skid mounted, shall be provided, one with each SSDG, to prevent the temperature of the day tanks increasing beyond acceptable levels for proper engine performance. These coolers shall be plate heat exchangers and shall be cooled by the on-engine low temperature cooling circuit.

2320 The SSDG fuel systems and design shall satisfy all the requirements of the manufacturer as to pipe size, bends, and other restrictions in order to ensure that diesel engine performance and long system component life is not compromised.

541.7.3 Emergency Diesel Generator Service System

2325 The fuel oil service system for the EDG shall take suction from the EDG tank. Fuel oil service return piping to the EDG tank shall terminate high within the tank in a manner that minimizes fuel aeration.

The EDG fuel systems and design shall satisfy all the requirements of the diesel engine manufacturer as to pipe size, bends and other restrictions in order to ensure that diesel engine performance and long system component life is not compromised.

2330 541.7.4 Fuel Metering System

2335 A fuel metering system shall be provided to measure the real time fuel consumption by the two SSDGs, the two main engines, and the oil fire hot water heater. The system shall be provided by a single vendor. The system vendor shall advise the Contractor on the proper layout and installation of the system based on design data supplied by the Contractor. A vendor supplied and programmed screen shall be provided in the Pilothouse and the EOS. The information to be displayed by the system shall be provided in the form of mock-up screens and shall be approved by the Resident Engineer before installation.

2340 Flow meters shall be provided in the fuel supply and return for each consumer listed above. The meters shall have a measurement accuracy of $\pm 0.1\%$ of flow or better. The system shall provide real-time fuel consumption rates. The system shall not require subscription to a third party monitoring or data management service in order to access logged fuel consumption data.

The system shall have the following features:

1. Data logging/collection on vessel.
- 2345 2. All recorded sensor data such as gal/hr, gal/nm, gal/kW, total gallons, GPS position, engine data etc.
3. The ability to generate reports showing daily, weekly and monthly fuel consumption.
4. Interactive displays in both the Pilothouse and the EOS.
5. Ability to display data shore side.

2350 The consumption monitoring and the bunkering system shall be tested and commissioned both dockside and during sea trials to ensure that the completed system meets the manufacturer's specifications for accuracy and performance.

541.8 Fuel Oil Overflow Piping

The service and storage tanks shall overflow into the overflow tank(s) as described in Section 506. See Reference 506-01 for overflow pipe routing.

2355 542 LUBRICATING OIL SYSTEMS

542.1 General

2360 The main diesel engines, SSDGs, EDG, bow thrusters, and podded stern thrusters shall have fixed lube oil transfer systems which shall be provided and installed as shown on Reference 542-01. All other machinery shall be filled from portable storage containers. It is intended that the number of different oils used on the vessel be kept to a minimum. Where different lubricating oils are required for smaller machinery, that type of oil shall be stored in portable storage

containers. All machinery requiring lubricating oils shall be supportable using Chevron products. Manufacturer's recommendations for lubricants shall identify the acceptable Chevron product.

- 2365 Built-in containment coamings shall be provided for all oil equipment foundations, with fixed piping to waste oil collection tanks. Drip pans shall be permanently installed beneath such items as strainers and filters.

542.2 Clean Lubricating Oil Storage Tanks

- 2370 Each lube oil storage tank shall be equipped with a ½" quick-closing valve drain connection with cap and chain for draining water and sediment. This drain connection shall act as a portable container fill station with container stand and drip pan, located within a containment coaming.

542.2.1 Main Engine Lube Oil Tank

- 2375 A clean lube oil storage tank shall be provided for the main diesel engine lube oil. The main diesel engine lube oil storage tank shall be structural and shall have a low-level alarm, high-level alarm, sight glass, and level indicator. The tank shall be appropriately sized to store at least the quantity of lube oil necessary for sump make-up and 1 oil change for each main engine. The tank shall be located in the Pump Room of the Hold Level on the forward bulkhead in accordance with Reference 070-01

542.2.2 SSDG and EDG Lube Oil Tank

- 2380 A clean lube oil storage tank shall be provided for the three generator engines' lube oil. The SSDG and EDG engine lube oil storage tank shall be free-standing and shall have a low-level alarm, high-level alarms, sight glass, and level indicator. The tank shall be appropriately sized to store at least the quantity of lube oil necessary for sump make-up and 2 oil changes for each SSDG. The tank shall be mounted in the 1st Platform of the AMR in accordance with Reference 201-02.

- 2385 A separate, independent clean lube oil tank with a minimum capacity of 20 gallons shall be provided in the Emergency Generator Room. The tank shall be mounted high enough on the bulkhead to allow gravity filling of the EDG sump. The intention of this tank is for small amount of make-up oil to be added to the EDG sump. A separate line shall be provided to bypass the tank when an oil change is necessary for the EDG.

542.2.3 Bow Thruster Lube Oil Tank

- 2395 A clean lube oil storage tank shall be provided for the bow thruster lube oil. The bow thruster lube oil storage tank shall be structural and shall have a low-level alarm, high-level alarm, sight glass, and level indicator. The tank shall be appropriately sized to store at least the quantity of lube oil necessary for 2 oil changes for each thruster. The tank shall be located in the Pump Room of the Hold Level on the forward bulkhead in accordance with Reference 070-01.

542.2.4 Stern Propulsor Lube Oil Tank

- 2400 A clean lube oil storage tank shall be provided for the stern propulsors lube oil. The lube oil storage tank shall be structural and shall have a low-level alarm, high-level alarm, sight glass, and level indicator. The tank shall be appropriately sized to store at least the quantity of lube oil necessary for 2 oil changes for each propulsor. The tank shall be located in accordance with Reference 070-01.

542.3 Lubricating Oil Fill and Transfer Systems

The lubricating oil fill and transfer system shall provide the following fill and transfer operations independently for each clean lube oil storage tank (main engine, generator, gear, and thruster):

1. Fill the associated clean lubricating oil storage tank from the Main Deck via a permanently installed piping system.
2. Transfer clean lubricating oil from the storage tank to the associated equipment oil sump(s) via a single dedicated transfer pump.
3. Discharge clean oil to the shore connections.
4. Start/stop button stations shall be located near equipment where frequency of oil change is high. At a minimum this shall include both main engines and both SSDGs.

The Main Deck filling stations for the lubricating oil storage tanks shall be arranged for pressurized filling. The filling stations shall have shutoff valves, pressure gauges, and shall be located within containment coamings.

Each lube oil transfer pump shall be a gear type pump and shall be horizontally mounted. Pumps shall be electric motor-driven and appropriately sized to fill the ME LO sump within 15 minutes and fill the Reduction Gear/Bow Thruster LO Tank or Generator LO Tank within 10 minutes. The main engine lube oil pump, the generator engine lube oil pump, and the reduction gear/bow thruster lube oil pump shall be rated in accordance with Reference 542-01.

Each lube oil transfer pump shall be equipped with a fine-mesh simplex suction strainer with magnets. The simplex strainer basket area shall be generously sized to accommodate the transfer of cold viscous oil.

Valves used for storage and gravity tanks (head tanks), which are subjected to a static head of fuel, shall be constructed of materials that are not rendered ineffective by heat and shall pass a recognized fire test acceptable to ABS and be certified USCG positive shut-off. Valves required to be operable locally and outside the space shall have remote hydraulic operators as a secondary means of closure. All hydraulic actuators shall be led to a single control station cabinet outside the space.

542.4 Lubricating Oil Service Systems

Main generator set engines shall have a self-contained, on-engine lubricating oil system with integral sump, circulating pumps, and require a heat exchanger, using the low temperature jacket water cooling circuit to cool the lube oil. A main engine manufacturer-supplied and shipped-loose lube oil keep-warm heater shall maintain adequate lube oil temperatures for engine startup and act as the pre-lube pump. The keep-warm heater may be integrated with the jacket water keep-warm heater.

The ship service and emergency generator engines shall have self-contained lubricating oil system with integral sump, circulating pumps, pre-lube pumps, coolers, and filters. The system shall be sized and configured in accordance with the engine manufacturer's recommendations.

The EDG shall be provided with a gravity tank to allow easy filling of the EDG sump.

The main and auxiliary generator engine lube oil systems and design shall satisfy all the requirements of the diesel engine manufacturer as to pipe size, bends and other restrictions in order to ensure that diesel engine performance and long life is not compromised.

2445 Each podded stern thruster shall be provided with a lube oil system for integral steering and reduction gear. The lubricating oil system shall consist of an independent lube oil cooling unit with oil lubrication pump, oil header tank, vacuum pump, waste tank, and oil cooler. The lube oil cooler shall be cooled by the auxiliary freshwater cooling system, see Section 532.

2450 Each bow thruster motor shall be provided with a gravity tank for filling which is provided with the bow thruster motor. This shall be mounted high in the space and installed per manufacturer's recommendations. The bow thruster gravity tanks shall be filled using the same pump that serves the reduction gears.

543 WASTE OIL SYSTEM

543.1 General

2455 The waste oil system shall collect and hold the waste oil and sludge from the main engines, generators, thrusters, gears, FO purifier, and various machinery. The system shall be provided and installed as shown on Reference 543-01. The waste oil system shall include a waste oil tank, waste oil pump, and shore connections. Fixed piping shall connect the main equipment oil sumps to the waste oil tank. The waste oil pump shall be capable of taking suction directly from the main equipment lube oil sumps and pump the oil to the waste oil tank.

543.2 Waste Oil Transfer System

The one (1) waste oil pump shall be a positive displacement gear type pump and shall be horizontally mounted. The waste oil pump shall be sized in accordance with Reference 543-01.

2465 The waste oil pump shall be located in the Aft Machinery Room. The pump shall take suction from the bottom of the waste oil tank and pump it up to shore connections on the Main Deck. A shore connection and containment coaming shall be provided on each side, port and starboard, of the vessel. The shore connection shall be fitted with an international discharge connection in accordance with MARPOL regulations. Waste oil shall be pumped ashore for proper disposal at a shore-side facility.

2470 The waste oil piping system shall include crossover lines between the waste oil pumps and oily water transfer pumps suction and discharge lines. The oily water transfer pump shall provide back-up service for the waste oil pump (see Section 594).

543.3 Tank

2475 The waste oil tank shall be fitted with high-level alarm, a sounding tube and remote TLI. The waste oil tank shall also act as the sludge collection tank for the vessel. The waste oil tank shall be fitted with hot water heating coils as described in Section 517. The waste oil tank shall be sized to hold a minimum of 1,000 gallons.

543.4 Coamings and Drip Pans

2480 Coamings and drip pans serving diesel engines and other equipment in machinery spaces, where frequent or continuous accumulations of oily fluids can be expected, shall have gravity drainage piping installed with drains to the waste oil tank. The drain piping between the coamings and the collection tank shall have a check valve and shall be sloped ¼" per foot where possible.

546 HYDRAULIC FLUID SYSTEM

546.1 General

2485 Each stern propulsor and each fin stabilizers shall have a fixed hydraulic oil system which shall be provided and installed as shown on Reference 546-01 and Reference 070-01. All other machinery shall be filled from portable storage containers. It is intended that the number of different oils used on the vessel be kept to a minimum. Where different hydraulic oils are required for smaller machinery, that type of oil shall be stored in portable storage containers.

All deck equipment shall use the same hydraulic oil unless approved by the Resident Engineer.

2490 All hydraulic systems shall be supportable using Chevron products and shall be suitable for operation in Arctic conditions. Manufacturer's recommendations for hydraulic oils shall identify the acceptable Chevron product.

546.2 Clean Hydraulic Oil Storage Tanks

546.2.1 Fin Stabilizer Hydraulic Oil Tank

2495 A clean hydraulic oil storage tank shall be provided for the fin stabilizer system and serve as general oil storage for smaller equipment, assuming oil compatibility. The tank shall be structural and sized at a minimum of 750 gallons. The tank shall have a sight glass and fill connection from the Main Deck above. Oil filling of the fin stabilizer hydraulic power units (HPUs) shall be done through portable pumps or buckets. The tank shall be located in the Pump Room of the Hold Level on the forward bulkhead in accordance with Reference 070-01.

546.3 Fin Stabilizer Hydraulic Power Units

2505 Two (2) dedicated HPUs, port and starboard, shall provide power to the fin stabilizers' hydraulic cylinders and rotary vane actuators. Each HPU shall have main and emergency backup pumps with control valves and filters mounted on a common reservoir. The emergency pumps shall be as small as practical and be sized to retract the fins in an emergency. The HPUs, valves, piping, and cylinders shall be arranged as indicated on Reference 546-01. The HPUs shall be located within each Fin Stabilizer Room and supplied by the fin stabilizer manufacturer.

546.4 Side Door Hydraulic Power Unit

2510 One (1) dedicated HPU shall provide power to actuate hydraulic cylinders for the side doors, hoistway hatch and folding deck sections. The HPU shall have main and backup double pumps with control valves and filters mounted on a common reservoir. The HPU, valves, piping, and cylinders shall be arranged as indicated on Reference 546-02. The HPU shall be located within the Vehicle Elevator Machinery Room and supplied by the vehicle elevator manufacturer.

See Section 575 for more information regarding side door system powering.

2515 546.5 Stern Door Hydraulic Power Unit

One (1) dedicated HPU shall provide power to actuate hydraulic cylinders for the stern door and dogs. The HPU shall consist of a pair of pumps mounted to a common reservoir and supplied by the stern door manufacturer. The HPU, valves, piping, and cylinders shall be arranged as indicated on Reference 546-02.

2520 See Section 573 for more information regarding stern door system powering.

546.6 Watertight Sliding Doors

Sliding watertight doors shall be provided by the door manufacturer with the necessary electro-hydraulic components to perform operations described in Technical Specification Section 167.

550 AIR, GAS, AND MISCELLANEOUS FLUID SYSTEMS

2525 551 COMPRESSED AIR SYSTEMS

551.1 General

2530 A compressed air system shall be provided to supply compressed air for starting the main engines and SSDG engines, supplying the ship service air system, supplying the control air system, and supplying the ship's whistle. The system shall be provided and installed as shown on Reference 551-01.

Air shall be compressed to 250 psig by the two start air compressors, as described in Section 551.3, set up for lead/lag operation. The compressed air shall be stored in four receivers: two starting air receivers, one control air receiver and one whistle air receiver. Moisture separators, cut-out valves, blow down valves, low pressure alarms, and pressure relief valves
2535 shall be installed in the system. All pressure relief valves and blowdown valves located in machinery spaces shall have their exhaust/relief path piped to the bilge.

Measures shall be taken to reduce noise and minimize vibration in the system. For information regarding resilient mounting see Technical Specification Section 1E.11.4.

Built-in containment coamings shall be provided for all compressor foundations.

2540 See Technical Specification Section 431 for IMACS interfaces with the compressed air system.

551.2 Receivers

Two (2) starting air receivers shall be provided and installed. Each receiver shall have a capacity in accordance with Reference 551-01. Total air receiver capacity is based on providing a minimum of 8 main engine starts per ABS Rules.

2545 One (1) control air receiver shall be provided and installed. The receiver shall have a capacity in accordance with Reference 551-01.

One (1) ship's whistle air receiver shall be provided and installed. The receiver shall have a capacity in accordance with 551-01.

All receivers shall be ASME certified and ABS certified Grade II Type B.

2550 551.3 Compressors

Two (2) electric motor-driven, reciprocating air compressors shall be provided and sized in accordance with Reference 551-01 and ABS Rules. The compressors shall have an air intake filter and silencer, an automatic unloader, an automatic start-stop pressure switch, a self-contained lubricating system, a belt guard, and accessories. Automatic lead-lag pressure controls
2555 shall be set for intermittent operation. A manually selectable lead/lag control shall be provided

to allow the operator to select the lead compressor. Both air compressors shall be resiliently mounted to reduce noise and vibration, see Technical Specification Section 1E.11.4.

551.4 Starting Air System

2560 The starting air operating pressure shall not exceed 250 psig. Reducing stations (if required) shall be of the full flow type with manual bypass. Starting air shall be provided for each main propulsion and SSDG engine through high-pressure flexible connections. The starting air system design and installation for each engine shall be in accordance with the requirements of the respective engine manufacturer.

551.5 Ship Service Air System

2565 Ship service air shall be supplied at 120 psig and reduced locally wherever lower pressure supply is required. Starting air receivers shall supply air through a water separator and pressure reducing station to the service air system. Ship service air headers shall run throughout the overhead of machinery spaces and shall supply various on-deck and machinery space quick-disconnect locations with air for pneumatically powered tools. The ship service air system shall
2570 also supply compressed air to the sea chest blowdowns, miscellaneous pumps and equipment, and hydro-pneumatic tanks.

Ship service quick-disconnect locations shall be in accordance with Reference 551-01. At least one of the stations both port and starboard in the Vehicle Space shall be supplied near each fuel oil fill station.

2575 551.6 Control Air System

A compressed air system shall be provided and installed to serve the control air requirements of the vessel including vehicle elevator controls and miscellaneous supplied machinery skids. Ship's service air shall pass through an air dryer and be supplied at 120 psig. The treated air shall accumulate in a dedicated control air receiver.

2580 The air dryer shall be of the desiccant type with a minimum dew point of -20°F, in accordance with outside design conditions of the vessel. A 5-micron filter shall be supplied after the air dryer to ensure clean air.

551.7 Ship's Whistle System

2585 A compressed air system shall be provided and installed to serve the ship's whistle air requirements. Air from the starting air system shall be supplied at 150 psig after passing through a pressure reducing station. The whistle air system shall be designed and installed in accordance with the whistle manufacturer's requirements.

555 FIRE EXTINGUISHING SYSTEMS

2590 All firefighting equipment shall be designed and installed for ease of access, use and maintenance.

555.1 Portable Fire Extinguishers

Approved portable fire extinguishers shall be provided and mounted in accordance with the regulations. Spare charges shall be provided in accordance with the regulations. Each extinguisher shall be equipped with a discharge and recharge instruction plate.

- 2595 The mounting of all portable extinguishers shall comply with required access clearances. Where an extinguisher is recessed into a joiner bulkhead, the recess structure shall not compromise the integrity of the bulkhead. Portable fire extinguishers located in areas accessible to the public shall have approved glass enclosures to discourage tampering. Prior to installation, all portable fire extinguisher locations shall be approved by the Resident Engineer.

2600 555.2 Fixed Fire Extinguishing Systems

Fixed fire extinguishing systems shall be installed to protect the following compartments:

1. Forward Machinery Room.
2. Aft Machinery Room.
3. Emergency Generator Room.

2605 4. Paint Locker.

5. Chemical Locker.

- Each system shall be sized and installed in accordance with the regulatory requirements. The fixed fire extinguishing for all systems may be stored in a common room but each set of cylinders shall be dedicated to the specific space served. Alternatively, individual fire extinguishing systems may be installed for each compartment served in such cases as the
- 2610 Emergency Generator Room, Paint Locker, and Chemical Locker.

- Fire extinguishing agent release to any space shall actuate a siren in the room protected, shall automatically shut down the ventilation fans and the main/generator engines (as appropriate), and shall automatically close all fire dampers, in conjunction with a time delayed discharge.
- 2615 Each compartment shall have individual ventilation shut downs and fire damper actuation through IMACS when the fire extinguishing agent is released. See Technical Specification Section 431 for details.

- All fixed fire extinguishing systems shall utilize 3M™ Novec™ 1230 agent or equal, with the exception of the Galley hood system. Alternate fire extinguishing agents shall have the same or better ozone depleting potential (ODP) and global warming potential (GWP) values as the Novec 1230 and shall result in a breathable mixture in the protected space after deployment.
- 2620

555.3 Galley Hood Protection

- The Galley ventilation hoods over the range shall be equipped with a ABS Rules and SOLAS approved wet chemical fire extinguishing system. This system shall provide protection for all equipment under the hood. The system shall spray an aqueous, potassium-based liquid through spray heads installed under the hood. The system shall have a fusible link pressure release mechanism that operates at 360°F installed under the hood. The system shall also be equipped with a manual operating mechanism for local control of the fire extinguishing agent. Alarms and indication of agent release shall be integrated and shared with the shipboard fire alarm system.
- 2625

2630 The Galley hood protection system shall include shutdowns for ventilation, fire dampers, and galley equipment under the hood.

The system shall be installed in accordance with the manufacturer's recommendations.

555.4 Water Mist System

2635 In addition to the fixed firefighting system protecting the entire machinery spaces, each main engine, SSDG engine, and the oil-fired hot water heater firing box shall be provided with and protected by a dedicated local water mist fire extinguishing system. The water mist system shall be sized and arranged in accordance with the regulations, MSC/Circ. 1387. The water mist systems shall be combined and sized for the most demanding section of protection. Activation of the water mist system shall automatically shut down the engine or oil-fired heater served by that section.

2640 The water mist system shall draw suction from a dedicated water mist system tank located within the MSD Room. The tank shall have a freshwater capacity sufficient for 20 minutes of supply to the largest section. The tank shall be provided with a fill from the potable water system through a backflow preventer.

2645 555.5 Emergency Equipment Lockers

Two emergency squad equipment lockers shall be provided and outfitted in accordance with USCG requirements.

560 SHIP CONTROL SYSTEM

561 STEERING GEAR SYSTEMS

2650 Steering is integral to the podded thrusters. See Technical Specifications Section 249 for details.

563 EXHAUST SYSTEMS

563.1 General

2655 The exhaust system includes the main diesel engine exhaust, SSDG exhaust, oil-fired hot water heater exhaust, EDG exhaust, and the combustion air for all systems. The exhaust system shall be designed and installed in accordance with Reference 563-01.

The system shall be complete with all components necessary for satisfactory operation and performance including piping, silencers, expansion joints, and hanger assemblies.

2660 The exhaust piping shall be arranged and supported so as to safely withstand stresses induced by weight, vessel accelerations, thermal expansion, and engine movement. The exhaust systems shall be resiliently mounted, with mountings and hangers arranged to minimize structure-borne vibration, in accordance with Technical Specification Section 1E.11.4.

Silencers shall be arranged with access to the carbon collectors and drain valves for periodic cleaning, and shall be resiliently mounted on low-frequency isolation mounts as further defined in Technical Specification Section 1E.11.4.

2665 Hangers, anchors, and guides shall be installed to allow for thermal growth in the exhaust piping as well as isolate heat, noise, and vibration from the vessel's structure.

Exhaust piping shall be airtight, with drains provided at the low points of the exhaust piping within the respective machinery space. All exhaust piping runs shall be sloped so that no concentrated volume of liquid can accumulate.

- 2670 With the exception of vendor-supplied engine turbo connections, all exhaust pipe, flexible bellows, and silencer flange connections shall have an ANSI B16.5, 150# bolting pattern.

- 2675 Expansion joints or flexible bellows shall be provided at each exhaust outlet to allow for vibration and thermal deflection. The expansion joints shall be multi-ply bellows, Type 316L stainless steel tube, with liners. Liner diameter shall be sized with calculated deflection of the joint in mind. Liners may be omitted at the engine flange expansion joint if engine vibration is deemed above acceptable limits for a joint with liner. Additional flexible bellows shall be installed per the reference drawing and as needed to provide for thermal expansion of exhaust piping.

- 2680 Engine exhaust systems and design shall satisfy all the requirements of the diesel engine manufacturer as to pipe size, bends and other restrictions, such as turbocharger exhaust flange loading, in order to ensure that diesel engine performance and long life is not compromised.

The penetration of the exhaust piping to weather shall be designed to accommodate the movement of the resiliently mounted piping and shall be configured to prevent rainwater from entering the uptake.

- 2685 Easy access shall be provided for all maintenance, removal, and replacement of expansion joints, valves, gaskets, and hangers without the necessity of hot work.

Weather terminals for exhaust systems shall be located to avoid re-ingestion of any exhaust gases from the ship into any air intakes under all normal operating conditions.

All exhaust piping and insulation shall be kept at least 2" away from all structure.

- 2690 See Technical Specification Section 431 for IMACS interfaces with the exhaust system.

563.2 Main Diesel Engine Exhaust

Each main engine shall have a separate exhaust piping system between the engine exhaust manifold outlet and the top of the stack.

- 2695 Each main engine combustion exhaust system, including the silencer, shall not impose a back pressure greater than 10" water gauge at full load, in accordance with manufacturer recommendations, which shall be verified during Sea Trials.

- 2700 Each main engine shall be fitted with a silencer. The main engine silencers shall be Maxim MSA44-24C1, or equal. The silencers shall be hospital grade, spark arresting, with flanged connections and a drain connection. The exhaust silencer shall not produce a backpressure on the system exceeding 5.0" water gauge.

The diesel engines shall be fitted with a 90° engine exhaust elbow provided by the engine manufacturer.

The main engine aftercooler drain shall be routed to the bilge with a P-trap at the EGR tank outlet. The main engine intercooler drains shall be routed to the bilge.

- 2705 Each main engine exhaust pipe shall be fitted with the manufacturer supplied temperature sensor assembly for interface with the engines' electronic control module. The sensor shall be located near the turbocharger outlet in accordance with the manufacturer's requirements.

563.3 Oil-Fired Hot Water Heater Exhaust

- 2710 The oil-fired hot water heater shall be provided with an independent exhaust piping system between the heater exhaust and the top of the stack. Heater exhaust shall be sized to minimize backpressure and be no smaller than the nominal outlet flange size of the heater.

563.4 Ship Service Diesel Generator Exhaust

Each SSDG shall have a separate exhaust piping system between the engine exhaust manifold outlet and the top of the stack.

- 2715 Each SSDG combustion exhaust system, including the silencer, shall not impose a back pressure greater than 40" water gauge at full load, in accordance with manufacturer recommendations, which shall be verified during Sea Trials.

- 2720 Each SSDG shall be fitted with a silencer. The SSDG silencers shall be Maxim MSA55-10C1, or equal. The silencers shall be super-critical grade, spark arresting, with flanged connections and a drain connection. The exhaust silencer shall not produce a backpressure on the system exceeding 10.0" water gauge.

563.5 Emergency Diesel Generator Exhaust

The EDG shall have a separate exhaust piping system between the engine exhaust manifold outlet and the top of the stack.

- 2725 The EDG combustion exhaust system, including the silencer, shall not impose a back pressure greater than 40" water gauge at full load, in accordance with manufacturer recommendations, which shall be verified during Sea Trials.

- 2730 The EDG shall be fitted with a silencer. The EDG silencer shall be Harco Model 5815CFHI pancake style, or equal. The silencer shall be critical grade, spark arresting, with flanged connections and a drain connection. The exhaust silencer shall not produce a backpressure on the system exceeding 10" water gauge.

563.6 Combustion Air

The combustion air system provides filtered air for combustion to the main diesel engines, SSDGs, EDG, and oil-fired hot water heater.

- 2735 The diesel engine combustion air system for main engines and SSDGs includes the air filters, turbochargers, intercoolers, and aftercoolers which are mounted to the respective diesel engines. All combustion air shall be drawn directly from the machinery space.

- 2740 The EDG shall draw combustion air from within the Emergency Generator Room. A supply and exhaust air louver sufficiently sized to provide full combustion air charging and radiator air circulation per the engine manufacturer's specifications shall be provided. The supply and exhaust louver shall be fitted with a motorized fire damper configured to open upon the EDG receiving the "crank" signal. The fire dampers shall be powered by the EDG starting batteries. Under normal operating conditions, the fire dampers shall be closed. Emergency Generator Room ventilation air details shall be in accordance with Reference 513-01.

2745 **563.7 Crankcase Ventilation**

The crankcase exhaust system for each diesel engine or generator shall be independent and provided with its respective engine or generator. Crankcase exhaust systems shall be in accordance with engine or generator manufacturer's recommendations.

2750 General Electric (GE) shall supply a set of orifices for the main engine crankcase. During commissioning these shall be appropriately installed to achieve the desired crankcase pressure. Crankcase fumes are pulled from the crankcase by a vacuum created by the crankcase ventilation system and exit through the exhaust system with the exhaust gases.

2755 A flexible hose shall be provided by GE for the main engine to connect the coalescer on the engine to the eductor on the stack assembly. Contractor shall install hose and crankcase vent per manufacturer's recommendations.

SSDG and EDG engines shall have on-engine closed crankcase ventilation systems.

563.8 Insulation

All exhaust piping shall be effectively insulated as per Section 508.

2760 Insulation applied to exhaust piping and components located in the engine rooms shall be removable blanket insulation. Segments shall be no greater than 6' long to permit removal for maintenance. An aluminum sheet metal cover shall be installed over lagging in way of access areas where the insulation might become damaged.

All insulation shall be comprised of calcium silicate material designed to protect personnel. The exhaust piping shall have the following minimum thicknesses in way of accessible locations:

- 2765
1. Main engine exhaust: 4".
 2. EDG exhaust: 4".
 3. SSDG exhaust: 4½".
 4. Oil-fired hot water heater: 3".

565 FIN STABILIZERS

2770 Two (2) active fin stabilizers shall be installed to improve the vessel motions. The fins shall be the retractable type so as to not impact docking and port operations. Fins shall fold forward to stow for maximum efficiency. Each fin shall be a high lift flapped type, SKF UHL-S600 or equal, having an area of 109.8 ft² (10.2 m²). Effective wave slope capacity shall be 5.9° at 15 knots with a maximum fin angle of ±18°, as measured from the zero angle of attack position.

2775 Each fin with its supporting box structure and operating mechanisms shall be supplied as a complete functional unit, including but not limited to piping, wiring, and structure. The fin stabilizer system shall be factory tested prior to shipping and ready for welding into the ship structure upon receipt from the vendor.

2780 Each fin shall be provided with an auxiliary powered means to align and stow the fin (when waterborne) in the event of fault or failure of the normal hydraulic or control means.

Primary control of the starting and stopping, extending or retracting, and operating of the fins shall be from a control panel in the Pilothouse. The stabilization command signals to the fins shall be adaptive to ship's speed, and the severity and the frequency of the rolling motions. The

2785 stabilization system shall minimize the roll motion with respect to the apparent vertical, as modified by any long-term heeling that may be present.

The stabilizer fins shall be designed and controlled in a manner that avoids overloads, stalling, or cavitation on the fin surface, with automatic compensation for relative ship and wave motions.

2790 A dedicated two-axis speed log shall be provided as part of the fin stabilizer system, with its sensors tied into the fin stabilizers. The unit shall be capable of simultaneous computations of water and ground speed and shall be provided by the same manufacturer as the fin stabilizer.

568 BOW THRUSTERS

2795 Two (2) transverse tunnel thrusters shall be provided and installed. Thrusters shall have a tunnel diameter of 5'-2" and be installed with propeller positioned as near to centerline as possible without interfering with ship's structure. Each bow thruster shall deliver a minimum thrust of 10.5 long tons force at rated speed.

Each thruster shall be powered by a variable speed electric motor rated for 850 kW at 1500 RPM. Motor voltage shall be 690 VAC fed from the main propulsion switchboard, see Technical Specification Section 322. Bow thruster controls shall be integrated through the EMS, see Technical Specification Section 322. Each motor shall be configured with insulated bearings and shaft grounding brushes. Motor enclosure shall be IP22 or greater and be water cooled from the freshwater cooling system, see Section 532.

2805 The suction and discharge openings of the bow thruster tunnels shall be chamfered to increase thruster efficiency and shall be faired into the hull to reduce resistance at service speed. A protection grid shall be installed over all tunnel openings. The grid shall be comprised of elliptical shaped bars installed in accordance with the thruster manufacturer's recommendations.

Operational controls for the thrusters shall be in accordance with Technical Specification Section 431.

The Contractor shall provide permanent lifting arrangements over each motor and thruster to permit inspection, removal, and maintenance of the tunnel thrusters.

2810 573 CARGO HANDLING

573.1 Stern Door

The stern door shall be equal to the stern door aboard the M/V *Kennicott*, see Walz & Krenzer Inc. Drawing H-WK-814-2.

2815 The stern door shall be watertight, gasketed, and dogged. The stern door shall have a minimum clear opening width of 24' and shall have a minimum clear opening height of 16'. The door shall be of stiffened steel panel construction and delivered complete with frame assemblies and operating gear for dogging/undogging, opening, and closing. Hardware such as pins or rollers shall be Type 316L stainless steel, door dogs shall be bronze.

The stern door with its sealing and dogging system shall be ABS approved for its location.

2820 Each stern door panel shall be opened and closed by a pair of hydraulic lifting cylinders and four dogging cylinders. Hydraulic cylinders shall have stainless steel rods and fittings. All cylinders shall be operated by a common HPU located in the Steering Gear Room. The HPU shall include two electric motor driven hydraulic pumps, a single hydraulic tank, a manual backup hydraulic

2825 pump, filters, and appropriate valving to permit pump selection and control of the doors. The HPU shall be controlled by an on-off switch with an indicator light near the doors. Door opening/closing controls shall be installed adjacent to the pump set controls; the exact location shall be approved by the Resident Engineer.

2830 The stern door shall be capable of opening in less than 2 minutes. Door controls and control boxes shall be watertight. Leads to the control boxes shall enter from the bottom of the box. Door opening/closing sequence shall be operator controlled rather than automatic. Proximity switches with indication in the Pilothouse shall be provided in order to identify when the door is closed and dogged. The design and arrangement of the door control station shall be configured such that one person can safely control the full operation of door opening/closing without moving from the station.

2835 The control station shall have convenient access to the door area and shall have a clear view of the door and the deck area in the immediate vicinity. Communication shall be provided via sound powered telephone within reach of the door control station operating position and the HPU manual backup controls. Simple and clear operating instructions on an etched plate shall be mounted conspicuously adjacent to each control station. A flashing lamp and audible alarm shall be mounted on the ship's structure adjacent to the equipment, providing warning signal whenever the equipment is moving. A Pilothouse panel shall be provided for remote indication of door status.

573.2 Side Doors

2845 Mirrored side doors (Port and stbd) shall fold aft to be nearly flush with the topsides as depicted in Contract Drawing (Reference 169-01) under development.

2850 The side doors shall be watertight, gasketed, and dogged. The side doors shall have a minimum clear opening width of ~24' and shall have a minimum clear opening height of ~20'. The door shall be of stiffened steel panel construction and delivered complete with frame assemblies and operating gear for dogging/undogging, opening, and closing. Hardware such as pins or rollers shall be Type 316L stainless steel, door dogs shall be bronze.

The side doors with its sealing and dogging system shall be ABS approved for its location.

2855 Side doors shall be opened and closed using hydraulic cylinders, for rotation, lifting dogging.. Hydraulic cylinders shall have stainless steel rods and fittings. All cylinders shall be operated by a common HPU. The HPU shall include two electric motor driven hydraulic pumps, a single hydraulic tank, a manual backup hydraulic pump, filters, and appropriate valving to permit pump selection and control of the doors. The HPU shall be controlled by an on-off switch with an indicator light near the doors

2860 The side door shall be capable of opening in less than 2 minutes. Door opening/closing sequence shall be operator controlled rather than automatic. Proximity switches with indication in the Pilothouse shall be provided in order to identify when the door is closed and dogged. The design and arrangement of the door control station shall be configured such that one person can safely control the full operation of door opening/closing without moving from the control station.

Subsequent revisions of this document will add more details.

573.3 Lifting Gear

2865 In addition to special lifting guides, jacks, and supports furnished by manufacturers of machinery plant components, lifting gear shall be furnished to service, remove, and overhaul machinery components and piping systems.

2870 Padeyes, lifting points and trolley beams shall be installed in the overhead of the machinery spaces to facilitate future removal and maintenance of major machinery items. Machinery layout shall be such as to allow an unobstructed path for removal of major machinery items in accordance with Technical Specification Section 1E.8.4.

2875 An overhead rail and trolley system shall be provided in the FMR and Aft Machinery Room with rails over each engine cylinder bank and turbocharger. Each rail and trolley system shall be designed to lift and transport each turbocharger and cylinder bank components and be interconnected with curved sections and switches to accommodate the use of the same trolley in the respective machinery room. The FMR rail shall lead aft into the Workshop and utilize bolted plate access opening in the Main Deck and/or bulkheads in the respective machinery spaces. Each rail and trolley system shall have rail stops, and latch for stowage of the hoist(s) at an unobtrusive location. Suitable means shall be provided to expediently remove any interferences in way of the trolley's path.

2880 A minimum size W8x13 trolley beam supported from the overhead at intervals of 10' or less shall be provided for the trolley. At least one chain hoist shall be provided on the rail system of each machinery space, Harrington NTH-020 or equal 22ton capacity chain hoist - push trolley with a 120 standard 10' capacity.

2885 Individual lifting appliances shall be load tested and the allowable load stamped on the appliance.

574 PASSENGER BOARDING LADDER SYSTEMS

2890 The passenger boarding ladders shall enable passengers to access the vessel, independent of the vehicle elevator, from piers at all tidal ranges. Given the large variation in piers serviced by the vessel and the large range of tide elevations in Alaska, the vessel's passenger boarding ladder design requirements are very challenging.

2895 The Contractor shall provide and install two mirror-image but otherwise identical passenger boarding ladder systems in accordance with this section. The passenger boarding ladders shall be arranged for efficient handling and safe operation and deployment, to the satisfaction of the Resident Engineer. The passenger boarding ladder shall be fully functional at any of three passenger decks on the vessel, be capable of rapid deployment and rapid adjustment for tide changes, and be capable of safely embarking and disembarking passengers throughout the operating range.

574.1 Design Requirements

2900 A notional boarding ladder design that meets the Resident Engineer's requirements is described below. With some differences in dimensions and details, the boarding ladder shall be similar in function and construction to system currently installed on the M/V *Kennicott*.

The boarding ladder has three modes of operation:

1. Positioning/Dynamic – Carriage travel between decks.

- 2905 2. Deployed/Static – Passenger and crew carrying operations.
3. Stowed – Ladder system is secured.

This system consists of an aluminum nesting telescopic accommodation ladder, lift beams, a carriage assembly, and guide posts as shown in Figure 500 - 1. The system stows vertically, can be deployed athwartships at any passenger deck, and automatically adjusts accommodation ladder length in relation to angle of accommodation ladder.

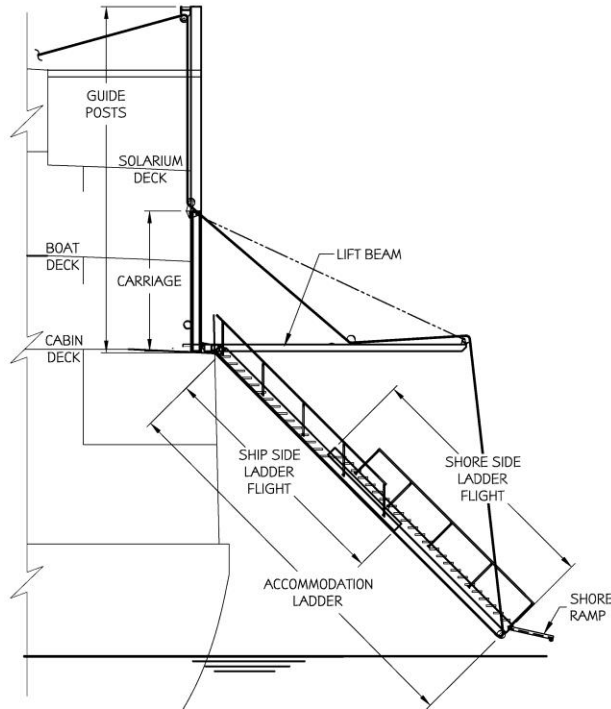


Figure 500 - 1 Boarding ladder design

The Resident Engineer requires that the Contractor partner with a boarding ladder vendor for design and fabrication. A Contract Drawing (Reference 179-01) was created to facilitate this process. See Section 574.1.5 for more information. It is the Contractor's responsibility to team with a vendor and revise the Contract Drawings to include actual components and new design calculations, and to submit the new drawing for approval.

Boarding ladder vendor and associated accommodation ladder and hoisting equipment shall have a proven successful history of at least five years in similar marine operation. The Contractor shall design and fabricate the boarding ladder system with as much stock components as possible.

574.2 Load Requirements

When deployed, passenger boarding ladder systems shall be capable of withstanding $\pm 1.0^\circ$ of roll motion (7.5" over 35'), $\pm 6"$ of heave motion, and $\pm 6"$ of surge motion.

Accommodation ladders shall have a load capacity of 165 pounds in the center of each step when the ladder is horizontal. Each ladder segment shall be tested individually, and the combined ladder shall be tested. The lift beam, carriage assembly, and guideposts shall be designed to support the accommodation ladder design loads.

2930 The FS for all passenger boarding ladder system structures shall comply with ISO 5488. At a minimum, steel structure shall have a FS of 2 to the yield of steel, and aluminum structure shall have a FS of 2 to the 0.2% proof stress of aluminum.

All wire ropes shall have a FS of 5 to the expected forces.

The SWL of sheaves, fairleads, shackles, and wire rope terminals shall be equal or greater than breaking strength of wire.

2935 Structural deflections for guide posts in way of the carriage shall be less than length/360 in any direction.

Structural deflections for the aluminum accommodation ladder shall be less than length/75 in any direction, per ISO 5488.

2940 When stowed, no part of the boarding ladder may exceed 10'-0" above the Solarium House Top. Therefore, the accommodation ladder shall be comprised of two nested (telescoping) parts: the ship-side flight and the shore-side flight. The two flights shall overlap each other by a minimum of 10', unless design calculations permit otherwise.

2945 Ladder treads shall be slip resistant and have a clear width of 24". Collapsible handrails with 4" course spacing shall be provided along the entire length of the accommodation ladder and handrails shall be clear of the 24" width.

574.3 Functional Requirements

2950 The boarding ladder shall be capable of being deployed from the Cabin Deck, Boat Deck, and Solarium Deck. The boarding ladder shall be capable of being raised from horizontal to vertical (90° above horizontal) to reach stowage position. Given the heights of the ports of call, the extreme tidal ranges, and the maximum ladder slope limitation, the geometric height limitations of the ladder during operation are:

1. High Tide - Reach the dock surface 26'-6" below Cabin Deck.
2. Low Tide - Reach the dock surface 7'-5" below the Solarium Deck.
3. Athwartship extension beyond guard of no more than 38'-7" during passenger operations.
- 2955 4. Maximum normal operating slope of 40° below horizontal during passenger operations.
5. The absolute range of the boarding ladder slope shall be between 45° below horizontal and 90° above horizontal.

2960 Boarding ladders shall deploy athwartships. During deployment, accommodation ladder stair treads shall remain horizontal at all times. Shore end of accommodation ladder shall be supported by the deployment wires and shall not touch the dock. A small hinged shore ramp, located outboard of the shore end of the accommodation ladder, may touch the dock. The ship-side flight of the accommodation ladder shall be secured to the lower end of the carriage assembly.

2965 Carriage hoist winches and accommodation ladder deployment winches shall be mounted on the Solarium House Top, not on the carriage assembly. Mounting the accommodation ladder deployment winches on the Solarium House Top requires the deployment wires be reeved to allow deployment of the accommodation ladder at all three passenger decks.

No electrical wires or sensors shall be mounted on the carriage or accommodation ladder.

Gaps where items can fall through the boarding ladder shall be not more than 1" wide.

2970 **574.4 Control and Operating Requirements**

The boarding ladder is required to operate in remote and harsh arctic climates. Accordingly, the design of the boarding ladders must allow for a high level of reliability in icing, low temperatures, saltwater, heavy precipitation, and high winds.

2975 In positioning mode (no passengers or crew), when the carriage travels between decks, the carriage and accommodation ladder shall not drop if a single cable fails. The carriage hoist winches shall not be capable of back driving. A backup means of operating all hoisting and lashing systems is required so that the accommodation ladder can be stowed in the event of failure. During a failure mode, it is acceptable that the passenger boarding ladder operate more slowly than normal. Emergency backup systems and processes shall be provided so that

2980 accommodation ladder can be raised and stowed and the carriage lowered to the Cabin Deck after any failure. Both carriage lifting and accommodation ladder deployment shall be manually controlled.

The boarding ladder carries passengers and crew only in the deployed/static mode when it is not moving. Therefore, the boarding ladder does not need to be designed to meet elevator code. .

2985 The accommodation ladder shall be fully redundant in cases of passenger load. 'Fully redundant' means that failure of any one component will not result in a failure of boarding ladder operation or harm to any persons.

In stowed mode the accommodation ladder, lift beam, and carriage shall be securely stowed to prevent movement of passenger boarding ladder system components.

2990 The passenger boarding ladder system shall be surrounded by a railing or wire mesh system at each deck that shall keep passengers from touching moving components. Each railing or wire mesh system shall be provided with a locking gate. All gate locks shall be monitored by the alarm/control system and shall be provided with a "deck gate" group alarm.

2995 Passenger boarding ladder shall be manually controlled by a trained operator. The operator shall control the ladder with control and alarm panels located at waist level at each of the three decks: Cabin Deck, Boat Deck, and Solarium Deck. The operator must be able to see the critical areas above and below carriage operation at all times. Operating stations shall be provided a direct view of the carriage and accommodation ladder at all three deck levels through the use of deck grating instead of deck plate.

3000 The carriage shall be hoisted at two speeds: high and low. High speed shall approximately equal travel from deck to deck (9') in 60 seconds, low speed shall be half of high speed. Carriage hoisting to each deck shall be manually controlled using visual observation of the operator. The carriage shall be provided with a carriage over-travel sensor for upward travel above the Solarium Deck and shall be provided with a Cabin Deck stop sensor to avoid over-travel in the

3005 downward direction due to a sensor failure.

The carriage shall remain supported on its hoisting wires during operation. However, in order to establish a redundant level of safety when the carriage is stopped at a deck position, the system shall be provided with a manually deployed, loose fit, shear pin "carriage lock" to keep the carriage from dropping more than a few inches in the event of failure of both hoisting cables or

3010 the hoisting winch. Loose fit means that the safety pin does not carry any weight and can be deployed over a 3" range in carriage height. The system shall sense and indicate when the manual "carriage lock" is engaged at each deck position.

3015 No passenger boarding ladder operation may occur in the presence of a “deck gate” group alarm or “carriage lock” alarms. Accommodation ladder shall only be capable of being lowered below horizontal when the carriage has a “carriage lock” engaged. Alarm systems shall be fitted with a locked alarm override feature. Once activated the alarm override system shall allow low speed operation of the boarding ladder irrespective of the presence of alarm conditions.

3020 The accommodation ladder shall be raised from the horizontal position to the vertical (upright) secured position only when both ladder flights have been collapsed (accommodation ladder length minimized) and a deck lock engaged. Accommodation ladder and lift beams shall be hoisted at two speeds: high and low. High speed shall approximately equal the speed required to travel from the horizontal position to the vertical (upright) position in approximately 60 seconds, low speed shall be half of high speed. The accommodation ladder shall be provided with an over-travel sensor for upward travel past the upright position and shall be provided with an over-travel sensor for downward travel past the accommodation ladder low travel limit. Since
3025 electronics are not allowed on the carriage, the accommodation ladder over-travel sensors shall be integrated into strain gauges located at the bitter end of each accommodation ladder hoisting cable.

3030 The accommodation ladder shall stow vertically in carriage assembly and be locked in place while the vessel is at sea. Carriage assembly shall stow in the lowest position (Cabin Deck) and shall be locked in place while the vessel is at sea.

3035 Accommodation ladder telescoping shall be interlocked with lowering of accommodation ladder. Telescoping of the accommodation ladder shall automatically occur when the accommodation ladder is lowered below horizontal. Telescoping of the accommodation ladder shall be mechanically controlled by the same mechanism as the deployment.

All electronic components shall have full watertight ratings. The number of sensors and switches shall be minimized. The number of moving parts in the passenger boarding ladder system shall be minimized.

575 VEHICLE ELEVATOR AND TURNTABLE SYSTEMS

3040 The vehicle elevator and turntable systems are critical to the ship carrying out its mission. They enable vehicles to load and unload from piers at various tidal ranges. The vehicle elevator shares a hoistable platform that forms a turntable when at the Main Deck. The turntable aligns vehicles, including large RVs and tractor trailer combinations, with the appropriate lanes on the Vehicle
3045 Deck. Hoistable and articulating transfer ramps, provide a road surface for vehicles to transit between the elevator platform and the pier. Reliability and ease of maintenance are of upmost importance to assure the ship meets its mission requirements.

575.1 Codes and Certification

All applicable codes and standards shall be followed in the design, installations, operation, and maintenance of these systems, including:

- 3050
1. ABS Guide for Certification of Lifting Appliances
 2. ASME A17.1 - Safety Code for Elevators & Escalators.
 3. ASME A17.2 - Guide for Inspection of Elevators, Escalators & Moving Walks.
 4. ASME A17.5 - Elevator & Escalator Electrical Equipment.

5. ASME A17.7 - Performance-Based Safety Code for Elevators & Escalators.
6. AWS D.1.1 - Structural Welding Code – Steel.
7. OSHA Safety Regulations.
8. CFR Title 46 – Shipping.
9. ABS Rules for Building and Classing Steel Vessels, Part 3 Chapter 2 Section 16.

Equipment and components that fall outside the scope of Codes 1 through 4 shall be designed to an equivalent level of safety in accordance with ASME A17.7.

The vehicle elevator shall meet the certification and regulatory approval requirements of ABS and USCG. The Contractor shall employ the services of a third party reviewing agency (Reviewer) on behalf of the Owner and at the Contractor's sole expense. The Reviewer shall have competency recognized by the U.S. Coast Guard under 46 U.S.C. 3116 and shall be approved by the Owner. The Reviewer shall perform engineering reviews, make inspections, and witness tests as necessary to ensure design and construction is in compliance with the Specification and applicable codes. When the elevator is complete, fully inspected, and successfully tested, before sea trials, the Reviewer shall provide a certificate to the Owner that confirms the elevator and turntable systems meet applicable codes and the Specification. A placard containing a true copy of the certificate shall be affixed to the elevator platform before sea trials. The Contractor shall maintain the certificate in force from the start of sea trials through the end of the vessel's Correction Period. See General Conditions §14.6 for details regarding Correction Period. The Reviewer shall be capable of providing maintenance of certificate services to the Owner, at the Owner's expense, following expiration of the Correction Period. ABS Consulting is capable of serving as the Reviewer.

575.2 Elevator Requirements

The elevator shall be certified as a freight elevator that can also carry passengers subject to the limitations shown in Tables 500 - 5 through 500 - 7. Additional requirements for the platform, turntable, turntable drive system, hoist system, ramps and controls are listed in the appropriate sections that follow.

Table 500 - 5 Elevator design requirements

Parameter:	Value	Units	Notes
Payload:	80,000	lbs	
Live load at platform corner:	30,000	lbs	
Platform lift height, operational limit:	34.0	ft	above Main Deck
Platform lift height, physical limit:	≥ 35.0	ft	above Main Deck
Platform speed	50	ft/min	
Turntable speed	1.5	RPM	0.157 rad/sec
Platform acceleration (maximum):	1.6	ft/sec ²	
Turntable acceleration (maximum):	0.15	rad/sec ²	
Roadway/ramp clear width:	17.0	ft	
Roadway load bearing length, single center lane:	48.0	ft	for trucks & vans
Roadway load bearing length, two parallel lanes:	46.2	ft	for automobiles

Parameter:	Value	Units	Notes
Roadway overhead clearance:	16.0	ft	
Platform clearance circle diameter:	55.9	ft	
Ramp length (side door height)	18.5	ft	
Tare weight of platform plus carriers:	100,000	lbs	

Table 500 - 6 Platform and ramp design vehicle particulars

Parameter:	Value	Units	Notes
Length:	53.0	ft	
Width:	8.5	ft	without mirrors
Height:	16.0	ft	
Truck wheel track:	6.0	ft	
Maximum axle load, dual wheels:	20,000	lbs	
Maximum axle load, single wheels:	12,000	lbs	
Maximum wheelbase:	46.25	ft	
Minimum axle spacing in tandem axle:	4.0	ft	
Minimum distance, axle to bumper:	3.375	ft	for 53 foot length
Maximum load on landing gear, per pad:	20,000	lbs	
Landing gear pad size:	14 x 14.5	in	length x width
Truck tire ground pressure:	100	psi	
Minimum ground clearance	5.50	in	
Wheelbase at minimum ground clearance	120.0	in	24 inch dia. tires
Approach angle, minimum	13.7	degrees	24 inch dia. tires
Departure angle, minimum	23.0	degrees	24 inch dia. tires

Table 500 - 7 Elevator rating conditions

Cargo:	Payload Rating	Units	Conditions
Unrestricted freight and vehicles not containing passengers	80,000	lbs	1 or 2 crew plus maximum 1 operator per vehicle
Vehicles containing passengers	64,000	lbs	1 or 2 crew plus 1 operator per vehicle plus 90 total passengers
Pedestrians inside gated enclosure plus baggage secured on platform	64,000	lbs	1 or 2 crew plus 34 passengers

The vehicle elevator and turntable systems shall in general be arranged as shown in Reference 575-01. This drawing shows proof of concept for the elevator arrangement described herein. A design verification shall be performed during which the Contractor shall take ownership of all engineering and design aspects. The Contractor shall be responsible for independently developing all supporting engineering, finalizing design details and obtaining regulatory approval and certification.

3085

3090 The vehicle elevator and turntable systems shall be capable of achieving a loading/unloading cycle time of 3 minutes or less.

3095 The vehicle elevator and turntable systems shall be designed to be operational and out-of-service within the vessel conditions listed in Table 500 - 8. Within the operational condition range, the elevator shall meet all specified design requirements at maximum rated capacity. Within the out-of-service condition range, the vehicle elevator shall remain undamaged. The elevator shall survive the out-of-service condition with the platform lashed to the Main Deck (loaded) and locked in the storage position in the overhead (unloaded).

Table 500 - 8 Vehicle elevator operation and out-of-service vessel conditions

	Operational	Out-of-Service	Notes
Roll	$\pm 1^{\circ}$	$\pm 30^{\circ}$	at 12 second period
Pitch	$\pm 0.5^{\circ}$	$\pm 10^{\circ}$	at 9 second period
Permanent List	$\pm 7^{\circ}$	$\pm 15^{\circ}$	
Permanent Trim	$\pm 1^{\circ}$	$\pm 5^{\circ}$	
Exterior Ice Accumulation	1.3" on horizontal surfaces & 0.65" on vertical surfaces	1.3" on horizontal surfaces & 0.65" on vertical surfaces	Per 46 CFR 28.550(b)(1) & (2)

3100 All major components that require shipyard facilities and/or manufacturer's assistance to repair shall be designed for a minimum life of 30 years. Components that can be repaired by the ship's crew without taking the elevator out of service shall be designed for a minimum service life of 5 years and be readily accessible for inspection and replacement. Calculations establishing the service life of all wearing components shall be prepared for the Resident Engineer's review and approval prior to plan review. Calculations shall assume the following number of annual operating cycles for the payloads listed in 500 - 9 below. A cycle assumes one complete round trip from the Main Deck up to pier level and back (rotation of the turntable 90°, platform up 34 feet, platform down 34 feet, and rotation of the turntable 90°).

Table 500 - 9 Elevator annual operating cycles

Platform Payload	No. of Cycles	Load Per Screw
Empty	8,200	25,000 lbs
40,000 lbs	3,000	35,000 lbs
80,000 lbs	5,200	45,000 lbs

575.3 Safety Requirements

3110 The following will be required as a minimum for safety:

1. Safety factors for strength of materials in accordance with the applicable codes.
2. Accessibility for emergency evacuation of passengers from any height of the platform within the hoistway.
3. Barriers at each end of the platform to restrain vehicles from accidental movement over the ends.

3115

- 3120
4. Brakes to prevent the platform from dropping suddenly in the event of power failure or any other cause of accidental lowering.
5. Sensors that halt any unsafe operation of the elevator system, i.e., lowering when personnel or obstructions are present on the Main Deck in the path of the platform, carriers, turntable or ramps.
6. The ability for operators to have unobstructed vision of the Main Deck where the platform operates and rotates.
- 3125
7. Gaps where items can fall through the roadway, such as between end flaps or between the carrier and transfer ramp, shall be not more than 1" wide. Steps in the road surface, such as at the interface of the platform and the carriers, shall be not more than 1/2" high. Height of ends of flaps above the deck or dock surface on which they rest shall be not more than 1-1/2".

575.4 General Requirements

3130 The Buy America requirements of Section 5.9 of the Contract General Conditions apply to the vehicle elevator and turntable systems.

3135 Except as noted, ordinary strength structural steel used for elevator applications covered by ASME A17.1 and ASME A17.7 shall be ASTM A36. Except as noted, ordinary strength structural steel used for non-elevator applications shall be ABS Grade E. Steel that can certified as both ASTM A36 and ABS Grade E is acceptable in all applications requiring ordinary strength steel and shall be used for elevator applications located outside the heated boundaries of the vessel.

Electrical installation of the vehicle elevator and turntable systems shall meet the requirements of Sections 302, 303, 304, 305, and 320. If there is a conflict between the electrical requirements of this Section 575 and other sections, Section 575 shall prevail.

3140 The vehicle elevator and turntable systems shall be painted in accordance with Section 631. Everything on or above the Main Deck shall be painted according to the schedule for the exterior. Everything below the Main Deck shall be painted according to the schedule for the interior. The top of the hoistway hatch is not intended to be a normal walking surface and may be painted without any non-skid treatment although the Contractor may elect to use non-skid at his

3145 own expense.

3150 The Contractor shall monitor the weight and center of gravity of the vehicle elevator and turntable systems as the design and construction progresses. Computed weights and centers of gravity compatible with the vessel weight control plan described in Section 1A.11 shall be provided in a timely manner to the Resident Engineer and the weight control coordinator identified in Section 1A.11. At the time of installation aboard the vessel, actual, measured weights and installed centers of gravity of components and assemblies shall be provided to the Resident Engineer and the weight control coordinator.

3155 Equipment requiring lubrication at intervals of one month or less shall be fitted with automatic lubrication systems. Equipment requiring lubrication at intervals of more than one month shall be arranged for manual lubrication from locations that are readily accessible on the Cabin Deck,

Main Deck, or the First Platform without climbing any vertical ladders. Pressure grease fittings shall be monel metal.

3160 Machinery requiring lubricating oils, hydraulic oils, or greases shall be supportable using Chevron products. Manufacturer's recommendations for lubricants shall identify the acceptable Chevron product.

575.5 Arrangement

3165 Reference 201-05 shows the arrangement of the elevator machinery room. Reference 575-01 shows the vehicle elevator arrangement. The elevator consists of a platform that forms a turntable when lowered to the Main Deck. A control station for turntable operation is located on the Main Deck adjacent to the fore port kingpost. A friction drive system recessed below the Main Deck rotates the platform using four wheels that project above the main deck to bear against the bottom of the lowered platform. A screw column hoist system with four ball screws lifts the platform by way of carriers on each side of the vessel. The carriers travel in unison vertically, guided by tracks built into the kingposts at the corners of the hoistway. Each carrier is supported by two ball screws, one in each kingpost on the same side of the vessel. A thrust bearing at the top of each screw transfers elevator load into the top of the kingpost. Ball screws are driven by a system of shafting and gears in a large "H" pattern lying flat below the main deck. At the ends of the stems of the "H" are bevel reduction gears with horizontal input shafts and vertical output shafts. At the junctions of the bar with the stems are bevel dividing gears, and forming extensions of the bar are variable speed electric motors, one on each side. Between the bevel dividing gears and the bevel reduction gears are centrifugal brakes to limit descent speed in the event of control failure. A load holding disk brake with emergency stop capability is mounted along with a torque meter on each vertical shaft connecting a bevel reduction gear output to a ball screw. An operator control station for elevator operation is located on centerline on the Cabin Deck aft of the hoistway.

3185 Reference 169-01 in conjunction with Reference 575-01 shows the side door arrangement. The side doors function as transfer ramps when raised and deployed. Ramp carriers travel up and down on tracks within the kingposts while supporting the hinged end of the ramp. The carriers that normally support the elevator platform also lift the ramps. Winches located in the elevator machinery room deploy and retrieve the ramp from the pier by way of two 2-part tackles per ramp. The dead ends of ramp tackles are fitted with gas springs to maintain tension without winch operation while allowing some relative movement between the ship and the pier. Ramp operation including vertical adjustment, folding, and securing is controlled from the same control cab as the elevator.

3190 Reference 168-01 shows the hoistway hatch and hinged decks. The hatch with its end flaps closes off the opening in the Cabin Deck inboard of the kingposts through which the elevator platform travels. The hinged deck sections close off the opening in the Cabin Deck outboard of the kingposts through which the transfer ramp travels. The hinged decks are only used on one side at a time so that the other side can be used for access to the aftermost section of the Cabin Deck when the elevator is in operation. Operation of the hoistway hatch and the hinged decks is controlled from a pair of operating stations port and starboard on the Cabin Deck forward of the hoistway.

575.6 Elevator Platform

3200 The elevator platform consists of a roadway between two side girders that span between corner
lifting points. The roadway shall have a clear width sufficient for two parallel lanes of
lightweight and short vehicles. Long vehicles or heavy vehicles shall be loaded in a single,
center lane that straddles the two parallel lanes. Platform dimensions shall produce lane lengths
and clear width as defined in Table 500 - 6 and shall allow carriage of vehicles with
3205 characteristics described in Table 500 - 7. Vehicle length greater than load bearing roadway
length shall be accommodated by allowing vehicles to overhang the hinged end flaps on the
platform. The elevator shall be designed to accommodate 53-foot trailers with tractors
disconnected or 40-foot trailers with tractors provided the overall rig length does not exceed 53
feet.

3210 Swinging gates shall enclose a diamond-shaped passenger area in the middle of the platform for
containing passengers in a safe location when the platform is being hoisted and rotated. The
crew will operate the gates manually. Telescoping, sheet metal barriers shall be located on the
side girders of the platform to act as reach barriers between the passenger area and ship's
structure. The top of the barriers in the raised position shall be a minimum of seven feet above
the roadway and in the lowered position shall be below the top of the side girder.

3215 Barriers shall be provided at each end of the platform to prevent vehicles from moving past the
end of the platform. The ship's crew will operate the barriers manually. Barriers shall be
comprised of aluminum pipe stanchions with nylon webbing (cargo net) between stanchions.
Stanchions shall fit into sockets in the platform deck. Sockets shall be provided along the side of
the platform for storing stanchions when not in use.

3220 Provision shall be made for securing the platform in place during storm conditions. The platform
shall be designed so that vehicles can be stowed on the platform when it is secured on the Main
Deck during voyages. The platform shall be suitable for stowage on the Main Deck and in the
overhead, tight to the hatch.

575.7 Turntable

3225 The elevator platform descends to the Main Deck to form a turntable. When on deck and acting
as a turntable, the platform shall be supported by 24 steel wheels, Hamilton W-830-FST-1-1/4 or
equal, that run on a circular insert plate in the Main Deck. The deck insert plate shall be high
strength steel, ASTM A 514 Grade E. The wheels shall be positioned to land on longitudinal
deck girders when the platform descends. Ring spring buffers supporting each wheel shall have
3230 1.5" stroke as required by ASME A17.1 and shall be sized to dissipate the kinetic energy of a
descending platform in accordance with ASME A17.1.

A 4" diameter stainless steel center pivot pin shall be provided at the bottom of the platform that
engages a socket in the Main Deck. The Main Deck socket shall be fitted with an oil-
impregnated bronze bushing for the pin and a spring-loaded plug that fills the hole in the deck
3235 flush when the pin is removed and is pushed out of the way when the pin is inserted. The plug
spring shall be spring-tempered steel, 12" long, 3.406" OD, 3/8" wire, 82 lb/in, closed and
ground, McMaster-Carr 96485K272 or equal.

Flaps shall be hinged from the end of the platform to provide a gradual transition between the
Main Deck and the platform roadway. When the turntable returns to the lifting position, end
3240 flaps shall span between the platform roadway and the carrier bridges. When the platform is

supported by the carriers, the edge at the end of the platform roadway, the end flap road surface and the carrier bridge top shall be within 1/8" of a single plane.

575.8 Turntable Drive System

3245 When the elevator platform descends to the Main Deck to form a turntable, the carrier lifting
lugs disengage from the platform, which becomes free to rotate as controlled by the turntable
drive system. The turntable drive system shall use friction from tires pressed against a circular,
diamond plate path under the platform to develop the torque necessary for rotation. These tires
will consist of four (4) tubeless 255/70 R22.5 radial tires with 6,940 pound load rating at 130 psi
inflation, 17.6 inch loaded radius, 38 inch overall diameter, and steer axle tread, Michelin XZA2
3250 or equal, on 8.25" wide rims. These shall be driven by inverter duty, 1800 RPM, 15HP AC
motors through two-stage, double-enveloping worm drives having reduction ratios of 225:1 in
two 15:1 stages. Worm drives shall be capable of overhauling to allow the turntable to coast if
power to the motors is shut off abruptly. Each drive motor shall be fitted with a spring set,
electric release brake to hold the platform in position when it is not being driven. Brakes shall
3255 have manual override capability.

Drive tires shall project above the Main Deck by approximately 2" when the platform is hoisted
out of the way. Axle position shall be established such that the load on each tire does not exceed
its load rating while providing 3,650 pounds of tractive effort against a fully loaded platform.
Drive tires shall be housed in recesses in the Main Deck with each recess draining to the oily
3260 bilge tank. Motors, gears, and brakes shall be located in the elevator machinery room below the
deck with drive shafts projecting through bulkhead seals into the tire recesses.

Drive shafts shall have through bores connected to the air fittings on the tires and to filling
fittings and pressure gauges inside the elevator machinery room to allow filling, venting and
monitoring inflation from inside the elevator machinery room when the tires are not rotating.
3265 Close fitting, lift-off access plates into the tire recesses shall be provided in the Main Deck for
tire maintenance.

Turntable drive speed and accelerations shall be limited to maxima listed in Table 500 - 5 (see
Section 575.2).

575.9 Kingposts and Platform Carriers

3270 Four kingposts shall be located at the corners of the hoistway. The kingposts provide the lifting
support structure, backing for carrier guide tracks, and support for the side ramps. Tie beams
shall connect the tops of the kingposts transversely and longitudinally. Solid rod diagonal stays
shall connect between the kingposts port and starboard. Stays shall be routed clear of the
hoistway hatch.

3275 A platform carrier on each side of the vessel shall be suspended between fore and after kingposts
and together two carriers shall support the platform. Guide rollers on the carrier cheeks shall
engage vertical tracks mounted on the kingposts.

The carrier cheeks shall have fixed hooks inboard for lifting the platform and swing arms
outboard for lifting the side ramps. A bridge between the cheeks shall maintain separation and
3280 act as a roadway extension between the platform and the transfer ramp.

Carriers shall begin to disengage from the platform when they are approximately 3" above the
Main Deck and be fully unloaded when they are approximately 2" above the Main Deck.

3285 Carriers shall clear the lifting points on the platform by one inch when at their normal lowest stop approximately one inch above the Main Deck. There shall be approximately one inch of overrun distance between the lowest normal stop and the elevation where a carrier rests on the Main Deck.

575.10 Hoist System

3290 The hoist machinery consists of ball screws, bevel gears, screw brakes, centrifugal brakes, interconnecting shafting, motors, and controls to lift and lower the platform. This equipment, except for the ball screws, shall be located in the vehicle elevator machinery room under the Main Deck. The hoist shall have four ball screws, one for each corner of the platform or two for each carrier.

3295 Ball screws shall be 5" diameter, hardened AISI 6150 steel, ground for 32mm lead and 5/8" diameter balls, with matching ball nuts, safety nuts and seals. Dynamic load capacity of the screws shall be 129,000 pounds at 10⁷ inches of travel and static capacity shall be 925,000 pounds. Design screw life shall be at least 30 years with a root mean cube load of 35,450 pounds corresponding to the load profile shown in Table 500 - 9. Because the screws are loaded only in one direction, screws and nuts shall be designed to be changed end for end and, after the balls and seals are replaced, used for another 30 years of life.

3300 Ball screws shall hang from their top ends by 29420E spherical roller thrust bearings in sealed housings. The arrangement of the ball screws shall be such that they can be removed and replaced using only tools and equipment carried aboard the ship. Ball nut mounting shall allow for up to 1/4 inch of relative radial motion between the nut and the platform carrier without transmitting load perpendicular to the screw. Ball nut mounting shall allow the nut axis to remain parallel to the screw axis when the platform carrier becomes tilted as much as 0.5 degrees from perpendicular to the screw axis. Ball nut mounting shall allow the nut to disengage from the platform carrier and turn freely in the event the hoist drive does not stop when the carrier contacts the Main Deck. Such an incident shall not damage the elevator or prevent it from being put back into service by the ship's crew alone.

3310 Gears in hoist machinery shall have strength and durability calculated to American Gear Manufacturers Association (AGMA) standards for the required life. The gear tooth beam strength shall have a bending stress below the material ultimate strength when eight times the full load is reached in accordance with ASME A17.1/2.24.3. Inspection ports shall be provided in gear cases to allow for borescope inspection of the load flanks of all teeth. Gauges or sight ports for checking oil level shall be provided along with fill and drain connections. Cooling fins shall be provided on gear cases as necessary.

All gears shall have the following characteristics:

1. Spiral bevel gears.
2. AGMA Quality 9 or better.
- 3320 3. Tooth contact ratio of 2.0 or more.
4. Shafts loaded in torque only.
5. Duty cycle ~ 25%: load / hoist / unload / lower / repeat.
6. Gear life equivalent to L1 life > 22000 hours
7. Tapered roller bearings throughout.

- 3325 8. Bearing L10 life > 60000 hours.
 9. Air cooled with external source from ship's ventilation system.

Bevel reduction gears for connection to ball screws shall have the following characteristics:

1. Reduction ratio 48:13.
 2. Output speed = 476 RPM.
3330 3. Maximum output torque = 12250 lb-in.
 4. Root mean cube output torque = 7900 lb-in.
 5. Minimum static torque on output shaft without breakage = 88200 lb-in.
 6. Factored transmitted power for calculating heat dissipation = 60 HP.
 7. Horizontal input shaft, 2" minimum diameter.
3335 8. Vertical output shaft pointing up, 3" diameter.

Bevel gears for dividing motor output among the ball screws shall have the following characteristics:

1. Reduction ratio 1:1.
 2. Input/output speed = 1,758 RPM.
3340 3. Maximum input torque = 7,200 lb-in.
 4. Maximum through shaft torque = 3600 lb-in.
 5. Maximum output torque = 3,420 lb-in.
 6. Root mean cube output torque = 2,204 lb-in.
 7. Minimum static torque on output shafts without breakage = 24,600 lb-in.
3345 8. Factored transmitted power for calculating heat dissipation = 120 HP.
 9. Horizontal through shaft and output shafts, 2" minimum diameter.

3350 Load holding brakes shall be spring set, air released, disc type with a disc mounted on each shaft between a bevel reduction gear and its driven screw. There shall be two brake caliper assemblies per disc, located 180° apart to minimize side load on the shaft. Brakes for any three of the four screws shall be capable of holding a fully loaded platform and stopping a fully loaded platform from a descent speed of 70 feet per minute. Dry air supply for load holding brakes shall be from the control air system. See Section 551.6.

3355 A torque meter, Binsfeld TorqueTrak TPM2, shall be mounted above the load holding brake on the shaft between each bevel reduction gear and its driven ball screw to measure the torque in the screw regardless of brake status. A full bridge of 350 ohm strain gauges shall be bonded to the shaft in an orientation to be sensitive only to torque and covered with protective materials to form a permanent installation. Torque meter bandwidth shall be DC – 1,000 Hz to provide output suitable for ball screw condition monitoring. Torque meter gain shall be set for DC output between half and full scale at the torque produced by 55,000 pound tension in the ball screw.
3360

Centrifugal brakes shall be mounted on the inputs to the bevel reduction gears. Centrifugal brakes shall begin to activate when the shaft speed reaches 1,850 RPM and shall develop

approximately 7,000 lb-in (800 Nm) torque at 2,800 RPM. An example of a sufficient centrifugal brakes could be Warner Electric Europe model FC-80-1850/2800.

- 3365 Two (2) inverter duty, 1,800 RPM, 200 HP, 460 VAC, TEBC hoist motors shall work in tandem to drive the hoist with sufficient power to accelerate a fully loaded platform upward to rated speed and sufficient torque in one motor to raise an empty platform or operate a ramp in the event of a single motor failure. Hoist motors shall be capable of developing full rated torque at zero RPM for bringing the platform to a stop before brakes are set. Hoist motors shall have shaft encoders fitted for use by the control system.
- 3370

- Lubrication for all mechanical operating parts shall be provided with lubricants suitable for the operating conditions. Grease fittings and lubrication points shall be readily accessible for routine maintenance. Where manual lubrication is necessary, lubrication intervals shall not be shorter than one month. Machinery with oil bath lubrication shall have readily accessible fill and drain connections and level indicators. Ball screws shall be fitted with automatic oil lubrication systems that assure lubricant coats the entire screw length regardless of hoist travel.
- 3375

The Contractor shall develop foundations having strength in accordance with ASME A17.1 for all hoist system components, with special attention to increased loads on ball screw support bearings and gear and brake foundations during emergency conditions.

3380 **575.11 Ramps**

- Transfer ramps to span from the end of the platform to the pier. There shall be two ramps, one on each side of the vessel. The outboard end of the ramp rests on the pier deck and the inboard end is supported directly by the kingposts by way of sliding ramp carriers, separate from the platform carriers. Ramps shall be designed to support the transit of all vehicles for which the elevator platform is rated.
- 3385

- Ramps shall be 18-1/2' long and, when closed as doors, fit beneath the Cabin Deck. Folding deck sections shall cover the stowed ramp ends to permit clear access to the aft Cabin Deck. Folding handrails shall be provided on both sides of the driving lane on ramps and dock flaps with 17' clear width to match the roadway on the elevator platform. The inboard edge of each ramp shall have a hinged filler plate that spans the clearance between the ramp's driving surface and the platform carrier bridge. Operation of the filler plate shall be automatic by gravity when opening the door and by contact with the Main Deck when the door closes.
- 3390

- The fixed kingposts described in Section 575.9 shall support sliding ramp carriers that move vertically from the Main Deck to the uppermost platform position. The ramp carriers contain UHMW guides, hinge links for the ramp, and sheaves for the tackles used to control deployment of the ramp. Hinged slot covers shall be provided for each kingpost to keep weather from entering the ramp carrier slots when the ramp is not in use. Slot covers shall be manually dogged and opened/closed by air-over-oil cylinders. The air supply for slot cover cylinders shall be from the control air system. See Section 551.6. Ramps shall be lifted and lowered by swing arms on the platform carriers. Swing arms shall be operated manually and linked together to engage simultaneously the hinge link attachment eyes on both ramp carriers. Hinge links composed of thin laminations that reduce torsional rigidity shall connect the ramps to the carriers and allow ramps to pivot around one carrier when the ship surges and the ramp does not slide on the pier. Spring-loaded, retractable pawls in the kingposts shall hold the ramp carriers above the Main Deck at 6" increments of elevation. Air-over-oil cylinders shall be provided to retract pawls while lowering. Dry air supply for pawl cylinders shall be from the control air system. See Section 551.6.
- 3395
- 3400
- 3405

Ramps shall be deployed and retrieved by wire rope tackles passing over the tops of the kingposts and connected to grooved drum winches located below the Main Deck. Each ramp shall have its own winch and two tackles. The tackle arrangement shall ensure the angle of the ramp does not change as the ramp moves up and down the kingposts until it becomes supported by the pier. The ramp handling system shall be designed to deploy or retrieve the ramp between vertical to a maximum of 12° below horizontal. The ramp shall be free to rotate from 90° (vertical) to 12° below horizontal without making contact with the vessel structure or damaging any components. Fleet angles for ramp handling rigging shall not exceed 2° for sheaves. Dead ends for ramp handling wire ropes shall be inside the elevator machinery room so rope replacement can be done using the old rope as a messenger. Dead ends for ramp handling wire ropes shall be connected to gas springs having at least 4-foot stroke and means of pressure adjustment to keep the force of an unloaded ramp resting on the pier near zero while holding the ramp against the kingposts. Ramp tackles shall use 5/8" diameter 6x37 Class IWRC wire rope with appropriate steel composition to achieve a factor of safety of at least 5 on rupture. Sheaves shall have a 12.5" minimum tread diameter. Winch drums shall be grooved with a 12.5" minimum tread diameter. Ramp winch drums shall have provisions to attach two wire ropes spooled on two zones along the drum length. The drum shall have sufficient length to stow on a one layer the amount of wire rope required to fold the ramp. At no time shall the wire rope have less than three wraps on the drum from the termination attachment point on the drum. Fleet angle of the wire in the active wraps shall not exceed 2°. Ramp winches shall be driven by inverter duty, 1800 RPM, 20 HP, 460 VAC, TEFC electric motors through a two-stage double enveloping worm drive with a reduction ratio of 375:1. Ramp winch motors shall be fitted with spring set, electric release brakes with manual override capability.

575.12 Power

The Contractor shall provide a 480 volt, 3 phase, AC power panel for mounting in the elevator machinery room. The panel shall receive power from the ship's main 480 VAC switchboard and distribute it to all of the electric power consumers associated with the vehicle elevator and turntable systems and the stern and side doors. Items powered from this panel shall be as shown on Reference 430-01. The power panel shall be from the same manufacturer as, and use interchangeable circuit breakers with, the other 480 volt power panels used throughout the vessel.

Control power for solenoids and relays shall be 24 volt AC and signal power for limit switches, sensors, and indicator lamps shall be 24 volt AC or DC.

Power for elevator systems shall be supplied by 480 volt 3 phase AC feeders to two (2), redundant, 120 volt single phase AC control power transformers and two (2), redundant, active rectifiers feeding a DC bus in an elevator electrical cabinet located in the elevator machinery room. The feeders shall be interlocked at their source by to prevent both from being energized at the same time. The Contractor shall provide variable frequency drives (VFDs) drawing power from the DC bus for platform hoist motors, turntable drive motors ramp winch motors and hydraulic power supplies. No constant speed motors shall be used for hoisting, ramp handling, turntable rotation or hydraulic power. All VFDs shall be programmed for ramped starts and stops. Acceleration during normal and emergency stops shall not exceed the design limits or code requirements. VFDs, except those driving hydraulic power units, shall be capable of four quadrant operation including regenerating power back into the electrical supply system. Braking resistors shall be provided to dissipate regenerated power that exceeds the capacity of the supply system to absorb it.

575.13 Controls

3455 All controls shall be arranged for manual initiation by a trained operator. No elevator system functions described in this Section 575 shall be initiated by the Integrated Machinery Alarm and Control (IMAC) system described in Section 431. Depending on function, stop controls shall be either manual by a trained operator or automatic by limit switch. All movement functions shall be provided with a normal speed and a creep speed that is approximately $\frac{1}{10}$ of normal speed. In
3460 general, creep speeds shall be initiated by manual jog control requiring maintained actuation of a pushbutton by the operator. All movement velocities shall have ramped starts and stops capable of being reprogrammed after the ship's crew gains experience with the elevator and turntable.

Ramp and platform hoist controls shall be located on a console in a cab above the Cabin Deck from which the whole operation of loading and hoisting can be observed. An emergency stop
3465 and the rotation controls shall be located in a station on the Main Deck in the fore port corner of the hoistway.

Operator console and control panel layouts shall match those on M/V *Kennicott* to the greatest extent practicable for fleet commonality. In addition to manual jog control for hoisting, there shall be a "2 floor" semi-automatic control where one button in the control cab sends the
3470 platform to the Main Deck at rated speed and another button sends the platform at rated speed to an upper "floor" that is programmable in 6" increments above the Main Deck. In addition to manual jog control for rotation, there shall be a variable rate joystick control for rotation. A "home" function shall return the platform automatically to transverse orientation aligned with the carrier lifting lugs for platform hoisting.

3475 Controls shall not require any electrically powered devices to be mounted on the platform or carriers. Except for final terminal stopping devices specifically required by ASME A17.1 to be mechanical, all limit switches located outside the elevator machinery room shall be of the photoelectric or proximity type. Limit switch installations accessible to passengers shall be tamper resistant. Limit switches on the Main Deck shall be protected against vehicle contact.

3480 Limit switches in the weather shall be capable of functioning during icing conditions, heavy rain and spray.

A programmable logic controller (PLC) located in the elevator machinery room shall provide control, interlock, alarm and timing functions in conjunction with operator controls, limit switches, and VFDs. Acceleration ramps and reduced speed functions for platform hoisting shall
3485 be implemented in PLC programming and not in the hoist VFDs. The PLC shall be fitted with a troubleshooting display showing the status of every control and limit switch. A duplicate troubleshooting display shall be provided in the control cab. The PLC shall provide an output signal for a summary alarm in the IMAC system.

Controls shall provide interlocks including but not limited to the following functions:

- 3490
1. Platform carriers cannot be hoisted without hoistway hatch fully opened. A partial override for this function shall be provided to allow the platform to be hoisted to the upper stowage level with only the hatch flaps open to clear the carriers but the platform shall be stopped automatically before it can contact the hatch.
 2. Hoistway hatch cannot be opened until the hatch flaps are open.
 - 3495 3. Ramp cannot be hoisted when door is dogged closed.
 4. Hinged decks cannot be raised until same side hatch flap is fully opened and door carrier slot covers are fully opened.

- 5. Ramp cannot be hoisted until same side hinged deck is fully raised.
- 6. Ramp cannot be dogged until fully closed and resting on the Main Deck.
- 3500 7. Hinged deck cannot be lowered until same side ramp is fully stowed.
- 8. Ramp carrier slot covers and hatch flaps cannot be closed until same side hinged deck is lowered fully.
- 9. Platform carriers cannot be raised with door lift swing arms extended unless ramp can be or has been hoisted.
- 3505 10. Ramps cannot be lowered unless pawls are retracted.
- 11. Ramps cannot be folded out beyond 12° below horizontal.
- 12. Platform carriers cannot be hoisted unless platform is aligned with lift hooks or the platform is rotated completely clear of carriers.
- 13. Platform carriers cannot be hoisted after ball nuts have disconnected from carriers as a result of bottom overrun.
- 3510

Controls shall provide alarms and stop elevator motion then allow operation at creep speed for conditions including but not limited to the following:

- 1. Hoist overload (excess screw torque).
- 2. Platform load imbalance (torque difference between screws too large).
- 3515 3. Hoist motor power and mechanical power mismatch.
- 4. Ball screw overspeed ($480 \text{ RPM} < \text{screw RPM} < 505 \text{ RPM}$).
- 5. Platform carrier top stop (upper terminal stopping device).
- 6. Platform carrier bottom stop (lower terminal stopping device).
- 7. Ramp angled down more than 12 degrees (hyper extended).
- 3520 8. Slack ramp tackle.

Controls shall provide alarms, stop elevator motion, set emergency brakes, and require manual reset for conditions including but not limited to the following:

- 1. Operator initiated emergency stop.
- 2. Ball screw runaway ($\text{screw rpm} \geq 505 \text{ RPM}$).
- 3525 3. Platform carrier top overrun (upper machine final terminal stopping device).
- 4. Ball nut bottom overrun (lower machine final terminal stopping device).
- 5. Obstructed deck beneath a descending platform.

3530 The Contractor shall provide sensors and switches for indicating ramp is stowed to allow door closure. Connection to the door closed indicating system described in Section 431.11.4 and the voyage data recorder described in Section 444 to signal when the door are open or closed and dogged. These sensors and switches shall also be connected to a separate indication system for doors being closed and dogged that shall be provided on the operator's console in the cab on the Cabin Deck. Electrical sensors, switches, and controls shall be generally as shown on Reference 430-01.

3535 **575.14 Hoistway Hatch**

The hoistway hatch shall provide weathertight integrity for the entire hoistway opening. Hinged flaps shall provide coverage for the area between the kingposts to the hinged decks. Hatches and flaps shall be actuated by hydraulic cylinders. The hoistway hatch shall be elevated above the Cabin Deck so 15 feet of headroom is maintained below the platform when it is stowed in a raised position. The fore edge of the hatch shall be hinged to the coaming. The after edge of the hatch shall be secured to the coaming by drop bolts. The hatch shall have rubber gaskets to the coamings at the fore and after edges. Where hoist cables and guide tracks on the kingposts make joints with gaskets impracticable, rubber flap seals shall be provided.

575.15 Hinged Decks

3545 Hinged decks shall be on located on either side of the vessel at the Cabin Deck. The hinged decks provide access between the fore and after Cabin Deck. Each deck section shall fold forward to provide a gap through which a Ramp can pass unimpeded through the Cabin Deck. Actuation shall be via hydraulic cylinders located below the hinged decks. Hinged decks shall enclose the fore Cabin Deck perimeter when raised to the vertical orientation. Openings in handrails on the hinged decks, or gaps between Cabin Deck handrails and a vertical hinged deck or hinged deck handrails, shall not exceed six inches. Clear width along the hinged decks shall meet ADA standards for wheelchair access. Gutters under the hinged deck ends shall make them rain tight to the spaces below. The undersides of the hinged decks shall engage the top edge of the closed door to resist the force of exterior water pressure on the door. The undersides shall also have gaskets that seal against the top edge of a closed door to render the joint weathertight.

Hinged decks shall have adequate structure and snug end fittings so that they transmit compression load between the parts of the Cabin Deck fore and aft of the hoistway caused by vessel sagging. End fittings shall be positioned to carry no load with an empty vessel in still water but shall begin to carry load immediately as the vessel sags when cargo, people and stores are brought aboard. Structure shall withstand 485,000 pounds compression per deck section, corresponding to full vessel load in extreme seas.

575.16 Hydraulic Systems

3565 The system shall have a hydraulic power unit (HPU) fitted with main and backup pumps plus control valves, suction filters, and return line filter(s) mounted on a common, 20 gallon reservoir. Both pumps shall have high pressure discharge filters to capture particles from a failing pump before they can contaminate the remainder of the system. Hydraulic fluid used in this HPU shall be Arctic rated with viscosity between 13 and 16 centistokes at 40°C, viscosity index greater than 300 and pour point less than -46°C. Hydraulic tubing and fittings shall be austenitic stainless steel. Hydraulic fittings shall be SAE J514 with 37° flare.

3570 Door carrier pawls and slot covers shall be operated by air/oil cylinders with air on the cap ends and hydraulic oil on the rod ends. The hydraulic oil shall be pressurized by air through a piston device to maintain fluid separation. Directional control shall be on the air side. Filtered, dried air shall be taken from the control air system described in Section 551.6. The oil used shall be the same Arctic rated hydraulic fluid as used in the HPU described above. Air/oil tubing and fittings shall be the same as for hydraulic tubing and fittings.

575.17 Emergency Operation

Emergency backup fixtures, systems, and processes shall be provided so that ramps can be stowed or removed to enable door closure for a watertight ship made ready for sea after a failure of a ramp closing winch or ramp tackle. For example, temporary soft lines routed over sheaves at the tops of the kingposts and connected to the elevator platform can be used to pull the ramps closed in the event a ramp closing winch fails. All necessary equipment, whether fixed or portable, shall be mounted on or stowed aboard the ship, ready for immediate use. Raising and lowering the ramps shall be possible using the elevator platform carriers even with one of the platform hoist motors electrically inoperative.

575.18 Documentation

Documentation shall be provided by the Contractor to make it possible for the State to repair, replace, or reprogram any part of the vehicle elevator and turntable systems if the Contractor's company no longer exists. Documentation shall include design calculations, installation drawings, assembly drawings, individual part drawings, lists of purchased parts with their specifications and sources, wiring diagrams, control program listings, procedures for certification testing, operating procedures, and maintenance procedures. Documentation shall be provided electronically in .pdf format. Documentation shall be provided with an index in electronic and paper form (4 bound paper copies).

575.19 Training

A minimum of 16 hours of classroom and on-board training shall be provided by the Contractor for a class of up to six (6) members of the State's staff. Training shall cover normal operation, emergency operation, routine maintenance, replacement of wearing parts, adjusting limit switches, reprogramming controls, and testing for certification. Training shall take place when the elevator is fully operational and ready for certification. Emergency ramp closing without use of ramp winches and with only one platform winch motor operating shall be demonstrated for both ramps.

575.20 Testing

Shop tests shall be performed on components and assemblies that require high reliability such as safety brakes, winches, bevel gearboxes, turntable drives, and the control system. The empty platform shall be set on a temporary fixture with the turntable drives and rotated using the same VFDs and PLCs to be used in the installation on the ship. Shop testing shall demonstrate the turntable system is free from torsional vibration and surging and shall demonstrate the automatic "home" feature of rotation control positions the platform with sufficient accuracy to align with the carriers.

The Contractor shall develop and execute a test program for installation and commissioning of the vehicle elevator as required by the applicable elevator codes. Testing shall demonstrate reliable and repeatable performance of the following functions:

1. Raising and lowering the platform carriers alone at creep speed.
2. Raising and lowering the platform carriers alone to all stops at rated speed
3. Opening and positioning both ramps at all stops using the platform carriers.

4. Closing both ramps using the platform carriers.
5. Opening and closing both door ramps using the platform carriers and only one hoist motor.
6. Raising and lowering the empty platform at creep speed.
- 3620 7. Raising and lowering the empty platform to all stops at rated speed.
8. Raising and lowering the empty platform at rated speed using only one hoist motor.
9. Raising and lowering a fully loaded platform at creep speed.
10. Raising and lowering a fully loaded platform to all stops at rated speed.
11. Load holding of fully loaded platform using disc brakes.
- 3625 12. Carrier free fall speed limit by centrifugal brakes.
13. Empty platform buffer action and free fall speed limit by centrifugal brakes.
14. Fully loaded platform buffer action and free fall speed limit by centrifugal brakes.

3630 The turntable shall be tested with full platform load to be free from torsional vibration, surging, and drive tire slippage and to stop with accurate alignment with the carriers. ramps, hatches and folding decks shall be tested for proper and reliable opening and closing and hose tested for tightness in accordance with ABS Rules and USCG regulations.

The Contractor shall demonstrate the vehicle elevator/turntable system is capable of achieving the required cycle time, listed in Section 575.2, using the following test scenario:

- 3635 1. The test shall begin with the turntable loaded to maximum capacity (80,000 lb) and oriented 90° from the lifting lugs (longitudinal in vessel coordinates). The transfer ramp shall be deployed at the stop 34 feet above the Main Deck.
2. The turntable shall rotate 90° and align with the lifting lugs.
3. The platform and payload shall be raised to a height of 34 feet above the Main Deck and aligned with the transfer ramp.
- 3640 4. The payload shall be removed from the platform. The time required to remove the payload shall not be included in the cycle time.
5. The empty platform shall descend to the Main Deck.
6. The turntable shall rotate 90° to the original starting position completing the test.

3645 The above test scenario represents vehicle-unloading. If vehicle-loading results in a slower cycle time, it shall also be demonstrated that vehicle-loading can be performed within the allotted cycle time. The platform and turntable speed shall meet the requirements listed in Table 500 - 9 and at no time exceed the maximum acceleration limits. Test time shall include time to open/close barriers and engage/disengage rotating and hoist mechanisms. Operation of the vehicle elevator during the above defined scenario shall comply with all applicable safety and
3650 regulatory requirements.

Tests shall be complete when the Reviewer responsible for inspection and certification of the vehicle elevator turntable issues a certificate of compliance with the applicable codes and the Specification.

580 MECHANICAL HANDLING SYSTEMS

3655 581 ANCHOR SYSTEMS

The Contractor shall provide and install an anchor system in accordance with this section. The installed anchor system arrangement shall prevent the anchor or chain from fouling or damaging the hull, hull appendages, or equipment when weighing, dropping, or riding at anchor. Anchor stowage and handling equipment shall be arranged for efficient handling and securing of anchors and chain to the satisfaction of the Resident Engineer.

581.1 Design Requirements

581.1.1 Load Requirements

The anchor system shall comply with the requirements for ABS Equipment Number 1140 (ABS Equipment Numeral U25).

3665 The anchor system shall consist of the following equipment and load requirements:

1. Anchors - Two high holding power anchors, weighing 6,250 pounds each. See Section 581.2.1.
2. Anchor Chain - A total of 285 fathoms (19 shots) of 1⁷/₈" ABS Grade 3 stud link chain. See Section 581.2.4.
- 3670 3. Anchor Windlasses – Two anchor windlasses with the capabilities listed below. See Section 581.2.2.
 - a) A continuous duty pull of 24,200 pounds.
 - b) An overload pull of 36,300 pounds.
 - c) Two hoisting speeds of 30 ft/min and 60 ft/min.
 - 3675 d) Forward and reverse operation at full load.
 - e) A brake capacity of 180,900 pounds.
4. Anchor Chain Stoppers – Sized for a design load of 321,600 pounds.

581.1.2 Functional Requirements

3680 The functionality and arrangement of the anchor systems shall be as shown on Reference 581-01 and as required by this section.

The intersection of the lower hawse pipe centerline and the hull shall be 7'-11" aft of Frame 0, 11'-³/₄" outboard of vessel centerline, and 6'-1³/₄" above the 30' waterline.

3685 When stowed, the angle between the anchor flukes and the anchor shank shall be 39°, and the stowage angle between the base of the anchor and horizontal shall be 11.7° when viewed in profile.

Anchor system shall be arranged to provide efficient handling and securing of anchors and chain, and to provide convenient access to all parts of the anchor and mooring systems. The arrangement of the anchor system shall be to the satisfaction of the Resident Engineer.

3690 To reduce forces in anchor chain and structure in way of the chain path, the included angle of corners in the anchor path shall be maximized and no sharp corners or abrupt transitions are permitted. In general, included corners in the anchor chain path shall not be less than 115°.

The horizontal distance between the chain lockers and the anchor windlasses shall be minimized. The location where chain leaves the windlass when being hoisted shall not be greater than approximately 4'-10" horizontally from the longitudinal center of the chain locker.

3695 Anchor deployment and retrieval shall be to the satisfaction of USCG, ABS, and the Resident Engineer. Under all operating conditions, the anchor handling arrangement shall ensure that:

1. The anchors drop immediately upon release.
2. The anchors do not jam the hawse pipe.
3. The anchors do not pound in a seaway.
- 3700 4. The anchors self-stow against the hull and have at least three-point contact when stowed against the hull.
5. The anchors and chain do not foul or catch the bulb or keel.

Each anchor chain shall include a swivel shot and detachable links, devil's claw, bitter end connections and other fittings necessary to make a complete and workable arrangement as shown on Reference 581-01. When anchors are stowed, anchor chain shall have a detachable link between the devil's claw and the anchor windlass as shown on Reference 581-01.

3705

581.1.3 Control Requirements

Operation of anchor windlasses shall not result in a crew member located near the path of the exposed anchor chain or moving windlass parts.

3710 Each anchor windlass shall be operable by two people. One person shall be capable of running the windlass controls, and one person shall be capable of controlling the windlass brake.

Anchor windlasses shall have smooth rotation throughout range of motion and standard operation shall not result in binding or jamming.

3715 Anchor system shall have port and starboard pedestal-mounted windlass control stations, mounted on the wave break. Each control station shall consist of maintained-contact pushbuttons marked "Fast Hoist", "Hoist", "Stop", "Lower" and "Fast Lower" installed in a NEMA-4X enclosure. A "Stop" button shall be provided on each windlass control station which shall stop both port and starboard windlasses, regardless of which windlass control station is in use.

3720 Anchor windlasses shall have control circuitry to automatically energize and thermostatically control the motor and brake heaters whenever the anchor windlass is not being used. A manually operated switch shall be provided on the anchor windlass power panel to override the automatic heater control circuitry and de-energize the power to the motor and brake for maintenance.

581.2 Design

3725 Contractor shall provide anchor systems in accordance with the Contract Drawing, Reference 581-01, and the provisions of this section. Major anchor system components shall have the salient characteristics as described below.

581.2.1 Anchors

3730 Two (2) identical stockless anchors shall be provided, one port and one starboard. Anchors shall meet the requirements given in Section 581.1. Anchors shall be high holding power Poole type N with a weight of 6,250 pounds, or equal. Anchors shall be fully balanced for pocket-less stowage.

3735 Reference 581-01 is based on an anchor shank length of 7'-9¹/₈". Actual shank length may vary depending on manufacturer. Any deviation of anchor size, type, dimensions, or shank length will cause the anchor to not seat properly on the hull side plate or in the hawse pipe and will necessitate a revision of the chain path and equipment locations between the hawse pipe and the windlass.

3740 If the Contractor obtains an anchor with different dimensions than shown in Reference 581-01, Contractor shall completely revise Reference 581-01 using a three-dimensional model which clearly illustrates:

1. New anchor position.
2. New hawse pipe position.
3. Three point anchor contact on hull side plate.
4. Anchor stowage angle in profile.
- 3745 5. Anchor shank angle perpendicular to hawse pipe.
6. Revised anchor chain route to windlass including component locations.
7. New anchor chain route to chain locker.

581.2.2 Anchor Windlasses

3750 Two (2) anchor windlasses shall be provided. The windlasses shall be a Markey model VEP-30-80 vertical shaft combination anchor windlass/forward mooring capstans, or equal, as shown on Reference 581-01. Anchor windlasses shall meet the design requirements given in Section 581.1.

3755 Each anchor windlass shall be provided with a wildcat sized for 1⁷/₈" ABS Grade 3 stud link chain. Each wildcat shall be of six-pocket design. Each windlass shall be fitted with a manual key-type clutch actuated by turning a cam-cover on the top of the capstan barrel. The clutch shall permit the use of the capstan with the wildcat remaining stationary. Each windlass shall be provided with a wildcat brake to hold anchor while using the capstan and to allow controlled lowering of the anchor by gravity. Each anchor windlass shall have a chain stripper.

3760 The wildcat brake shall be a below deck band brake with an above deck handwheel assembly. Wildcat brake shall meet the requirements given in Section 581.1.

3765 The windlass capstan barrel shall be of at least 21" working diameter by 15" high. The capstan shall have machined and ground working surfaces and shall be suitable for use with high modulus polyethylene mooring lines required by Section 582. At a minimum, windlass capstan shall be able to develop a mooring line pull of between 9,000 and 10,000 pounds at 60 ft/min and between 18,000 and 20,000 pounds at a line speed of 30 ft/min. Final mooring line pull and mooring line speed shall be determined by wildcat speed and diameter.

Gearing shall be totally enclosed and oil bath lubricated. A stainless steel ball type oil drain valve shall be fitted along with ample inspection and oil-fill plates. There shall be a gauging

3770 tap/plug or sight glass indicating oil full condition and fitted at the factory to properly account for any significant vessel sheer. All bearings shall be line-bored for accuracy and stability (pillow block bearings shall not be used).

Anchor windlasses shall have the additional salient characteristics described below:

1. Gearing between the electric motor and the wildcat designed to withstand all braking loads.
- 3775 2. Auto-brake to stop and hold the load until the handbrake is set or the chain stopper is engaged.
3. Configuration for bolt-down installation, with the handbrake, gearbox, electric motor and automatic brake all suspended below-deck from the bolting-plate.
4. Clutch mechanism located within the capstan head.
- 3780 5. Marine duty epoxy coating system.

Each windlass shall be powered by a 480 VAC, three-phase, 60 Hz, four-pole, 1800 RPM, NEMA D crane and hoist duty electric motor/brake. Motor/brake shall be of a vertical shaft up configuration. Each motor/brake shall have a 30-minute 175-ft-lb auto-brake capable of stopping and holding the anchor chain until the band brake or chain stopper is engaged.

3785 581.2.3 Chain Lockers and Chain Pipes

Two (2) chain lockers, one port and one starboard, shall be provided, each sized to accommodate at least 10 shots of 1⁷/₈" ABS Grade 3 stud link chain (20 shots total). Each locker shall have sufficient room to stow the 10 shots of chain with sufficient head room remaining to facilitate the self-stowage and paying out of the chain.

3790 Access shall be provided to each chain locker. Recessed handholds and footholds shall be provided in each locker for vertical access.

Chain shall stow on a steel grating designed to support the 10 shots of chain under all conditions. A chain locker sump shall be provided.

3795 Each chain locker shall be provided with a padeye to which the bitter end of each chain shall be secured by a weak link. The weak link shall be several loops of ³/₈" braided line (or a similar system) designed to fail at a load less than the breaking strength of the chain, but greater than the proof load of the chain, without failure of any other member and without damage to the hull structure.

3800 Chain pipes shall be provided from the vertical capstan to the chain locker as shown on Reference 581-01. Chain pipes shall terminate over the center of each chain locker. Ends of chain pipes shall be provided with a bellmouth.

581.2.4 Anchor Chain

3805 Anchor system shall use 1⁷/₈" ABS Grade 3 stud link chain. Anchor system shall have 142.5 fathoms (9.5 shots) of chain on the port side and 142.5 fathoms (9.5 shots) on starboard side of the vessel. All detachable links, swivels, and other similar components included in the anchor system shall meet or exceed the strength requirements of 1⁷/₈" ABS Grade 3 stud link chain.

The Contractor is cautioned that US manufactured chain is required by this Contract, unless specially exempted in writing by the Resident Engineer.

3810 The anchor chain shall be capable of being washed using the nearest firemain hose connection (see Section 521).

582 MOORING SYSTEMS

The Contractor shall provide and install a mooring system in accordance with this section. Mooring equipment shall be arranged for efficient handling of mooring lines to the satisfaction of the Resident Engineer.

3815 582.1 Design Requirements

582.1.1 Load Requirements

The mooring system shall comply with the requirements for ABS Equipment Number 1140 (ABS Equipment Numeral U25), unless otherwise noted in this section.

3820 Hawser for this vessel have a breaking strength in excess of ABS requirements. 1⁵/₁₆" Samson Quantum 12 rope, or equal, shall be used for hawsers. The minimum breaking strength of hawsers shall be 146,000 pounds. Consequently, the Contractor shall design and supply all mooring system equipment with a SWL equal to the hawser breaking strength of 146,000 pounds, except for the capstans, which shall be specially considered.

3825 Mooring bitts shall be fabricated steel and shall comply with ISO 13795. Mooring bitts shall be designed for a mooring line force of 182,500 pounds, and shall have a nominal SWL, marked by a weld bead on the fitting, of 146,000 pounds.

3830 Warping heads (mooring capstans) shall be able to develop a mooring line pull of between 9,000 and 10,000 pounds at a line speed of 60 ft/min and between 18,000 and 20,000 pounds at a line speed of 30 ft/min. Warping heads shall be capable of two-speed forward and reverse operation at full load. Each warping head shall be of 21" working diameter by 15" high. When acting as a mooring bitt, warping head design force shall be 75,750 pounds, and each warping head shall have a nominal SWL, marked by a weld bead on the warping head, of 60,600 pounds. Warping head strength as a bitt is determined by ABS criteria, not by the breaking strength of the hawsers required by the State. In this case, the warping head is not acceptable for use as a bitt when used
3835 with the hawsers required by the State. This discrepancy requires that all hawsers be secured directly to bitts to generate adequate forces.

582.1.2 Functional Requirements

The functionality and arrangement of the mooring systems shall be as shown on Reference 582-01 and as required by this section.

3840 Mooring system shall be arranged to provide efficient handling and securing of mooring lines, and to provide convenient access to all parts of the anchor and mooring systems. The arrangement of the mooring system shall be to the satisfaction of the Resident Engineer.

The State requires mooring capstans be located on the vessel as shown on Reference 582-01.

3845 The State requires chocks be located along the length of the vessel as shown on Reference 582-01.

The State requires double bitts be located on the vessel as shown on Reference 582-01.

Chocks, bitts, and fairleads should be smooth in way of the line working surfaces and not have any burrs, sharp edges, or casting flashing that could damage the mooring lines. Welds shall be

3850 ground flush as needed to prevent line chafing on fabricated components. Chocks shall be polished stainless steel.

Heated stowage boxes shall be provided forward and aft and sized to enclose the mooring lines. Location of mooring line storage shall be to the satisfaction of the Resident Engineer.

582.1.3 Control Requirements

3855 Operation of mooring capstans shall not result in a crew member located near the path of mooring lines or moving capstan parts.

Each mooring capstan shall be operable by one person.

Mooring capstans shall have smooth rotation throughout range of motion, and standard operation shall not result in binding or jamming of mooring lines or capstans.

3860 Each capstan shall be provided with controls that allow for two-speed forward and reverse operation and braking control of the capstan barrel. Each control station shall consist of maintained-contact pushbuttons marked "Fwd Fast," "Fwd," "Stop," "Reverse" and "Reverse Fast" installed in a NEMA-4X enclosure.

3865 Mooring capstans shall have control circuitry to automatically energize and thermostatically control the motor and brake heaters whenever the capstan is not being used. A manually operated switch shall be provided on the capstan power panel to override the automatic heater control circuitry and de-energize the power to the motor and brake for maintenance.

582.2 Design

3870 Contractor shall provide mooring systems in accordance with the design shown in Reference 582-01 and the provisions of this section. Major mooring system components shall have the salient characteristics as described below.

582.2.1 Mooring Lines

Six (6) new High Modulus Polyethylene (HMPE), 1⁵/₁₆" Samson Quantum 12 rope, or equal, mooring lines with shock pendants shall be provided for the vessel. Each line shall be at least 300' long and fitted with an eye (and chafing gear) at one end.

3875 Six (6) 150' long nylon heaving lines (one per mooring line), each with a leather covered weight attached to one end and the other end whipped, shall be provided for the vessel. Heaving lines shall have a ¼" or 5/₁₆" diameter.

582.2.2 Mooring Chocks, Bitts, and Fairleads

3880 Nine (9) closed ring bulwark chocks and six (6) closed ring deck chocks shall be provided for the vessel. Chocks shall meet Panama Canal regulations. The chocks shall be cast stainless steel, Type 316L, polished face. Chocks shall be located along the length of the vessel as shown on Reference 582-01.

3885 Fifteen (15) Schoellhorn-Albrecht ISO13795-450A-Type B fabricated steel double bitts, or equal, shall be provided for the vessel. Double bitts shall be located on the vessel as shown on Reference 582-01. Bitts shall meet ISO 13795 with a wide base and shall have a nominal SWL, marked by a weld bead on the fittings, of 146,000 pounds to match the 1⁵/₁₆" Samson Quantum 12 mooring lines.

582.2.3 Mooring Capstans

3890 Two (2) Markey CEW-70-30HP, or equal, above-deck mooring capstans and one (1) Markey CEV-70-30HP, or equal, thru-deck capstan shall be provided for the vessel, as shown on Reference 582-01:

1. One (1) above-deck capstan shall be installed at the port mooring station on the aft Cabin Deck.
- 3895 2. One (1) above-deck capstan shall be installed at the starboard mooring station on the aft Cabin Deck.
3. One (1) through-deck capstan shall be installed at centerline on the Boat Deck, forward of the superstructure.

3900 The capstan barrels shall be 21" working diameter by 15" working height. The capstan shall have machined and ground working surfaces and shall be suitable for use with the mooring lines. Capstan structure shall be rated for a nominal SWL, marked by a weld bead on the mooring capstan, of 60,600 pounds when acting as a bitt.

3905 Gearing shall be of the high speed helical and main worm types, totally enclosed and oil-bath lubricated. Anti-friction bearings shall be used at the input and worm shafts, with bronze bushings at the vertical main shaft. A non-corrosive ball-type drain valve and large inspection covers shall be provided for simplifying the gear case oil maintenance.

3910 Capstan motors shall be 30 HP, two-speed, 480 VAC, three phase, 60 Hz, squirrel cage marine type and of NEMA D, 5-8% slip, 30-minute duty, TENV-waterproof construction. The motor shall be twin-shafted for brake mount. A 115 VAC, single-phase, 60 Hz motor heater and in-winding thermal cut-out protection shall be incorporated in the motor. The motor shall be flexibly coupled to an independent input shaft and fitted with a heavy coupling guard. The motor shall be bolted and taper-doweled to machined pads. The motor and brake shall be removable for service without disturbing the shaft seals or opening the gear case.

583 LIFE SAVING EQUIPMENT

583.1 Life/Rescue Boats & Davits

3915 Port and starboard life/rescue boat and davit installations shall be provided. Arrangement and installation details shall conform to the Contract Drawings.

Life/rescue boats shall be 50-person minimum, totally-enclosed lifeboats, Harding KISS 700, or equal. Associated davits shall be gravity-based Harding model VIP 1000, or equal, with hydraulic brake system and boat hooks.

3920 The boats, davits and boat hooks and outfitting shall conform to all USCG and ABS certifications requirements applicable to the ship's service.

The boats shall be fitted with the following options available from the manufacturer: engine heater, cabin heater, EPIRB and SART.

3925 The davits' SWL shall be rated for the boat load. Hoist speed shall be two-speed, 3.28 ft/min (5 m/min) and 59.06 ft/min (18 m/min) nominal.

583.2 Marine Evacuation System

Two (2) marine evacuation systems (MESs) shall be provided, one port and one starboard in conformance with the Contract Drawings. Each MES shall be LSA 65.6' (20m) Mk2 slide systems. No "or equal" substitutions will be permitted for these systems.

3930 Each system, port and starboard, as supplied from LSA, shall include:

1. Twin path inflatable slide, with pre-connected 100-person self-righting "slide" liferaft, with SOLAS "B" emergency pack and including stowage/launching rack, mounting beds, inflation systems, bowing lines, installation hardware and hydraulic release units (HRUs).

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- o Note: The mounting beds shall be furnished by the vendor with additional depth applied to the bed flanges, such that they may be scribed and cut to suit deck camber while retaining the proper vertical and horizontal positioning of the mounting beds relative to the MES enclosure's outboard (deployment) door.

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2. Marine grade aluminum MES enclosure, with roller curtain entry door, automatic release outboard (deployment) door, and including associated hydraulic release unit (HRU) and installation rigging. Entry roller doors shall conform to the specifications given on the Contract Drawings.

3. One 100-person self-righting "link" liferaft with SOLAS "B" emergency pack and including hardware and HRUs.

3945

4. Link liferaft stowage/launching rack fabricated from marine grade aluminum.

5. Means-of-rescue (MOR) system (supplied for starboard side installation only), including electric winch-motor assembly, motor controller panel, hand-held winch controller with pigtailed cable connection to control circuit, retrieval line, line pulley/shackle assembly, MOR sled (in bag) and MOR ladder (in bag).

3950

6. System installation drawings and instructions.

7. Copies of USCG type approval/examination certificates. Required type approval is USCG Approval No. 160.175 for SOLAS 20m twin track MES with integral 100-person inflatable self-righting liferaft and USCG Approval No. 160.151 for SOLAS 100-person inflatable self-righting liferafts.

3955

8. System operations manual (designed for crew use).

9. System certificates of manufacture.

The Contractor shall mount the vendor-supplied MES enclosures to the ship's structure in accordance with the Contract Drawings, system vendor guidance, and ABS rules.

3960 The Contractor shall mount the vendor-supplied MES liferaft stowage/launching racks in the MES enclosures on the vendor-supplied foundations with the mounting beds scribed and cut to account for the local deck camber. Underdeck structure in way of the mounting bed installations shall be configured to dissipate the maximum loads imposed by the slide equipment in both the undeployed and deployed situations; see the Contract Drawings. Similarly, the Contractor shall mount the vendor-supplied link liferaft stowage/launching racks on Solarium Deck on

3965 Contractor-fabricated foundations.

The Contractor shall mount the vendor-supplied bowing systems' components on the ship in conformance with vendor guidance and such that a complete and fully functional bowing

system is achieved for launched liferafts on each side of the vessel. Primary runs of bowing lines shall be stored and held in place in track along the ship's side in accordance with vendor guidelines.

The Contractor shall mount the vendor-supplied MOR system components in the starboard MES enclosure on the vendor-supplied foundations. Power shall be supplied to the winch motor as specified on the Contract Drawings. Storage hooks shall be used for securing the stowage bags associated with the MOR ladder and sled.

Padeyes shall be provided in the MES enclosure for the following purposes:

1. Two (2) padeyes shall be provided low on the inboard MES bulkhead to allow for the rigging-in of the MES skid (slide and stowage/launching rack) on to the rack foundation.
2. Two (2) padeyes shall be provided high in the MES overhead in way of the exterior door to allow for rigging and controlled retention of the exterior during launch test events.
3. One (1) padeye shall be provided for mounting of the MOR retrieval line pulley/shackle assembly in the MES enclosure overhead. This applies only to the starboard installation.

A light shall be provided in each enclosure, powered from a ship's emergency lighting circuit. A switch for this light shall be installed where shown on the Contract Drawing.

Adequate emergency lighting shall be provided in way of the embarkation area of each MES, and along exterior routes thereto.

The system vendor shall be involved, under agreement with the Contractor, in the supervision of the MES installations and testing and final commissioning of the installations. In accordance with USCG requirements, final testing of the MES installation shall include test deployment of at least one of the systems, followed by repacking and reinstalling on the vessel.

583.3 Life Jackets

Lifejackets shall be provided in types and quantities required by SOLAS regulations for operation of the vessel in its intended service, with full complement of crew and passengers on board.

All lifejackets shall include markings, attachments and fittings as required by regulation, including but not limited to:

1. Name of vessel in block capital letters.
2. Retro-reflective tape conforming to USCG Type Approval Series 164.018 and IMO Resolution A658(16).
3. Light conforming to USCG Type Approval Series 161.112 and securely attached to the front shoulder area of the lifejacket.
4. Whistle firmly secured by a cord to the lifejacket.

Lifejackets for passengers shall be stowed under the bench seating in the passenger lounges, dining room and elsewhere throughout the vessel as required by the regulatory agencies.

Lifejackets for crew members shall be located in their staterooms and work locations as required by the regulatory agencies. Final locker locations shall be approved by the Resident Engineer.

583.4 MES and Life/Rescue Boat Immersion / Anti-Exposure Suits

An immersion suit or anti-exposure suit shall be provided for each person assigned to the life/rescue boat and MES crews. Immersion suits shall conform to USCG Type Approval Series 160.171. Anti-exposure suits shall conform to USCG Type Approval Series 160.153.

4010 Lockers shall be provided for the immersion/anti-exposure suits and located as directed by the Resident Engineer.

583.5 Lifebuoys and Miscellaneous Equipment

4015 Lifebuoys conforming to USCG Type Approval Series 160.150 shall be provided. Lifebuoy quantities and locations shall be in accordance with the regulatory requirements. The Resident Engineer shall provide final approval on all locations.

Lifebuoys shall be stowed, marked, and outfitted with attachments and fittings in accordance with the requirements of 46 CFR 199.70(a).

584 FAST RESCUE BOAT AND DAVIT

584.1 Fast Rescue Boat

4020 The Contractor shall provide and install a rigid inflatable boat (RIB) Willard SEA FORCE 540 IB, or equal. The work boat shall be approximately 18' long and have a fiberglass reinforced plastic (FRP) hull with inflatable fender around the perimeter. The capacity shall be rated for a minimum of 6 persons or 1,000 pounds of payload.

4025 The boat propulsion package shall include a minimum 140 HP diesel engine with marine gear complete with a waterjet drive and steering helm. The boat shall be capable of making at least 8 knots with a full complement of persons. An integral fuel tank shall provide capacity for at least 4 hours at 8 knots with a full complement of persons.

The work boat shall have the following features and equipment:

1. Arch/A-frame with navigation lights.
- 4030 2. Single-point lift sling with release hook compatible with davit.
3. Instrumentation package including magnetic compass, tachometer/hour meter, temperature gauge, fuel gauge, and voltmeter.
4. Shore power system including a dedicated shore power inlet for integration with the ship's electrical system and portable battery charger.
- 4035 5. Electric and portable/manual bilge pumps.
6. Set of hull fittings including forward mooring bit, painter fittings, towing eyes port and starboard, and bow eye.
7. FRP seating and stowage, bow storage box, and aft stowage box.

The work boat shall be designed and constructed and equipped to IMO/SOLAS requirements.

4040 **584.2 Rescue Boat Davit**

The Contractor shall provide a davit and cradle assembly to store and launch the rescue boat similar to the configuration shown in Reference 070-01. The davit shall be designed for the necessary SWL rating to launch/recover the fully loaded rescue boat with up to 6 persons.

The davit shall fully comply with IMO/SOLAS requirements for fast rescue boats.

4045 **589 PASSENGER AND SERVICE ELEVATORS**

589.1 General

One (1) passenger elevator shall be provided serving all decks from the Main Deck to the Solarium Deck as shown on the Contract Drawings. One (1) crew only service elevator shall be provided serving all decks from the 1st Platform to the Boat Deck as shown on the Contract Drawings and Contract Drawings. Elevator speed shall be a minimum of 80 ft/min and a maximum of 90 ft/min in both the up and down direction.

The passenger and service elevators shall be from a single vendor with at least ten (10) years of demonstrated successful experience in the design and construction of oceangoing shipboard elevator systems. The components, design and assembly of these elevators shall meet and satisfy all regulatory requirements.

Both elevators shall be a heavy-duty, industrial, cable actuated traction type, specially designed to provide wheelchair access and egress from the elevator car and to allow access to physically impaired individuals between the Main Deck and the accommodation decks. Alternative configurations shall be approved by the Resident Engineer.

The State intends to operate the elevators while the ship is in motion. The elevators, together with ancillary equipment and controls, shall be designed to be operational and out-of-service within the vessel conditions listed in Table 500 - 10 below. Within the operational condition range, the elevator shall meet all specified design requirements at maximum rated capacity. Within the out-of-service condition range, the elevators shall remain undamaged. The elevators shall maintain alignment without additional adjustments, maintenance, or repair.

Table 500 - 10 Passenger and service elevator operation and out-of-service vessel conditions

	Operational	Out-of-Service	Notes
Roll	±10°	±30°	at 11 second period
Pitch	±5°	±10°	at 9 second period
Permanent List	±15°	±15°	
Permanent Trim	±5°	±5°	

A valid inspection certificate shall be provided to the Resident Engineer and a placard affixed to the elevator after testing and commissioning is complete.

4070 **589.2 Elevator Cars**

The passenger and service elevator car dimensions, doors, controls, markings, etc. are to comply with the requirements of the Americans with Disabilities Act (ADA). The interior car

dimensions for the passenger elevator shall be approximately 6'-2" by 5'-3". The interior car dimensions of the service elevator shall be approximately 6'-8" by 4'-2". Each car assembly shall be a welded structure. Both elevators shall be rated to handle at least 3,500 pounds. The wall and floor panels shall be well stiffened with painted sheet metal interior finish.

The cars shall be equipped with power-operated, center-opening, horizontal sliding doors, presenting a minimum clear opening of at least 3' wide by 6'-8" high to accommodate wheelchair passengers for the passenger elevator and 4' wide by 6'-8" high clear opening for the service elevator.

Both elevators shall have doors located on two sides of the cars, at opposite ends. The doors shall be equipped with a protective edge, which reverses the door motion if an obstacle is encountered while closing. A multi-beam infrared photoelectric system shall be employed on the doors to prevent the door's closing if an obstruction blocks any photoelectric beam. The photoelectric beams shall be installed on the fixed side of the door assembly. The door control logic shall include an adjustable time delay, holding the doors open for any time between 4 and 15 seconds.

Car equipment includes, as a minimum:

1. A sound-powered phone.
2. Handrails.
3. Car lights.
4. Battery-powered emergency lights with charger.
5. Ventilation fan.
6. Car escape hatch.
7. All additional fixtures to meet ADA requirements including all audio and visual alarms.

An outward-opening, removable escape hatch shall be located in the car ceiling and interlocked to completely remove power from the hoisting machinery (but not the lighting system) unless the hatch is closed and locked. The escape hatch shall be provided with a manual reset. Folding steps shall be provided in the car to provide access to the hatch.

A car-top inspection station shall be provided with a light and AC power receptacle located on the roof of the car for use during servicing and repair.

Deck covering, ceiling and bulkhead lining materials shall match the passenger deck areas. Standard color and style samples of bulkhead lining, ceiling, and deck covering shall be submitted to the Resident Engineer for approval.

Control location, arrangement, and signage shall comply with the ADA.

Control shall be vendor supplied as an integral part of the car assembly.

589.3 Elevator Controls

Elevator controls shall be designed and connected as required by the manufacturer and the regulatory bodies. These shall include call stations at the deck levels, stop switches in the car and pit, over-travel limit switches, supervisor's controls and car assembly controls. Control systems shall be vendor installed with the power source supplied by the Contractor.

Elevator controls shall be interfaced with an industry standard, heavy-duty, PLC suitable for shipboard ambient noise levels. Ladder diagrams for the PLC specific to the system installation shall be provided by the vendor. The PLC shall have gold contacts, and shall have permanent memory.

4115

The control panel shall include a key-operated switch to lock the elevator out-of-service and to lock out levels below the cabin deck by the crew without reprogramming the system.

Operation of elevators shall be automatic by means of the car and landing buttons. Stops registered by the momentary actuation of the car or landing buttons shall be made in the order in which the landings are reached in each direction of travel after the buttons have been actuated. All stops shall be subject to the respective car or landing button being actuated sufficiently in advance of the arrival of the car at that landing to enable the stop to be made. The direction of travel for an idle car shall be established by the first car or landing button actuated.

4120

“Up” landing calls shall be answered while the car is traveling in the up direction and “Down” landing calls shall be answered while the car is traveling down. The car shall reverse after the uppermost or lowermost car or landing call has been answered, and proceed to answer car calls and landing calls registered in the opposite direction of travel.

4125

If all calls in the system have been answered, the car shall park at the last landing served.

Supervisor's controls shall consist of a key-operated, off-on switch at the Main Deck control station that can be used to lock out the “Call” pushbutton at all control stations during emergency or test procedures.

4130

The elevator pit shall be provided with pit switches for locking the elevator when out-of-service. A car safety stopping system shall be provided in accordance with the ABS guide.

589.4 Hoistway Doors

When open, the passenger elevator doors shall present a clear opening of at least 3' to accommodate wheelchair passengers. When open, the service elevator doors shall have a clear opening of 4'. The doors shall be interlocked so that normal car operation is prevented if a door is open.

4135

The hoistway doors shall meet the U.S. Coast Guard requirements for A-60 elevator doors. The Contractor shall provide a redundant set of fire doors at applicable levels as required by the regulatory bodies.

4140

The passenger elevator doors at the Main Deck shall actually open onto a platform 6" above the Main Deck level, to avoid water getting into the elevator pit. Sloped ramps from the Main Deck shall be fitted up to the raised platform to allow wheelchair access.

The aft service elevator hoistway doors shall have an additional weathertight door at the Main Deck level, as discussed in Technical Specification Section 624, to avoid the trunk being considered a downflooding point.

4145

590 POLLUTION ABATEMENT SYSTEMS

593 MARINE SANITATION DEVICE (MSD) AND SEWAGE TREATMENT

4150 593.1 General

The MSD and sewage treatment system includes storage tanks, pumps, and MSDs. The MSD and sewage treatment system shall be designed and installed in accordance with Reference 593-01.

4155 The sewage treatment system shall have the capacity to collect and hold all sewage (blackwater) and wastewater (graywater), generated within a 24-hour period.

4160 All tanks shall be installed with a vent. The effluent tank shall have a passive vent led to the Vehicle Space with a ball check turning overboard above the Main Deck. The sewage tank and aft lift station tank shall each have a powered blower positioned in the casing above the Main Deck, which will carry the vent fumes from the tanks via an ejector system to the top of the stack.

The system shall not emit sewer gas odors in any compartment, working deck area, or weather deck area of the vessel.

4165 All pumps in the MSD and sewage treatment system shall be fitted with drip pans. A large containment coaming shall be fitted around the MSD skids and sewage transfer pumps in the lower MSD Space. The containment coaming shall be fabricated from 14-gage stainless steel plate with a 3" high coaming, and an approximately 6" wide open area around the skids or pump base. The containment coaming shall be arranged to prevent any spills during maintenance of the system components. Drip pans and containments shall be provided with plugs and dewatered with a portable pump if necessary.

4170 Additional deep p-traps, a minimum of 20" in height, shall be installed in the graywater and blackwater lines connecting to the sewage collection tank and the aft lift tank. Traps shall be sized to ensure vacuum created by the tank vent blowers will not purge the traps under any condition.

4175 See Technical Specification Section 431 for IMACS interfaces with the MSD and sewage treatment system.

593.2 MSD Plant

Three (3) MSD units shall be provided. The units shall be sized such that two units meet the capacity of generated blackwater and graywater aboard. The third unit shall be installed for redundancy and use during maintenance periods.

4180 Each MSD unit shall be an Omnipure 6440 Series Marine Sanitation Device, or equal, with a maximum treatment capacity of 10,680 gallons (40,430 liters) per day of combined gray and black water. Each unit shall be USCG type-approved and certified to IMO MEPC 227(64). The units shall include the optional centrifuge solids handling system for dewatering of wet solids.

4185 The MSD shall discharge dewatered solids to a solids holding tank. The solids tank shall have capacity to hold approximately 2,500 gallons based on a 14-day endurance with two MSDs operating at max output of 80 gallons per day. The solids tank shall be arranged for discharge to shore.

The MSD controls shall be arranged such that each MSD is in one of three operational modes. A single MSD shall be required to be selected as lead, lag, and standby respectively. A control panel shall be supplied with the MSD that shall determine set points.

A powered vent system known as the dilution blower option shall be provided with the MSD. Three (3) dilution blower skids shall be provided. The dilution blowers shall be dedicated to the effluent tank in order to vent hazardous gases from the effluent tank up the stack.

A chlorine removal system shall be provided with the MSD. The system is known as the de-chlorination option and is designed to counteract and remove hazardous chlorine from the treated sewage before it is discharged from the vessel.

593.3 Sewage Holding, Overboard, and Transfer System

The sewage holding tank shall have the capacity to hold approximately 23,000 gallons. The size of the tank shall be based on a one (1) day endurance for 292 persons (passengers and crew).

The sewage holding tank shall collect all untreated graywater and blackwater from all drains originating forward of the MVZ line. The sewage tank shall also receive sewage transferred from the aft lift tank by the sewage transfer pumps.

An aft lift tank shall be installed in the Shaft Alley & Pump Room. The aft lift tank shall collect all untreated graywater and blackwater from all drains originating aft of the MVZ line. The aft lift tank shall have the capacity to hold approximately 1,000 gallons based on a 2-hour endurance. The aft lift tank shall be fitted with a tank-level indicator, level switches to operate transfer pumps, and high-level alarm. All switches and level indication shall be designed to operate in sewage tanks and solids handling systems.

Two (2) identical non-clog sewage transfer pumps shall be provided with the aft lift station, each rated in accordance with Reference 593-01. These pumps will be dedicated to the transfer of sewage from the aft lift tank to the sewage holding tank. The pumps shall be sized such that each is able to pump out the aft lift tank to the sewage holding tank in ½-hour and be in accordance with Reference 593-01. Pump controls shall be arranged such that the pumps can operate independently or in a lead/lag arrangement with the ability to set either pump as the lead unit. The aft lift tank level switch start/stop and alarm settings shall be arranged such that lead pump starts at 70% full, lag pump starts at 80% full, pump(s) stops at 10% full, and high level alarm at 95% full.

Three (3) overboard discharge pumps shall be supplied with the MSDs (one per MSD), and have a suction/discharge rate equal to the discharge rate of the MSDs. The pumps shall operate such that when one MSD is online and processing sewage, one overboard pump shall be taking suction on the effluent tank overflow line and discharging overboard. When another MSD comes online, the MSD's dedicated overboard pump shall start and operate in conjunction with the current pump.

The sewage tank shall be fitted with two (2) identical macerating pumps to reduce the amount of large solids in order to aid in the transfer, treatment, and discharge of sewage. These pumps shall also be capable of discharging raw sewage to the shore connection, each rated in accordance with Reference 593-01. The pumps shall be sized to pump out the sewage holding tank in under 8 hours. The pumps shall operate in a start/stop operation and shall be manually operated by vessel crew when necessary. Start/stop controls shall be provided locally near the pumps.

The sewage holding tank, aft lift tank, and effluent tank shall be fitted with a flushing connection, utilizing seawater from the auxiliary service system. A rotating tank-cleaning nozzle shall be provided for each tank with a flanged connection for flushing.

594 OILY WATER SYSTEM

4235 594.1 General

An oily water system shall be provided to collect the vessel's oily water during normal operations for processing by the OWS in accordance with Reference 594-01. The oily water system shall consist of:

1. An oily water transfer pump.
- 4240 2. OWS.
3. OWHT.
4. Processing tank.
5. Shore connection.
6. Associated piping.

4245 See Technical Specification Section 431 for IMACS interfaces with the oily water system.

594.2 Oily Water Transfer System

The oily water transfer pump shall be a positive displacement diaphragm pump and shall be horizontally mounted. The oily water transfer pump shall be sized in accordance with Reference 594-01.

4250 The oily water transfer pump shall be located in the Aft Machinery Room. The pump shall take suction from the bilge suction manifolds and shall discharge to the OWHT or to the processing tank. The pump shall act as a bilge house-cleaning pump. The pump shall also be able to take suction from each tank and discharge to a shore connection. The shore connection shall be shared through the waste oil crossover line.

4255 The piping systems shall include crossover lines between the waste oil pumps and oily water transfer pumps suction and discharge lines. The waste oil pump shall provide back-up service for the oily water pump (see Section 543).

594.3 Tanks

4260 The OWHT and the processing tank shall be a minimum of 1,000 gallons capacity each. Oily water shall generally be pumped directly to the OWHT via the oily water transfer pump and allowed to decant. The oily water shall then be pumped via the oily water transfer pump to the processing tank through a filter and stored, to be processed by the OWS.

The OWHT shall have direct gravity fills from the Emergency Generator Room as well as the Workshop sink.

4265 The OWHT and processing tank shall each be fitted with:

1. High level alarm.
2. Remote TLI.

3. Sounding tube.
4. Vent to the Main Deck.

4270 Each tank will also contain hot water heating coils as described in Section 517. The processing tank shall be fitted with a low-level switch for stopping the OWS.

594.4 Filtration

4275 A filter with minimum 50 fine-mesh perforations shall be provided for mechanical separation of the oily water before entering the processing tank. The filter should remove any foreign debris that would be difficult for the OWS to process.

594.5 Oily Water Separator

4280 A USCG approved OWS shall be provided to process oily water from the processing tank for overboard discharge. The OWS shall be a GEA Westfalia WSE 10 Bilge Master 1200 Clean Design System or equal. The OWS shall be a centrifugal-type separator with heater and shall have a demonstrated ability to separate with environmentally acceptable lubricants.

The OWS shall be equipped with an oil content monitor and shall discharge water with an oil content of not more than 15 parts per million (ppm). Discharge effluent with oil content higher than 15 ppm shall be re-circulated back to the OWHT. The low-level switch in the processing tank shall automatically secure the OWS.

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SECTION 600 OUTFIT AND FURNISHINGS

REFERENCES

- 070-01 *General Arrangements*, AMHS Drawing No. 14-070-001-001.
 651-01 *Galley Arrangement Drawing*, AMHS Drawing No. 14-651-017-001 [To Be
 10 Developed].

601 GENERAL REQUIREMENTS

601.1 General

15 All outfit materials and furnishings shall be of commercial marine quality, in full compliance with the specifications and suitable for the intended use. All outfitting materials shall be USCG and ABS approved. Unless explicitly stated otherwise, all materials and furnishings shall be new and unused, except for factory testing, of current manufacture, and currently supported by spare parts. In general, outfitting materials and furnishings shall be supplied by a single vendor.

20 Joiner bulkheads, linings, shelving, and furniture shall be fabricated and installed to follow the shape of the hull and make maximum utilization of the available volume in each compartment. This requirement may necessitate customization of the outfit, furniture, and furnishings for some compartments. Squaring off boundaries and creating unusable voids behind the joiner work shall not be accepted. In areas where there is extensive hull shape the joiner work shall extend vertically upward 3'-6" and if possible, step back before continuing upward creating a shelf along the bulkhead. The minimum step back shall be 9". Areas where the step back would be less than
 25 9" may be left as a single vertical surface.

30 All outfitting materials and furnishing, both prefabricated and customized, shall provide for the elimination of sharp edges, corners, and burrs that might cause injury to personnel, damage to equipment, unsightliness of the equipment, or that might hamper cleaning and maintenance. Latches shall be provided for doors and drawers to prevent opening while underway. Drawers shall be drop-track suspended on steel tracks with nylon slides and positive stops to prevent them from falling out when open. Removable sea rails shall be provided for storage shelving. Shelving and tabletops shall be provided with raised and rounded lips on exposed edges. Penetrations in counters shall be sealed watertight.

601.2 Interior Décor

35 The Contractor shall prepare color boards and provide samples of all interior finishes and materials. Finishes shall be consistent throughout the vessel. The final interior finishes, material selection, and colors shall be approved by the Resident Engineer.

602 LABEL PLATES AND MARKINGS

602.1 General

40 All applicable nameplates, signs, labels, notices, and other similar markings and devices shall be provided throughout the vessel as required by these Specifications, USCG regulations and ABS rules, and the applicable requirements of cognizant local, state, and federal authorities.

All Working Drawings, signs, notices, and markings shall reflect the “as-built” conditions of the vessel.

45 All markers, labels, notices, and signs in public spaces shall be coordinated and developed with the interior décor. Such items shall be of high contrast and shall be sized for the visually impaired. Signage and advisories shall be in accordance with ADA, including Braille and notices to the hearing impaired. These notices shall be provided throughout the parts of the vessel that are accessible to passengers.

50 Lettering shall be clear and concise and have a minimum of abbreviations.

Attachments shall be such as to prevent theft and vandalism.

All signage required by regulatory agencies shall state the warning or advisory and cite the applicable code or requirement.

55 The Contractor shall prepare a label plate and marking schedule for approval by the Resident Engineer. The label plate and marking schedule shall list the material, location, and wording for instruction plates, nameplates, markings, signs, notices, and all other similar markings.

Label plates for any specific purpose shall be uniform in size and of the same material. Lettering shall be at least ½" high of the same style, all capital letters. A symmetrical and well-balanced arrangement of letters and lines shall be used. The color, material, and style of label plates shall
60 be approved by the Resident Engineer.

Label plates shall be located to ensure visibility and shall not be located where they can be obscured by furniture, pipes, or other fittings.

Label plates installed in the weather or areas exposed to seawater shall be UV resistant and sealed to prevent seepage behind the plates.

65 All equipment and components shall be labeled as to service and function. All remote operating gear shall be labeled. All bulkhead and ceiling access plates shall be labeled as to the service concealed. Exterior vents and outlets shall be labeled.

Whenever possible, warning and advisory markings shall be positive in tone rather than negative.

70 The Resident Engineer will provide the design and dimensions of the insignia and approve final locations for all insignias.

602.2 Official Number Markings

The vessel's official number shall be permanently marked on the vessel's main beam by deep center punching and painted with high-gloss black epoxy.

602.3 Ship's Name Boards

75 A solid brass Owner's nameplate shall be provided and mounted in a location approved by the Resident Engineer. It shall be of an Owner-approved design, with a legend containing the name of the vessel and “Alaska Marine Highway System.”

Carved teak name boards shall be provided port and starboard. The name boards shall be mounted at the Solarium Deck or above, in way of the Pilothouse. The name boards shall be
80 finished bright, and 12" high letters shall be gold paint. Letters shall be of the “Vee” groove type.

602.4 Builder's Plaque

85 A solid brass Builder's nameplate shall be provided and mounted in a location approved by the Resident Engineer. The plaque shall be approximately 3' x 2' in size. It shall be of a design approved by the Resident Engineer, with a legend containing the name of the vessel, year built (keel laying), the builder, builder's hull number, the State, and the naval architect (Glosten).

602.5 Alaska Marine Highway System Logos and Markings

90 Funnel markings shall be the Alaska state flag symbol of stars in the big dipper and the north star. The Contractor shall develop the insignia proportions to suit the vessel's funnel and submit to the Resident Engineer for approval during the detail design.

The funnel insignia shall be of ¼" steel plate, seal-welded and ground smooth as a guide for repainting.

95 A color band, similar to that shown on the outboard profile shall be marked by 2" weld beads along its top and bottom edge every 18', around the entire periphery of the vessel as a guide for repainting.

Paint colors for funnel insignia, color band, ship name and hailing port shall be as specified by the State and Section 631.

602.6 Space Designation and Access Marking

100 Doors, watertight hatches, manhole covers and scuttles throughout the vessel shall be labeled, including description of the space being entered from the given side of the boundary and the compartment number.

105 Compartment numbering shall follow Navy standard convention (XX-YYY-Z) where "XX" gives the deck number, "YYY" gives the frame number and "Z" indicates port, starboard or centerline. The passenger cabin numbering scheme shall follow the guidelines the State has developed. This scheme will be provided to the Contractor during the detail design phase.

110 All passenger staterooms, officer and crew cabins and all public rooms shall be provided with engraved phenolic labels stating the name or room number of the space to be entered on the entrance door exterior or above the door where the door is permanently open. The labels shall have white letters on a black background for the officer and crew cabins and shall have contrasting colors on a background compatible with interior décor in passenger spaces.

115 All other doors, watertight hatches, manhole covers and scuttles shall have identification plates of brass, 1/20" thick and at least 2" wide. The characters shall be engraved 1/50" deep and filled with black enamel except where otherwise required. In general, letters shall be ¼" high and not less than 3/16". Fastenings shall be of brass or bronze and at least 1/8" clear of characters and edges.

"CREW ONLY" signs and labels shall be provided and posted at boundaries between crew and passenger areas and where passenger access is not allowed. This includes signage/labels on doors, security gates, chain rails and portable rails, as required.

602.7 Machinery and Equipment Markings

120 System and component identifying labels or nameplates shall be provided and installed throughout the vessel. Lettering shall be not less than $\frac{3}{16}$ " in height. Primary information shall be in letters of larger size than secondary information.

For all machinery and equipment not otherwise labeled by the manufacturer, a label plate listing the function of the component and other pertinent data shall be provided and installed.

125 A label shall be provided and installed for all instruments, indicating the purpose of the instrument.

602.8 Piping and Ventilation Designation and Markings

Ventilation ductwork and related equipment and piping, valves and related equipment shall be labeled as follows:

- 130
1. Piping and ducts shall be marked at least once in every space and at least twice in engine spaces, preferably near bulkhead penetrations.
 2. Pipe exposed to the weather shall be marked by label plates.
 3. Marking is not required in voids, bilges, or similar unmanned spaces, or in cases where the run is identified by a nearby valve or piece of equipment where the function is
 - 135 obvious.
 4. A direction-of-flow arrow shall be painted on all pipes or ducts within a space.
 5. At the interconnection of systems, each shall be marked nearby if practicable.
 6. Ventilation ducts shall be marked with system number preceded by the word "EXH," "SUP," or "RECIRC," as the case may be.
 - 140 7. Pipes shall be marked with a name describing the system, such as "L.O. FILLING," "COLD F.W.," "FIRE MAIN," etc. Lettering and flow arrows shall be stenciled using color paint as required below, except where the color of the pipe or duct is so dark that white must be used for the marking to be legible.

The size of stenciled letters shall be generally as follows:

- 145
- All insulated pipe: $1\frac{1}{2}$ " high lettering
 - 2" and above, bare pipe: $1\frac{1}{2}$ " high lettering
 - $1\frac{1}{2}$ " to 1", bare pipe: 1" high lettering
 - $\frac{3}{4}$ " and $\frac{1}{2}$ ", bare pipe: $\frac{1}{2}$ " high lettering
 - $\frac{3}{8}$ ", bare pipe : $\frac{3}{8}$ " high lettering
 - 150 • Ventilation ducts: $1\frac{1}{2}$ " high lettering

Valve handwheels and remote operator handwheels shall be painted to match the system color code listed below in Section 631.5.3.

155 Valves shall have label plates conforming to ASTM F992. In general, label plates shall be of the brass under-nut type with letters and numbers etched or engraved and filled with enamel, though other non-corrosive metals may be substituted subject to approval. All remote-control valve

operators, tank fills, and sounding tubes shall be clearly identified with labels stating their purpose. Labels shall be engraved and of approved non-corrosive material.

All valves shall be labeled except where the function of the valve is obvious. The label shall list the function of the valve. Remote operated valves shall be marked at the handwheel location and at the valve. Valves located beneath grating or floor plates shall be labeled, and a label plate duplicate shall be secured to nearby structure above floor plates or on the access section so that they can be easily seen. Labels may be engraved on the handwheel, or label plates secured to the handwheel or adjacent structure.

Valves shall have a unique numbering system shown on all labels and system drawings. Valves shall be labeled, where appropriate, indicating "normally closed" (with NC) or "normally open" (with NO). The valve numbering system shall match the preliminary scheme developed on the system drawings or an alternative shall be provided to the Resident Engineer for approval. The Contractor is responsible for all valves to be uniquely numbered. System drawings are not representative of all valves in each system.

All machinery and equipment, not otherwise labeled by its manufacturer, shall have a label plate listing the function of the component and other pertinent data.

Label plates shall have characters that are $\frac{3}{8}$ " high where possible, but in no case less than $\frac{3}{16}$ " high.

Dampers and closers in the ventilation system shall be labeled as to open and closed position, and as to the compartment or system affected.

602.9 Electrical Designation and Markings

All fixed electrical equipment shall be fitted with identifying label plates. All electrical outlets shall be labeled with circuit identification. All junction boxes shall be labeled with system and circuit identifiers. Label plates shall include the identification of the electrical circuit powering the equipment. Any special instructions or precautions shall be included on the label plate or on a separate plate on or adjacent to the equipment. Blank nameplates shall be provided for spare feeder switches and circuit breakers. Switchboard and distribution panel busses shall be stamped in a readily visible location with their polarity or phase identification.

Temporary labels shall be installed on the cable as it is installed.

Cables shall be permanently labeled at the time of final installation on board the vessel. Using embossed corrosion-resisting metal cable tags with embossed letters and numbers, each cable shall be identified with its circuit number at all points of connection, penetrations to equipment, wiring devices, through bulkheads and decks (both sides), and all other locations where both sides of the penetration are not readily visible for cable tracing. The Contractor shall provide the circuit-numbering scheme for review by the Resident Engineer.

Permanent, readable wire markers shall be provided for individual conductors at all terminal points and shall uniquely identify the conductor using the cable circuit number for a base.

All operators and indicators shall be labeled with nameplates that mount on the circumference of the device. Label plates shall be either engraved phenolic or metal and shall indicate the purpose, function, position, or condition, as required. Each motor controller shall have an external label that shall indicate the controller name, circuit number, motor horsepower, and circuit breaker rating.

Size of nameplates shall, in general, be selected to conform to the relative size, type, and prominence of the equipment for which they are used.

- 200 The size of the lettering shall be selected to give predominance to circuit designation, with smaller letters being employed for secondary information.

602.10 Regulatory Markings

- 205 The Contractor shall provide label plates, markings, signs, and instruction plates required to comply with the cognizant local, state, and federal regulatory agencies. These include, but are not limited to, exit signs, pollution abatement, rudder orders, non-smoking signs, fire alarm bells, fire alarm pull-boxes, fire screen door numbers, and aids to mobility-impaired persons.

The Contractor shall provide at minimum nameplates, signs, labels, notices, and other similar markings for the following:

- 210 1. Lifesaving Equipment - To include identification labels and instructions concerning the use of inflatable buoyant apparatus, liferafts, marine evacuation slide systems, davits, and lifeboats.
- 215 2. Fire Extinguishing Equipment To include identification labels and instructions concerning the use of fire stations, fixed system alarms and flooding system, fire sprinkling control station, general alarm, ventilation shutdown mechanisms, fire dampers, and other emergency systems.
- 220 3. Passenger and Vehicle Space Signage To include:
- a) Photoluminescent striping for emergency escape as required by USCG and ABS, including tactile signage in compliance with ADA recommendations.
 - b) Restroom signs in sufficient quantity to direct the public to toilet spaces.
 - c) Elevator signage with directional arrows in sufficient quantity in the Vehicle Space and passenger decks to direct the public to the elevators.
 - d) Signage to direct passengers to muster stations, lifeboats, the marine evacuation slide systems, and life preserver lockers.
 - e) Other ADA signage, as recommended by ADA guidelines.

- 225 Plastic instruction plates shall be provided for operating instructions and emergency procedures as required to safely navigate and operate the vessel, including but not limited to the following:

- 1. Pilothouse:
 - a) Emergency ventilation shutdown procedure.
- 2. Switchboard:
 - 230 a) PTO and SSDG startup and paralleling procedures.
 - b) Shore power connection and switching procedure.
 - c) Emergency ventilation shutdown procedure.
- 3. Paint Locker:
 - a) Fire extinguishing system activation.

- 235 4. Emergency Generator Room:
- a) Fire extinguishing system activation.
5. Chemical Locker:
- a) Fire extinguishing system activation.
6. Accommodation spaces automatic sprinkling system manifold:
- 240 a) Sprinkling system setup, testing and operating procedures.
7. Vehicle Space:
- a) Deluge system actuation procedure (located adjacent to deluge system valve manifold).
 - b) Shore power connection procedure.
- 245 c) Stern and side port loading door operating procedures.
8. Thruster Equipment Room:
- a) Operating and emergency procedure.
9. Forward Machinery Room and Aft Machinery Room:
- a) Fire extinguishing system activation.
- 250 b) Oil pollution prevention procedure.
10. Vehicle elevator:
- a) Normal and emergency operating instructions.
11. Passenger and service elevator:
- a) Emergency call pushbutton operating instructions.

255 602.10.1 Alarm Markings

The alarm markings shall be in 1" high red letters in visible locations.

602.10.2 Markings at Firefighting Equipment

260 The various firefighting systems and the emergency gear lockers shall be conspicuously marked in red letters, at least 2" high: "FIRE SUPPRESSION AGENT" "WATER SPRAY FIRE APPARATUS," "MANUAL SPRINKLING SYSTEM," "EMERGENCY GEAR LOCKER," as the case may be.

Each fire hydrant shall be marked in red letters, at least 2" high: "FIRE STATION NO. 1" (or "NO. 2," "NO. 3," etc.).

Each hand-portable fire extinguisher with a number and stowage location shall be marked with a corresponding number at least ½" high.

265 Fire axes, hoses, etc. shall bear the vessel's name.

602.10.3 Emergency Lights

Emergency lights shall be marked with a letter "E" at least 1" high.

602.11 Miscellaneous Labels, Signs, and Markings

The following markings are to be provided in accordance with regulatory body requirements:

- 270 1. Self-contained breathing apparatus.
- 2. No smoking signs.
- 3. Fire door markings.
- 4. Watertight door markings.
- 5. Fire damper markings.
- 275 6. Exit signs (lighted).
- 7. Embarkation direction signs to life rafts and lifeboats.
- 8. Life raft and lifeboat station signs.
- 9. Life preserver markings and operation instructions, etc.
- 10. Lifeboat, life raft, life buoy and buoyant apparatus markings.
- 280 11. Life Saving Equipment Instructions.
- 12. Thruster direction.
- 13. Steering control transfer procedure.
- 14. Emergency steering selection and operation.
- 15. Emergency call to EOS.
- 285 16. Fire door release procedure.

Any other signs required by the regulatory bodies shall also be provided.

Plastic laminate signs shall be provided for each of the flashing lights or beacons installed in the machinery rooms. These signs shall identify the function of the light, with large lettering easily visible from across the space.

- 290 Lifesaving equipment instructions shall be provided as phenolic, UV-resistant placards.

At the entrances to the FMR and Aft Machinery Room, and at the entrance to any other space where the noise levels exceed 84 dB(A), signs shall be posted reading “DANGER – HIGH NOISE LEVEL, HEARING PROTECTION REQUIRED.”

602.12 U.S. Public Health Services Notices

- 295 Notices shall generally be engraved phenolic brass or stainless steel as applicable for the location. Notices shall include, but not be limited to, the following:

- 1. “POTABLE-WATER HOSE ONLY” (minimum 1" high letters).
- 2. “POTABLE-WATER FILLING” (minimum ½" high lettering - stamped noncorrosive label plate).
- 300 3. “WASH HANDS OFTEN” (adjacent to galley lavatory).
- 4. “SEWAGE DISCHARGE ONLY” (adjacent to deck connection discharge valve).

602.13 Marking of Padeyes

Padeyes shall be marked with their safe working load.

602.14 Certificates, Licenses and Notice Frames

305 Glazed frames of corrosion-resisting metal, hinged if necessary and finished to suit their locations, shall be provided for all required notices as approved by the Resident Engineer, including, but not limited to, the following:

1. ABS Classification Certificate.
2. ABS Load Line Certificate.
- 310 3. Admeasurement Certificate(s).
4. USCG Stability Letter.
5. USCG Certificate of Inspection.
6. Vessel Fire Control and Safety Plans.
7. Certificates of Licensed Officers.
- 315 8. Pilot Rules.
9. Light Rules.
10. Station Bills/Emergency Signals.
11. Life Preserver Notices.
12. Ship's Radio License.

602.15 Fire and Safety Plan Displays

Laminated or phenolic-backed copies of the ship's Fire and Safety Plan (printed in color using regulatory body-required symbols) shall be posted throughout the vessel in accordance with regulatory requirements and as approved by the Resident Engineer. Three additional full-size copies of the plans shall be provided to the Resident Engineer.

602.16 Warnings, Caution, Operating, and Instruction Plates

Warning, caution, operating, and instruction plates shall be installed in accordance with USCG regulations.

330 All labels are to be in the English language regardless of the national source of the equipment. Non-corroding commercial label plates provided by the equipment manufacturer which contain the required information are acceptable. Commercial label plates that are deficient in any portion of the required information may be used and augmented by Contractor-installed label plates as required.

602.17 Whiteboard and Bulletin Boards

335 A white marking board (dry-erase) of approximately 2' x 3', and a cork-surfaced bulletin board of 2' x 3' with glazed frame of corrosion-resisting metal, shall be provided and installed in the

Officer and Crew Messes. Additionally, magnetic, white marking boards (dry erase) of approximately 2' x 3' shall be provided and installed in the Pilothouse and EOS.

A tank sounding board, suitably sized, marked and lined, shall be provided at a location approved by the Resident Engineer.

340 **602.18 Passenger Orientation Plans**

Color laminate passenger orientation plans shall be provided. Passenger orientation plans shall be conspicuously posted at or near the entrance to each passenger stateroom passageway and major public spaces and should show the passenger's present location and give the directions to the most commonly used spaces and facilities in the ship. Each plan posted shall identify the
345 location on the plan where the passenger currently is (i.e., "YOU ARE HERE"). The Contractor shall provide orientation plans in the following locations:

1. Stair tower, each level.
2. Purser's foyer.
3. Solarium.
- 350 4. Observation lounge.
5. Food service area.
6. Aft passenger area (in passage).
7. Forward passenger area (in passage).

These plans shall clearly indicate all accessible areas and paths on the Main Deck and above.
355 Location shall be as approved by the Resident Engineer prior to delivery.

All display plans shall be submitted to the Resident Engineer for review and approval prior to production and installation.

602.19 Directional Signage

Low-location lighting consisting of photoluminescent escape route marking strip,
360 photoluminescent escape route symbols, and photoluminescent firefighting equipment markings shall be provided and installed throughout the vessel in accordance with the requirements of this section and the guidelines of IMO Resolution A.752 (18). Such markings and symbols shall be provided throughout the vessel (except within the Pilothouse) to facilitate emergency egress of all persons on board, and to ensure ready identification of firefighting equipment throughout the
365 vessel.

Low-location photoluminescent strip markings shall be provided and installed in all accommodation and work areas, and all stairwells and passageways leading from these spaces to the muster stations. Small compartments, such as cabins, do not need photoluminescent markings; however, large spaces such as the Dining Area, messes, lounges, and Theater shall be
370 fitted with such markings.

Markings and symbols shall be mounted on flat vertical surfaces (e.g., bulkheads and doors), except for specific locations where other mounting schemes are proposed by the material supplier.

The Contractor shall ensure that the lighting system in the areas with photoluminescent markings installed provides sufficient illumination to charge the photoluminescent markings in accordance with the manufacturer's recommendations.

603 HULL MARKINGS

603.1 General

The hull markings shall be in colors specified unless otherwise approved by the regulatory bodies and the Resident Engineer.

603.2 Ship's Name and Hailing Port - Hull Marking

The vessel's name shall be placed on both sides of the bow and on the transom in block letters 24" high. The hailing port shall be placed on the transom in block letters 12" high. All letters shall be constructed of ¼" Type 316L stainless steel and seal-welded to the hull and painted white.

603.3 Draft Marks

Draft marks shall be Arabic numerals of 6" projected height. Marks shall be of ¼" steel plate, seal-welded and ground smooth, and painted white. The bottom of each figure shall be at integer feet above the bottom of the keel. The numbers shall be cut using a computer-controlled cutter.

Draft marks shall cover the draft of the vessel under all probable conditions of loading and corresponding trims.

The centerline of each set of draft marks shall be in a plane perpendicular to the vessel's centerline plane and to the molded base plane.

603.4 Load Line Marks

Load line marks shall be provided in accordance with regulatory body requirements. Plimsoll figures shall be painted in accordance with Section 631.

603.5 Thruster Marks

Thruster marks shall be provided above the bow thruster locations. Thruster figures shall be painted in accordance with Section 631.

604 LOCKS, KEYS, AND TAGS

604.1 General

Hardware on all doors and other closures shall meet regulatory body requirements including those associated with UL's 3-hour A label rating for single swing doors.

All hardware shall be supplied by the door manufacture. All locks, padlocks and cylinders shall be supplied by one manufacturer.

All hardware shall be of the best marine quality, heavy-duty type, ruggedly constructed, with satin stainless steel finish. Screws for securing items to closures shall be stainless steel, countersunk and finished to suit the item secured.

410 All doors shall have bored locks with ADA approved lever handles with turnback on both sides of the door.

Tamper-proof screws shall be provided for hardware in all public areas.

Lock strikes shall have extended lips to protect the closure trim from the latch bolts.

604.2 Lever Locksets for Joiner Doors

415 Each passenger stateroom joiner door shall be fitted with a cylindrical type corridor lock with the following operating characteristics:

1. Deadlocking latch retracted by either lever.
2. Pushing the inside button locks the outside lever until either unlocked by key from the outside; turning the inside lever; or closing the door.
- 420 3. Pushing and turning the inside button locks the outside lever, latch is retracted either by key or turning inside lever.
4. Lever remains locked until button is manually returned to unlocked position.

Each crew stateroom joiner door shall be fitted with a cylindrical type dormitory deadlocking latchbolt with the following operating characteristics:

1. Deadlocking latchbolt operated by lever from either side.
- 425 2. Lever locked or unlocked by key from the outside or by push button from the inside.
3. Key outside, rotating the inside lever, or closing the door releases button unlocking outside lever.

430 Each joiner door of storerooms, lockers, machinery spaces (in public areas only) and crew areas shall be fitted with a cylindrical type classroom deadlocking latchbolt with the following operating characteristics:

1. Deadlocking latchbolt operated by lever from either side, except when outside lever is locked from outside by key.
2. When outside lever is locked, latchbolt is operated by key outside or by rotating the inside lever.

435 Each private and semi-private toilet or shower space door shall be fitted with a cylindrical type privacy lockset operated by lever on each side. The outside lever shall be locked by a pushbutton from inside the toilet space. The lockset shall be unlocked by key on the outside, by rotating the inside lever, or by closing the door.

440 Each entrance door to a public, multi stall, toilet space shall be fitted with a cylindrical type classroom lockset with no means for locking from inside the space.

Each emergency exit door shall be fitted with fire exit “panic hardware” with a key lock lever trim device on the outside.

Each public exterior door shall be fitted with a cylindrical type classroom lockset operated by lever on each side and having a locking key on the outside and a panic-proof knob on the inside.

445 Each expanded metal door and each door to a refrigerated space shall be fitted with a heavy-duty tamper-proof hasp and staple. Keyed padlocks shall be provided for these doors.

Doors of types not addressed above shall generally be of the passage latch type, except where a more suitable type is identified and approved by the Resident Engineer. Latchbolts shall be operable by lever from either side at all times.

450 **604.3 Keys**

Six (6) keys with tags shall be provided for each door giving access to a living space. Each door to non-living spaces shall have three (3) keys. The keys to each lock shall be different from the keys to other locks, except where there is more than one door to the same compartment, in which case they shall be keyed alike.

455 Key stock for all keys shall be readily available in Alaska.

604.3.1 Key Lockers

Key lockers shall be provided in the Steward's Office, Purser's Office, Chief Engineer's Stateroom, and the Master's Stateroom, to stow the keys that come under the supervision of the various ship department heads. Each locker shall be fitted with hooks, with names or numbers at
460 each hook for readily distinguishing the keys. Each key locker shall be provided with a lock and key.

604.3.2 Grouping of Locks

Door locks of the same type shall be master keyed in the following groups, as appropriate to their service:

- 465
1. D – Deck Department.
 2. E – Engineering Department.
 3. P – Purser Department.
 4. S – Steward Department.

Door locks to staterooms shall have individual keys.

470 604.3.3 Master Keys

Three master keys shall be furnished for each of the groups, and three grand master keys for all groups. Padlocks shall be similarly grouped and master keyed, with three (3) sets of keys provided. An additional set of keys shall be provided to the Resident Engineer for inspection purposes. Group master keys and grand master keys shall work uniformly in all types of locks.

475 604.3.4 Numbering

Keys shall be numbered and have a tag of heavy fiber or plastic with the name of the department, space, and vessel inscribed thereon. A key tag index book, in loose-leaf form, shall be prepared identifying the key tag number, the key serial number, and the compartment or item secured by the key.

480 A lock, key, and tag index for spaces and equipment shall be prepared.

604.4 Programmable Locks

Security doors shall have programmable keypad-controlled lever latch locks on the passenger side, weatherproof, and approved by the Resident Engineer. Crew side of door shall have non-

locking lever latch inaccessible from passenger side. Latches in way of wire mesh door or partitions shall have non-locking knob latch on crew side.

Programmable keypad-style lock system shall be provided on the following doors:

1. Doors leading from passenger-accessible areas to crew living and work areas, including weather deck security fence gates.
2. Doors in the casing leading into the Vehicle Space from passenger areas above the Main Deck.
3. Doors leading down into machinery spaces below the Main Deck from the Vehicle Space and passenger-accessible stairwells in the casing.

The lock system shall be programmable from a central location, with all doors having the same code.

605 RODENT AND VERMIN PROOFING

Rodent and vermin proofing features shall be provided to protect the ship from infiltration by rodents and vermin (cockroaches, flies, etc.) to the maximum extent practicable. Rodent and vermin proofing features shall be provided in accordance with USPHS/Maritime Administration's Joint Publication No. PB 61010, to entitle the vessel to receive both a "Deratization Exemption Certificate" and a "Certificate of Sanitary Construction."

Aluminum funnel-type rat guards shall be provided for each mooring and spring line.

610 SHIP FITTINGS AND MOORING EQUIPMENT

611 HULL FITTINGS

611.1 Deck Chafing Plates

Chaffing bars shall be provided at all sharp or discontinuous edges to minimize damage to lines.

611.2 Mooring Fittings

See Technical Specifications Section 582.

611.3 Hull Fittings

Hull fittings shall be provided, sized, and located as required to safely secure, launch, and recover the life/rescue boats, life rafts, and MES systems. Locations for the hull fittings shall be Resident Engineer approved prior to installing the fittings.

Hull fittings shall be provided, sized, and located as required to secure covers, gates, doors, hatches, and other moveable equipment. Locations for the hull fittings shall be Resident Engineer approved prior to installing the fittings.

Cleats or other fittings shall be provided and installed for lines from masts and staffs.

611.4 Securing Fittings

611.4.1 Padeyes

520 Padeyes shall be provided throughout the vessel in number, location, and capacity to suit the anticipated loads. Padeyes shall be provided for convenient and rapid handling of stores to and from storerooms. Padeyes and lifting fittings shall be provided over machinery, as may be necessary for lifting parts of the machines and transfers to the workshops or over-the-side. Padeyes shall be located and installed in order that the load will be applied in the plane of the eye or shall be designed for side loading when required by the handling arrangement.

611.4.2 Vehicle Lash-Down Buttons

525 Raised deck buttons-type tie downs rated at 15.9MT working load shall be installed on the Main Deck in the Vehicle Space for securing vehicles as shown on the Contract Drawings. Buttons shall be Peck and Hale F266-1C-1 or equal and welded to the deck on ½" plate doublers. All buttons shall be placed at intersections of webs and longitudinals. Where this is not possible, additional under-deck structure shall be added to compensate.

530 Flush tie downs Peck and Hale F518-1E, or equal, shall be used in place of the raised buttons in way of the vehicle turntable as shown on the Contract Drawings.

611.4.3 Vehicle Space Tire Rail

535 A tire rail/lashing rail (curb) shall be provided and installed in the Vehicle Space as shown on the Contract Drawings. The tire rail shall be fabricated from 3" Schedule 80 steel pipe supported by ½" steel "crinkle" (round) lashing bar. The curb shall be located as follows:

1. Around the perimeter of the Vehicle Space.
2. Around the perimeter of the machinery casing, passenger elevator trunks and ladderways.

The curb shall be located a minimum distance of 6" from the curtain plate or bulkheads. Cutouts shall be provided in way of doors and walkways as shown on the Contract Drawings.

611.4.4 Garbage Bin Lash-Down Fittings

540 Garbage bin lash-down fittings shall be provided for two bins located as shown on Reference 070-01.

611.4.5 Eyebolts

545 Eyebolts, ringbolts, cleats, and other fittings necessary for the attachment, working, belaying, and securing of all parts and appliances shall be fitted. Portable fittings on deck shall be arranged to leave the deck flush when the portable parts are removed and stowed.

Sockets and supporting structure shall be designed to safely withstand the largest load that can be applied to the eyebolt. Sockets on the weather decks or in the vehicle space shall be Type 316L stainless steel.

550 611.5 Lookout Station Weather Screen

A weather screen of rugged construction shall be provided at the bow lookout station to protect the lookout's upper body from wind and sea spray. The screen shall be fabricated from thick plexiglass and metal framing and configured to be readily dismantled or retracted to protect the

555 screen during severe storms. The screen shall afford protection from wind and spray over a 90° horizontal arc centered at the bow (up to 45° port and starboard). The back, top, and sides of the lookout station shall be exposed to the weather.

612 RAILS, STANCHIONS AND LIFELINES

612.1 General

560 All accessible areas of exterior decks not protected by bulwarks shall be fitted with liferails. Safety harness tiedowns shall be provided on the top of stack.

Removable lifelines and removable lifeline stanchions shall be installed where a clear deck edge is required, such as gangway locations, life/rescue boat launching, and life raft launching.

612.2 Liferails

565 Galvanized steel handrails shall be provided around all exterior decks and landings as required by regulations.

All rails shall be free of clothes-entangling projections and supported and braced to prevent vibration. Rails shall have a minimum finger clearance of 2" from any structure.

Safety rails shall be provided for the Pilothouse maintenance platform and forward Observation Lounge for window cleaning. The rail shall be suitable for attachment of safety belt clips.

570 Periphery life (storm) rails in way of passenger weather deck areas and inclined ladders shall have a top rail of 4¼" by 2½" oval section with five additional equally spaced pipe courses below the top rail.

575 Periphery storm rails on the Solarium House Top, where not accessible to passengers, shall have at least three pipe courses inclusive of the top rail. The top rail of these storm rails may be of circular cross section and standard rail dimensions in lieu of the oval cross section described above for other rails.

Liferails for the hinged deck sections in way of the vehicle elevator shall accommodate the movement (opening and closing) of the deck sections.

580 Climber safety rails shall be Type 316 stainless steel. Means of access, such as vertical ladders or rungs, shall be provided to tanks, voids, masts, stack, top of the vehicle elevator system, and other areas where access is needed for maintenance.

612.3 Lifelines

Lifelines shall be three courses high to a minimum height of 3'-3½", of ½" diameter Type 316 stainless steel wire rope, with Type 316 stainless steel end fittings, turnbuckles, and sister hooks.

585 Lifeline stanchions shall be located no more than 5' apart. Removable lifeline stanchions shall use bolt-down sockets with Type 316L attachment fittings. Stanchions shall be reinforced to prevent bending by loaded wire.

590 Except in way of the stern door and side port doors, a ½" diameter Type 316 stainless steel wire-rope lifeline shall be provided along the outside of the hull, port and starboard, located approximately 3'-3" above the main deck and spaced approximately 2" off the hull in way of the docking guard. Removable wire rope lifelines and pipe stanchions shall be provided and

installed across the stern ramp and side door openings. The removable stanchions shall be threaded to screw into flush sockets.

Extra bolt-down fittings around hatch locations as necessary.

595 Lifelines around life/rescue boats and life rafts shall be removable for maintenance purposes.

Ladderway chain guards of $\frac{5}{16}$ " diameter chain shall be provided at all ladders that give access to restricted areas. "CREW ONLY" type notices shall be attached to the chain in accordance with Section 602.

600 A $\frac{5}{16}$ " diameter, galvanized closed-link chain with snap fittings at one end shall be provided at the top of each exterior vertical ladder, so that when closed it forms a continuation at the top courses of the guard railing.

612.4 Interior Handrails

Interior grabrails shall be provided and installed throughout the interior of the accommodation spaces as required by the regulations and as delineated below:

- 605
1. On both sides of all interior passageways in the public areas.
 2. On one side of the passageway in crew areas.
 3. On both sides of interior stairways. Storm rails shall continue along the bulkheads around the landings at the top and bottom of stairways.
 4. On interior of perimeter bulkheads of the Pilothouse and lounges.
 - 610 5. On the exposed bulkheads around the ADA Staterooms, their associated toilet/shower spaces and above the lower bunk.
 6. On the First Aid Room bulkheads and its associated toilet/shower space.

The interior grabrails shall be stainless steel, satin finish, $\frac{1}{4}$ " rail, with stand-offs and smooth returns. Commercial grade grabrails may be used in lieu of fabricated pipe rails.

615 The handrail heights shall be consistent throughout the vessel. Handrails shall follow the pitch of the stairs. Handrail gripping surfaces shall be consistent by location throughout the vessel.

Intersecting handrails shall be radiused and not have sharp corners.

Wooden rails shall be provided in the overhead of the Pilothouse in locations specified by the Resident Engineer. Handrails on ladders shall be readily removable in way of hatches.

620 612.5 Pipe Railing

625 All exterior deck house bulkheads shall have storm rails 3'-3½" above the deck. This includes fore and aft house ends as well as sides and includes grabrails under Pilothouse and passenger lounge windows. Rails shall be 1" pipe with soft returns. Storm rails may be omitted if the bulkhead is within 4'-0" of a liferail or in way of doors and other openings. Storm rails shall also be installed inside Solarium in front of exterior windows.

612.6 Safety Nets

Safety nets made of heavy nylon webbing shall be provided at the ends of the elevator platform. Safety nets shall be supported by aluminum pipe stanchions that fit into deck sockets in the turntable platform.

630 613 RIGGING AND CANVAS

613.1 Flag Hoists and Rigging

At least two signal flag hoists and retrievers shall be provided on each yardarm. A hoist shall also be provided on the after part of the forward mast for the national ensign. The ensign shall be displayed in such a way as to avoid entanglement with nearby structure or halyards under variable wind conditions. Flag hoists shall also be provided for the fore and aft flagstaffs. Cleats shall be provided at the bases of masts and staffs to secure loose lines.

All necessary rigging and associated fittings shall be provided and installed for the mast, radio antennas, etc., to produce a thoroughly workable installation complete for the intended service.

Wire rope shall be stainless steel. All fittings, shackles, etc., shall be made of commercially available Type 316 stainless steel. Rigging fittings shall be constructed so that shackle or clevis pins are close fitting and subjected only to shearing stress.

Flag and signal halyards shall be provided of $\frac{3}{8}$ " Dacron line with appropriately-sized bronze snap hooks at each end. Thimbles shall be spliced into eyes where necessary.

All loose gear and running rigging, including fittings, shall be tested to demonstrate function and suitability.

613.2 Covers

Covers shall be provided for all items of topside hardware requiring weather protection when not in use, such as searchlights, anchor windlass, capstans, workboat, and other deck machinery. Covers shall be provided for all electrical and control boxes which may be subjected to green water or heavy spray impact. Grommets and fittings used on covers shall be brass.

Covers for small equipment requiring 10 ft², or less, of material shall be Herculite "Reviera" marine fabric, or equal. Covers for larger equipment requiring more than 10 ft² shall be Herculite "Regatta" marine fabric, or equal. Cover color shall be approved by the Resident Engineer. Each cover shall have stenciled markings to indicate its use and location. Covers shall fit neatly and shall be fitted with accessories to secure them in place. Covers shall be reinforced in areas where sharp edges of machinery may cause damage.

620 HULL COMPARTMENTATION

621 NON-STRUCTURAL BULKHEADS AND PARTITIONS

621.1 Joiner Bulkheads, Linings and Ceilings

660 621.1.1 General

Ceilings, joiner bulkheads, and linings shall be provided in accommodation areas, common areas, Pilothouse, and the passageways in these areas. All steel bulkheads shall be lined on the

stiffened side in accommodation spaces. Linings shall be provided on the unstiffened side of steel bulkheads in staterooms and offices. Joiner linings need not be provided on the unstiffened side of steel bulkheads in passenger and crew passageways, foyers, lounges, and other public spaces. Joiner linings need not be provided in lockers and storerooms with structural bulkheads.

The construction of joiner work shall be of such design as to conceal insulation and bulkhead stiffeners, electrical cables, electrical connection boxes, ventilation and air conditioning ductwork, and piping. Finished ceilings shall be provided and shall be integrated with lights, speakers, and HVAC terminals.

Joiner bulkheads, linings, shelving, and furniture shall be fabricated and installed to follow the shape of the hull and make maximum utilization of the available volume in each compartment. This requirement may necessitate customization of the outfit, furniture, and furnishings for some compartments. Squaring off boundaries and creating unusable voids behind the joiner work shall not be accepted. Large web frames, girders and other deep structural members shall be “framed around” with the joiner work. In areas where there is extensive hull shape the joiner work shall slope outboard parallel to the hull. Areas that would slope less than 9° may be left as vertical surfaces.

Joiner bulkhead and lining panels that surround spaces with terrazzo, or slip-resistant deck covering, shall be provided with 6" high Type 316 stainless steel coamings made watertight by continuous weld. Particular attention shall be paid to the lower edges of linings in such spaces to prevent water wicking into the lining core. Joints of these panels shall be caulked.

All joiner work shall be installed securely to prevent rattling using countersunk or low-profile stainless steel screws. Fasteners shall be concealed by joiner joints where practicable. Rivets shall not be used for securing joiner work. Where access is required for maintenance, inspection, or repair, the hinged and latched panels shall be tamperproof. Panels, where provided, shall be labeled to indicate the item concealed.

Concealed framing, molding, hangers, and furring used in the erection of bulkheads and linings shall be of steel. Steel trim shall be provided at the intersection of linings and joiner bulkhead with overheads. Exposed framing, moldings, and trims shall be finished to blend in with the color of the bulkhead finishes.

Heavy items that need to be secured to bulkheads, such as berths and lavatories, shall be secured to structural members or to specially reinforced joiner bulkheads.

Joiner linings and bulkheads shall extend up beyond the continuous B-class ceiling to maintain the structural fire integrity as required by the regulatory bodies and to attenuate noise. Draft stops shall be provided between all accommodation spaces, staterooms, and passageways, carried to the deckhead between separate spaces, for improved noise attenuation. Linings and ceiling panels shall be fitted and caulked to be tight at all joints.

See Technical Specifications Sections 1E.11.9 and 1E.11.10 for additional acoustical requirements for all joiner panels and ceiling systems, respectively. See Technical Specifications Section 1E.11.5 for additional acoustical requirements for joiner and ceiling panels to be used in the EOS.

Continuous, B-rated ceiling systems shall be provided in the Mezzanine Deck crew living spaces (except laundry) and in all interior spaces above the Main Deck, except in machinery uptakes; utility spaces; wire, plumbing and ventilation trunks; machinery rooms (e.g., fan rooms); storerooms, and lockers.

Locations without ceiling systems shall be painted in accordance with the paint and coating schedule.

Continuous ceiling systems shall be identical to the extent practical, except as noted below. The ceilings shall have the following characteristics:

1. Ceilings shall have sufficient suspension attachments to preclude any sagging, vibration, or buckling.
2. Ceilings shall be installed squarely to ensure the proper fit of ceiling panels for ease of installation and future access.
3. Ceiling panels shall be individually removable.
4. All components, such as lights, fire detectors, access panels, and public address speakers, shall be fully integrated with the ceiling system.
5. All lighting fixtures and ventilation terminals shall be installed flush with the ceilings without any exposed edges.
6. Ventilation terminals and grilles shall be finished to blend with the ceilings and joiner work colors.
7. Ceiling panels shall be hinged for ready access, where required for maintenance, inspection, and repair.
8. Where required by Section 635, ceiling panels shall have an inlay of acoustic insulation. The insulation shall be firmly attached to the ceiling panels. Ceiling panels shall have acoustical requirements as given in Technical Specifications Section 1E.11.10.

Minimum clear ceiling heights shall be as follows:

1. Living, walking, and working areas: 6'-9".
2. Storerooms: 7'-6".

Deviations from these height requirements shall be approved by the Resident Engineer on a case-by-case basis where these minimum headroom requirements are demonstrated to be impractical. For example, ceiling height might be lowered above fixed furnishings such as desk or lockers where walking is prevented.

621.1.2 Toilet and Shower Spaces and Galley

In way of the joiner bulkheads and linings for the Galley, built-in place toilet/shower spaces, and other wet spaces, a ¼" by 6" flatbar coaming shall be provided and seal welded all around the deck. The joiner linings shall be lapped over the coaming, stopped short of the deck, and sealed watertight to prevent wicking.

Toilets and shower spaces shall be built-in or prefabricated enclosures. Built-in enclosures shall be made of joiner panels and ceilings. The deck of the built-in place toilet/shower spaces shall be flush with the deck level of adjacent spaces.

All toilet/shower spaces shall have the exterior sides treated with a lining and covering matching both color and material of the adjacent space (i.e., staterooms or passageway). The finish of the interior for combined toilet/shower spaces shall be waterproof, scratch resistant, stain resistant, readily repairable, and integrated with seamless floors and ceiling.

621.1.3 Accommodation Spaces

A modular, aluminum softcore bulkhead and lining system shall be provided in the accommodation spaces. The joiner work shall follow the curvature of the hull to maximize the usable space in each compartment. Softcore bulkhead and lining system partitions shall be NORAC series A585/50, or equal, and conform to the following:

1. Physical dimensions:

- a) Bulkheads/Linings: Minimum 585 mm (~23¾") wide by 50 mm (~2") deep, with no visible horizontal joints.

2. Materials:

- a) Cladding: 150-micron flame-proof class 1 PVC foil.
b) Surface: 0.6 mm (~0.024") aluminum.
c) Color: to match color boards.

3. Core material: mineral wool, 150 kg/m³ minimum density.

4. Fire rating: B-15 (bulkheads).

5. Sound Transmission Class (STC, Rw or Ia) rating: 46 dB(A) (bulkheads).

6. Weight:

- a) Bulkheads/Linings: 12.3 kg/m² (2.5lb/ft²).

7. Thermal insulation:

- a) Bulkheads/Linings: 0.62 W/m² (0.058 W/ft²).

NOTE: NORAC aluminum panels need to be 50 mm thick when aluminum is used on both sides of the panels, whether in bulkheads or linings, to be Buy America compliant. In the Observation Lounge half height joiner bulkheads shall be installed as shown on the Contract Drawings to subdivide the space into three sections. Tempered glass shall be installed above the transverse half height bulkheads at Frame 74 port and starboard up to the false ceiling, as shown on the Contract Drawings. Support mullions for the tempered glass shall be minimized to keep passenger sightlines as clear as possible.

621.2 Security and Safety Fences

Mesh security and safety fences shall be installed to limit passenger access to certain areas of the vessel. Fences shall be located on the Boat Deck at Frame 110 port and starboard, on the Solarium Deck at Frame 100/110 port and starboard, and at the boarding ladder entries on Boat and Solarium decks port and starboard.

The fences shall be fabricated from 1" square mesh x 0.177", Type 316 stainless steel weld mesh suitably framed with Type 316 stainless sheet metal and stiffened with Schedule 40, galvanized pipe with 1" x 3/16" Type 316 stainless steel clips. A door fabricated from the same material and with Type 316 stainless steel butt hinges, hasp, and handle shall be provided for each fence. Mesh panels shall be fastened to supporting structure with Type 316 stainless steel bolts with Nyloc nuts.

622 FLOOR PLATES AND GRATINGS

622.1 Floorplates

785 Machinery space floorplates shall be provided for personnel access in all machinery spaces with
above deck framing and structure. Machinery space floorplates shall be diamond pattern
stainless steel plates secured with Type 316 stainless steel countersunk machine screws. Self-
tapping screws are not permitted. Floorplates shall be provided with flush handgrabs to facilitate
790 lifting. All plating shall be installed with backing tape. Hinged plates shall be provided for
access to valves, strainers, manifolds, and spaces below the floorplates and shall be provided
with means to secure in the fully open position. Coaming bars shall be fitted along the edges and
at permanent openings. Each floorplate panel shall weigh less than 60 pounds. Floor plates and
supporting structure shall be designed to carry a load of 200 lb/ft².

622.2 Gratings

795 Machinery space walkways and platform raised levels shall be provided with removable stainless
steel gratings as necessary for ventilation and visibility purposes.

Each grating panel shall weigh less than 60 pounds. Grating panels shall not be larger than
25 ft².

800 Chain locker gratings shall be galvanized steel fitted with the bars spaced so that their distance
shall be one-half the diameter of the wire of the chain, but no greater than 1½".

Aluminum or glass-reinforced plastic removable gratings, with slip-resistant coating or safety-
tread pattern, shall be installed in storerooms and refrigerated spaces. Gratings shall be raised
1" above the deck by supports at 12" intervals, in a direction that provides drainage and air flow.

805 Gratings and ramps accessible to passengers shall be glass-reinforced plastic with slip-resistant
solid surfaces supported at 12" intervals. Ramps shall be provided for wheelchair access at
changes in elevation greater than 1".

Grating shall be installed as necessary for convenient access to and operation of all machinery
apparatus and controls, and for entrance to and escape from all of the machinery spaces.

810 Gratings shall be provided at each deck level of the uptake space and ventilation spaces unless
otherwise provided with decking.

Gratings and supporting structure shall be designed to carry a load of 200 lb/ft² unless otherwise
noted.

815 Particular care shall be taken to provide portable or hinged grating giving access to operational
equipment below the grating level. Hinged gratings are to be provided with means of securing in
the open position where practicable. Slotted handgrabs shall be provided for lifting the plates.
Raised portions of floor grates, if fitted, shall be provided with steps and railings between levels.
Localized access cuts for reach rods and valve handles shall be provided.

820 Where special shapes or cutouts are necessary, the edges shall be finished with a bonding bar for
rigidity and to eliminate protruding members. Supports for abutting sections shall not extend
above the grating surface. Stainless steel fastenings shall be provided for firmly holding the
gratings to the supporting structure. Fasteners and clips shall not protrude above the grating
level.

623 LADDERS

623.1 Inclined Ladders and Stairways

825 Inclined ladders and stairways shall be provided and installed as shown on the Contract Drawings . Ladders shall lead fore and aft whenever possible. Inclined ladders shall be removable and provided with slip resistant cap treads.

830 Inclined ladders and stairways shall be in accordance with USCG requirements, but in no case shall they be steeper than a 50° slope, measured to the horizontal. All inclined ladders shall maintain a minimum of 7'-0" head room measured vertically from the step toe to the overhead.

Ladders shall be attached in a manner that permits relative motion of decks and bulkheads and shall be removable. Inclined ladders in passenger accessible areas, over stowage spaces, over other inclined ladders, or where otherwise appropriate, shall have steel shielding underneath.

835 Exterior inclined ladders shall be galvanized steel with bolted non-skid treads, complete with galvanized back shields.

Exterior inclined ladders shall be provided with a trough drain at the top landing of the ladder with sill cut out flush with surrounding deck.

623.2 Vertical Ladders

840 Vertical ladders shall be provided and installed to afford access to all compartments and areas of the vessel not accessible via inclined ladders. Vertical ladders and ladder rungs shall be constructed of steel in accordance with ASTM F1166 and ASTM F783. Vertical ladders shall be removable. Width, rung spacing, and toe clearance shall conform to ANSI A14.3. Vertical ladders shall be recessed under decks no more than is necessary to clear the opening. Where conditions do not permit installation of a vertical ladder, ladder rungs shall be welded to the structure.

845 Portable ladders shall be provided in storerooms where upper shelves are not accessible from the deck. Means shall be provided to secure the ladders when in use by personnel.

The base of exterior ladders shall terminate above the deck in a return bend to the Deckhouse side or bulkhead.

850 Vertical ladders up the vehicle elevator king posts shall be provided with back scratcher/safety cages. Vertical ladders up the stack shall be provided with climber safety device(s).

623.3 Guard Rails

855 Three-course steel pipe guardrails, with a 1¼" diameter top course and ¾" second and third courses, shall be provided and installed at all perimeter boundaries of differing height grating levels in machinery spaces and on each side of open inclined ladders. All deck openings and other areas where falling and personal injury is a danger shall be fitted with guardrails.

Guardrails in machinery spaces shall be removable. Guardrails shall be provided and installed around moving parts of machinery which are not enclosed.

860 Handrails and stanchions throughout the machinery spaces shall be of 1¼" NPS steel pipe and, where attached to bulkheads, shall have a minimum of 2½" finger clearance.

Removable stiles with open tread grating and handrails shall be provided where necessary to allow safe movement over the shafting and mechanical drive components.

623.4 Handgrabs

Handgrabs shall be of ASTM F783 Table 2, Type II round bar handgrab configuration.

865 Handgrabs shall be secured to the vessel's structure and shall be installed where they will assist personnel who are ascending, descending, stepping down from ladders to ingress or egress through a scuttle or hatch, and where required for the safety of personnel.

623.5 Pilot Boarding Equipment

870 Pilot boarding (Jacob's) ladders and related equipment and features shall be provided, port and starboard, in accordance with 46 CFR 77.40-1. Each boarding ladder must be approved under 46 CFR 163.003.

A hinged or removable gateway shall be provided in the deck rail in way of each ladder station, with handholds provided on associated adjacent rail stanchions to facilitate safe boarding.

875 Securing padeyes shall be provided in the deck at the ladder stations, with each ladder fastened to the padeyes with metal shackles.

Sufficient deck lighting, as well as over-the-side floodlighting, shall be provided in way of the pilot boarding areas to provide for safe use of the boarding systems at night.

623.6 Fall Protection Systems and Equipment

Fall protection systems and equipment shall be provided as follows:

- 880
1. Around the front of the pilothouse for cleaning the windows.
 2. Around the sides and front of the observation lounges for cleaning the windows.
 3. Up the outside of the stack.
 4. Up the aft light staff.

885 The Contractor shall propose fall protection systems for approval by the Resident Engineer prior to purchase and installation. Horizontal fall protection shall function as a sliding point of attachment for safety harnesses. Fall protection tracks shall be heated to limit icing.

624 NON-STRUCTURAL DOORS

624.1 General

890 Interior doors shall be steel, hollow joiner-type in accordance with ASTM F821, except where other types are required for structural fire protection, acoustic properties, tightness, security, and damage resistance, or as otherwise required by the compartment function. The clear height above the finished deck for all doors shall not be less than 6'-6". The clear width of interior doors shall be as shown in the General Arrangement. In general, doors shall open into rooms from passageways, except for small lockers where outward opening doors conserve interior space. Doors in refrigerated spaces shall open outward.

895 All doors shall be fitted with bumper stops and friction type holdbacks acceptable to the Resident Engineer and regulatory bodies. Fire doors shall not be fitted with friction type holdbacks.

A-Class fire screen doors shall be provided with magnetic holdbacks and automatic closures (with activation from the Pilothouse) as described in Technical Specifications Section 431.

900 Joiner doors to staterooms shall be provided with kick-out panels large enough to permit emergency ingress/egress. Kick-out panels shall be solid to reduce noise transmission.

Door thresholds shall be Type 316 stainless steel.

Doors shall have the same fire rating as the surrounding bulkheads. Doors that open into passageways (except lockers) shall be provided with portlights, where allowed by regulation.

905 Doors shall be provided with lever action handles. Exterior doors shall be lever-actuated, quick-acting, and weathertight with a minimum of 6 dogs. Doors without solid overhead deck protection shall be provided with drip sheds above the doors.

Miscellaneous small doors, of design and construction suitable to their intended purpose, shall be provided and installed as shown on the Contract Drawings .

910 **624.2 Weathertight Doors**

624.2.1 Main Deck

USCG approved weathertight doors shall be provided and installed as shown on the Contract Drawings for access from the Main Deck to areas below the Main Deck. The doors shall be fitted with a minimum of 3 hinges and 6 dogs. Sill heights shall be minimized to the extent
915 allowed by the regulations. The weathertight doors for normally accessed areas of the vessel shall be quick acting and shall be provided with a 12" diameter fixed portlight with deadlight cover.

A USCG approved weathertight door shall be provided and installed at the Main Deck to protect the service elevator doors and elevator trunk from downflooding. The weathertight door shall
920 maintain the clear width of the elevator doors.

Doors giving access through air-conditioned boundaries shall be insulated and lagged.

624.2.2 Weathertight Doors—Cabin Deck and Above

USCG approved weathertight doors shall be provided and installed for access to weather from the Cabin Deck and above as shown on the plans. Exterior (weather) doors shall have Type 316
925 stainless steel outer surfaces. Door frames shall be no lighter than 14-gage. Face sheets shall be no lighter than 16-gage.

Each door's inside perimeter shall be equipped with a replaceable neoprene gasket for complete weathertight contact between the door and frame.

930 An easily replaceable window of safety glass shall be installed in each door on the Cabin Deck and above that is used by passengers.

Cabin Deck doors shall be provided with a 3" high exterior sill. Foyer doors shall be fitted with a ramp on both sides, satisfying ADA requirements. Ramps on the exterior sides shall be fitted with a grating and sump if required for water drainage or they may be provided with latchable, removable ramps.

935 Boat and Solarium Deck doors shall be provided with a ¾" high sill meeting ADA requirements. Exterior doors shall be fit with a closer mounted on the inside.

Single weather doors on the outboard sides of deckhouses shall have hinges on the forward side and wind protection wing walls if appropriate.

Watersheds shall be provided over all exterior doors not protected by deck overhangs.

940 **624.3 Fire Doors**

Fire doors of appropriate A-class construction shall be provided and installed in all A-class bulkheads as required by the regulatory bodies and as shown on the Contract Drawings . Fire doors shall be provided with USCG and ABS certificates. Fire doors shall be fitted with regulatory body approved closures, where required.

945 Hose ports shall be provided in joiner type, fire doors only as necessary to support the fire station spacing.

Rectangular lights of approved safety glass shall be provided in fire doors where allowed by the regulations.

950 Fire screen doors in the public stair towers, large public spaces and passageways shall be controlled by a magnetic holdback system (fire screen door system) as specified in Technical Specifications Section 431, unless required to isolate crew only accessible spaces from public spaces.

624.4 Metal Joiner Doors

955 Metal joiner doors shall be provided and installed for general interior access as shown on the plans. Joiner doors shall be of the appropriate B-class construction for the bulkheads in which they are installed. B-class fire doors shall be provided with USCG and SOLAS (IMO) certificates.

960 All inside doors shall be not less than 1³/₈" thick, sound-deadened hollow steel, flush type. Doors shall be reinforced for butts, locks and other hardware. Door handles shall be the lever type. Kick-out panels shall be provided where there is no secondary means of escape. Doors to toilet/shower modules shall be 1" thick hollow steel.

Doors in noise boundaries that are also used for ventilation shall be NORCO, type G007, or equal. Joiner doors shall not be undercut to meet the ventilation system requirements (see Technical Specifications Section 512).

965 Doors shall be fitted to allow clearance through the swing, but particular attention shall be paid to details to avoid noise on entry into spaces. The doors to staterooms shall fit tight all around. All doorframes should be fitted with soft rubber bumper strips or pads to prevent slamming noise.

970 All interior door sills shall be Type 316 stainless steel. Door sills shall be no higher than ¼" above the finished floor surface.

624.5 Refrigerated Spaces Doors

Refrigerated space doors, frames and hinges shall be stainless steel, Type 304 or 316.

Each door shall be factory assembled and aligned, complete with frames, hinges, hardware, gaskets, and thermal breaks, so that it can be secured aboard the vessel in steel bulkheads without

975 distortion to the plane of the frame or disturbance to the gasket seals. Each door shall be filled with insulation to be equivalent in R-value to the bulkhead in which it is located.

Each door shall be operable from both sides. A padlock-locking device and an emergency lock release, operable from within the refrigerated space, shall be provided. The emergency lock release on the inside shall open the door even when it is padlocked on the outside. A label plate, 980 containing directions for operating the emergency lock release, shall be mounted in a suitable location adjacent to the release.

Doors shall be designed to allow full swing. Each door shall be square, shall not follow camber, and shall be provided with a hold-open hook with rubber bumper.

985 All hardware shall be stainless steel and fastened to tapped steel inserts secured to structure behind the sheathing and insulation.

Thermal strip heaters shall be provided for the doorframes.

624.6 Acoustic Doors

990 Hollow steel, flush, insulated, joiner type, fume-tight, acoustical doors with fixed light shall be provided and installed at the entrances to the machinery spaces, electrical equipment rooms, fan rooms and the EOS. These doors shall be fitted with automatic closures, fume-tight gaskets of acoustical quality, and have acoustic fill. The sound transmission class (STC) for these doors and frames shall be at least 40. The doors to the EOS shall exceed this rating, as necessary to meet the noise level limits prescribed for the space in Technical Specifications Section 1E.11.2.

995 624.7 Roll-Up Curtain Doors

A-class fire-rated Galley roll-up curtain doors shall be provided between the Galley and Servery and between the Scullery and the Dining Area. The door(s) shall comply with the A-class fire door requirements. Each door shall be "normally open" and equipped with a holdback device with fusible link and local manual override switch to close the curtain in the event of fire. An 1000 additional interlock shall be provided to release the curtain door in the event that the Galley fire suppressant is released. A positive locking device shall be provided in order to secure the Galley and adjoining Scullery when not staffed. Construction of the curtain shall satisfy the requirements of the USPHS and the *WHO Guide to Ship Sanitation*.

1005 B15-class roll-up curtain doors shall be provided in the Boat Deck Passage, Frame 136, for isolating the Vending Machine Area from the Passage itself. The door shall be "normally open" and equipped with a holdback device with fusible link and local manual override switch to close the door in the event of fire. A positive locking device shall be provided in order to secure the Vending Area when necessary. The roll-up curtain door shall be the manual push-up type and shall close in a deliberate controlled manner.

1010 624.8 Metal Mesh Security Doors

Doors of metal mesh construction shall be provided in the Boat Deck and Solarium Deck security partitions described above in Section 621.3. Door construction shall be similar to the partition.

625 FIXED PORT LIGHTS AND WINDOWS

1015 625.1 General

1020 Windows and fixed port lights, of the size and quantity shown on the Contract Drawings , shall be provided and installed. Windows and fixed lights shall be thermo-pane construction. Glass thicknesses shall be sized per ABS rules for steel vessels under 90 m. Windows and fixed lights in way of lifesaving equipment, launching areas, embarkation areas and along escape routes shall meet the structural fire protection requirements of the regulatory bodies.

625.2 Fixed Lights

1025 Fixed lights 12" in diameter with deadlight covers shall be fitted to the hull in way of Mezzanine Deck crew spaces, as shown on Reference 070-01. Coamings shall be extended as required to make deadlight covers easily accessible and operated while still maintainable from the exterior. Fixed lights in way of lifeboat and MES launching areas shall meet the structural fire protection requirements of the regulatory bodies.

625.3 Windows and Wipers

625.3.1 General

1030 Windows, of the size and quantity shown on the Contract Drawings , shall be provided and installed. In general, windows shall be thermo-pane construction centered 5' above the finished interior deck, unless indicated otherwise on the Contract Drawings. Windows in the EOS shall be acoustically treated as required by Technical Specifications Section 1E.11.

1035 Window shades shall be provided and installed for all windows except for Pilothouse windows. Shades shall be sized and shaped appropriately for the associated window to fully darken the space. The shades shall slide in vertical tracks to maintain a fully darkened space with vessel motions (Figure 600 - 1). Window shade materials and design shall be approved by the Resident Engineer.



Figure 600 - 1 Window shade

1040 625.3.2 Pilothouse Windows and Wipers

Windows shall be provided in the Pilothouse exterior bulkheads as shown on the Contract Drawings to maximize viewing area and be arranged to provide clear visibility in all directions.

1045 Window mullions shall be minimized and shall not be located directly in the primary viewing area of operating personnel at each control station. Windows shall be of the weld in style, not the through bolted or clamp-in styles. All windows in the Pilothouse except for the two lower windows, shall be sloped inward at the bottom. The two lower Pilothouse windows, sloped outward at the bottom, shall have frame drains to prevent water accumulation in the window pockets. Glass for the Pilothouse windows shall be tempered glass and shall be free of distortion when viewed from within the Pilothouse at any angle. All Pilothouse windows shall be heated.

1050 Drop windows shall have defroster blower if preferred film heater is impractical. Window heaters shall be on programmable thermostats. Pilothouse windows shall be equipped with polarized sun screens. Sun screens shall be sized and shaped appropriately for the associated window. The sun screens shall slide in vertical tracks to be fully removable when not required.

Drop windows, one port and one starboard in way of the wing control stations, shall be provided.

1055 Drop window specifications and style shall match adjacent Pilothouse windows. Drop windows shall be provided with stainless steel drip pans draining outboard.

Marine grade, heavy duty, multi-speed, heated, electric wipers shall be provided and installed for all forward-facing windows in the Pilothouse. Wiper speed settings shall include high, low, and intermittent variable speed options. Wipers shall be parallel sweep with interior mounted motor housing and maximum blade length. Each window wiper shall have a washing system supplied directly from the potable water system, via a common backflow preventer. An eductor type system shall provide an antifreeze or cleaning solution spray. Controls for wipers and washers shall be located in a consolidated location.

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625.3.3 Lounge Windows

1065 Windows shall be provided in the Observation Lounge exterior bulkheads as shown on the Contract Drawings to maximize viewing area and be arranged to provide clear visibility in all directions. Window mullions shall be minimized. Lounge windows shall be of the weld in style, not the through bolted or clamp-in styles. Windows sloped outward at the bottom shall have frame drains to prevent water accumulation in the window pockets. Glass for the Lounge

1070 windows shall have tempered glass and shall be free of distortion when viewed from any angle.

625.3.4 Solarium Windows

Windows shall be provided throughout the extent of the Solarium sides and overhead, and in all Solarium front surfaces, as shown on the Contract Drawings . The windows shall be sized to maximize public viewing with due regard being given to maximizing the view around

1075 obstructions such as lifeboats and davits. Windows shall start approximately 24" above the deck and extend to approximately 7' above the deck. Aft facing windows shall start approximately 6" above the deck and extend to approximately 7' above the deck. Solarium windows shall be single pane tempered glass with ceramic fretting directly bonded to the plating without frames.

625.4 Solar Tubes

1080 Heavy duty commercial solar tubes shall be installed on steel coamings and routed to officer stateroom offices in four places as shown on Contract Drawings . Domes shall be weathertight to marine standards with bonded, bolted, or clamped flange connections.

630 HULL PROTECTION

631 COATING SYSTEMS

- 1085 The intent of this section is to define the coating systems to be used, the surface preparation required, and the work to be accomplished with respect to painting.

631.1 General

631.1.1 Paint Procurement

AMHS uses International Paints.

- 1090 The paints employed in a given coating system shall be from the same manufacturer and shall match the existing paints and systems used by the State in terms of equivalent protection, identical color matching, and compatible chemistry/adhesion properties. The intent of these requirements is to avoid future maintenance discontinuities within the fleet.

631.1.2 Compliance with Regulatory Requirements and Manufacturer Recommendations

- 1095 In accomplishing the work required, the Contractor shall at all times comply with all local, state, and federal laws, rules, and regulations concerning the protection of the environment.

All coating and covering systems shall be applied in accordance with manufacturer's recommendations and under the guidance and supervision of the manufacturer's field service representative.

- 1100 Solvents used for thinning and clean-up shall be in strict accordance with the coating manufacturer's recommendations.

631.1.3 Resident Engineer Inspections

All sandblasted areas and other surface preparation shall be inspected and must be approved by the Resident Engineer prior to application of any coating.

- 1105 Required thickness of coatings shall be confirmed through spot checks in the presence of the Resident Engineer after each coat is applied. Environmental conditions shall be recorded.

631.1.4 Prerequisites to Coating Application

- 1110 Welds and piping system joints or connections requiring pressure- or water-testing or visual inspection shall not be coated until after all tests and inspections are complete and the weld, piping joint, or connection has been accepted by the Resident Engineer.

Prior to the application of coatings, all surfaces shall be dry and free of foreign matter such as dirt, dust, crayon marks, grease, mill scale, residual abrasive, rust, salt deposits, and weld spatter.

Scuppers and drains shall be sealed or extended as required to prevent moisture or water contamination on coated surfaces during the drying period.

- 1115 Under no circumstances shall a freshly blasted steel surface be left more than 6 hours without primer. Should freshly blasted steel be left unprimed, the Contractor shall re-blast to the originally required quality, removing all traces of rust bloom at no cost to the State.

Before application of any follow-on coat, all bare or lightly covered spots in the previous coat shall be cleaned and built up to the required thickness. Surfaces shall be kept dry during the coating process and during the drying period.

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631.1.5 Requirements during Coating Application and Curing

Film thickness shall be as specified in Section 631.3 for AMHS' standard coating systems. Where both the film thickness per coat and the number of coats are specified, both requirements must be met.

1125 All surfaces shall be kept dry, clean, and free of rust and foreign matter at the time of application of any coating and throughout the curing period.

Coatings shall be applied under environmental conditions conforming to the manufacturer's recommendations as listed on the manufacturer's published data sheets for the coatings being applied. A copy of the manufacturer's published data sheets shall be given to the Resident Engineer prior to commencement of painting. Coatings shall not be applied at ambient or surface temperatures less than the minimum application temperature recommended by the manufacturer for the particular coating involved. No coating shall be applied when the dew point temperature is equal to or greater than the surface temperature of the surface to be coated.

1130

Should the Contractor choose to paint hull structures or attachments that may be affected by condensation caused by the vessel being waterborne or for any other reason, extraordinary care shall be exercised to ensure that surfaces to be painted are thoroughly dry and remain dry throughout the coating and curing periods. Spaces shall be heated and dehumidified to levels in accordance with the paint manufacturer's preparation and application guidelines to obtain and maintain proper application and curing temperatures and prevent the onset of condensation.

1135

631.1.6 Protection of Items and Surfaces during Surface Preparation and Painting

Special care shall be taken to avoid contamination of adjoining spaces, machinery, equipment and finished surfaces during sandblasting, painting and other activities associated with surface preparation and painting.

Prior to any blasting or painting on the vessel, all exposed ventilation system supply and exhaust terminals shall be sealed, or temporary filters installed, to prevent the ingestion of blasting dust, paint or any other contaminants. Equipment, nameplates, labels, valve stems, fire hoses and nozzles, bright work, glass, trim and other items, devices, materials and surfaces shall be carefully protected and masked prior to damaging surface preparation operations. Open ends of piping, vent pipe openings, habitability ventilation openings, and other such features shall be similarly covered and protected from entry of sandblast grit and paint residue.

1145

1150

Protection shall be repaired or renewed if damaged during blasting or painting prior to continuing with process.

631.1.7 Correction of Damage Resulting from Paint Overspray and Grit Blasting

Any paint overspray applied to any of the aforementioned items and surfaces shall be immediately and carefully removed.

1155

Machinery, equipment, and surfaces damaged (including signage), marred, or contaminated shall be promptly repaired, replaced, or cleaned to pre-existing condition at the Contractor's expense.

631.1.8 Removal of Blast Grit

1160 Affected spaces and interior and exterior surfaces shall be thoroughly cleaned of grit and residue immediately after grit blasting.

Items and materials that would be damaged by surface preparation techniques shall be carefully protected. Special care shall be taken to avoid contamination of adjoining spaces, machinery, and equipment. Any equipment damaged or contaminated shall be promptly repaired, replaced, or cleaned to pre-existing condition at the Contractor's expense.

1165 **631.2 Surface Preparation and Painting**

631.2.1 General

Surface preparation shall be defined by the SSPC. Visual Standard SSPC-VIS-1-89 is invoked and will be used to judge the adequacy of surface preparations.

1170 Prior to preparing, all sharp edges, weld splatter, temporary fittings, etc., shall be removed so that no projections exist that would penetrate the coating film. Power tools used in preparation work shall be operated in such a manner that no burrs or sharp ridges are left on the surface and no sharp cuts are made in the steel.

1175 Surface preparation may be accomplished before or after fabrication at the discretion of the Contractor. Although not required by this Specification, an initial coat of pre-construction, burn-through primer may be used to hold the surface during fabrication. If used, this coating shall not count towards the system build-up required and shall be compatible with the specified coating system.

631.2.2 Preparation of Primed Surfaces for First Coat of Coating System

1180 Pre-construction primed surfaces shall be prepared as follows prior to application of the first coat of each coating system:

1. Exterior

a) High pressure (3000 psi) freshwater wash to remove any zinc salts and surface contaminants.

b) If zinc salts remain, brush-off-blast to SSPC-SP-7.

1185 c) For all areas of rust, spot-blast to SSPC-SP-6.

d) Degrease to remove all oils, grease, zinc salts.

e) Spot-power-clean to SSPC-SP-15 all areas of polished steel, welds, soot, burn contamination, slag and splatter.

2. Interior (Other than Interior of Seawater Ballast, Potable Water, and Sewage Tanks)

1190 a) Degrease to remove all oils, grease, zinc salts, and surface contaminants.

b) Spot power-clean to SSPC-SP-15 all areas of polished steel, weld, soot, or burn contamination, slag, and splatter.

3. Interior of Seawater Ballast, Potable Water, and Sewage Tanks

a) Degrease to remove all oils, and grease.

631.3 Paint Schedule

631.3.1 Exterior

1. Keel to Waterline, Including Hull, Rudder, Sea Chests, and Bow Thruster Tunnels:

- 1235 Apply 1 full coat Intershield ENA 300V (Bronze) @ 6.0 MDFT
Apply 1 full coat Intershield ENA 301V (Aluminum) @ 6.0 MDFT
Apply 1 full coat BEA46S Tin/Rosin Free Self-polishing copolymer @ 5.0 MDFT
Apply 1 full coat BEA469 Tin/Rosin Free Self-polishing copolymer @ 5.0 MDFT*

A1. Keel to Waterline (ALTERNATE):

- 1240 Apply 1 full coat Intershield ENA 300V bronze @ 6.0 MDFT
Apply 1 full coat Intershield ENA 301V aluminum @ 6.0 MDFT
Apply 1 full coat Interspeed BRA 642 Black AF @ 5.0 MDFT
Apply 1 full coat Interspeed BRA 640 Red AF @ 5.0 MDFT*

2. Boot Topping:

- 1245 Apply 1 full coat Intershield ENA 300V (Bronze) @ 6.0 MDFT
Apply 1 full coat Intershield ENA 301V (Aluminum) @ 6.0 MDFT
Apply 2 full coats Interthane 990 Series Black @ 2.0 MDFT

3. Above Top of Boot Topping, Except Decks and as Noted Below, Including but not Limited to Bulwarks, Superstructure, and Exterior Machinery:

- 1250 Apply 1 full coat Interzinc 52 @ 3.0 MDFT
Apply 1 full coat 262 Intertuf KHA @ 6.0 MDFT
Apply 1 full coat 262 Intertuf KHA @ 6.0 MDFT
Apply 2 full coats Interthane 990 Series @ 2.0 MDFT*

*Final coat colors shall be as follows:

- 1255 Hull: PHE992 Ocean Blue
Superstructure: PHB000 White
Stripe: PHB134 Yellow
Hull Markings: PHB000 White

4. Railings, Galvanized, and Aluminum Surfaces:

- 1260 Apply 1 full coat Formula 117 wash primer @ 1.0 MDFT
Apply 1 full coat 262 Intertuf KHA Series @ 5.0 MDFT
Apply 1 full coat Interthane 990 Series Gloss @ 2.0 MDFT
Apply 1 full coat Interthane 990-PHB000 (White) Gloss @ 2.0 MDFT

5. Weather Decks:

- 1265 Apply 1 full coat Intergard 262 (FPL274) @ 2 – 3 MDFT
Apply 1 full coat Intershield PRA250 @ 125 MDFT
Apply 1 full coat Intershield PRA350 Nonskid Medium Grit
Apply 1 full coat Interthane 990-K724 (Storm Grey) Gloss @ 2.0 MDFT

A5. Weather Decks (ALTERNATE)

Apply 1 full coat Interzinc 52 @ 3 MDFT

1270 Apply 1 full coat Intershield ENA 300V Series (Bronze) @ 6.0 MDFT

Broadcast non-skid 7754D over ENA while wet. Remove excess

Apply 1 full coat Intershield 301V ENA Series (Aluminum) @ 6.0 MDFT

Apply 1 full coat Interthane 990-K724 (Storm Grey) Gloss @ 2.0 MDFT

6. Parking Area (Vehicle Space/Main Deck):

1275 Apply 1 full coat Interzinc 52 @ 3.0 MDFT

Apply 1 full coat Intershield 300V ENA Series (Bronze) @ 6.0 MDFT

Broadcast Interzone non-skid 7754D over ENA while wet. Remove excess

Apply 1 full coat Intershield 301 ENA Intertuf Series (Aluminum) @ 6.0 MDFT

Apply 1 full coat Intershield 990-K724 (Storm Grey) Gloss @ 2.0 MDFT

1280 Walkways and Lines Only

Apply 1 full coat Intershield ENA 300V Series (Bronze) @ 6.0 MDFT

Broadcast Interzone non-skid 7754D over ENA while wet. Remove excess

Apply 1 full coat Intershield ENA 301V Series (Aluminum) @ 6.0 MDFT

Apply 2 full coats Interthane 990-B134 (Safety Yellow) Gloss @ 2.0 MDFT

1285 7. Top of Stacks and Any Other Exposed High Temperature Areas:

Apply 2 full coats HTA097 High-Heat Aluminum Coating @ 2.0 MDFT each

8. Anchor and Anchor Chain:

Apply 1 full coat Intertuf KHA Series @ 6.0 MDFT

Apply 1 full coat Intertuf KHA Series @ 6.0 MDFT

1290 Apply 1 full coat Interthane 990-PHY (Black) finish @ 2.0 MDFT, except as follows:

a. The detachable link between shots, excluding the connecting link to the anchor, shall be painted as follows:

i. 15 fathom, first-second shot detachable link, red.

ii. 30 fathom, second-third shot detachable link, white.

1295 iii. 45 fathom, third-fourth shot detachable link, blue.

iv. 60 fathom, fourth-fifth shot detachable link, red.

v. 75 fathom, fifth-sixth shot detachable link, white.

b. Additionally, the first link on each side of the 15-fathom detachable link shall be painted white. The first link at each side of the detachable link shall also be marked by one turn of wire around the stud. The first two links on each side of the 30-fathom detachable link shall be painted white. The second link at each side of the 30-fathom detachable link shall also be marked by two turns of wire around the stud. This pattern of marking detachable links shall be continued for the 45-, 60-, and 75-fathom connections.

1300

- c. All of the links in the next-to-last inboard shot shall be painted yellow.
- 1305 d. All of the links in the last inboard shot shall be painted red.

631.3.2 Interior

1. Bilge Keels, Sponsons, and Inaccessible Voids:

1310 Provide a float coat rust preventative application with Resident Engineer-approved and regulatory body accepted coating system. The Eureka Chemical Company's Fluid Film, Liquid A, product is acceptable. The Contractor may provide an alternative product for approval by the Resident Engineer.

2. Bulkheads (Side Shell Where Applicable in Hull Locations) and Overheads of Machinery and Work Spaces, Except Pilothouse, Above Grating or Floor Plate Level Where Applicable and Not Covered by Insulation or Linings:

1315 Apply 2 full coats 262 Intertuf KHA @ 5.0 MDFT

Apply 1 full coat Interthane 900-PHB000 (White) @ 2.0 MDFT

3. Bilges (Below Lowest Grating or Floor Plate Level):

Apply 2 full coats 262 Intertuf KHA @ 5.0 MDFT

Apply 1 full coat Interthane 900 Series @ 2.0 MDFT

1320 4. Exposed Bulkheads and Overheads of Passenger Spaces and Pilothouse:

Apply 2 full coats 262 Intertuf KHA @ 5.0 MDFT

Apply 1 full coat Interthane 900 Series @ 2.0 MDFT

5. Behind Insulation on Bulkheads and Overheads

1325 Apply 1 stripe coat 262 Intertuf KHA @ 3.0 MDFT

Apply 1 full coat 262 Intertuf KHA @ 6.0 MDFT

6. Exposed Insulation (Except Acoustic):

Apply 1 full coat 262 Intertuf KHA Series @ 2.0 MDFT

Apply 1 full coat Interthane 900-PHB000 (White) @ 2.0 MDFT

7. Interior Galvanized and Aluminum Surfaces (Exposed Side):

1330 Apply 1 full coat Formal 117 primer @ 0.5 MDFT

Apply 1 full coat 262 Intertuf KHA Series @ 5.0 MDFT

Apply 1 full coat Interthane 990 Finish @ 2 MDFT

8. Interior Stainless Steel Surfaces (Exposed Side):

No coating applied.

1335 9. Exposed Decks (Not Covered with Deck Covering):

Apply 1 full coat 262 Intertuf KHA Series @ 6.0 MDFT

Apply 1 full coat Interthane 990-K724 (Storm Grey) Gloss @ 2.0 MDFT*

* Apply with #36 garnet grit over for non-skid

10. Decks Covered with Deck Covering:

1340 Apply 1 full coat 262 Intertuf KHA Series @ 6.0 MDFT

11. Uptakes:

- 1345 Apply 1 full coat 262 Intertuf KHA Series @ 5.0 MDFT
 Apply 1 stripe coat 262 Intertuf KHA @ 5.0 MDFT
 Apply 1 full coat 262 Intertuf KHA Series @ 5.0 MDFT
 Apply 1 full coat Interthane 990 Series @ 2.0 MDFT
 Apply 1 full coat Interthane 900-PHB000 (White) @ 2.0 MDFT

12. Voids and Chain Locker:

- 1350 Apply 1 full coat Intershield 300V ENA 300 (Bronze) @ 5.0 MDFT
 Apply 1 stripe coat Intershield 300V ENA 301 (Aluminum) @ 3.0 MDFT
 Apply 1 full coat Intershield 300V EMA 301 (Aluminum) @ 5.0 MDFT

13. Ballast Tanks:

- 1355 Apply 1 full coat Intershield 300V ENA 300 (Bronze) @ 5.0 MDFT
 Apply 1 stripe coat Intershield 300V ENA 301 (Aluminum) @ 3.0 MDFT
 Apply 1 stripe coat Intershield 300V ENA 300 (Bronze) @ 3.0 MDFT
 Apply 1 full coat Intershield 300V ENA 301 (Aluminum) @ 5.0 MDFT

14. Interior of Lubricating Oil and Fuel Oil Tanks:

The interior of these tanks shall not be painted, but rather shall be sprayed with oil after surface preparation.

15. Potable Water Tank:

- 1360 Apply 1 full coat of Interline 100% solids 925 (White) @ 16.0 MDFT*
 Apply 1 stripe coat of Interline 100% solids 925 (White) @ 6.0 MDFT
 * The potable water tank shall be continually mechanically ventilated and dehumidified for at least seven (7) days immediately following coating application.

16. Sewage Holding Tank:

- 1365 Apply 1 full coat of Interline 100% solids 925 (White) @ 16.0 MDFT*
 Apply 1 stripe coat of Interline 100% solids 925 (White) @ 6.0 MDFT
 * The sewage holding tank shall be continually mechanically ventilated and dehumidified for at least four (4) days immediately following coating application.

631.4 Ceiling and Joiner Panels Repairs

- 1370 Where already-installed ceiling and joiner panels are disturbed, the surfaces shall be locally repainted or restored to like-new condition to the Resident Engineer's satisfaction or shall otherwise be replaced with new.

631.5 Machinery, Equipment, Piping and Cables

631.5.1 Machinery and Equipment

- 1375 All machinery and equipment shall be given 1 prime coat and 2 finish coats, except items furnished with a prime coat shall receive the 2 finish coats, and items furnished with prime and finish coats shall receive 1 finish coat.

631.5.2 Cables

Electrical cables shall not be painted.

1380 631.5.3 Piping

Interior copper-nickel (except exposed firemain piping) and copper piping and tubing need not be painted, except that all valves and/or valve handles shall be painted in accordance with the color coding listed below for the system use.

Firemain piping shall be red in all exposed areas.

1385 Steel piping that is covered by decorative bulkhead/ceiling systems or insulation shall be given 2 primer coats (International CPA series) on exterior surfaces after being tested and cleaned free of all scale, oil, and grease. Valves and/or valve handles in these piping systems shall be painted in accordance with the color coding listed below for the system use.

1390 Steel piping which is exposed (outside the engineering spaces) shall be given 2 primer coats (International CPA series) on exterior surfaces after being tested and cleaned of all scale, oil, and grease, and followed by 1 finish coat (International CL series) to match surrounding area. Valves and/or valve handles in these piping systems shall be painted in accordance with the color coding listed below for the system use.

1395 Steel piping within the engineering spaces shall be given 2 primer coats (International CPA series) on exterior surfaces after being tested and cleaned of all scale, oil, and grease. Piping below the lowest deck plate level shall be top coated with 1 finish coat (International CL series) to match the surrounding area. Piping above the lowest deck plate level shall be top coated with 1 finish coat (International CL series) in accordance with the system color coding listed below. Valves and/or valve handles in these piping systems shall be painted in accordance with the color coding listed below for the system use.

1400 Note: On galvanized steel piping the first coat of primer shall be a wash primer, Interprime 539, or equal.

Piping or its lagging, as applicable, shall be stenciled indicating service and direction of flow in accordance with Section 602.

1405 Exterior surfaces of combustion exhaust piping systems requiring insulation shall be painted with 2 coats of heat resistant aluminum paint before application of insulation.

System color coding shall be as follows:

1. Refrigerant: White.
2. Ventilation duct: Black.
- 1410 3. Hydronic heating: Silver.
4. Potable water: Blue.
5. Ship service air: Gray.
6. Sea water: Green.
7. Diesel: Black.
- 1415 8. Lube Oil: Yellow.
9. Hydraulic: Orange.

10. Feed water: White.
11. Fire extinguishing water and Novac 1230: Red.
12. Plumbing drains and sewage: Brown.

1420 633 CATHODIC PROTECTION

633.1 Zinc Anodes

1425 Sacrificial anodes shall be installed on the hull, propeller shaft struts, rudders, bow thruster tunnel, sea chests, fin pockets, ballast tanks, and other locations to complement the impressed current cathodic protection system. The quantity, weight, and installed locations of anodes shall be coordinated with the manufacturer of the impressed current cathodic protection system.

Anodes shall be high purity zinc (meeting DoD MIL-A-18001K) and of standard, weld-on type with galvanized steel straps. All straps shall land on a 4" round x ¼" continuously welded shell doubler plate.

Additional small anodes may be fitted to other machinery per manufacturer's recommendations.

1430 The number of anodes to be installed shall be based on the formula

$$N = 6.5W/1000,$$

where:

W = the surface area to be protected and

1435 N = the number of 6" by 12", 22-pound anodes,
after rounding up to the nearest whole number.

This quantity shall be doubled where 3" by 12" anodes are required and adjusted accordingly for the corresponding surface area if other zinc sizes are selected.

The anode straps and their welded attachments shall be painted, except where the steel straps are in contact with the zinc material. The zinc material shall not be painted.

1440 633.2 Impressed Current Cathodic Protection System

An impressed current cathodic protection system by Electrocatalytic Inc., or equal, shall be provided to protect the submerged hull and appendages against corrosion. The system shall be arranged for both manual and automatic operation.

1445 The number and dissolution rate of the anodes shall be such that this output can be maintained for at least twenty (20) years without replacement of anodes. The number of anodes shall be as recommended by the manufacturer.

A dielectric coating shall be applied on the hull around each anode as recommended by the manufacturer.

1450 External underwater components, including anodes and reference cells, shall be designed for minimum drag and minimum chance of damage by ice, and shall not protrude from the hull at any point.

The system shall maintain all areas of the underwater hull at the proper potential.

634 DECK COVERINGS

634.1 General

- 1455 Materials, thickness, underlayments, and applications shall be in accordance with the manufacturers' recommendations.
- Materials shall contain no asbestos, formaldehyde, 4-PCHs, or any other compound that is known, or has been identified by the EPA, as a potential hazardous material due to long- or short-term exposure.
- 1460 Deck coverings shall not be laid until any required testing for watertightness has been completed and after all connections to decks for fastening machinery, equipment, furniture, etc., are installed.
- All deck coverings shall be thoroughly cleaned after finishing and waxed or otherwise sealed as recommended by the deck covering manufacturer. Thereafter, the decking shall be thoroughly
- 1465 protected to prevent damage or wear prior to delivery of the vessel.
- Deck covering colors shall be presented in color boards and approved by the Resident Engineer.

634.2 Surface Preparation

- Decks shall be dry, free of dirt and rust, and primed or otherwise protected in accordance with manufacturer's recommendations, to prevent rust and corrosion, prior to application of
- 1470 underlayments and deck coverings. Welds shall be ground to a maximum of $\frac{1}{8}$ " to avoid excessive underlayment thickness. Underlayments shall be clean and fully cured before installation of deck covering.

634.3 Underlayment

- 1475 Latex underlayment shall be used to fill all hollows and uneven interior decks. Where adjacent deck coverings are of different thickness, the underlayment for the thinner shall be gradually increased in thickness such that the top of the thinner covering will lie flush with the top of the thicker covering. Particular attention shall be given to walking areas to acquire a smooth contour without noticeable change in pitch.
- 1480 Underlayment thickness shall be held to a minimum consistent with regulatory agencies and application requirements. In accessible spaces, deck coverings shall be sloped to door sills for wheelchair access.
- Underlayments must be clean and fully cured before installation of deck covering. Deck coverings shall be sloped to the drains where deck drains are installed.
- 1485 Bonding agents for deck coverings shall be as recommended by the manufacturer and approved by all regulatory bodies. Sealer shall be applied to the underlayment if required by manufacturer's installation instructions.
- All deck coverings must be thoroughly cleaned after installation and shall be free of stains and discoloration.
- 1490 Galley flooring shall be installed after installation of Galley equipment. The seamless floor shall cover up the foundations of the Galley equipment.

634.4 Deck Coverings

634.4.1 General

Deck coverings shall be provided throughout the vessel in accordance with Reference 621-01.

1495 All deck coverings shall be commercial grade and selected to provide long life under heavy traffic and abuse.

Each deck covering shall have a low maintenance level for appearance retention over the product's life span. Many of the required deck coverings are hard surfaces that can easily be washed. Carpeted areas, where feasible, shall be solution dyed for enhanced cleanability.

1500 Operating stations that require prolonged standing, including, but not limited to, the Pilothouse and Galley shall be provided with standing mats. Rubber mats shall be installed in front of electrical switchboards and elsewhere as required by the regulatory bodies.

Deck covering in the Electrical Equipment Room shall be electrical grade sheet.

Deck covering shall not be installed under enclosed built-in furniture or under equipment with enclosed foundations. Decks in machinery spaces, workshops, and storerooms shall be painted.

1505 Three 6" × 24", fabric-backed, slip-resistant deck treads with tactile strips shall be installed on each side of weather doors, at the head and foot of inclined ladders and on each side of doors with sills higher than 4".

1510 In built-in shower stalls, within coamings and in the immediate vicinity of drains, adjustment of deck covering thickness or underlay shall be used to slope the deck for drainage. Underlay may be used for drainage in other areas where location of drains makes this necessary, and to smooth over deck welds and irregularities to prevent wear spots.

Slip-resistant deck covering shall be applied in all working deck areas, the deck around the anchor windlass, and in weather deck areas. The nonskid shall be stopped 2" short of all deck fittings.

1515 All deck coverings shall be selected so that they satisfy the regulatory body requirements and the minimum requirements listed below.

634.4.2 Carpet

1520 The carpet shall be 80/20 wool/polyamide, single-level cut pile, woven through to the back. All carpets shall be laid wall to wall, unless specified otherwise in the room finishes schedule. The number of visible joints shall be minimized. The warp (direction) of carpets shall be the same within any single room or area. The following additional salient characteristics shall apply:

1. Construction: Woven, Axminster.

2. Pile height: 0.312".

3. Face weight: 48 oz/yd².

1525 4. Rows per inch: 10.

5. Pitch: 7.

6. Yarn ply: 3.

7. Primary backing: Polypropylene.

8. Secondary backing: Fray resistant latex.

- 1530 9. Color and pattern direction: Color boards.
10. Warranty: Ten (10) year limited wear.

634.4.3 Vinyl Composition Tile

The following salient characteristics shall apply:

- 1535 1. Form: 12" x 12" tile.
2. Thickness: $\frac{1}{8}$ ".
3. Federal specification SS-T-312B (1), Type IV, Comp. 1.
4. ASTM F1066, Comp. 1, Class 2 through pattern.
5. Color Direction: Color Boards.
6. Warranty: Five (5) year limited warranty.

634.4.4 Rubber Tile

The following salient characteristics shall apply:

- 1540 1. Thickness: 5.0 mm (0.2").
2. Tile size: Standard.
3. Content: Minimum 55% virgin rubber without processing oils, balance material to be
1545 made of vulcanizers, color pigments, dirt expelling agents, and mineral fillers, or equal.
4. Slip resistance: ASTM D2047 equal to or greater than 0.6.
5. Color and pattern direction: Color Boards.
6. Warranty: Ten (10) year limited wear warranty.

634.4.5 Walk-Off Mats

1550 The following salient characteristics shall apply:

1. Content: 100% polypropylene.
2. Size: Appropriate for each application.
3. Backing: Vinyl.
4. Edging: Vinyl.
1555 5. Pattern: Raised block.
6. Color and pattern direction: Color boards.

634.4.6 Heavy Use Abrasive Sheet Vinyl Flooring

The following salient characteristics shall apply:

- 1560 1. Thickness: 3.5 mm (0.13").
2. Slip resistance: ASTM D2047, dry greater than 0.90.
3. Wear resistance: ASTM C501, abrasive wear index in excess of 400.
4. Static load limit: 250 psi in accordance with LF-475a.

5. Antibacterial.
6. All seams must be heat welded according to manufacturer's instructions for installation.
- 1565 7. Backing: Woven fiber glass.
8. Contents: Quality vinyl, aluminum oxide and quartz crystals, silicon carbide, and fiberglass mesh.
9. Color and pattern direction: Color boards.
10. Warranty: Seven (7) year limited warranty.

1570 **634.4.7 Polyurethane Seamless Coating - Interior**

Polyurethane seamless coating shall be of colors approved by the Resident Engineer. The installation shall consist of a primer, a polyurethane rubber deck coating, a low -profile nonskid coating and two coats of glaze. Total thickness of coating shall be ¼" nominal.

- 1575 The polyurethane seamless coating shall be applied over underlayment in accordance with the manufacturer's instructions. Deck clips shall be tack welded in place to secure the underlayment. An approved technique to protect the deck and clips against corrosion shall be used prior to installation of the underlayment. Coves of underlayment shall be provided around the perimeter of the space over which the polyurethane shall be carried up to a minimum height of 5" to finish in a neat line.

- 1580 The final finish shall be a nonskid surface with a surface profile of approximately 15 to 20 mm (0.43" to 0.79") and shall be smooth enough to allow wet mop cleaning.

634.4.8 Floating Floor

Floating floors shall be used as defined in Technical Specifications Section 1E.11.12.

634.4.9 Paint

- 1585 All decks not covered with deck covering shall be painted as generally outlined in Section 634.4. Color shall be described in the color boards.

634.4.10 Electrical Safety Sheet Covering and Matting

- 1590 Electrical grade sheet deck covering shall be installed on decks in electrical and electronic spaces. Electrical safety mat shall conform to ASTM D178 Type II, Class 2. Matting shall have a diamond-embossed surface, shall be easily cleaned, and shall not collect contaminants. No seams shall be within 3' of electrical or electronic equipment, panels, or work benches. All seams shall be heat welded or chemically sealed to provide a continuous surface free of seams, craters, or porosities.

634.5 Cove Molding

- 1595 Sanitary rubber base cove molding shall be provided around all boundaries of carpet, vinyl tile and rubber tile deck coverings. Coving shall be a minimum of 5" high and of continuous roll type with inside and outside corners. Rubber base cove molding shall be firmly secured to joiner bulkheads with adhesive, such as a suitable silicon, which will not react with the plasticizers in the joiner wall vinyl. Coving shall also be sealed along its top edge to prevent any moisture from seeping behind the molding.
- 1600

All coving materials shall be installed per manufacturer's recommendations.

634.6 Safety Treads and Tactile Strips

1605 Pressure sensitive, fabric-backed, silicon carbide safety treads with tactile strips shall be provided at the head and foot of all interior and exterior stairways, inclined and vertical ladders, on each side of door thresholds, on stair treads that are not safety treads by design, and in other locations where it is deemed necessary to ensure safe footing. Safety treads shall not be installed on any surface until they have been thoroughly cleaned of all waxes, sealers, oils, and other contaminants that may prevent firm adhesion to the deck.

634.7 Stair Tread Nosings

1610 All stair treads shall have aluminum nosings with anti-slip PVC grit insets on the exposed surface of the nosing. The gage of the aluminum shall be $\frac{9}{32}$ ". The nosing shall be approximately $2\frac{7}{16}$ " deep from front to back and $\frac{3}{8}$ " high. Fitting and fixing necessary for proper installation and integration with flooring materials must be identified by the Contractor. Means of fastening shall permit periodic replacement of worn nosings without damaging the stairs.

635 HULL INSULATION

635.1 General

The insulation system shall minimize the HVAC load and assist in noise requirements. Insulation exposed to view shall be provided with protection from damage.

1620 All structural fire protection insulation, thermal insulation, and acoustic insulation shall be faced type unless located behind joiner panels or overhead ceilings. All cut and exposed edges shall be taped and sealed, and a suitable sealer shall be applied. Acoustic insulation facing shall not be painted.

1625 At intersections defining the boundary extent of the insulation for thermal and acoustic barriers, the insulation shall be extended or wrapped at least 12".

Insulation installed on bulkheads shall be cutback 4" (100 mm) from the bottom at the deck/bulkhead intersection. The edges of the insulation shall be tightly and neatly sealed with tape of a type recommended by the insulation manufacturer.

1630 All insulation, linings, and ceiling materials shall be incombustible. Installation shall comply with USPHS rat proofing requirements.

In designing the insulation systems, the effect of structural fire protection shall be considered in the acoustical treatment. Both structural and acoustical insulation may be considered as contributing to the thermal insulation for heat transmission.

1635 Insulation material shall be impaled on steel welding studs or pins. Studs or pins shall be spaced not over 12" on bulkheads and 9" on overheads, with staggered centers, and be a maximum of 3" from the edges of the insulation, or as approved. Insulation shall be secured with 1½" diameter washers secured with button-head washer caps, which are to be brought even with the insulation surfaces without depressing or cutting the insulation. Insulation shall not be packed in or compressed during installation.

1640 All insulation shall be in direct contact with the surface that is being insulated (plates, beams, stiffeners, etc.) to eliminate voids between the structure and the insulation.

The metal to which insulating material is to be applied shall be cleaned by suitable means of all dirt, dust, oil, grease, rust, and other foreign matter and then given protective coat(s) of paint.

1645 In way of bolted access plates, insulation and sheathing shall be installed in such a manner as to permit the removal of the bolted access plate without the necessity of totally removing or seriously damaging the insulation and sheathing. The outline of the bolted access plate shall be stenciled on the sheathing or insulation in a visible, contrasting color.

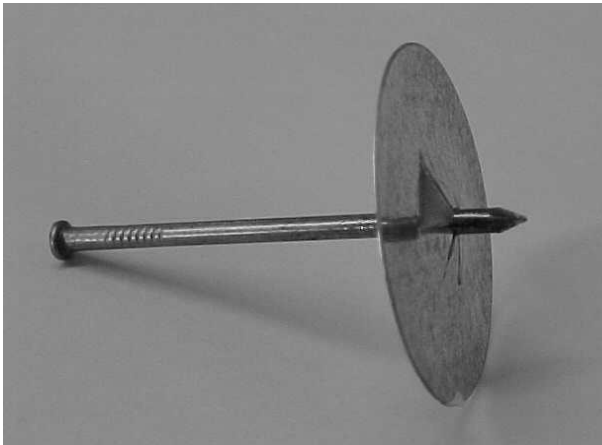


Figure 600 - 2 Standard Pin and Speed Clip



Figure 600 - 3 Navy style pin and stainless steel mushroom cap

635.2 Anti-Sweat Protection

Anti-sweat treatment shall be applied:

- 1650 1. On the warm side of uninsulated boundaries, including webs and flanges of beams and stiffeners, extending 12" onto attached bulkheads.
2. On all vertical boundaries of air-conditioned spaces common to non-air-conditioned spaces.
3. On the exterior surface of tanks.
- 1655 4. On any area where condensation can affect electrical installation.

Anti-sweat treatment shall be Mascoat Products, Delta-T Marine, or equal.

635.3 Vapor Barriers

Vapor barriers shall be applied to insulation located within the Laundry Spaces, Scullery, and Galley, and to the insulation on the warm side of refrigerated stores spaces.

1660 635.4 Structural Fire Protection Insulation

Structural fire protection insulation shall be installed in accordance with ABS Rules and SOLAS regulations. All structural fire protection material shall be currently certified by ABS Rules and SOLAS for the use intended, shall be 100% free of asbestos-containing materials (ACM), and shall be 5½ lb/ft³ density mineral wool. Documented proof of the certification shall be provided.

- 1665 All insulation and facing materials shall be incombustible. Installation shall comply with USPHS rat proofing requirements. Structural fire insulation materials shall satisfy 46 CFR 164.007.
- Unfaced mineral wool insulation may be used in locations that will be covered by decorative bulkhead/ceiling systems. Unfaced insulation shall be impaled on steel welding studs or pins
- 1670 using either speed clips or mushroom caps as shown in Figure 600 - 2 and Figure 600 - 3.
- Mineral wool insulation faced with fiberglass cloth or Mylar attached to the insulation using a USCG approved adhesive shall be used in all areas where the insulation will be exposed. All seams shall be sealed with fiberglass cloth strips or with minimum 2" wide fibrous glass tape as recommended by the manufacturer. All cut and exposed edges shall be taped and sealed and a
- 1675 suitable sealer applied. Faced insulation shall be impaled on steel welding studs using stainless steel mushroom caps as shown in Figure 600 - 3. The sealed insulation shall be coated with two coats of paint.
- At intersections defining the boundary of a higher rated 'A' class boundary surface with a lower rated boundary, the insulation shall be extended or wrapped at least 450 mm (~18"), in
- 1680 accordance with NVIC 10-99, from the higher rated 'A' class boundary along the lower rated boundary. This extended or wrapped insulation is known as the insulation return.
- Penetrations for piping and electrical cabling shall be insulated 450 mm (~18") beyond the fire boundary in accordance with regulatory requirements. Ventilation ducting shall be insulated from the rated boundary to a point 450 mm (~18") beyond the fire damper in the system.
- 1685 Penetrations through insulation return areas shall be insulated as required to maintain a 450 mm (~18") heat path to the higher rated 'A' class boundary in accordance with regulatory requirements. Insulation installed in 'wet' areas such as the Vehicle Space may have a gap at the deck not exceeding 4", unless regulatory approved. This will prevent the insulation from becoming water soaked and failing.
- 1690 All structural members supporting the 'A' class boundary shall be insulated 450 mm (~18") from the boundary in accordance with NVIC 10-99. The insulation on the structural members that are fully encased (such as small stiffeners) shall be at least one-half the thickness of the insulation used on the boundary. The insulation on structural members that are not fully encased (such as deep web frames extending more than 450 mm (~18") from the rated boundary) shall be the
- 1695 same thickness as the rated boundary and be applied on both sides of the structural member.
- Insulation shall be installed behind all machinery and equipment mounted on surfaces to be insulated. Where machinery and equipment are mounted directly to surfaces being insulated, mounting brackets and foundations shall be extended such that the equipment is not "embedded" in the insulation. Insulation shall not be packed in or compressed during installation.
- 1700 The metal to which insulating material is to be applied shall be cleaned by suitable means of all dirt, dust, oil, grease, rust and other foreign matter. Areas of rust shall be hand prepared and primed. All surfaces to be covered shall be presented to the Resident Engineer for inspection, to verify that surface preparation is complete and acceptable prior to the application of insulation.
- The edges of the insulation shall be tightly and neatly sealed with tape of a type recommended
- 1705 by the insulation manufacturer.

635.5 Thermal Insulation

All thermal insulation shall be fiberglass and faced.

1710 Thermal insulation shall be applied on the boundary surfaces of all spaces that are heated or cooled, and which are exposed to the weather or are adjacent to or below unheated spaces, except in way of stacks. Insulation shall in general cover the inside surface of the bulkhead and overhead plating and shall extend at least 12" beyond the exposed area around webs and flanges of beams, stiffeners, girders, and other contiguous structure.

Thermal insulation installed on bulkheads and overheads shall be at least 3" thick and shall have a K-factor of 0.23 at 75°F.

1715 Beam wraps shall be 1" thick and shall have nominal density of no less than 3 lb/ft³.

All material used in providing thermal insulation shall be currently certified by the USCG for the intended use and shall be 100% free of ACM.

1720 All edges of the insulation shall be tightly and neatly sealed in a manner in accordance with the recommendations of the manufacturer to present a smooth, continuously sealed surface. The type of sealing tape used shall be as recommended by the insulation manufacturer. Both tape and application shall be suitable for a twenty (20) year life.

Thermal insulation for the chill and freeze rooms shall be as described in Section 638.

635.6 Acoustical Insulation

1725 See Technical Specifications Section 1E.11.11 for details on specific insulation for acoustic purposes. The noise limits given in Technical Specifications Section 1E.11.2 take into account the fire protection and thermal insulation and any modifications to any type of insulation requirements must be reviewed and approved by the NVCC. The acoustical insulation shall be impaled on pins, faced, sealed, and protected as required for other insulations specified in this section.

1730 637 SHEATHING

Access panels shall be provided in sheathing for maintenance and inspection of equipment located behind the sheathing.

637.1 Sanitary Sheathing

1735 Sanitary bulkhead sheathing shall be installed in the Galley. Sanitary sheathing shall be CRES Type 304 or 316, satin finish, USSG 16. Bulkheads along the shell of the Galley and refrigerated spaces shall follow the curvature of the vessel. Soft-core boarding with incorporated stainless steel facings will be allowed on bulkheads.

637.2 Protective Sheathing

1740 Protective sheathing shall be installed in spaces without linings or sanitary sheathing, in stair towers, and where insulation is subject to damage by personnel, material handling, or storage.

Sheet metal sheathing shall be at least 22-gage and shall be attached to all surfaces required to be sheathed in accordance with Table 600 - 1.

1745 Portable sections of sheathing shall be provided where required for accessibility in way of wiring, ducts, piping, air conditioning controls, filters at unit air conditioners, etc. They shall be hinge-fitted with quick-acting catches where frequent access is necessary.

All edges of linings shall be neatly trimmed and deburred. Seams shall be butted and covered with a smoothed and deburred strip of the next heavier gage metal.

Trim pieces and escutcheon plates of like material shall be provided around linings and penetrations. Fasteners for stainless steel linings shall be stainless steel. Fasteners for galvanized lining shall be either plated to resist corrosion or of stainless steel.

Table 600 - 1 Sheet metal lining schedule

Space	Location	Type
Forward Machinery Room and Aft Machinery Room	Overhead and wrapped down 18" from the overhead on the bulkheads.	Perforated sheet metal over acoustic insulation – see Section 635.
Vehicle Space	Hull sides, 1' above deck to 7' above deck.	Perforated sheet metal sheathing over insulation.
Storerooms	Bulkheads, 1' above deck and up.	Sheet metal sheathing over insulation.
Fan Rooms	Bulkheads, 1' above deck to 4' above deck.	Perforated sheet metal sheathing over insulation.
Bow Thruster Room and Upper MSD Room	Bulkheads, 1' above deck to 4' above deck	Perforated sheet metal sheathing over insulation.
Chill and Freeze Rooms	Bulkheads and overhead.	CRES sheathing.
Galley	Bulkheads.	CRES sheathing.

638 REFRIGERATED SPACES

An approved (USCG fire rated) 2-pound density polyurethane insulation, or equal, shall be sprayed onto all the hull sides, flat bulkheads, and overhead surfaces, to a minimum thickness of 6" (minimum 1" over stiffeners) and providing an R value of at least 30. The insulation shall be seal-coated with an approved material to prevent moisture penetration or abrasion. Insulation and sheathing along the shell of the refrigerated spaces shall follow the curvature of the vessel.

The decks shall be insulated with two 2-inch courses of foamglass type insulation, with a 9-pound density.

Common boundaries between the chill rooms and freeze rooms need only be insulated on one side of the boundary.

The foamglass deck insulation shall be covered with a 1½" layer of wire mesh-reinforced latex concrete, which in turn shall be covered with a ¾" latex deck covering. A 6"-high cove base shall be installed around all boundaries.

Each compartment shall be fully lined on the bulkheads and overhead with ⅛" Type 5086 aluminum or 12-gauge CRES (Type 304 or 316). The lining shall be screwed to furring using stainless steel flat head screws (Type 304 or 316). The furring shall be stainless steel and bolted to steel clips welded to the vessel structure.

Lining over polyurethane insulation shall be stenciled with a warning indicating that it is protecting the combustible insulation from fire.

Modular refrigeration units for Galley stores shall have heavy-duty marine-quality doors, latches, and hinges. Wall panels shall be reinforced with 4" foamed-in-place polyurethane (R-30

1775 minimum.) and supported by full perimeter molded dense urethane support system handrails, and
all is encased in 0.035" thick stainless steel. The floor shall be 0.060" thick stainless steel,
1780 reinforced with a rigid underlayment, and shall be capable of supporting 2500 lb/ft². Doors shall
be positive latching with inside safety release on door and steel-reinforced door frame. Floors
shall be liquid-tight with drain, Unit sections shall have positive seals between sections. Units
shall have interior lights with exterior switches and LED temperature display. Units must be
able to be installed in place, with no preassembly other than what is provided by the
manufacturer. Provide interior bulkhead stainless steel shelving with three levels of shelves and
supporting framing from deck to overhead, with clear passage and door opening with no
hindrance. Shelving shall be 16-gage stainless steel. Unit shall meet USCG, ABS, and USPHS
requirements.

640 ACCOMMODATION SPACES

1785 640.1 Officer Staterooms

The character and arrangement of furnishings in these staterooms and offices are depicted on
Reference 070-01.

Master and Chief Engineer Staterooms shall be furnished with:

1. One (1) single berth with drawers.
- 1790 2. Two (2) lockers each 3'-0" x 1'-6" x 6'-0" high.
3. Two (2) coat hooks.
4. Three (3) side tables and two (2) lamps.
5. Two (2) easy chairs.

First Assistant Engineer and Chief Mate Staterooms shall be furnished with:

- 1795 1. One (1) single berth with drawers.
2. Two (2) lockers each 3'-0" x 1'-6" x 6'-0" high.
3. Two (2) coat hooks.
4. One (1) side table with one (1) lamp.
5. One (1) easy chair.

1800 Standard Officers' Staterooms shall be furnished with:

1. One (1) single berth with drawers.
2. Two (2) lockers each 3'-0" x 1'-6" x 6'-0" high.
3. Two (2) coat hooks.
4. One (1) side table with one (1) lamp.
- 1805 5. One (1) desk and one (1) chair.

Steward's and Purser's Staterooms shall be furnished with:

1. One (1) single berth with drawers.
2. Two (2) lockers each 3'-0" x 1'-6" x 6'-0" high.

- 3. Two (2) coat hooks.
- 1810 4. One (1) side table with one (1) lamp.
- 5. One (1) couch.
- 6. Lavatory with mirror (Steward only).
- 7. One (1) desk and one (1) chair.

640.2 Crew Staterooms

1815 The character and arrangement of furnishings in these staterooms and offices are depicted on Reference 070-01.

Two-Person Staterooms shall be furnished with:

- 1. One (1) Two-Person stacked berth with drawers under lower berth and portable ladder.
- 2. Two (2) Lockers each 1'-6" x 1'-6" x 6'-0" high.
- 1820 3. Two (2) coat hooks.
- 4. Lavatory with mirror.
- 5. One (1) desk and one (1) chair

One-Person Staterooms shall be furnished with:

- 1. One (1) single berth with drawers.
- 1825 2. Two (2) Lockers each 1'-6" x 1'-6" x 6'-0" high.
- 3. Two (2) coat hooks.
- 4. Lavatory with mirror.
- 5. One (1) desk with chair.

640.3 Passenger Staterooms

1830 640.3.1 Four-Person Staterooms

The character and arrangement of furnishings in passenger staterooms are depicted on Reference 070-01. Four-Person Staterooms shall be furnished with:

- 1. Two (2) two-person stacked berths with drawers under lower berths and two (2) portable ladders.
- 1835 2. One (1) locker. Full height (6'-0") with dimensions to suit compartment arrangement.
- 3. Four (4) coat hooks.

640.3.2 Two-Person Staterooms

The character and arrangement of furnishings in passenger roomettes are depicted on Reference 070-01. Two-Person Staterooms shall be furnished with:

- 1840 1. One (1) two-person stacked berth with drawers under lower berth and one (1) portable ladder.
- 2. One (1) locker. Full height (6'-0") with dimensions to suit compartment arrangement.

3. Two (2) coat hooks.
4. One (1) chair.

1845 **640.3.3** Roomettes

The character and arrangement of furnishings in passenger roomettes are depicted on Reference 070-01. Roomettes shall be furnished with:

1. One (1) two-person Pullman style berth and one (1) portable ladder.
2. One (1) chair.

1850 **643** **SANITARY SPACES**

643.1 **Plumbing Fixtures and Fittings**

643.1.1 General

1855 The lavatories, sinks, and showers shall be provided with drains trapped at the fixture. Access to traps shall be arranged for ease of maintenance. Traps for fixtures shall be chrome-plated brass, with a swivel pattern.

643.1.2 Lavatories

Lavatories shall be made of 14-gage CRES, Type 304, and No. 4 finish. A pop-up drain shall be provided for each lavatory.

1860 Lavatories in public spaces shall include mirror, paper towel dispensers, soap dispenser, and trash receptacle. Lavatories in private spaces shall be installed with cabinets below.

Faucets shall have manual two-handle controls. Faucets shall have chrome finish and brass bodies, renewable seats and aerators with 2.5 GPM flow restrictors. Faucets for the accessible lavatory are to have extended paddles.

643.1.3 Showers

1865 Shower stalls shall be rigidly constructed and finished with a material that is durable, waterproof, sanitary, easily cleaned and easily maintained. Waterproof, tamperproof access panels shall be provided for maintenance and inspection of piping joints and electrical services. Access panels shall match the adjacent material and finish.

1870 Showers shall be equipped with a shower spray unit having a hose at least 5' long that can be used as a fixed showerhead or as a hand-held shower. The shower spray unit shall be mounted to a wall bar allowing for adjustable height and angle. Showerheads shall be chrome plated.

1875 Showerheads shall be fitted with restricting devices that limit the flow of water to 1.75 GPM at 40 psi and a quick shut-off devices. Valves shall be the mixing type. Showers shall be provided with shower curtain, curtain rod, curtain hooks, and, except for ADA showers, a 4" watertight coaming around the base. One handgrab shall be provided for each shower and one for each toilet. Showers shall be provided with two baskets for soap and shampoo.

Toilet/shower modules shall have two drains, one in the shower and the other in the floor. Floor, shower, and lavatory drains shall be combined to allow a single module hookup.

643.1.4 Toilets

1880 All toilets shall be of vitreous china, water-saver type. All toilets shall have elongated white bowls and shall be fitted with open fronted seats, with covers.

Easy access shall be provided to all flushometers for inspection and repair.

1885 Toilets may be either deck or bulkhead mounted. Their attachment shall be specifically reinforced to prevent damage or removal due to severe abuse. All units shall be mounted with a minimum of 4 bolts.

643.1.5 Accessories

The following accessories shall be provided:

1. Toilet paper holders, with lock spring rollers and bulkhead brackets, shall be provided at each of the toilets.
- 1890 2. Grab rods, 1" diameter by 9" long, shall be provided at each of the toilets. The wheelchair-accessible heads shall have the required grab bars.
3. Towel bars, 18" long, shall be provided for each occupant in the staterooms, and at each of the private lavatories and at each of the showers. The towel bars shall be installed such that they are capable of acting as grab bars.
- 1895 4. Double hooks shall be provided within each of the heads and within each toilet/shower module.
5. Roller type paper towel holders shall be provided at service sinks.
6. Air hand dryers shall be provided in the public heads.

643.1.6 Drinking Fountains

1900 Drinking water fountains with self-contained cooling units shall be provided and located as follows:

1. First Platform Deck: Inboard, forward end of Workshop (for easy access from EOS as well).
2. Mezzanine Deck: Aft of the starboard CG Locker, near the Exercise Room.
- 1905 3. Cabin Deck: Foyer, on bulkhead immediately aft of the Network Room.
4. Boat Deck: On forward bulkhead of Passage at Frame 128, on centerline.

The units shall be a refrigerated type, utilizing a non-ozone depleting refrigerant and rated at 6 GPH. The drinking fountains shall be selected to allow for filling containers up to 8" tall. The fountains shall be connected to a potable water supply with carbon filters and wastewater drains.

1910 The drinking fountains on the Cabin and Boat Decks shall be bi-level and compliant with the ADA recommendations.

643.1.7 Service Sinks

1915 Service sinks with faucets shall be provided and installed in cleaning gear lockers, laundries, and elsewhere as shown on the Contract Drawings. The sinks shall be of cast iron construction with acid-resistant enamel tile and sized to accommodate filling of a standard 5-gallon bucket.

Faucets shall have brass bodies, renewable seats, center spout outlet threaded to match a standard hose threading, and brass lever handles. Spouts shall be formed with a bucket hook and be provided with a vacuum breaker.

A deck drain with coaming shall be located in the deck below the service sink.

1920 **643.1.8 Eye Wash Stations**

Self-contained eye/face wash stations meeting ANSI Z358.1 shall be provided and located as follows:

1. Near areas of chemical use in the MSD Room, Paint Locker, Workshop, and Bosun's Stores.
- 1925 2. In the First Aid Room.
3. Near each battery charging area.
4. At fuel oil purifying stations.

Final installation locations shall be approved by the Resident Engineer.

643.2 Public Restrooms and Shower Rooms

1930 Public Restrooms shall be outfitted as follows in Table 600 - 2 through Table 600 - 7:

Table 600 - 2 Outfitting for men's restroom and showers - Cabin Deck

Qty	Item
2	Lavatory Sink
1	Lavatory Counter, Fabricated, 10'-5" x 22", with backsplash
2	Toilet w/ Seat, Commercial Grade, Deck-Mounted
1	Urinal
2	Shower Head and Mixing Valve
2	Faucet and Drain, Sink
2	Flushing Valve, Toilet
1	Flushing Valve, Urinal
1	Mirror, 10'-5" x 4'-0"
2	Dispenser, Toilet Paper
2	Dispenser, Paper Towel, Stainless
2	Dispenser, Soap
1	Dispenser, Air Freshener
1	Receptacle, Trash, Stainless
2	Towel Bar
4	Clothes Hook (one for each toilet and shower stall)

Table 600 - 3 Outfitting for women's restroom and showers - Cabin Deck

Qty	Item
3	Lavatory Sink
1	Lavatory Counter, Fabricated, 10'-5" x 22", with backsplash
2	Toilet w/ Seat, Commercial Grade, Deck- Mounted
2	Shower Head and Mixing Valve
3	Faucet and Drain, Sink
2	Flushing Valve, Toilet
1	Mirror, 10'-5" x 4'-0"
2	Dispenser, Toilet Paper
2	Dispenser, Paper Towel, Stainless
2	Dispenser, Soap
2	Dispenser, Sanitary Napkin
1	Dispenser, Air Freshener
1	Receptacle, Trash, Stainless
2	Towel Bar
4	Clothes Hook (one for each toilet and shower stall)

Table 600 - 4 Outfitting for men's restroom – Boat Deck

Qty	Item
3	Lavatory Sink
1	Lavatory Counter, Fabricated, 8'-4" x 22", with backsplash
3	Toilet w/ Seat, Commercial Grade, Deck -Mounted
2	Urinals
3	Faucet and Drain, Sink
3	Flushing Valve, Toilet
2	Flushing Valve, Urinal
1	Mirror, 8'-4" x 4'-0"
3	Dispenser, Toilet Paper
2	Dispenser, Paper Towel, Stainless
2	Dispenser, Soap
1	Dispenser, Air Freshener
1	Receptacle, Trash, Stainless
3	Clothes Hook (one for each toilet stall)
1	Grab Bar (for ADA toilet stall)

Table 600 - 5 Outfitting for women's restroom – Boat Deck

Qty	Item
3	Lavatory Sink
1	Lavatory Counter, Fabricated, 8'-4" x 22", with backsplash

Qty	Item
3	Toilet w/ Seat, Commercial Grade, Deck Mounted
3	Faucet and Drain, Sink
3	Flushing Valve, Toilet
1	Mirror, 8'-4" x 4'-0"
3	Dispenser, Toilet Paper
2	Dispenser, Paper Towel, Stainless
2	Dispenser, Soap
3	Dispenser, Sanitary Napkin
1	Dispenser, Air Freshener
1	Receptacle, Trash, Stainless
3	Clothes Hook (one for each toilet stall)
1	Grab Bar (for ADA toilet stall)
1	Couch

1935 **Table 600 - 6 Outfitting for men's restroom - Solarium Deck**

Qty	Item
2	Lavatory Sink
1	Lavatory Counter, Fabricated, 5'-9" x 22", with backsplash
2	Toilet w/ Seat, Commercial Grade, Deck-Bhd-Mounted
1	Urinal
2	Faucet and Drain, Sink
2	Flushing Valve, Toilet
1	Flushing Valve, Urinal
1	Mirror, 5'-9" x 4'-0"
2	Dispenser, Toilet Paper
1	Dispenser, Paper Towel, Stainless
2	Dispenser, Soap
1	Dispenser, Air Freshener
1	Receptacle, Trash, Stainless
4	Clothes Hook (one for each toilet and shower stall)
1	Grab Bar (for ADA toilet stall)

Table 600 - 7 Outfitting for women's restroom - Solarium Deck

Qty	Item
2	Lavatory Sink
1	Lavatory Counter, Fabricated, 5'-9" x 22", with backsplash
2	Toilet w/ Seat, Commercial Grade, Deck- Bhd-Mounted
2	Faucet and Drain, Sink
2	Flushing Valve, Toilet

Qty	Item
1	Mirror, 5'-9" x 4'-0"
2	Dispenser, Toilet Paper
1	Dispenser, Paper Towel, Stainless
2	Dispenser, Soap
2	Dispenser, Sanitary Napkin
1	Dispenser, Air Freshener
1	Receptacle, Trash, Stainless
4	Clothes Hook (one for each toilet and shower stall)
1	Grab Bar (for ADA toilet stall)

643.3 Watchstanders' Heads

The Pilothouse Watchstanders' Heads shall be outfitted with a water closet, lavatory, soap dish, toilet paper dispenser (single roll type), paper towel dispenser, and mirror (18" x 24").

1940 645 PUBLIC DINING AND LEISURE SPACES

Lounge seating shall be booths and recliner units as shown on Reference 070-01. All booths and recliner units shall be equipped with power outlets for charging portable electronics. Booths shall be configured to store lifejackets.

Reclining seats shall be grouped in twos, threes, and fours as shown on Reference 070-01.

1945 Reclining seats shall be Beurteaux Ocean Club, or equal, beam-mounted in groups, with calf rests, fabric upholstery, and 15" x 19" beam mounted tables between seats.

645.1 Observation Lounge

The Observation Lounge shall be furnished with one (1) 4-person booth, with the remaining seating being recliner units. Including space allowance for 2 persons in wheelchairs, the space currently has capacity for 64 seated passengers.

1950 Primary egress from this space is aft to the stair tower Foyer. Independent secondary escape routes are available through the port and starboard Side Lounges.

645.2 Side Lounges

645.2.1 Port Side Lounge

1955 The port Side Lounge shall be furnished with three (3) 4-person booths, with the remaining seating being recliner units. Including space allowance for 1 person in a wheelchair, the space currently has capacity for 30 seated passengers.

A door on the aft bulkhead of this space provides the required secondary escape route from the space (the other route being through the interior to the stair tower Foyer).

1960 645.2.2 Starboard Side Lounge

The starboard Side Lounge shall be furnished with two (2) 6-person booths, two (2) 4-person booths, and four (4) 4-person pedestal tables with chairs. One table has two chairs removed for

wheelchair access for 1 person. Pedestal tables with chairs shall match dining area furnishings. Space is therefore available for 34 seated passengers.

1965 Space is provided in the aft portion of this side lounge for child play.

A door on the aft outboard bulkhead of this space provides the required secondary escape route from the space (the other route being through the interior to the stair tower Foyer).

645.3 Theater

1970 The arrangement of furnishings in the Theater are depicted on Reference 070-01. Seating for 27 persons is provided, including 1 person in a wheelchair. Standard theater seating with flip-up seats shall be provided.

645.4 Passenger Dining Area

1975 The Dining Area shall be furnished with booth, bulkhead-mounted counter, and pedestal table seating conforming to the layout depicted on Reference 070-01. The layout provides seating capacity for 79 persons. Three (3) ADA-accessible seating locations shall be provided. All booth and counter seating shall be equipped with power outlets for charging portable electronics. Booths shall be configured to store lifejackets. Chairs at pedestal tables shall be fixed with swiveling seats.

645.5 Passenger Servery

1980 The Servery contiguous to the Dining area and Galley serving window shall be designed for use for queuing and cafeteria style service. Servery shall be furnished and equipped as shown in Reference 651-01.

645.6 Solarium

1985 The Solarium shall be equipped with four (4) 6-person pedestal tables with chairs, ten (10) 4-person outdoor seats, and three (3) 3-person outdoor seats. Outdoor seats shall be Café Flyer, or equal, with aluminum slats, pedestal-mounted. Space is therefore available for 73 seated passengers.

1990 One (1) bank of passenger luggage storage lockers shall be provided, approximately 18'-6" x 7'-0" x 2'-6", suitable for large luggage, with locks as approved by the Resident Engineer.

648 CREW DINING AND LEISURE SPACES

648.1 Officer Mess

The Officer Mess shall be outfitted as follows:

- 1995
1. One (1) four-person table w/chairs.
 2. One (1) six-person table w/chairs.
 3. Full height, 17 ft³ minimum refrigerator.

- 4. Counter with space for:
 - a) Microwave oven.
 - b) Coffee brewer.
 - 2000 c) Tea dispenser.
 - d) Cold well for salad bar.
 - e) Ice cream freezer.
 - f) Two (2) soup wells.
- 5. Trash container.
- 2005 6. POS system.
- 7. Two (2) easy chairs.
- 8. Two (2) side tables.
- 9. One (1) bookcase.

648.2 Crew Mess

- 2010 The Crew Mess shall be outfitted as follows:
 - 1. Four (4) four-person tables w/chairs.
 - 2. Full height, 17 ft³ minimum refrigerator.
 - 3. Counter with space for:
 - a) Microwave oven.
 - 2015 b) Coffee brewer.
 - c) Tea dispenser.
 - d) Cold well for salad bar.
 - e) Ice cream freezer.
 - f) Two (2) soup wells.
 - 2020 4. Trash container.
 - 5. POS system.
 - 6. Two (2) easy chairs.
 - 7. One (1) side table.

648.3 Crew Day Room

- 2025 The Crew Day Room shall be outfitted as follows:
 - 1. One (1) 4-person table w/chairs.
 - 2. Two (2) couches.
 - 3. Five (5) side tables.
 - 4. Three (3) bookcases.

- 2030 5. Two (2) easy chairs.
6. Trash container.
7. POS system.
8. Toilet/shower module.

648.4 Crew Exercise Room

2035 The outfit for the Exercise Room is to be determined through consultation with AMHS during the Contract Design phase. The following types of exercise equipment are potential candidates for inclusion in the design: weights machine, stair-stepper machine, elliptical trainer, exercise bike, rowing machine, treadmill, yoga and pilates mats, punching bag, and inversion table. Exercise equipment will be State furnished.

2040 650 SERVICE SPACES

650.1 General

650.1.1 Design Considerations and Arrangements

2045 Servery, Galley and Scullery spaces shall be provided to service the crew and passenger complement. Such spaces shall be provided with the furnishings, equipment and features as prescribed in this section, and sized for the total complement. The Galley shall be provided with marine grade equipment, sized for serving the total complement.

A separate pass-through window shall be provided from the passage into the Scullery area for passing soiled dishes, see Section 624.7.

2050 Equipment in the Galley shall be arranged for preparation and service of meals and clean-up. The Mess shall be arranged to accommodate the smooth flow of personnel from the serving line, past the self-service beverage service area and to the mess tables with minimum interference with seated or exiting personnel.

2055 Deck-mounted equipment and dressers shall be installed on 6" high angle mounts. Where height is restricted, equipment shall be mounted on angle base foundations. Equipment mounted on counter tops shall be secured to the countertop directly. Equipment that needs clearance for heat dissipation shall be stood off from the countertop with 4" high angle mounts.

2060 Cabinets shall be provided with hinged doors. Bulkhead-mounted cabinets and shelves shall be mounted 18" above the counter tops. The lower edge of the cabinets and shelves shall be adjusted in way of equipment requiring more than 18" in height. The upper edge of cabinets and upper shelves shall be continuous.

650.1.2 Materials, Fabrication, and Installation

Materials used shall be approved by the Resident Engineer, but in general shall be smooth, hard, impervious to moisture, and resistant to stain and corrosion.

2065 Any exposed surfaces which may come in contact with food and drink, unless otherwise specified, shall be stainless steel, AISI 304, Finish No. 4.

Construction details of equipment, both prefabricated and customized, shall provide for the elimination of sharp edges, corners, and burrs that might cause injury to personnel or unsightliness of the equipment, or that might hamper cleaning and maintenance.

2070 All welding including field joints shall be flush, ground smooth, and polished on exposed surfaces. Solder and/or rivets shall not be used.

2075 Equipment abutting other pieces of equipment or bulkheads shall be installed so that they are easy to clean, and in a manner to prevent soil, grease, or other organic material from catching in crevices. Equipment located on countertops in the Galley and messes shall be securely fastened. All top seams shall be butt-welded. Flashing and sealing shall be provided as necessary to make all areas vermin proof and shall be at least 16-gage.

Sub-bases for equipment shall be provided, and equipment shall be secured to deck, sub-base, or bulkheads as necessary. Securing devices shall be capable of withstanding loads generated by vessel motions.

2080 All equipment mounted on countertops shall be without legs, set and sealed to the countertops with no gaps or crevices between the top and equipment.

650.1.3 Hardware

Door and drawer handles shall be stainless steel flush type combination pull and positive latching devices to eliminate opening due to vessel motions. Hinged doors shall use semi-concealed type hinges with lubrication-free nylon bearing inserts.

2085 650.1.4 Countertops

Countertops and drainboards shall be constructed of one-piece, 14-gage stainless steel, Type 304 or 316 grade wherever possible. Countertops shall be fully reinforced in order to support heavy loads without deflection. Countertops shall be provided in the longest lengths possible.

2090 All seams in horizontal surfaces, including sinks and other inserts abutting countertops, shall be butt-welded and finished as an integral part of the countertop.

2095 Countertops in way of bulkheads shall be constructed with a minimum 6" high integral backsplash, flanged back a minimum of 1" at approximately a 45° angle to the bulkhead or lining. Backsplashes in way of faucets shall be 2" deep. Top edges of backsplash shall be fitted with finishing strips. Backsplashes shall be continuous wherever possible. Where utility outlets are needed, they shall be located above the top of the backsplash.

2100 The edges of countertops not provided with backsplashes shall be formed to provide a retainer edge and an apron integral with the countertop. The top of the retainer shall be approximately ¾" above the working surface, and the apron shall extend down far enough to cover the top horizontal frame member. The crown of the retainer shall be formed to approximately a 5/16" inside radius. The retainer shall be coved at the working surface to at least a 3/8" inside radius.

All corners between countertops and backsplashes and marine edges shall be constructed with a minimum radius of ½". All outside corners shall be constructed with a 3" radius for safety.

650.1.5 Counters and Cabinets

2105 Counters in the Galley shall be approximately 3' high from finished deck to working top when mounted on a sub-base, unless otherwise noted. Countertops and tray slides in the serving line and mess area shall not be more than 2'-10" high from the finished deck.

Counter and cabinets shall be enclosed on sides, back, and front, except in way of drawers and doors, with panels of 18-gage stainless steel secured to 12-gage frames and shall be fitted with a 16-gage stainless steel bottom with a marine edge.

2110 Cabinets shall have adjustable shelves of 16-gage stainless steel with marine edge and with removable sea rails. Shelving shall sustain uniformly distributed loads of not less than 100 lb/ft² and concentrated edge loads of no less than 200 lb/ft².

2115 All drawers shall be fabricated of 18-gage stainless steel with all corners rounded and coved. Mount drawers with fabricated 14-gage interlocking channel supports having large size quiet ball bearing wheel suspension and stops to prevent drawers from being pulled out of fixture. Support slides shall be constructed so that drawers may be pulled out a minimum of two-thirds of their length and support heavy loads without deflection. Drawers shall be easily removable without the use of tools.

2120 Doors for cabinets and sideboards shall have double doors with 18-gage stainless steel outer panel and 20-gage inner panel with hemmed edges. Doors shall be fitted with insulation to provide sound deadening and be approximately ¾" thick.

650.1.6 Sub-Bases

2125 Sub-bases for the installation of counters, lockers, cabinets, etc., shall be constructed of 3/16" stainless steel top plate supported at the front by a stainless steel coaming plate, finishing approximately 6" above the finished deck, and welded to the top plate 4½" in from the front edge to form a toe space. Sub-bases shall have watertight welds on the wet side and form an airtight enclosure when installed. A 1/16" neoprene watertight gasket shall be installed between the equipment and sub-base. Equipment shall be securely attached to the sub-base. Deck covering shall cover up to the sub-bases.

650.1.7 Shelves

2130 Shelving units shall be 16-gage stainless steel and shall sit on adjustable height supports. Exposed edges of shelving shall have a 1½" retainer edge hemmed over 3/8" and removable sea rail(s) unless otherwise noted.

650.1.8 Sinks

2135 Sinks shall be integral with the top and be constructed of no less than 16-guage stainless steel. They shall have cove corners. The bottom of each compartment shall have 4 radial die-stamped grooves pitched to center drain. Partitions for compartment sinks shall be of the same material, double thickness and continuously welded where sinks join at the top and front.

2140 Sink compartment covers shall be provided for prep sinks. Covers shall be 14-gage stainless steel.

650.1.9 Shelving

Shelving, bins, racks, and other items installed in sanitary, utility, and service spaces shall be arranged to suit the material and equipment to be stowed and shall have scantlings sized to support the loads imposed.

2145 Generally, shelving shall be adjustable and not less than 14-gage galvanized steel sheet metal with edges flanged up 3" and hemmed down 1".

Shelving shall be arranged to provide maximum use of the space, with shelves spaced for maximum stowage of items. At least 2'-8" shall be provided between shelving for aisle space.

2150 Fixed and/or portable battens shall be provided above each shelf level in all storerooms, and below the bottom shelves in all refrigerated storerooms, ship's stores and dry-provision storerooms.

Shelving units shall be bolted to the support structure.

650.2 Galley

2155 The Galley Arrangement Drawing, Reference 651-01, depicts the intended Galley, Scullery, and Serverry arrangement and equipment. The Galley and Scullery shall be located immediately forward of the Dining area and adjacent to the Serverry. Serving and condiment/service counters shall be configured as depicted. The Galley shall be outfitted with heavy gage stainless steel countertops and storage cabinets as depicted.

650.3 Scullery

2160 The Scullery shall be outfitted with heavy gage stainless steel countertops and storage cabinets to suit Scullery arrangements. Primary Scullery equipment is shown in Reference 651-01.

650.4 First Aid Room

The First Aid Room shall be outfitted as follows:

- 2165 1. Aluminum hospital berth, 2'-10" wide x 6'-3¼" long x 2'-6" high, with drawers/stowage.
2. Oxygen bottles.
3. Small refrigerator.
4. Metal storage locker, 3'-6" wide x 1'-4" deep x 6'-0" high, with two hinged solid surface access doors and five adjustable shelves.
- 2170 5. Metal storage locker, 3'-6" wide x 1'-0" deep x 3'-6" high, with two hinged solid surface access doors and two adjustable shelves.
6. Metal storage locker, 2'-0" wide x 1'-4" deep x 5'-0" high, with two hinged glass front doors, and five shelves.
7. Fold-down writing surface, 2'-8" wide x 2'-0" deep.
8. Metal end table, 21" wide x 21" deep nominal, with laminate top surface.
- 2175 9. Dial telephone.
10. Iridium Satphone.
11. Hand sanitizer dispenser.
12. Eye wash station (see Section 643.1.8).
13. Portable fire extinguisher.

2180 The hospital berth shall be oriented for complete access along both sides and the foot of the berth.

650.5 Crew Laundry

The following are intended outfit items for the Crew Laundry, located at Frames 50-57, starboard side, Mezzanine Deck:

- 2185 1. Two (2) heavy-duty electric washers.
- 2. Two (2) heavy-duty electric dryers.
- 3. One bulkhead mounted ironing board, with pad and cover.
- 4. Clothes-folding counter space, with a plastic laminated top and backsplash.
- 5. One (1) service deep sink.

2190 650.6 Engineers' Laundry and Shower

The Engineers' Laundry, and Shower, located aft of the EOS on the First Platform, shall be outfitted with the standard suite of fixtures and accessories, including:

- 1. Water closet.
- 2. Lavatory.
- 2195 3. Soap dish.
- 4. Toilet paper dispenser (single roll type).
- 5. Mirror (18" x 24") with integral shelf with marine edge and cup restraining rail.

In addition, it shall have:

- 1. One (1) heavy-duty electric washer.
- 2200 2. One (1) heavy-duty electric dryer.
- 3. Clothes-folding counter space, with a plastic laminated top and backsplash.
- 4. One (1) shower stall.
- 5. One (1) sink vanity.
- 6. One (1) toilet stall.

2205 650.7 Officers' Laundry

The following are intended outfit items for the Officer's Laundry, located at Frames 117-123, port side, First Platform:

- 1. One (1) stacked heavy-duty electric washer and dryer.

660 WORK AND MISCELLANEOUS SPACES

2210 660.1 Offices

660.1.1 Purser's Office

The following are intended outfit items for the Pursers' Office, located at Frames 114-122, center line, Cabin Deck:

- 1. One (1) computer workstation/desk with drawers on one side.

- 2215
2. Three (3) filing cabinets.
 3. Two (2) chairs.
 4. Two (2) bookshelves.
 5. One (1) monochrome copier/scanner/fax, Sharp model MX-M264N (latest iteration at time of construction), or equal.

2220 660.1.2 Steward's Office

The following are intended outfit items for the Steward's Office, located at Frames 198-208, Boat Deck:

1. One (1) computer workstation/desk with drawers on one side.
2. One (1) filing cabinet.
- 2225 3. Two (2) chairs.
4. One (1) bookshelf.

660.1.3 Officers' Stateroom Offices

The following are intended outfit items for the four Officer's Office, located on the Solarium Deck:

- 2230
1. One (1) computer workstation/desk with drawers on one side.
 2. One (1) filing cabinet.
 3. One (1) desk chair.
 4. Two (2) easy chairs.
 5. One (1) bookshelf.
 - 2235 6. Two (2) side tables and (2) lamps.

660.1.4 Log Office

The following are intended outfit items for the Log Office, located at Frames 224-230, center line, First Platform:

1. One (1) computer workstation/desk with drawers on one side.
- 2240 2. Three (3) filing cabinets.
3. Two (2) chairs.
4. Two (2) bookshelves.

660.1.5 Purser's Cage

The following are intended outfit items for the Purser's Cage, located at Frames 122-128, center line, Cabin Deck:

- 2245
1. One (1) wrap around counter.
 2. One (1) customer service opening.

3. One (1) chair.
4. Two (2) bookshelves.

2250 **660.2 Engineer's Operating Station (EOS)**

The EOS shall have acoustically-treated boundaries to 75 dB(A) with propulsion engines operating at MCR and shall be fitted with windows, with fire shutters, that provide clear viewing of the Aft Machinery Room, to the maximum extent practicable. The EOS shall house the MCC and all control, alarm, and indicator panels and equipment that relate to the propulsion and auxiliary plants, and also ship's emergency systems that require control and/or monitoring actions by the EOS watch stander, in accordance with regulatory requirements and good operating practice. See Technical Specifications Section 1E.11.5 which lists all the acoustical requirements for the EOS.

2260 The EOS arrangement shall be in accordance with Reference 662-01. The MCC shall be built to provide ready front access for installation or repair and shall include hinged panels with door stops. The console shall be designed with removable back panels for further access.

In addition to the foregoing, the EOS shall be outfitted with the following furnishings:

1. One (1) computer workstation/desk, and one (1) chair.
2. Bookshelves and/or cabinets for technical pubs stowage.
- 2265 3. Ship's clock.
4. Network rack.
5. Ship clinometer.
6. A minimum of three (3) additional chairs positioned on the aft bulkhead.

660.3 Pilothouse

2270 Primary outfit items within the Pilothouse shall include centerline control console, port and starboard wing control consoles, steering stand, GMDSS console station with chair, radar consoles, a navigation chart table with multiple chart drawers under, coffee station (with cabinet under), a cabinet for publications and supplies, a flags and pennants locker, two pedestal-mounted "captain's" chairs, a lockable display board for ship and crew certificates, inclinometer, 2275 ship's bell clock, and barometer.

The space shall also be outfitted with an extensive array of other navigation and electronics outfit as listed in Technical Specifications Section 421, as well as various power panelboards and other features needed to support the electronic systems and equipment. Most of these items shall be mounted in way of the control consoles, over the chart table, or along the aft bulkhead of the 2280 space.

660.4 Training Room

The Training Room, Frames 38-50, starboard side, Mezzanine Deck, shall be outfitted with two (2) computer workstations, with power receptacles and connections to the ship's network system. A storage locker and shelving also shall be provided.

2285 **660.5 Shops and Work Stations**

660.5.1 General

Steel-top workbenches described in this section shall have 7.65 pound steel plate tops, with the backs flanged up 6" and the fronts flanged down 2". Hardwood-top workbenches shall have tops with 1½" finished thickness, sanded and coated.

2290 All workbenches shall have galvanized angle frames.

660.5.2 Engineers' Workshop

The Engineers' Workshop, Frames 206-230, First Platform, shall have the following baseline outfit; however, sizes and quantities of items such as work benches, cabinets, and lockers shall be adjusted, as appropriate, to suit the size and configuration of the space:

- 2295 1. Two (2) 2'-6" wide x 6'-0" long steel workbenches.
- a) Each workbench shall have 2 sliding drawers, 5" deep.
- b) One workbench shall be fitted with 1 piped jawed 5" vise.
2. One (1) hardwood topped steel workbench, 2'-6" wide x 6'-0" long. The workbench shall have 2 sliding drawers, 5" deep.
- 2300 3. Metal tool boards the same length as the workbench served, located above and behind each workbench to accommodate tools.
4. Suite of Stanley Vidmar, or equal, industrial grade tool and parts cabinets.
5. Stainless steel, bin-type shelving units.
6. Two (2) sheet metal tool lockers, each approximately 4' wide x 3' deep x 7' high.
- 2305 a) Each locker shall have a minimum of 4 drawers and 3 fixed shelves.
- b) Fixed shelves shall be suitable for holding 100 pounds of tools on each shelf. The spaces formed by the fixed shelves shall be fitted with doors. It shall be possible to lock the entire locker (i.e., shelves and drawers) using a padlock.
7. Service deep sink.
- 2310 8. Drill press.
9. Metal grinding wheel.
10. Metal lathe.
11. Welding machine.
12. Solvent cleaning station.
- 2315 13. Ship's service compressed air station, for use with portable air-driven tools.
14. One (1) clean rag locker and one (1) 30-gallon dirty rag bin.

Dedicated ventilation exhaust to weather shall be provided for the welding station and solvent cleaning station.

2320 Two electrical power and distribution panels shall be provided in the Workshop, dedicated to the operation of Workshop equipment. One panel shall be 120 V, 225 A, with a minimum of 6 two-pole spaces. The other panel shall be 220 V, 225 A, with a minimum of 4 three-pole spaces.

The arrangement of the Engineers' Workshop shall be developed during the contract design phase in consultation with AMHS management.

660.5.3 Bosun's Workshop

2325 The Bosun's Workshop, Frames 206-224, port, Main Deck level, shall be outfitted with the following, located in agreement with the General Arrangement plan:

1. One (1) 2'-6" wide x 6'-0" long steel workbench. The workbench shall have 2 sliding drawers, 5" deep, and 1 pipe jawed 5" vise.
- 2330 2. One (1) hardwood topped steel workbench, 2'-6" wide x 6'-0" long. The workbench shall have 2 sliding drawer, 5" deep.
3. Metal tool boards the same length as the workbench served, located above and behind each workbench to accommodate tools.
4. At least one (1) Stanley Vidmar, or equal, industrial grade tool and parts cabinet.
- 2335 5. Stainless steel, bin-type shelving units, in quantities and configurations to suit parts and equipment storage needs and available space.
6. One (1) sheet metal tool locker approximately 4' wide x 3' deep x 7' high.
 - a) The locker shall have a minimum of 4 drawers and 3 fixed shelves.
 - b) Fixed shelves shall be suitable for holding 100 pounds of tools on each shelf. The spaces formed by the fixed shelves shall be fitted with doors. It shall be possible to
- 2340 7. Ship's service compressed air station, for use with portable air-driven tools.
8. One (1) clean rag locker and one (1) 30-gallon dirty rag bin.

660.5.4 Forward Machinery Room and Aft Machinery Room Workstations

2345 A workstation shall be provided in both the FMR and Aft Machinery Room. Each workstation shall consist of a 6' x 3' steel topped workbench. The Forward Machinery Room workstation shall be located on the Hold Level near the center of the space and shall be provided with an adjacent cleaning basin. The Aft Machinery Room workstation shall be located on the Hold Level near the main engines.

2350 The cleaning basin shall be fitted with a shut-off valve suitable for cleaning centrifuge bowls and engine and other machinery parts and shall drain to the respective space's dirty drain collection tank.

660.6 Electrical Room

Computer and electronics racks shall be provided as needed.

660.7 Network Room

- 2355 Computer and electronics racks shall be provided as needed. One (1) computer workstation/desk shall be provided with chair and file cabinet.

660.8 Pilothouse Electronics Room

Electronics Room below the bridge shall contain electronics racks for all the bridge electronics that is not installed in the Bridge.

2360 670 STOREROOMS, LOCKERS AND SPECIAL STOWAGE

670.1 Mooring Line Stowage

Mooring line storage shall be in insulated and heated lockers located aft of the Emergency Genset Room on the Cabin Deck.

670.2 Pyrotechnics Stowage

- 2365 Pyrotechnic stowage shall be in well-marked, dedicated weathertight lockers aft of bridge wing doors.

670.3 Lifejackets and Immersion Suit Stowage

- 2370 Lifejacket storage shall be in weathertight bench/lockers adjacent to the lifeboats and evacuation slides as well as on the aft end of the Solarium Deck. Additional lifejacket stowage shall under booth seating in lounges and dining areas.

670.4 Fire Squad/Emergency Gear Lockers

- 2375 Squad lockers shall be outfitted with stainless steel shelving appropriate for the gear. The lockers shall be equipped for hanging of the required gear to enable expeditious donning of the gear. One bulkhead shall be fitted with up to 4 shelves, with a sea rail where practicable. Final arrangements shall be approved by the Resident Engineer.

670.5 Cleaning Gear Lockers

Each cleaning gear locker shall be outfitted with a service sink, a heavy-duty broom/mop rack, and aluminum or stainless steel shelving, with sea rail, to suit the space.

670.6 Linen Lockers

- 2380 Each Clean Linen Locker and the Dirty Linen Locker shall be outfitted with tiered stainless steel shelving/bins in quantities appropriate for the size and configuration of the specific space.

670.7 Bosun's Storeroom

The following are intended outfit items for the Bosun's Storeroom. Sizes and, where applicable, quantities of these items may be adjusted during the contract design phase to suit size and arrangement constraints:

1. A steel-topped workbench. The workbench shall be 3' wide x 6' long and fit with a 6" vise and tool drawers.
2. A sheet metal tool locker of approximately 4' wide x 3' deep x 7' high dimensions. The locker shall have 3 fixed shelves suitable for holding 100 pounds of tools on each shelf and doors fitted with staple and hasp.

670.8 Deck Lockers

Deck Gear lockers shall be fitted with 4 shelves, with sea rails.

670.9 Boat Gear Locker

Boat Gear locker shall be fitted with 4 shelves, with sea rails.

670.10 Crew Baggage Storeroom

The Crew Baggage Stores space, Frames 38-50, port side, Mezzanine Deck level, shall be outfitted with tiered stainless steel or aluminum shelving/bins along its periphery in quantities appropriate for the size and configuration of the space.

670.11 Chemical Locker

Chemical Locker shall be provided with adjustable height shelving extending from the floor to the ceiling. There shall be 4 tiers of 2'-3" wide shelving at 18' lineal extent each

670.12 Commissary Storage Spaces

Storeroom shelving shall be heavy duty stainless steel wire shelves to promote air circulation. Substantial sea rails shall be fitted on all open peripheries. In addition, transverse shelving shall be divided into discrete bins. Shelving shall be rated at 100 lb/ft².

670.12.1 Dry Stores Room

Dry Stores shall be provided with adjustable height shelving extending from the floor to the ceiling. There shall be 4 tiers of 2'-3" wide shelving at 42' lineal extent each.

670.12.2 Vegetable Stores Room

The Vegetable Stores Room shall be provided with adjustable height shelving extending from the floor to the ceiling. There shall be 4 tiers of 2'-3" wide shelving at 25' lineal extent each.

The Vegetable Stores Room temperature shall be adjustable for a maintainable temperature range between 33°F and 40°F.

670.12.3 Meat, Seafood, and Poultry Stores Room

2415 The Meat and Seafood Stores Room shall be provided with adjustable height shelving extending from the floor to the ceiling. There shall be 4 tiers of 2'-3" wide shelving at 36' lineal extent each.

The Meat and Seafood Stores Room temperature shall be adjustable for a maintainable temperature range between 33°F and 40°F.

670.12.4 Dairy Stores Room

The Dairy Stores Room shall be provided with adjustable height shelving extending from the floor to the ceiling. There shall be 4 tiers of 2'-3" wide shelving at 25' lineal extent each.

The Dairy Stores Room temperature shall be adjustable for a maintainable temperature range between 33°F and 40°F.

670.12.5 Passageway Stores Alcove

The stores alcove, Frames 230-248, starboard side, off the passageway, shall have tie downs and securing points suitable for securing 3 pallets of stores.

670.12.6 Freezer Stores Room

2430 The Freezer Stores Room shall be provided with adjustable height shelving extending from the floor to the ceiling. There shall be 4 tiers of 2'-3" wide shelving at 42' lineal extent each.

The Freezer Stores Room temperature shall be adjustable for a maintainable temperature between -10°F and 0°F.

670.12.7 Modular Refrigeration Unit

The modular refrigeration unit for Galley stores shall be outfitted as described in Section 638.

670.13 Paint Locker

The Paint Locker shall be outfitted with the following:

1. Two (2) steel-topped workbenches, each 6' long x 2'-6" wide and have a steel top and one sliding drawer.
2. A tool board of wood construction extending along the back of each workbench.
- 2440 3. Deep, heavy gage shelving, with sea rails, suitable for stowing thirty (30) 5-gallon and one hundred (100) 1-gallon paint cans.
4. Two (2) 20-gallon galvanized steel trash cans.

670.14 Bicycle and Kayak Storage

2445 Tie downs, hooks and/or racks for storing at least 10 bicycles and 4 kayaks shall be provided at one or more suitable location(s) in the Vehicle Space. The precise stowage locations shall be selected so as not to interfere with vehicle loading operations in any port and shall be approved by the Resident Engineer.