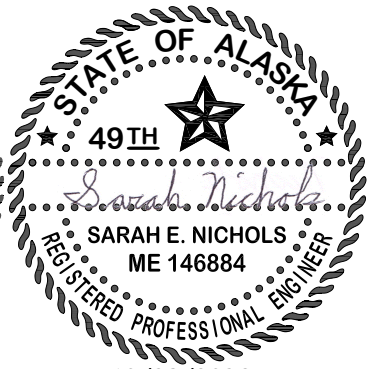
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Large Class Enforcement Vessel

Specification

Prepared for: Alaska Wildlife Troopers | Anchorage, AK

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General Notes

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Revisions

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–	Initial issue	10/23/26	SKW, 55707 PTE, 13275 SEN, 146884 TMH, 13580

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Group 000 – Requirements for Design and Construction

011 General Description

The vessel to be delivered is a patrol vessel, built of a steel hull and aluminum superstructure, outfitted for year-round service in Alaskan waters and icy conditions. It will have a 2,400nm range at 10kt cruising speed, and a design life of 50 years.

Fully redundant main propulsion shall be provided by two CAT C18 engines with reduction gears connected to independent fixed pitch propellers. An installed bow thruster will assist with steering and docking maneuvers.

011.1 Principal Characteristics

The principal characteristics of the vessel are as follows in Table 1.

Table 1: Principal characteristics of the vessel

Characteristic	Value
USCG Certification	Built to 46 CFR Subchapter T standards
Classification	No Classification or Load Line
Gross Tonnage	< 200 GRT
Length Overall	96' – 1/2"
Length on Design Load Waterline	91' – 7 7/8"
Beam, Molded	27' – 6"
Beam over Guards	28' or less
Depth at Main Deck side	11' – 9"
Draft at Design Load Water Line (DLWL)	7' – 9"
Light Ship Weight, Estimated	175LT
Maximum Displacement	270LT
Propulsion	2x fixed pitch propellers
Fuel Oil Capacity (95%)	14,400 gallons @ 95% capacity
Minimum Crew Complement	3 operators, 2 troopers, 5 passengers
Service Speed	10 knots

011.2 Route and Mission Description

This vessel is intended to patrol the waters of Alaska year-round in all conditions, including icy conditions. It will primarily patrol both inside waters and outside waters in Southeast Alaska and also transit through the Gulf of Alaska to destinations such as Kodiak, Yakutat, and Cordova. It is expected to perform patrolling missions to Yakutat two to three times per year.

012 Definitions

Term	Definition
ABS	American Bureau of Shipbuilding
Contractor or Shipyard	Where the term "Contractor" or "Shipyard" appear in this Specification and Contract Plans, such terms refer to the individual, firm, or corporation undertaking the execution of the work under the terms of the Contract.
Contract	The document which binds the Contractor with the Owner for the construction and delivery of the vessel.
Contract Plans	Contract Plans include Contract Drawings, Contract Guidance Drawings, and Supporting Documents as further defined and delineated in Section 030.
Install, or Furnish	Used together or separately, refers to the actions required of the Contractor to supply all materials, equipment, tools, labor, and incidentals to perform the work necessary to properly fit/integrate the equipment or system into the vessel and verify proper function for the intended use.
Detail Design / Construction Drawings	Developed by Contractor for purpose of Construction, to include shop drawings and other working drawings that support construction.
Naval Architect	Where the term "Naval Architect" appears in this Specification, this term refers to Elliott Bay Design Group LLC (EBDG), Naval Architects and Marine Engineers, Seattle, WA.
or equal	An "or equal" product or material is one which exhibits the same general size, weight, characteristics, performance, reliability, and maintainability as the product or material identified in this Specification. Demonstrating "or equal" is defined in Section 044.
OSHA	Occupational Safety and Health Administration
Owner	Alaska Wildlife Troopers (AWT) or a sanctioned representative of AWT.
Prepare	To develop or produce data or information for submittal and/or distribution to the Owner, or to regulatory bodies.
Provide	Design, purchase, install/integrate into the vessel, test, and verify proper function for intended use.
Regulatory Body	Any organization, government agency, or commission that regulates or oversees the construction, certification, and/or operation of vessels, as required by federal or state laws, including but not limited to: ABS, OSHA, USCG
Specification	Technical Specification (this document).
USCG	United States Coast Guard

030 Contract Plans

This Specification and the Contract Plans referenced herein are part of the Contract. In case of any difference or discrepancy between this Specification and the Contract Plans, this Specification shall govern. In the case of any difference or discrepancy between Contract Plans, or this Specification, and the Contract, the Contract shall govern.

Contract Drawings shall not be deviated from without prior written approval from the Owner. The Lines Plan showing the design of the vessel hull form is a Contract Drawing. The shape of the hull shall conform to the Lines Plan, and the hull shall be carefully faired. Except for fairing, deviations from the Lines Plan shall not be made without prior written approval from the Owner.

The arrangement of the vessel shall conform to the Profile and Arrangements drawing. The size and layout of spaces within the vessel, seating arrangements and other major features shown shall not be changed without written approval of the Owner.

Except where strict conference is expressly stated in these Specifications, the Contract Guidance Drawings show acceptable arrangements, basic technical information, performance requirements, and features to guide the Contractor in development of additional details required for construction, regulatory agency approvals, and Owner review.

Contract Guidance Drawings are not intended to restrict the Contractor to the details shown therein. Equivalent details, which may make use of more readily available material or permit use of the Contractor's standards and procedures of equal merit and quality are acceptable. Changes to major features, functionality, and materials shall not be made without written approval of the Owner prior to start of construction.

It is not the intent of this Specification and Contract Plans to cover every detail of construction and equipment. Any material or parts, the omission of which would be detrimental to the seaworthiness or serviceability of the vessel, and the inclusion of which is generally accepted good shipbuilding practice, shall be provided by the Contractor to the satisfaction of and without increase in cost to the Owner.

Contract Guidance Drawings illustrating piping, mechanical, electrical, and other systems are generally diagrammatic in nature. The Contractor is required to develop the systems and conduct its own interference survey. Machinery and equipment shall be arranged such that there are proper clearances for convenient operation, regular maintenance, and repair.

The Contractor is cautioned to check and verify dimensions, weights, and sizes from the manufacturer's certified drawings or the actual machinery or equipment itself, to ensure that the customary growth in machinery and equipment size does not cause interferences. Large changes in equipment size that may significantly affect the arrangement of the equipment must be promptly called to the attention of the Owner, including calling to the attention of the Owner any reasonably anticipated impacts of such changes on other systems and/or Specifications.

The Supporting Documents were developed with and in support of the Contract Plans. Any calculations provided therein support the Contract Design. As the Contractor develops the Functional and Detail Designs, the Contractor shall develop, update, or verify the supporting calculations as necessary.

The Contractor shall develop detailed other design and construction drawings (Construction Drawings or Working Drawings) as appropriate and as necessary for vessel construction, and construction and/or installation of components, equipment and machinery using sources of information not available during contract design development including certified vendor drawings, templating from actual equipment, or using more detailed information provided by equipment vendors under contract to the Contractor.

Construction Drawings shall be submitted to the Owner for review and approval in accordance with Section 810.

Contract Drawings

(A) 24065-100-1, Lines Plan

Contract Guidance Drawings

(B) 24065-200-101-1, Profiles and Arrangements
(C) 24065-200-101-2, Fire and Safety Plan
(D) 24065-200-120-0, Hull Structure
(E) 24065-200-150-0, Deck House Structure
(F) 24065-200-243-0, Shafting Arrangements
(G) 24065-200-256-0, Fresh Water Cooling System Diagram
(H) 24065-200-259-1, Engine Exhaust Arrangement
(I) 24065-200-259-2, Engine Room Air Supply and Exhaust
(J) 24065-200-320-0, Electrical AC One-Line Diagram
(K) 24065-200-506-0, Vents, Fills, and Sounds
(L) 24065-200-521-0, Bilge and Fire Main Piping Diagram
(M) 24065-200-528-0, Black and Gray Water System Schematic
(N) 24065-200-533-0, Fresh Water System Schematic
(O) 24065-200-541-0, Fuel Piping Diagram
(P) 24065-200-562-0, Steering and Rudder Arrangement

Supporting Documents

(Q) 24065-200-300-1, AC Electrical Loads Analysis
(R) 24065-200-833-0, Weight Estimate
(S) 24065-200-832-1, Electronics Specification
(T) 24065-200-843-5, Stability Assessment

044 Material Substitutions

Names of certain manufacturers and items, where mentioned in this Specification and Contract Guidance Drawings, are included as a means of describing the general character and quality of the design and construction of various items and articles. Further, specific equipment identified may have been selected as a basis for development of the Contract Design guidance. Substitutions for such items must be of equal quality and function and must be approved by the Owner in writing in advance of purchase.

An "or equal" product or material is one which exhibits the same general size, weight, characteristics, performance, reliability, and maintainability as the product or material identified in this Specification. The Contractor shall be wholly responsible for demonstrating the "or equal" status of any product or material, which is offered as a substitute for those sited in this Specification.

Requests for substitutions shall be made in writing to the Owner setting forth the reason for the proposed substitution and providing documented evidence of the substitute's equivalence or superiority to the specified product or material. The request shall also provide the Contractor's assurance that the substitution, if approved, will not result in any increase in the Contract Price nor an extension of the delivery date of the vessel.

Requests for substitution must include:

- Construction to marine appropriate recognized standards (UL, IEEE, ANSI, ASTM, etc.).
- Comprehensive comparison of construction features, quality of fabrication, and materials of construction between the specified item and the proposed item. Complete drawings and dimensional data shall be substituted for each item. The weight of each item shall be provided.
- Comprehensive comparison of the performance and functional characteristics between the specified item and the proposed item, including capacity, safety features, rated service duty life, maintenance life cycle, requirements, and warranty terms.
- Comprehensive list of impacts that the substitution will cause to arrangements, structure and interfacing piping, ventilation, electrical, and control systems.
- Valid manufacturers price (and if applicable, warranty) quote for the specified and the proposed substitute item.
- Location of nearest distributor stocking parts for the items and providing field service for the proposed substitution and the specified item.
- Statement from Contractor indicating that the proposed substitution will not be a cost increase and will not extend the delivery date of the vessel.

070 Requirements for Design and Construction

All work performed on the vessel shall comply with the requirements of the various regulatory body rules and standards listed in that are in force at the time of Contract signing, insofar as they may have jurisdiction or application.

[1] 46 CFR Subchapter T: Small Passenger Vessels (Under 100 Gross Tons)

[2] ABS Rules for Building and Classing Steel Vessels Under 61 Meters (200 Feet) in Length

[3] ABS Rules for Building and Classing Marine Vessels

[4] American Welding Society D1.1 "Structural Welding Code - Steel" (AWS D1.1)

[5] ABS Guide for Nondestructive Inspection

[6] International Association of Classification Societies No. 47 "Shipbuilding and Repair Quality Standard" (IACS No. 47)

[7] ABS Rules for Materials and Welding

[8] American Welding Society D1.2 "Structural Welding Code – Aluminum" (AWS D1.2)

[9] American Welding Society D3.7 "Specification for Aluminum Brazing" (AWS D3.7)

[10] SNAME T&R Bulletin 3-39, Guide for Shop and Installation Tests

[11] SNAME, T&R Bulletin No. 3-47, Guide for Sea Trials

[12] SNAME, T&R Bulletin No. 3-51, Practices and Procedures for the Alignment of Marine Maine Propulsion Shafting Systems

[13] ASTM F1166-95a, Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities

[14] ASTM F994, Standard Specification for Design and Installation of Overboard Discharge Hull Penetration Connections

[15] 29 CFR 1910.95 Occupational Noise Exposure

071 Access Requirements

The Contractor shall ensure that adequate and immediate access is provided throughout the vessel to operate, inspect, maintain, and repair installed equipment and machinery, including associated valves, filters, controls, sensing devices, and other features requiring periodic operation, adjustment, maintenance and repair. This requirement will involve care in routing exhaust piping, cabling, and ductwork and consideration of further restrictions imposed by insulation, linings, hangers, and brackets.

Access shall be provided throughout spaces and to and around machinery and equipment by means of adjacent deck plates or gratings, permanent ladders, doors, manholes, scuttles and/or bolted plates. Restriction of accession openings by pipes and valves or other items will not be acceptable. Permanent fittings shall not be installed in a manner to restrict routes for removal of machinery and equipment. Controls and valves shall not be located in areas rendered inaccessible by the positioning of other fittings.

071.1 Headroom and Clearances

The Contractor shall take care to maximize headroom in all spaces, especially those under the main deck. 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 individual walking along normal ship passageways. Large items potentially protruding down from the ceiling shall be located and oriented so as not to inhibit the clear headroom requirements along primary walkways and frequently access areas.

The required clear height in spaces is shown in Reference (B). If the Contractor needs to protrude below this threshold, the Contractor should discuss with the Owner to determine the best course of action. Where not specified, the minimum headroom in spaces below the main deck shall be 6'-6", or the maximum possible in these spaces.

071.2 Ergonomics

The ergonomic design criteria of Reference [13] shall be applied to the placement and layout of the vessel systems, equipment, controls, and other features with ergonomic implications. The Contractor is strongly encouraged to review this standard prior to establishing the location and/or layout of any vessel equipment control or operational devices.

073 Vibration and Noise

The Contractor is cautioned to pay particular attention to the design, construction, materials and equipment, both airborne and structural, in order to minimize vibration and noise. Noise levels shall be suitable for mission requirements and in accordance with good marine practice and OSHA standards for maritime operations (29 CFR 1910.95), to the satisfaction of the Owner. Joinery systems, in particular, shall be selected to mitigate noise in accommodations. It is the Contractor's responsibility to locate and correct unusual vibration and noise arising during tests/trials or subsequently during the warranty period.

074 Welding

Welding shall meet all applicable Regulatory requirements References [1] and [2], the Specification, and the Contract Guidance Drawings.

Prior to the start of construction, the Contractor shall submit the weld schedule, Welding Procedure Specifications (WPS), and Procedure Qualification Records (PQR). No deviation from the approved weld joint designs or procedures will be permitted without Owner review prior to fabrication.

All welding shall be performed by welders holding current certifications for the approved procedures in accordance with Reference [4]. Prior to the start of construction, the Contractor shall provide a roster of all qualified welders and their welding certifications. Certificates shall be maintained during the Contract performance period.

The Contractor shall visually inspect all welds. Cyclically loaded structure shall be visually inspected to the standards in Reference [4]. The Contractor is also responsible for visual and other non-destructive testing (NDT) of welds by the frequency, location, and methods specified by the Reference [5], and to the Owner's satisfaction. The Contractor shall prepare an NDT plan which must be reviewed by the Owner prior to performing NDT on the vessel. Defective welds and welds of poor quality that do not meet the satisfaction of the Owner shall be removed and rewelded or repaired in accordance with Reference [4] by the Contractor.

The welding sequence shall be designed to minimize distortion and locked-in stresses. Structural welding shall be carried out in such sequence as to compensate for creeping and shrinkage as the work progresses, keeping distortion within the fairness standards of Reference [6] unless a higher requirement for fairness is specified elsewhere in this Specification.

Intermittent welding is not permitted in the foundations for the main engines, generators, propeller struts, rudders, anchor winch, fore deck crane, and hull structure immediately in way of these foundations.

Welding in areas exposed to the weather or other conditions which may result in corrosion to the faying surfaces of attached members shall be continuous or shall be sealed between intermittent welds with an applied fillet of paintable marine grade epoxy or polyurethane-based caulking. Areas where continuous welding or caulking may be applied include bulwarks, curtain plates, exterior overhead structures, and pilothouse top and visor.

Fillet welds shall be wrapped around the ends of members, in weld relief locations, and around brackets to eliminate stress risers and corrosion points, and in accordance with Reference [7]. In way of built-up, radiused intersections of girders, welding of the flange to the web shall be double continuous through the extent of the radius. Errant arc strikes outside the area of permanent welds shall be avoided. The Contractor shall grind smooth any blemishes caused by errant arc strikes and repair any defects per Reference [4]. Peening or caulking of weld material will not be allowed. Surfaces to be welded shall be free from mill scale, excessive rust, moisture, grease, or other contaminants that would prevent proper welding.

078 Materials and Workmanship

Unless otherwise stated in this Specification, the Contractor shall supply the necessary labor, material, skill, and equipment required to complete the construction and testing of the vessel. All materials shall be new and of current manufacture unless specific approval to the contrary is obtained from the Owner in writing. At time of substantial completion, installed equipment shall be actively supported by manufacturer with readily available replacement parts, technical support, and software updates, where applicable.

The work shall be complete in all respects. Anything inadvertently omitted from this Specification or Contract Plans that is necessary and usual to a complete vessel, shall be supplied as a part of this

Contract. Materials used and the workmanship thereon shall be of the best description and quality throughout and of adequate sizes to accomplish the purpose intended. The work, in every respect, shall be to the complete satisfaction of the Owner.

Defects appearing at any stage of the work shall be cause for rejection even though the piece in question may have previously passed as satisfactory.

Pipe materials and fittings shall be appropriate for the service type and as noted on the Contract Guidance Drawings.

Structural steel shall be ABS Grade A and manufactured by an ABS approved steel mill. ASTM A36 may be substituted for ABS Grade A for plate thicknesses up to and including 0.5in and section thicknesses up to and including 0.75in. All materials (including plate, shapes, welding electrodes, etc.) shall be in accordance with ABS requirements. The Contractor shall provide mill certification or ABS certification to the Owner prior to installation of the material. Certification to include origin, heat number, size of member, and quantity.

Structural aluminum shall be 5086 H116 for plate and 6061 T6 for shapes and pipe. Flat bar bay be cut from plate. The Contractor shall provide mill certification to the Owner prior to installation of the material. Certification to include origin, heat number, material series and temper, size of member, and quantity.

Brasses and bronzes shall be mixtures of virgin material of proper proportion for the purpose intended and shall be clean, smooth castings, uniform in texture and finish.

Galvanizing shall be done by the hot-dip process after hot work has been completed. Electro-galvanizing will not be accepted except for pre-manufactured items and as approved by the Owner. Where galvanizing is damaged during construction, the Contractor shall repair the galvanizing using hot stick or zinc-spray metalizing methods in accordance with ASTM A780. Zinc repairs shall be lead free.

Where fasteners, pipe, tube, sheet metal, or plates and shapes are described as being stainless steel, marine grade 300 series stainless steel shall be used in all cases. Fasteners, fluid piping, and hose fittings shall be 316 stainless steel, unless otherwise specified. Piping and materials used for exterior handrails and ladders shall be 316L stainless steel where mounted to steel structure or 6061 T6 aluminum where mounted to Aluminum superstructure, unless otherwise specified. Where stainless steel is used and wire-brushed, only non-ferrous wire brush materials shall be used.

079 Environmental Conditions

The vessel shall be designed and built to operate safely and efficiently in all relevant water and weather conditions, including icy conditions. All vessel systems, structures, machinery, and outfit shall be capable of sustained operation while subjected to the pertinent static and dynamic design angles of inclination prescribed in Reference [3].

Structures not specifically addressed by the contract design or the ABS Rules, such as foundations, and equipment and machinery mounted on weather decks must be designed using standard AISC factors of safety to withstand all applicable loads, including the following:

- Wind Loading: 30lb/ft^2 of projected area. Reduction of the projected area because of heel must be neglected for vertical members.
- Snow and Ice Loading: 80lb/ft^2

The worst-case ambient air and sea water temperatures are as shown in Table 2.

Table 2: Worst-case ambient air and sea water temperatures

Parameter	Units	Summer	Winter
Air Temperature, dry bulb	°F	80	-10
Relative Humidity	%	80	100
Sea Water Temperature	°F	70	28

The vessel shall be designed to transit safely in 60kt winds and 12ft significant wave heights and survive wind gusts up to 100kt and 18ft significant waves.

084 Equipment Storage

Equipment purchased by the Contractor for use in the construction of this vessel shall be securely warehoused by the Contractor and segregated from equipment for other projects. The equipment shall be kept in a covered, clean, dry environment and relatively constant temperature (±30° from 70° ambient). Equipment requiring special handling by its manufacturer shall be stored in accordance with the manufacturer's requirements.

The Owner shall be provided with access to stored equipment at any time upon request.

The Contractor shall adequately protect equipment from overspray of solvents, paints, impact damage, and weld or cutting materials contact while in storage and onboard. Temporary fire-resistant covers or enclosures shall be placed over all equipment where overhead or adjacent hot work is being performed. Scaffolding or work platforms shall be placed over equipment to stand on or walk across for access to overhead or beyond. The Contractor and subcontractors shall not stand on equipment or furnishings to work overhead.

The Contractor shall immediately comply with all directives form the Owner to protect or improve protection of equipment and components from physical damage.

088 Care of Vessel During Construction

The Contractor is solely responsible for the welfare of the vessel, equipment, and construction materials until vessel acceptance. The Contractor shall maintain the vessel and surrounding worksite in a manner suitable for safe, efficient construction in accordance with modern shipbuilding practice and applicable regulations. All necessary measures shall be taken to minimize and prevent wear or deterioration due to installation, testing, weather, sunlight, water, dust, or moisture during construction.

The Contractor shall ensure that frequent cleaning of the vessel during construction to remove excess debris and components and interim cleanups are performed to maintain a housekeeping standard to the approval of the Owner.

All joiner and finished surfaces, including equipment components and machinery, installed before delivery shall be protected from scuffs, damage, dirt, or debris intrusion, and paint overspray or drips by appropriate covers and shields to the approval of the Owner. Protective coverings include the use of fire blankets during welding and cutting operations, covering walkways and interior floor finishes, and covering equipment, decks, and finished surfaces with adequate protection prior to any painting in the space. The protective covers and shields shall be maintained in satisfactory order during the remainder of construction and delivery and refreshed as necessary. Any damaged or inadvertently coated finished surfaces or equipment finishes shall be restored to a like-new condition prior to delivery of the vessel.

The Contractor shall remove any adhesive residue left after final removal of the protective covers or shields.

088.1 Fire Protection

During construction, flammable materials shall not be stored on board the vessel in such a manner as to create a serious fire hazard. The Contractor shall exercise special care to prevent the possible outbreak of fire and perform periodic cleaning to minimize fire hazards. A pressurized fire hose shall be available and maintained at the vessel construction site at all times.

Hot work shall comply with applicable regulations or orders of OSHA and the local fire department. Experienced supervisors shall be present during all hot work. Gas hoses shall be pulled out of spaces when work is not in progress.

Where hot work (torch cutting, welding, and grinding) is being carried out in the vicinity of combustible material, a fire watch, whose sole purpose shall be to watch for fires and keep firefighting equipment on hand, shall be on duty. Fire watch personnel shall remain on duty in the same space where hot work was performed for a period of at least 30 minutes after cessation of hot work.

Spent or partially spent portable fire extinguishers shall be immediately replaced with fully charged extinguishers. The Contractor shall ensure that there are no open fires on or within 50ft of the vessel at all times while in custody of the Contractor.

088.2 Hull Protection

The Contractor shall maintain rigid control of welding and grounding for the protection of the hull, its systems, and appendages during the entire time the vessel is in custody of the Contractor.

091 Quality Assurance Program

The Contractor shall develop and implement a comprehensive testing and quality assurance program. Contractor shall provide a description of the plan and procedures of this plan to the Owner for approval. The purpose of this program is to ensure that all workmanship is satisfactory, all equipment has been correctly installed, all systems are functioning properly, and all work performed by subcontractors is acceptable. The testing and quality assurance program will encompass all aspects of the vessel's construction including hull fabrication, machinery systems, piping systems, electrical systems, and outfitting.

092 Inspections

During construction and at any time prior to delivery of the vessel, the Owner shall be given free access to the Contractor's facility for the purpose of inspecting work and materials. The Owner shall be granted access to the vessel at any time prior to final acceptance and will have the authority to reject any material or workmanship that does not conform to the requirements of this Specification and the Contract Plans.

093 Weight Control Program

Minimizing weight growth during construction is vital to the success of this project. The Contractor shall not change the structural sizes, exceed the scantlings, or increase the pipe sizes and wall thicknesses described by this Specification and Contract Guidance Drawings unless it can be demonstrated by the Contractor to be necessary for the suitability of the vessel for its service.

The Owner will revise the Contract weight estimate during the course of this construction project, based on Contractor provided information. Contractor shall promptly report any changes in weight and location of installed equipment to the owner.

Throughout the construction of the vessel on a monthly basis, the Contractor and owner shall meet to discuss the actual weight and centers of equipment and materials against the contract weight estimate. Weight growth, changes in centers of gravity, final heel angle, and final trim angle shall be addressed and any corrective action discussed and implemented.

The Contractor is cautioned to pay close attention to the longitudinal and transverse centers of gravity of the vessel and will be responsible for additional permanent ballast if the vessel has trim or list exceeding the limits described in Section 843.3. The Contractor shall be responsible for delivering the vessel within the limit of the maximum light ship weight and operational freeboard range.

The Owner and the Contractor shall jointly conduct an informal deadweight survey at the time of launching for the purpose of establishing the as-built weight of the vessel.

Group 100 – Hull Structure

100 General

This section outlines the general hull construction requirements for the vessel. This section is intended to provide requirements, along with the referenced Contract Drawings and Contract Guidance Drawings and all applicable regulations, for the Contractor's development of Detail Design packages for the vessel.

The Contractor shall be responsible for the design, detailing, and construction of all structural components of the vessel meeting the requirements of this Specification, to the satisfaction of the Owner. The Contractor shall be responsible for the vessel's integrity during construction and ensure that the completed vessel is structurally designed and constructed for its intended service, including future drydocking.

100.1 Steel Construction

The structural arrangement and scantlings reflected on the Contract and Contract Guidance Drawings have generally been developed in accordance with Reference [2].

The Contractor shall develop the Detail Design package for use in construction based on this Specification and the Contract Plans. Scantlings and structural details shall meet the requirements of Reference [2]. Scantlings indicated in this Specification and Contract Guidance Drawings that exceed the requirements of Reference [2] shall not be reduced without Owner review.

All dimensional tolerances, fit, alignment, general workmanship, and finish of new structure shall be in accordance with References [4], [5], and [6]. Where tolerance limits are indicated in both Reference [6] and this Specification, the lesser limit shall apply. Reference [6] provides "Standard" and "Limit" ranges. For this contract, "Standard" shall define the expected range of regular work under normal circumstances. Work exceeding the "Standard" range, but within the "Limit" range may be acceptable only by Owner approval. Work exceeding the "Limit" range shall be corrected by Contractor.

The Contract Guidance Drawings referenced by this section describe primary structure and are not intended to show all structure and structural details. The Contractor shall develop detailed construction drawings and is responsible for all structure design and detailing including foundations, hangers, supports, framing, containment, enclosures, brackets, and localized stiffening that is necessary but not shown on the Contract Guidance Drawings.

The thickness of plating shall be as shown on the Contract Guidance Drawings. The boundaries of differing plate thickness shall be maintained as shown. Seams and butts shall be located to suit the Contractor's standard practice, subject to Owner review. Four-way joint intersections shall be avoided.

Changes from the structure (scantlings, shapes used, arrangement, etc.) shown on the Contract Guidance Drawings will be considered but are subject to Owner review and comment prior to fabrication. All changes in scantlings must consider lightship weight, systems clearance, and other elements of the completed vessel. The Contractor is responsible for any drawings, calculations, and resolution of interferences which may be associated with changes generated by the detail design drawings or other changes proposed by the Contractor.

The Contractor shall be responsible for adding brackets, chocks, and clips as required to develop the full strength of the members shown in the Contract Guidance Drawings. Brackets, chocks, and clips shall be in accordance with Reference [2] and good marine practice.

Longitudinal strength shall be developed by maintaining continuity of longitudinal structure including the deck, side, and bottom plates and longitudinal beams and girders. Where the strength of a main structural member is impaired by cuts or interruptions in continuity, efficient means of compensation shall be fitted. The termination of longitudinal structural members shall allow for the full strength of the member to be developed and avoid hard spots and stress concentrations. End brackets of large primary structural members shall be soft-toed.

Efficient means of compensation shall be fitted where necessary to provide holes for passage of wiring, piping, or ventilation in important structural members. In general, if holes remove more than 30% of the depth of a web of a member and/or if they are unfavorably located, reinforcement will be required. Openings in structural members shall be cut as near to the neutral axis of the combined section as possible. Opening details are subject to Owner review and approval.

Trunks and coamings in general shall be worked with corners rounded to approximately a 3in radius. Cutouts in decks, bulkheads, and any structural member shall have radiused corners. All cutout sizes for windows, doors, and hatches are nominal; the Contractor must obtain required cutout sizes from the vendors and incorporate them in the Detail Design.

Plating for the shell, bulkheads, and decks shall meet the fairness standards in Reference [6] and this Specification, whichever is more rigorous. 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. Misalignment exceeding the standards of References [4] and [6] shall be considered cause for rejection. Where discontinuities of structure are unavoidable, suitable brackets or other reinforcement shall be installed and brought to the attention of the Owner for review prior to installation.

Limber and vent holes, 1 1/2in radius minimum, shall be cut as necessary to ensure proper venting and drainage of all tanks, compartments, voids, and pockets to the lowest point of the tank or compartment.

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 with rounded corners. Semicircular weld reliefs shall be provided in framing members in way of passing welded seams or butt welds in the attached plating.

Sharp and ragged edges or corners of structure that could cause a stress riser, injury to personnel, interference with subsequent coatings applications, or which are unsightly, shall be removed, ground smooth, or sniped. Weld spatter shall be removed or ground smooth.

Use flush welds where practicable for interior and exterior deck plating. Remaining weld crown height shall not cause poor coating adhesion or cause excessive wear of deck coating in way of the weld crown. Leveling compound may be used to improve the smoothness of a deck with permission of the Owner.

The Contractor shall break edges on all cutouts and rat holes to allow for satisfactory coating adhesion.

100.2 Aluminum Construction

Design, fitup, and welding for the aluminum assemblies indicated for this project shall be accomplished per the ABS Rules([2] and [3]), Coast Guard regulations [1], and this Specification.

The Contractor shall use efficient means of compensation to restore continuity when cuts or interruptions impair the continuous strength of a main structural member. Brackets, chocks, and collars shall be used to develop the full strength of the structural connections for the aluminum assemblies.

Fabricate and fair all structure and fair, free of distortion, and in alignment within the construction tolerances indicated in the ABS Rules [7] and Reference [6]. The Contractor's aluminum welding practices and workmanship standards shall conform to References [8] and [9].

Precisely prepare material edges for welding. Material edges shall be smooth and free of discontinuities. Inspect and deburr all edges before welding. Wipe away all lofting and fabrication ink marks with an acetone swab, prior to welding. Weld surfaces shall be free of paint, grease, oxide film, and moisture. Oxide films shall be cleaned within 24 hours of welding operations. Bevel angles, bevel dimensions, root dimensions, and virtual position of joining members shall be prepared as detailed in the Contractor's qualified WPS and the requirements of this Specification. Slugging is prohibited.

The Contractor shall adequately support and stiffen plate and sheet panels and modules to produce smooth finished surfaces, free of buckles, bulges, and wrinkles to the satisfaction of the Owner. The Contractor shall control heat input and welding processes to eliminate print-through on all exposed surfaces. Aluminum plates with exposed exterior surfaces and unlined interior surfaces shall be free of lüder stripes and exfoliation. Provide standard mill finish aluminum sheet and plate for assemblies expected to be coated with paint or concealed behind linings. Provide standard bright finish aluminum sheet and plate for all exposed interior assemblies.

Welded aluminum tee joints exposed to salt water or other corrosive environments shall be sealed as necessary to eliminate crevice corrosion per Section 074. Alternative methods for sealing joints may be used upon owner approval.

Temporary welds, clips, dogs, and pad-eyes installed incidental to erection shall be carefully removed and disc-abraded smooth or, where undercut or gouged, shall be welded and disc-abraded smooth to the Owner's satisfaction.

Remove oxidation and burn marks, before and after assembly, on all hand cut and machine cut parts. Wipe away all soot and smoke on the welds and adjacent area. Remove all splatter when the joint is complete. Wire brush all welds clean when complete.

Aluminum may not be directly fastened to Steel, except in case of Detacouple (explosion bonded strip). Aluminum must be electrically isolated from Steel to reduce bimetallic corrosion.

100.3 Fit Up and Weld Inspection

The Contractor is responsible for 100% visual inspection of all fit up and welding of the hull to the standards set forth in this Specification and to the satisfaction of the Owner. Contractor shall provide timely notice to provide Owner opportunity to attend inspections and testing.

The Contractor is responsible for developing a non-destructive testing (NDT) plan for the vessel, to be submitted to the Owner for review prior to commencement of welding. The Contractor shall hire a certified weld inspector subcontractor to perform specialized NDT procedures as necessary. NDT shall be performed on a minimum of 5% of watertight and highly stressed welds. All welds shall receive visual inspection.

The Contractor will hydrostatically test tanks and test watertight hull boundaries; see Section 857 of this Specification.

Any deficiencies identified by the Contractor, third party NDT specialists, Owner, or USCG must be corrected at the Contractor's expense to the satisfaction of the party that identified the deficiency prior to application of coatings.

110 Hull Structure

110.1 Frames

The Contractor shall detail, layout, and construct transverse deck, side, and bottom frames as shown in the Contract Guidance Drawings. Frames shall be efficiently bracketed to stringers, girders, and floors where required. The offset between the molded line of each frame and the installed frame plate edge along the bottom shell, side shell, and deck shall be no more than 1/8in to either side. The as-built frame spacing between individual frames shall differ by no more than 1/4in from the molded layout dimension. This requirement does not override the global dimensional tolerance per [6].

110.2 Girders

Longitudinal girders shall be installed as shown on the Contract Guidance Drawings. Longitudinal girders shall be bracketed on both sides of oil-tight and watertight bulkheads or slotted through watertight bulkheads and collared.

110.3 Stanchions

Stanchions shall be fitted at both the top and bottom with sole plates, and the associated girders or plating to which they are attached shall be reinforced with sufficient bracketing to provide full support. Stanchion ends shall have 100% contact prior to welding to avoid putting weld in shear under loading.

110.4 Watertight Bulkheads

Transverse watertight bulkheads shall be located and constructed as shown on the Contract Guidance Drawings. Bulkhead scantlings shall be as shown in the Contract Guidance Drawings. Special treatment must be given to bulkheads in way of loads imposed by girders and superstructure bulkheads. The Contractor shall provide stiffeners, brackets, and chocks as required to complete the installation. Bulkhead stiffeners shall be arranged to line up with bottom and deck longitudinal stiffeners, girders, and/or bulkheads where practicable. Where watertight bulkhead stiffeners do not align with structure, they may have unattached sniped ends.

The offset between the molded line of each frame and the installed bulkhead plate along the bottom shell, side shell, and deck may be no more than 1/8in to either side.

110.5 Tanks

The Contractor must detail and install the integral tanks as described in the Contract Guidance Drawings. Tanks are to be tested in accordance with Section 857 of this Specification. The ends of all stiffeners in integral tanks are to be provided with an end connection, either bracketed or clipped.

130 Main Deck and Bulwarks

130.1 Main Plating and Stiffening

Deck cutouts shall be compensated for with radiused corners.

Deck inserts in way of mooring equipment, not shown in the Contract Guidance Drawings, are the responsibility of the Contractor. Also see Section 180 of this Specification.

Between deck stiffening, the main deck plate shall be fair within 3/16in.

All deck stiffeners shall be of the scantlings shown on the Contract Guidance Drawings. The Contractor shall detail and install headers and other required structure in way of openings in the deck.

130.2 Bulwarks

Bulwarks shall be provided and installed as shown on the Contract Guidance Drawings. The bulwarks shall meet all regulatory requirements. The bulwark cap shall be a flanged plate at a height of 42in above the working deck level. Welding on the bulwark cap shall be ground smooth. Distortion in the curved sides and caps of the bulwarks shall be minimized by the Contractor. Except for the chocks, no opening in the bulwark shall exceed 4in across its smallest dimension.

The bulwarks shall be fitted with freeing ports in the locations shown in the Contract Guidance Drawings. A 1/2in round bar shall be fitted around the edge of each opening, and lengths of 1/2in round bar shall be installed across the freeing ports to reduce the smaller dimension of the clear opening to no more than 4in.

Mooring ring chocks and cleats, as described in Section 582 of this Specification and the Contract Guidance Drawings, shall be installed in the bulwarks. The Contractor is responsible for strengthening the bulwarks in way of the chocks for the expected mooring loads.

Bulwark Notch Closure Plate

In way of port side skiff boarding notch, design and provide a removable aluminum closure plate that maintains the continuity of the bulwark from the main deck to the bulwark cap when inserted. Closure plate shall be designed to slot into place in channels built into forward and aft sides of notch. Provide stainless cotter pin or similar mechanism to lock closure plate in place underway. Closure plate shall be designed to support typical bulwark loads while being light enough to remove by hand. Provide lifting points on closure plate so it can also be lifted out by the crane. Steel/aluminum contact shall be mitigated by insulating faying surfaces with UHMW. Provide means of closing the gap between the top step of the boarding ladder and the closure plate, for example by a small section of grating mounted on the closure plate.

131 Swim Step

Design and install a swim step as shown in Reference (B). The swim step shall be designed to be bolted on transom for easy removal, notionally shown in Reference (D). Attachment bolts to be of 316 stainless steel.

Swim step deck level to be set at 6-8in above departure waterline or as directed by Owner. Swim step to be constructed of stainless frame and molded fiberglass molded with square or rectangular grid and grid height of 1-1/2in rated for exterior use. Grating to be attached with marine grade stainless fasteners. Swim step to be provided with three stainless steel cleats sized and located for temporary side mooring a 22ft skiff. Provide swim step with a vinyl marine grade rub rail to protect temporarily moored skiffs. Provide a removable swim ladder to assist in man overboard retrieval. Provide mounting bracket for swim ladder as located by Owner for stowing when not in use.

150 Deck House Superstructure

Superstructure decks, bulkheads, and casings shall be located and constructed as shown on the Contract Guidance Drawings. The main deck, upper deck top, and bridge deck top have camber as shown on the Contract Guidance Drawings.

Exterior plating must be fair between stiffeners to a tolerance of 3/16in. Interior plating must be fair between stiffeners to a tolerance of 1/4in.

The superstructure exterior shall be aluminum construction and shall be hose tested for tightness before installation of any lining, ceiling, insulation, or application of coatings. Large panels of plating shall be fabricated following an approved sequence of welding. Panels shall be well supported, and otherwise stiffened, during fabrication and welding to produce smooth, finished surfaces that conform to the fairness standards of Reference [6].

171 Masts

A navigation light mast shall be provided and located as shown on the Contract Guidance Drawings. The navigation light mast shall be of aluminum construction. It shall be fitted with sheaves and aluminum cleats for flag halyards. Provide brass pulleys for each gaff complete with flag halyard of 1/4in nylon line with two brass snap hooks secured to each halyard. Halyards shall be endless loop type, suitable for service intended.

180 Foundations

The Contractor shall design and provide foundations for all machinery and equipment including, but not limited to, main engines, generators, anchor winch, crane, rudders and steering gear, stores davit, struts and shaft bearings, and the mast.

Foundation design shall provide adequate strength, to support and maintain alignment of the mounted equipment in its operational mode, and stiffness, to prevent excessive vibration. Loadings to be considered in design of foundations shall include the dry weight of equipment, weight of fluids, dynamic loadings induced by equipment in operation, weights of supported ancillary components and/or systems (e.g. wiring, piping, control equipment, safety shields), and ship motions. Foundation design 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.

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 shall be provided as required. Foundations shall not be attached directly to unsupported plate. Abrupt discontinuities shall be avoided by gradual tapers at the extremities of foundation structure in accordance with the guidelines in Reference [2] and good shipbuilding practice.

Foundations for the main engine propulsion machinery shall be continuous structures, fitted as integral parts of the vessel's primary structure, as shown on the Contract Guidance Drawings. The heights of the main engine foundations shall allow for proper alignment of the drivetrain equipment, considering the range of the equipment alignment chocks and maximum/minimum allowable thickness of chocking compound to be used. Collision chocks shall be installed for equipment where specified by manufacturer.

Sway bracing shall be provided for electrical enclosures not solidly bolted or welded to structure. For enclosures that have been mounted using vibration isolators the sway bracing shall provide similar vibration isolation techniques.

Group 200 – Propulsion and Ship Service Machinery

233 Main Engines and Reduction Gears

Reference (B): 24065-200-101-1 Profile and Arrangements
Reference (F): 24065-200-243-0 Shafting Arrangements

The Contractor shall provide and install two main propulsion engines and reduction gears in accordance with References (B) and (F). A dry elbow transition to a standard ANSI flange and a 12in long flexible fitting shall be supplied with each engine. The Contractor shall provide main engine support systems in accordance with the contract documents: cooling systems per Reference (G), exhaust systems per Reference (H), fuel oil systems per Reference (O), and electrical, control, and alarm systems per this specification. The Contractor is responsible for installing the main engines and gears and making them operational in all respects, to the satisfaction of the Owner. The Contractor shall deliver the vessel such that the engines and gears maintain their one-year manufacturer warranty, starting from the date of sea trials.

233.1 Light off and Testing

The first start sequence of the main engines (light off) and all engine tuning and testing shall occur under the direct supervision of a certified Caterpillar (CAT) technical representative. The CAT representative shall coordinate with a certified Twin Disc technical representative to ensure the gear is correctly installed and protected. The Contractor is responsible for providing the technical representatives.

243 Propulsion Shafting

Reference (F): 24065-200-243-0 Shafting Arrangement

The Contractor shall purchase, fabricate, and install the vessel's propulsion shafting systems in accordance with Reference (F), this section, and other contract documents, to the satisfaction of the Owner.

The propulsion shafting system shall comply with Subchapter T requirements. .

243.1 Materials

Preliminary shafts and propellers have been incorporated into the contract documents, such as Reference (F); however, the design of these components is notional and is intended to facilitate the contract design of the vessel and provide information for preliminary Contractor planning.

The shafting arrangement shall be modified as necessary to eliminate serious torsional, flexural, and longitudinal vibrations within the normal and emergent operating conditions of the propulsion system.

Preliminary propeller characteristics are:

- Material: Ni-Al-Bronze (NiBrAl)
- Diameter: 56in
- Pitch: 51.1in
- Blade Count: 4 blades
- Series / Type: B-series, or equal
- Expanded Area Ratio (EAR) 0.478

Final propeller design to be confirmed by the manufacturer. Contractor shall provide propeller design documentation prior to approval.

Propellers shall be secured to the shafts using enclosed hex head type propeller nuts (F).

Propellers shall be designed to accommodate piranha dual line cutters, lifting bolts, and tapped puller holes in the hubs.

Calculations

Calculations shall be performed as required to finalize design of the propulsion shafting. A propulsion system vibration analysis, including torsional and lateral (whirling) vibration of the completed, finalized drivetrain, including the engines, reduction gear, couplings, bearings, shafting, and propeller shall be provided. The analysis and findings shall be submitted to the Owner and each drivetrain component supplier for approval prior to finalizing the system arrangement and start of component fabrication. Approval from each drivetrain component supplier shall include confirmation of the mass elastic data used in the analysis, and confirmation that the findings are within acceptable limits.

Fabrication of Propulsion Components

The Contractor or authorized subcontractor shall fabricate all necessary machined propulsion shafting components. Reference (F) contains a description of these components, however it does not contain adequate machining and tolerance details. The Contractor shall create a shop fabrication sketch of each machined component, complete with material and machining details, and submit it to the Owner for approval, prior to machining. The sketch shall be adequate to create replacement parts if necessary. The requirement for shop fabrication sketch also applies to the propeller shaft and its taper, length, keyways, etc.

Installation and Alignment

Once all materials are acquired and fabricated, the Contractor shall install the propulsion shafting systems in the vessel as described in Reference (F). Proper alignment of propulsion equipment and shafting is mandatory and will be specially considered and inspected by the Owner.

The shaft bearing in the aft end of the stern tube and the shaft bearing in the strut will determine the line of shaft centerline. This line must be closely centered on the centerline of the reduction gear output, in order for the engines to be in proper alignment with the engine foundation. This means the installation of the stern tube and the strut is critical to the shaft alignment process.

Both stern tubes and struts will receive a lot of welding after the preliminary alignment process. During weld out, the Contractor shall have some means to monitor any weld distortion and correct if necessary. Proper sequencing of welds on the stern tube and strut is required.

The Contractor shall create a plan to address all propulsion shaft alignment issues and present this plan to the Owner for approval, prior to any welding on the stern tube or struts. Failure to follow alignment plan or failure to obtain proper alignment of propulsion equipment will result in a stop work order and the Contractor will be required to rip out and correctly re-install the propulsion equipment at no cost to the Owner.

Prior to final alignment, all major machinery shall be installed, all welding of the vessel's primary structure and superstructure completed, and the vessel shall be afloat with no list or trim at light operating draft. Alignment shall be witnessed by the Owner and is subject to Owner approval.

The service of manufactures' representatives shall be engaged to attend this process, along with start-up and sea trials.

244 Ecology Box

The Contractor shall design, procure, fabricate, and install two ecology boxes and associated pumping systems in the vessel.

244.1 Design

The ecology boxes shall be removable and shall be designed to contain all drips from the stuffing box and keep the stores/workshop bilges dry.

The ecology box sump pumping for each sump shall consist of a submersible pump with 1in piping and a check valve immediately after the pump and an overboard discharge. Overboard penetrations shall have a bronze stop valve immediately inboard of the overboard penetration, to isolate any plastic pipe from the overboard. A common discharge pipe may be considered by the Owner, if proper pipe size increase and check valves are proposed.

244.2 Materials

The Contractor shall provide all materials required for this installation including but not limited to: two high quality stainless steel submersible sump pumps with level switches or automatic level sensing (similar to Grundfos Unilift KP150, 110VAC, with portable cord), valves, piping, etc. Level sensing for the pump must be specifically discussed with the pump vendor to work with a shallow box depth. Piping shall be Cu-Ni as defined for the Fire Main piping in Reference (L).

244.3 Installation

The ecology boxes shall be securely mounted between vessel frames to prevent movement. Overboard penetrations shall be located well above the maximum waterline. Final location of overboard discharge shall be approved by the Owner prior to installation.

244.4 Testing

Ecology box sump system inspection and testing shall be to the satisfaction of the Owner.

256 Cooling System

Reference (G): 24065-200-256-0, Fresh Water Cooling System Diagram

The Contractor shall provide and install freshwater cooling circuits in accordance with Reference (G).

256.1 Materials

All materials required for this installation shall be provided by the Contractor.

Strainers shall be provided for equipment as necessary to restrict particle flow through sensitive equipment. Strainers shall be inline wye or basket type. The Contractor shall verify the mesh or perforation size of strainer baskets for the final equipment selection.

256.2 Piping Installation

SCH 80 piping shall be used between the cofferdam and the cooler isolation valve. A positive shutoff or USCG Category A isolation valve shall be installed close to the hull penetration. The valves shall be easily accessible for operation and maintenance.

Connections to the generators and engines shall be in accordance with the manufacturer's requirements.

Each cooling circuit shall be equipped with an independent head tank sized in accordance with the manufacturer's requirements.

Each engine shall have a jacket water heater, provided by the manufacturer. Each jacket water heater shall be configured so that power to the heating coils is completely interrupted when the engine is running. The Contractor shall provide electrical relays and wiring as required to complete jacket water heater installation in accordance with the manufacturer's requirements.

Cooling arrangements assume ethylene glycol at 50% ratio. The Contractor shall verify water quality and glycol mix is suitable for all equipment served on each independent cooling loop. Where different coolant is used, each head tank shall be labeled accordingly.

All cooling circuits shall be flushed of all foreign matter prior to being placed in service. Flushing reports shall be provided to the Owner.

256.3 Keel Cooler Installation

Keel coolers shall be mounted to the hull exterior, below the chine, as illustrated on Reference (G) and in accordance with the manufacturer's instructions. Steel guards shall be welded to the hull to protect the keel coolers from underwater debris. All metal-to-metal connections between the hull and the keel coolers are to be isolated with non-metallic gaskets, washers, and bolt hole inserts. Electrical isolation shall be verified to the Owner's satisfaction with a multimeter prior to the vessel's entry into water.

Keel coolers shall be supplied with anodes, in addition, the keel cooler guards shall be fitted with six anodes at a minimum per guard of same alloy selected to meet Section 633. The six anodes for each cooler shall be bolt on type and electrically isolated from the guard by the use of insulation washers and sleeves. Each isolated anode shall be electrically bonded to the keel cooler with an insulated grounding strap connected between the anode and the anode post on the keel cooler. All metallic nuts, bolts, and washers in the grounding strap assembly shall be 316 stainless steel. Care shall be taken to assure that

the grounding strap only provides electric continuity between the anode and the keel cooler. Electrical isolation of the anodes from the keel cooler guard and electrical continuity between the keel cooler and the anodes shall be verified to the Owner's satisfaction prior to the vessel's entry into water.

All keel coolers shall be sized for sea water at 70°F and 100% load at 5 knot speed.

259 Exhaust Piping

Reference (H): 24065-200-259-0 Engine Exhaust Arrangement

The Contractor shall provide and install an independent exhaust system for each engine and generator leading to weather and terminating above the pilothouse top as shown in Reference (H). The system shall be complete with all components necessary for satisfactory operation and performance including silencers, expansion joints, and hanger assemblies.

Hangers above main deck shall be aluminum or stainless steel.

259.1 Installation

Provide flexible bellow joints at the engine exhaust outlets to allow for vibration and thermal expansion as shown in Reference (H). The exhaust piping shall be aligned and installed so that no reaction force is imposed on the expansion joints at installation. The Owner shall have the opportunity to inspect alignment prior to final bolt up. The shipping bars on the joints shall not be cut off until the exhaust assembly is completely installed.

Additional flexible bellows shall be installed, as needed, to provide for thermal expansion of the exhaust piping. Expansion joints shall be American Boa, DME Inc, or equal. Preliminary expansion joint locations are shown on Reference (H); however, the locations are notional and intended to facilitate the contract design of the vessel and provide information for preliminary Contractor planning. The Contractor shall have a qualified vendor ensure that static and dynamic loads on equipment exhaust flanges and exhaust backpressure are in accordance with manufacturer's recommendations.

The expansion joint and rain hat details are provided for guidance and subject to the detail design of the exhaust system by a qualified vendor. Final dimensioning and detailing are to be completed by the Contractor.

A drain and gate valve shall be installed at the lower end of each generator engine exhaust.

With the exception of proprietary engine turbo connections, all exhaust pipes, flexible bellows, and silencer flange connections shall have an ANSI B16.5, 150# bolting pattern.

The Contractor shall install a roughly 8in x 12in aluminum louver with a rain cover on the outboard side of the exhaust stack near the top of the stack to dissipate excess heat within the stack.

259.2 Spares

Provide one spare flexible bellows of each unique size and configuration on the vessel.

260 Engine Room Air Supply and Exhaust

Reference (I): 24065-200-259-2 Engine Room Air Supply and Exhaust

The Contractor shall provide and install an engine room air supply and exhaust system in accordance with Reference (I).

264 Lube and Waste Oil Systems

Reference (B): 24065-200-101-1, Profiles and Arrangements
Reference (K): 24065-200-506-0, Vents, Fills, and Sounds

The Contractor shall design, procure, fabricate, and install a lube and a waste oil system in the vessel. A system schematic of the lube and waste oil systems including materials, piping, and equipment details with sufficient detail for system maintenance shall be provided with the submittal of the as-built drawings.

264.1 Design

The lube oil system shall have a hose reel, for use in filling the engines, mounted near the lube oil pump. The hose reel shall have a 3/4in nozzle with a self-closing valve at the end to prevent spillage. The hose shall be suitable for oil service and of sufficient length to reach all main engine and generator oil fills.

The waste oil system shall have a hose reel, for removing waste oil, mounted near the waste oil pump. The hose reel shall have a self-closing valve at the end to prevent spillage. The hose shall be suitable for oil service and of sufficient length to reach all main engine, reduction gear, and generator oil drains.

The Contractor shall design and construct independent lube oil and waste oil tanks for mounting in the Engine Room and with capacities as indicated in Reference (B). Both tanks shall be constructed of mild steel.

The lube oil tank shall be provided with a fill and vent line as shown in Reference (K) and the waste oil tank shall be provided with a discharge and vent line as shown in Reference (K). Fill and discharge pipes shall be provided with camlock fittings.

In addition to the fill and vent line the lube oil tank shall be provided with the following:

- Visual sight gauge with self-closing valves for indicated liquid level in the tank and a continuous level sensor.
- 1in NPS schedule 40 pipe plug drain near the bottom of the tank.
- In addition to the discharge and vent line the waste oil tank shall be provided with the following:
  - Continuous level sensor
  - 1in NPS schedule 40 pipe plug drain near the bottom of the tank.
  - A steel drain box sized for eight filters shall be fabricated and installed. The box shall drain to the tank and have a latching lid with a mesh filter inside and shall be mounted on the top of the tank. Box shall be similar to the Stratex mesh filter drain box for waste oil disposal tank. Drain box arrangement and size to be approved by Owner.

264.2 Materials

All materials required for this installation shall be provided by the Contractor including but not limited to pumps, valves, pipes, etc.

Piping material shall be schedule 40 carbon steel, ASTM A53 or A106 Grade B, seamless or ERW, ANSI B36.10.

For the lube oil system, the Contractor shall provide and install a simplex strainer and one lube oil pump, Roper 2AM06 or equal. The strainer shall have a carbon steel body and a stainless steel basket. The pump shall be a gear pump with cast iron housing, ductile iron gears, integral relief valve, and a mechanical seal. The pump shall be equipped with a 1 hp/208 VAC/3-phase/60 Hz, TEFC marine duty

motor and remote shut down. A drip pan shall be provided under the pump and strainer and shall be provided with a drain valve. Local control shall be provided for the pump and shall be installed next to the pump.

For the waste oil system, the Contractor shall provide and install a simplex strainer and one lube oil pump, Roper 2AM06 or equal. The strainer shall have a carbon steel body and a stainless steel basket. The pump shall be a gear pump with cast iron housing, ductile iron gears, integral relief valve, and a mechanical seal. The pump shall be equipped with a 1 hp/208 VAC/3-phase/60 Hz, TEFC marine duty motor and remote shut down. A drip pan shall be provided under the pump and strainer and shall be provided with a drain valve. Local control shall be provided for the pump and shall be next to the pump.

264.3 Installation

Then engines and generators shall have self-contained lube oil systems with attached pumps, coolers, strainers, and filters.

The lube oil and waste oil pump shall be installed near the lube oil and waste oil tanks. Final pump location shall be approved by the Owner prior to installation.

Engine lube oil alarms and sensors shall be as required by Section 436.

The main engine and generators shall be filled with clean lubricating oil, of a brand and type chosen by the Owner and approved by the engine manufacturer, prior to start up and for tests and trials.

The lube oil tank shall be clean and free of paint, rust, or primer on the inside surface. The tank shall be filled with oil appropriate for the engines and generators prior to delivery of the vessel.

The waste oil tank shall be clean and free of paint, rust, or primer on the inside surface.

Group 300 – Electrical Systems

265 General

The ship service electrical system shall consist of two ship service generators rated at 99kW and one ship service switchboard. System shall operate at 208/120V three phase with a grounded neutral. The shipboard electrical system shall derive power either from one or both of the ship service generators or shore power.

This Specification outlines the general electrical requirements for the vessel. It is intended to provide guidance, along with the Contract Guidance Package and all required Regulations, for the development of a detailed electrical design for the vessel. Provide a complete electrical system, including wiring and equipment, as described in this Specification and References (J).

It shall be understood that anything that is omitted in any part of this Specification and/or Contract Guidance Package, but which may be necessary for, or a usual part of, a complete electrical design package shall be considered as included. Any such item or arrangement shall be provided and installed by the Contractor at no additional cost to the Owner. The installation of electrical equipment and wiring required for items called out in other sections of this Specification shall be provided and installed whether or not specifically called for in the electrical sections of this Specification. The Contractor shall be responsible for all alignment, connections, interaction, clearances, and proper design, installation, and construction of all electrical components of the vessel.

All equipment, materials, and workmanship shall fully comply with the requirements of 46 CFR Subchapter T, and the standards of all other agencies invoked or referenced by Subchapter T.

The electrical systems shall be ungrounded except for one neutral grounding point at the main switchboard. The neutral shall be grounded by means of a stud welded to the ship structural steel, to which the grounding conductor is attached using a ring connector. The grounding point shall be accessible to permit inspection and disconnection for insulation testing.

Auxiliary machinery control voltages shall be 120 volts or less, provided by internal and suitably sized control power transformers, when the control circuit extends outside the control enclosure. This includes such circuits as thermostats, remote shutdowns, and indicator and operator controls. Control power transformers shall include overcurrent protection.

301 Degree of Protection

All electrical equipment throughout the vessel shall include enclosures with IP Ratings as specified in 46 CFR Subchapter J. These enclosures shall suitably protect the equipment from moisture, dust, personnel contact, and other debris and contamination. Connection boxes, outlet boxes, junction boxes, light fixtures, and similar wiring fittings and fixtures installed in locations exposed to weather, condensation, or excessive dampness shall be watertight. They shall be stainless steel, brass, bronze, or other approved corrosion and flame-resistant material. Non-metallic enclosures shall not be used in locations subject to physical damage, such as near the working deck.

302 Materials and Equipment

Unless otherwise specified, all equipment and material shall be new, suitable for marine use, and shall meet the requirements of all regulatory agencies for the intended service. Equipment shall operate under environmental conditions as specified in Section 079. Equipment requiring external wiring shall have terminal boards or blocks with compression type or ring connector and screw type terminations. Ring connector and screw type terminations shall be made with ring or bent fork terminal lugs, which shall be installed using a manufacturer's-approved crimping device. Wire shall not be directly installed on any screw connector type terminal strip. Insulation between adjacent terminals shall be ensured, either through barriers integral to the terminal strip, or by the use of lugs insulated with soft vinyl.

Locate all electrical equipment to be readily accessible for operation, repairs, or removal. Equipment shall be accessible for servicing and adjustment without dismantling linings, insulation, panels, etc.

In watertight bulkhead, deck, equipment, and enclosure penetrations, penetrations shall be made through appropriately sized cable gland fittings or multi cable transits (MCTs).

Electrical system components shall be securely fastened to ship structure by bolting, or welded studs and nuts. In Owner approved locations and applications, alternative USCG approved mechanical fastening systems may be used. Threaded fasteners shall include provisions to prevent loosening, such as nylon insert nuts, locking washers, or thread adhesive. Cable hangars and light fixture foundations may be welded to ship structure. Electrical equipment shall be installed independently from piping, ventilation, and other mechanical systems.

303 Bonding

All conductive electrical enclosures or equipment shall be electrically bonded to the vessel's structure. Ground non-current-carrying metallic parts of electrical machinery and equipment to the structure, either by the mounting bolts and foundations, or by separate grounding straps or conductors sized per the National Electrical Code (NEC). Ground metal frames of portable lamps, tools, and other similar cord and plug appliances supplied as ship equipment or Owner-Furnished Equipment (OFE) through a suitable

conductor in the power supply cord at the ground pole of all receptacles. Provide bonding/equipment grounding systems in accordance with 46 CFR 120.

Each 120V receptacle circuit shall include an independent equipment grounding conductor included in the cabling supplying the circuit, and connected to the grounding connection on the receptacle. In circuits supplying multiple loads, such as receptacles, heaters, and lights, the removal of any device shall not interrupt the continuity of the grounding conductor.

Ensure bonding of the propulsion shafting and rudder stocks.

304 Nameplates and Labels

Each electrical enclosure or equipment item shall be labeled with an engraved phenolic nameplate using white text on a black field. Nameplates shall provide concise descriptions with minimal abbreviation, and shall be affixed with screws or a very high bond (VHB) tape system.

Each cable shall be labeled with its cable name per the cable schedule at each cable end. The labels shall be embossed aluminum, robustly banded to the cable. An assembled sample shall be submitted to the Owner for acceptance, and acceptance shall be obtained prior to installation aboard the vessel.

Wires within control, alarm and monitoring, and communications enclosures shall be labeled with adhesive labels, alpha-numeric floaters, or via labeling of the terminal to which the wire is connected. Labels shall correspond to design drawings.

305 Documentation

The Contractor shall develop an updated version of Reference (Q) with actual loads of selected equipment to verify circuit arrangement, bus sizing, cable sizing, and distribution circuit breaker selection. The Contractor shall submit the updated version of Reference (Q) to the Owner for review, and maintain its accuracy throughout the project. At completion of the project, the Contractor shall deliver the final version in editable electronic format to the Owner. The Contractor shall perform and document voltage drop calculations on the power distribution system as required to ensure regulatory compliance. Conductor sizes shall be increased if necessary to maintain voltage drop within limits. Provide the voltage drop calculation report to the Owner.

The distribution of electrical power shall generally be in accordance with Reference (J). The Contractor shall adjust the design to account for any updates to equipment selection or cable sizes, ensure circuit breaker coordination, or accommodate other details. The Contractor shall develop an updated version of Reference (J) which incorporates any changes that arise during detailed design and construction. The updated version shall be submitted to the Owner for review. Provide one laminated single sided 11in × 17in sized copy of the final as-built electrical one-line diagram. Locate near the ship service switchboard. At completion of the project, the Contractor shall deliver the final version in editable electronic format to the Owner.

306 Electrical Test and Trials

The Contractor shall perform tests and trials of all equipment and provide documentation of such tests and trials in accordance with section 857.

307 Motors

Motors shall be commercial marine grade, with corrosion resistant coatings. Motors shall be TEFC. Motors installed in the engine room and uptake trunk shall be rated to operate at 50°C; other motors shall be rated for operation at 40°C.

Motors intended to operate on VFDs shall be inverter duty rated.

308 Motor Controllers

All motor controllers 1hp and larger shall be of the combination type featuring local disconnect. Motor controllers shall be industrial type, complying with the requirements of the UL Standard for Industrial Control Equipment.

Provide contactors with as many auxiliary contacts as required for each control, alarm and indication function.

Mount operating controls in the front of the enclosure. Provide illuminated pushbuttons or buttons with separate indicating lights for run indication and speed and direction where applicable.

Motor controllers having a working power rating of 1hp or greater shall typically be provided with low voltage protection (LVP) to avoid excess starting currents when power is lost and then re-established. However, employ low voltage release (LVR) logic on fire pump and steering gear motors so that these motors automatically restart upon restoration of power. Single-phase fractional horsepower motors may use manual motor starters, also known as low voltage release effect controllers.

Label each starter with the load description and circuit number.

309 Variable Frequency Drives

Design variable frequency drive motor controllers to meet the requirement of the system load and be of the pulse width modulation type. Supply all variable speed controllers with line filtering and choke circuits or equivalent such that the ship suffers no adverse effects from harmonics.

Variable frequency drives shall be industrial grade. To the greatest extent possible, they shall be installed in climate-controlled spaces, where condensation will be minimized, and shall be fitted with drip shields. The bow thruster VFD may be installed in the thruster and bosun room. Engine room fan VFDs may be installed in the engine room. Other HVAC VFDs shall be installed in the interior spaces within the climate controlled spaces.

310 Fire Shutdown Circuit

The vessel shall be equipped with manually activated emergency shutdown circuits to shut down engine room ventilation fans and engines, and close fire dampers. Two independent circuits shall be supplied, with equipment divided evenly between the two. Manual switches to control the circuits shall be located in the pilothouse, and shall be labeled with red phenolic placards identifying the switches and including reset procedures. The circuits shall use relays to control individual equipment items, and the relays shall be supplied from battery banks via the control switches. The relays shall typically be energized during operation to allow machinery to operate, and power failure shall shut down the equipment. In addition to manually activated emergency shutdown, the shutdown circuits shall also be configured to be activated by pressure switches from fixed fire suppression system activation.

The Contractor shall provide complete wiring diagrams for all emergency shutdown circuits. The diagrams shall show all buttons, cabling, items controlled, power supplies, control relays, wire terminal

connections, fuses, and other pertinent details. Locations aboard the vessel, cable names, and conductor names shall be identified.

311 Circuit Breakers

311.1 General

Circuit breakers shall be molded case type, with thermal magnetic or electronic trip units. All circuit breakers shall be provided by one manufacturer. Each circuit breaker installation shall be clearly labeled with its nominal trip rating, frame size, and shall indicate ON or OFF position.

311.2 Generator Circuit Breakers

The generator circuit breakers shall be trip-free with instantaneous and long time over current trips.

Provide under-voltage protection to prevent the generator circuit breaker from closing when the generator is not generating voltage within the specified limits. The long time over-current protection is not to exceed 115% of the continuous load rating of the generator set. Provide any special tools required for removing the circuit breakers. The generator circuit breakers shall include draw out or plug on mounting.

312 Cables and Wiring

Prior to installation of cableways and penetrations, the Contractor shall develop a written plan for cable installation. The plan need not be fully developed engineering drawing or modeling, but shall include diagrams, cable lists, approach and philosophy descriptions, spreadsheets, or other documents necessary to ensure the final installation is functional, serviceable, and durable. The plan shall outline where cable trays and penetrations will be placed, their sizes, and contingency plans if it becomes evident that planned cableways require additional capacity. The intent of the cable planning effort is to satisfy the following goals:

- Cableway accessibility for inspection and cable addition throughout the life of the vessel.
- At least 12in separation of power cables from control, signal, instrumentation, and communication cables to avoid inductive interference.
- Cable installation which avoids chafing, abrasion, cutting, kinking, or fracture due to contact with edges of structure or cable tray, or insufficient bend radii.
- Cable installation which does not impede access to, or performance of, other systems. Examples would be cables which are too close to structure to allow surface preparation and painting, cableways that obstruct pipe flanges, or cables installed prior to piping resulting in excessive pipe bends and trapped fluids.
- Cables routed closer than 12in to exhaust pipes, silencers, or other high temperature locations.
- Cableways and penetrations which are properly sized with reserved space for future cable addition.
- Proper cable support and securing intervals, typically approximately 16in.
- Protection from excessive risk of physical damage, for example in way of crane operations or hatchways.

312.1 Cables

Electrical distribution cable shall meet the specifications of IEEE-1580 (2010) or MIL-C-24643 and be labeled as suitable for shipboard use. No cable smaller than 14AWG may be used for general power and lighting distribution.

Cable for power distribution, machinery alarm and monitoring, control, communications, instrumentation, and other cable directly purchased by the prime Contractor or electrical subcontractor shall be low smoke, zero halogen cable as provided by Tricab, or equal. Cable provided as part of vendor supplied systems, or directly specified by vendors, need not be low smoke zero halogen type. Ethernet, coaxial, fiber optic, or other network or specialized cables shall be industrial quality.

Cables used in variable frequency drive (VFD) applications shall be VFD type and shall include three radially symmetrical ground conductors and shielding.

All AC power distribution cables and those for DC distribution over 20 amps shall undergo insulation resistance (megger) testing. The testing may be performed on whole spools of cable when procured by the Contractor, or on individual lengths of cable when installed. The Contractor shall maintain records of the testing and deliver to the Owner with the vessel. Also see Section 857.3.

312.2 Cable Installation

Power distribution cables shall be installed in neat rows, single banked (i.e. single layer of cables side by side, with one diameter of space between layers) wherever possible. Double banking (i.e. two layers stacked in contact) with necessary cable derating is acceptable in locations of particular cable density.

Low current control, signal, instrumentation, and communication cables may be bunched or stacked in up to three layers, but shall be arranged and secured in a neat and orderly fashion.

Cables shall be installed in cable trays, wireways, or cable hangers, and secured with stainless steel bands. Securing shall prevent movement or excessive vibration; cables shall be secured approximately every 16in.

Exercise extreme care during installation of cable, wire, and other equipment that the external jacket of the cable or wire is not nicked, scraped, abraded, cut, burned, or otherwise damaged. Replace in its entirety any cable or wire that is damaged in any way. Splices or tape wraps **are not** permitted to repair or extend cables.

312.3 Cable Routing

Cables shall be routed as directly as reasonable, though shall minimize interference with vessel systems and access clearances. Cables shall not be routed over engine exhaust piping, or across access hatches. Cable shall be concealed from weather to the maximum extent possible, and behind ceilings and linings when in finished interior spaces. Where main cableways are installed behind linings in finished interior spaces, panels covering the cableways shall be removable in convenient sizes and labeled.

Install power and lighting cables with at least 12in separation from communication, alarm, monitoring, signal, control, and other cables potentially affected by electromagnetic interference. Interference experienced on any control or communication circuit shall be eliminated by the Contractor before acceptance of the vessel by the Owner.

312.4 Cableways and Hangers

Cableways and hangers shall be affixed to ship structure, via welding or bolting. Cableways, hangars, and grouped cables shall not be supported by piping, ducting, insulation, or machinery. Cableways and hangers shall be painted or galvanized steel, or shall be stainless steel. Where cableways pass below stairs or grating plates, provide sheet metal covers to protect from falling liquids and debris. Cableways and cables shall be sized and arranged to provide at least four inches of clearance to adjacent structure to allow cleaning, preparation, and painting.

312.5 Penetrations

Where cables penetrate watertight bulkheads or decks, watertight integrity of the penetration shall be ensured by individual cable glands, or by multi cable transit systems. Where cables penetrate decks, the penetrations shall have steel pipe stubs or boxes at least 12in above the finished decking to protect the penetration from damage. The specific penetration sealing system shall be submitted to the Owner for approval prior to purchase. Non watertight fire boundary penetrations may use STI Marine EZ Path cable transits.

Where cables pass through non-tight openings, the openings shall be ground smooth and the cables secured near the openings to prevent chafing or abrasion damage.

Where cables penetrate electrical enclosures or fixtures, cable gland or stuffing tube fittings shall be used to ensure a watertight seal.

312.6 Junction Boxes

Junction boxes shall be accessible, and those for vital circuits shall be metallic. When junction boxes are located behind joiner bulkhead and ceiling panels, provide access doors. Clearly label the presence of hidden junction boxes on the outside of the bulkhead or ceiling panel. Junction boxes shall be identified with phenolic tags, black with white lettering, which corresponds with the circuit that supplies power to the box.

313 Generator Sets

Provide and install two 99 kW ship service generators powered by diesel engines, as provided by MER Equipment, Seattle, WA. See section 314 for further details.

The engines shall meet EPA Tier 3 emissions standards. The engines shall be provided with all necessary documentation to demonstrate compliance with EPA emissions requirements.

Install the ship service generators as shown in References (B) and (J). Each diesel engine shall be provided with an electric thermostatically controlled jacket water heater and an anti-condensation heater within the electric machine.

Each generator set shall be resiliently mounted to reduce vibration and noise transmission to the ship structure. All cables, pipes, exhaust, and hoses connected to the generator sets shall be suitably flexible to withstand normal generator vibration without damage.

Each generator shall be complete with an automatic voltage regulator and shall include monitoring both locally and in the pilothouse. Power the governors, voltage regulators, and other control power consumers from battery banks or uninterruptible power sources. Hoses shall be fire resistant. Cooling water expansion tank shall be provided.

Each generator set shall have alarm, monitoring, and safety shutdown functions as required by regulation, located adjacent the engine and in the pilothouse. Each generator set shall have high jacket water temperature and high lube oil temperature alarms, and automatic shutdown upon overspeed or low lubricating oil pressure. Additionally, ship service generators shall have high jacket water temperature automatic shutdown. Each generator set shall automatically shut down upon release of firefighting media in the engine room.

Provide each generator with manufacturer specified air filters, fuel filters, oil filters, lubricating oil, coolant, belts, and other consumables necessary to provide an operational installation.

Each shall be keel cooled with dry exhaust with an engine driven jacket water pump. Each generator set shall include DC alternator and starter motor, dedicated starting battery bank, and battery switch. Provide a multibank battery charger, or individual battery chargers, for supplemental battery charging and control power.

314 Switchboard

The generator sets and switchboard shall be provided as an integrated package from MER Equipment (MER), Seattle, WA. It is recommended the switchboard and generator set package be constructed, assembled, and tested at MER's facility prior to delivery to the Contractor. The MER testing and commissioning regime may include:

- Interface and communication between engine electronic control modules, switchboard controls, automatic voltage regulators, electronic governors, local and remote display screens, and other electronic components.
- Functional testing of remote and local controls.
- Functional testing of automation functions, including interlocks, synchronizing and paralleling, load sharing, and automatic generator starting upon power failure.
- Functional testing of emergency stops and fire suppression release shutdown.
- Adjustment of programming parameters, including alarm set points and time delays.
- Testing of control and signal circuit integrity and continuity across wiring harness and plug/receptacle connections.
- Load testing with steady state and rapidly stepped load changes; dynamic governor and voltage regulator responses and programming.
- Verification of hose and pipe fitting tightness.
- Testing of accessory components such as alternators, jacket water heaters, internal space heaters, and switchboard lights.
- Verification of machine alignment and vibration response.

The assembly may include multi-pin plug and receptacle connections for control and communication interfaces between major components, facilitating shop testing and troubleshooting the connections and wiring harnesses prior to delivery to the Contractor's facility.

The electrical control and distribution functions shall be provided by a ship service switchboard. The installation shall be marine industrial grade in all respects. The assembly shall be designed for continuous operation at 45°C and shall operate satisfactorily when inclined at an angle of 30 degrees in any direction, and when subjected to normal shipboard vibrations and accelerations. The switchboard shall be installed within the engine room.

314.1 Switchboard Construction

The switchboard shall be dead front, constructed of steel, and coated to avoid corrosion in the marine atmosphere. It shall be a drip-proof enclosure with drip shield along the front. Any cable penetrations on the top or sides shall include cable gland seal fittings. Doors and side panels shall be gasketed. Manual circuit breaker controls shall feature through-door operators with at NEMA 4 rating.

Provide bus bars rated and sized to accommodate up to 20% future circuit breaker addition via bus space reservation or installed plug-in circuit breaker base. Bus bars shall be hard drawn, commercially pure copper, silver- or tin-plated or equivalent commercial grade construction. For stud connections, the threads shall be silver or tin plated as well. Bolts, washers, and nuts used to maintain bus contact shall be corrosion-resisting material. The bus connections shall be bolted to the bus bars and held captive with a washer-nut-bolt combination. All connection points shall use a corrosion-inhibiting compound suitable for the installation. The cabinet shall include a solid copper isolated grounding bus bar suitably sized for the current carrying capacity of the main bus.

The switchboard shall incorporate a split bus with bus tie circuit breaker or switch to facilitate return to port after a casualty. The intent is to permit split bus operation in case of a failure of the synchronizing and paralleling system, or isolation of one side of the bus in case of fault.

The switchboard shall be constructed such that a lockout device can be fitted to each circuit breaker. Doors shall be equipped with brackets, or locking arms, for holding them in the open position. A horizontal non-conductive grab rail shall be provided on the front of each section of the switchboard to prevent accidental contact with switchboard components. All panels shall be held closed with captive knurled fasteners or latches.

Maintain proper distances between energized parts of different potentials, and structural metal components. Insulating materials shall be suitable for the working potentials of the switchboard.

Provide an angle or channel foundation or flange surface for bolting or welding the switchboard to ship structure.

Provide lighting that adequately illuminates the switchboard. Lighting shall consist of a row of LED luminaires, with lenses, that are mounted integrally to the drip shields and extend the full length of the switchboard. Connect lighting fixtures to the engine room DC power supply.

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. Provide all necessary circuit breaker studs and mounting hardware. The front panel shall be cut out and fitted with a suitable cover plate or plug.

The structural steel switchboard components shall be epoxy powder coated. Other corrosion protection system may be submitted for Owner approval.

The switchboard control wiring shall be of SIS type wire rated to 90°C conductor temperature. The control circuits shall use a shrink tube labeling system for all circuit floaters. All internal wiring floaters must be constructed of Polyolefin, or equal. Before delivery, shrink the tube labels onto their respective conductors.

314.2 Switchboard Operations

The switchboard shall be capable of allowing parallel operation of the two generators. Controls shall be capable of automatically synchronizing, paralleling, and load balancing the generators as well as unloading and tripping either generator offline in an orderly fashion. Transition between shore power and generator power shall be de-energized; generator and shore power circuit breakers shall be

interlocked to prevent simultaneous closure. While the generator circuit breakers will require motor actuators, shore power and distribution circuit breakers may be manually actuated.

The switchboard shall provide protection for the generators and power system, including reverse power, undervoltage, and overload protection.

The switchboard controls shall be arranged to allow generation system control and monitoring both locally within the Engine Room and from the pilothouse. Each location shall allow:

- Start and stop of both generator sets
- Activation of synchronizing, paralleling, and load sharing sequences
- Activation of unloading and trip off-line of one paralleled generator set
- Trip off-line when only one generator set is operating
- Monitoring of generator kW, voltage, amperage, and frequency
- Monitoring and alarm of generator set engine parameters including coolant temperatures, oil pressure, oil temperature, fuel pressures, etc.

314.3 Switchboard Arrangement and Location

The switchboard shall be located in the engineroom and installed in accordance with 46 CFR 183 Subpart B and 183.330 and reference (B). The Contractor shall prepare and submit an arrangement plan of the switchboard face to the Owner prior to its construction. The arrangement plan shall be detailed, complete with features and technical data on all devices. Nameplates and labels shall be identified and located.

314.4 Switchboard Instruments

Switchboard instruments shall be marine quality components, with an accuracy of ±1%. The instruments shall be suitable for withstanding shipboard vibration and shall operate satisfactorily when inclined 30° in any direction. Analog switchboard meters shall have 4-1/2in diameter and 250° scale. Commercial marine grade multiple function digital display screens will be considered as alternatives to analog meters, dependent on Owner and regulatory approval of the specific meter. Indicator lights shall be LEDs except for ground fault detection lights.

Arrange pilot devices and operators in logical groups physically located respective to function. Components mounted on the switchboard doors shall provide finger safe and back of hand safe protection from electrical shock. Provide indicator/pilot lights in the switchboards with momentary push-to-test capability.

The switchboard shall contain, but not be limited to, the following instrumentation and control functions:

Item	Service For
AC ammeter	For each generator. Allows current to be read in each leg and neutral (A, B, C, N). If mechanical switch, include an Off position.
AC voltmeter	For each generator. Allows voltage to be read between legs and between leg-neutral. If mechanical switch, include an Off position.
AC frequency meter (55 to 65 HZ)	Generators 1 and 2.

Item	Service For
Idle-rated speed control	One for each generator engine, if not on generator control panel.
Automatic voltage regulator	One for each generator - unless mounted in generator enclosure or separate generator control unit.
Ground current lights with push to test switch, or other ground detection relay device.	Ship service bus.
Indicator light - shore power available	Shore power feeder.
Phase rotation indicator	For shore power feed.
AC voltmeter	Shore power feeder; at least one phase pair.

Use potential transformers (PTs) and current transformers (CTs) as necessary. Provide CTs with shorting terminal blocks so that it is possible to short out the current transformer under load. Provide suitable protective devices to prevent high voltages in the event of open circuits. Match instrument and relay CTs to optimize the metering scale.

Install a ground detection light or relay system to indicate fault conditions in compliance with 46 CFR 183.

315 Power Distribution Equipment

315.1 Distribution Panels and Load Centers

Power distribution panels supplied by the switchboard shall be provided as necessary to supply the necessary number of circuits in the necessary locations. Panels shall likewise be provided for the DC panels. Panels shall be Square D NQ panelboards or QO load centers.

Distribution panels shall have main lugs only. Bus bars and internal conductors shall be tin or silver plated copper. Panel buses shall be braced to withstand the maximum available fault current. Provide removable sheet metal front covers with a cutout for the circuit breaker toggle.

315.2 Enclosures and Interiors

The enclosures shall be manufactured of painted sheet steel in all areas except those exposed to weather. In areas exposed to weather, enclosures shall be 316 stainless steel.

Fit a circuit directory frame and card with a clear plastic covering on the inside of each distribution panel door. The directory card **shall not** be permanently attached to the door but shall be removable for modification. Circuit designations and load description of the circuit shall be typed in the proper place on the directory card. The circuit designations and load descriptions shall correspond exactly to the installed condition and to the final Contractor prepared versions of References (J) and (Q).

315.3 DC Power Systems

Provide 12 and 24 VDC power systems for navigation, control, communication, monitoring, alarms, and other DC electronic loads. These systems shall be primarily powered from dedicated battery chargers and shall be separate from engine starting systems. Additionally, provide at least two engine starting

systems; starting systems may be primarily supplied by engine alternators or battery chargers. The Contractor shall develop details of material schedules, cable sizes, circuit quantities and ratings, enclosure ratings, and metering necessary to create complete and functional DC power systems.

At minimum, provide five systems: 24 VDC engine room control power, 24 VDC pilothouse power, 12 VDC pilothouse power, and two engine starting systems. Each system shall include batteries, redundant charging sources, circuit breakers, cabling, and all associated components necessary to create a complete and functional system. Control power systems shall include distribution panels and associated circuit breakers. All circuit breakers shall be UL 489 listed, and any fuses shall be UL listed. The Contractor is advised that most components from Blue Sea Systems and Carling are not UL listed.

The DC systems shall be arranged to allow maintenance charging from shore power, and to allow vessel operation when one of the charging sources aboard the vessel is nonfunctional. Each DC power system shall be supplied by at least one battery charger and at least one additional charging source, such as additional battery charger, engine driven alternator, or switched cross feed from another system. The charging sources shall be sized such that, with the largest charging source for a system disconnected, the remaining source is capable of supplying nominal cruise loads. Battery chargers with sufficient amperage capacity and the capability to charge multiple isolated banks may be employed to supply multiple systems.

Batteries shall be commercial marine grade VRLA or AGM type, 4D size or smaller. Batteries shall be installed within ventilated battery boxes and secured to vessel structure. Cabling shall be arranged so that batteries are connected by one positive and one negative cable to bus bars or distribution panels, to which chargers and other circuits are connected. Size batteries for control power systems to provide at least one hour of operation at nominal cruise load. Size engine starting batteries per engine manufacturer recommendation. All DC systems shall have their negative points grounded to vessel structure.

Locate distribution panels in accessible locations in the engine room and pilothouse. Final placement shall be approved by the Owner. Mount pilothouse battery chargers in the crawl space below the pilothouse. Each circuit breaker, switch, battery charger, and cable shall be labeled.

The Contractor shall develop a final list of loads for each control power system. Examples of engine room loads would be DC lighting, switchboard control power, machinery alarm and monitoring, and ventilation fire dampers. Examples of pilothouse loads would be navigation and communication electronics, fire detection system, propulsion control, and steering control and indication.

315.4 Transformers

Provide a shore power isolation transformer as shown in Reference (J). The transformer shall be marine grade and vacuum resin impregnated. Mount the transformer in an interior location with adequate clearance space for cooling air circulation.

315.5 Switches

Switches shall have positive snap action to maintain open or closed position and shall be labeled to indicate the function of each handle position. The rated ampacity of each switch shall be at least that of the circuit breaker or fuse supplying the circuit.

Area lighting switches shall be 125 volt, 20 ampere, with handle set vertically. The UP position shall correspond to ON for all toggle switches unless the switch is installed in a three or four-way switching configuration. Each switch enclosure shall provide the degree of protection required for its location.

Switches mounted in lining panels or non-structural bulkheads shall be mounted with cover plates flush with the surface of the lining panel or non-structural bulkhead wherever possible. Use corrosion resistant fasteners to attach the wiring device enclosure to the plate.

316 Receptacles

Provide and install 120 VAC hospital grade duplex receptacles, 2-pole, 3-wire (grounded) for portable equipment. Receptacles shall be rated for 15A or 15/20A (NEMA 5-15R or 5-20R), to match the circuit breaker supplying the circuit, and shall use side mounted screw terminals. Push-in type connections shall not be used. Grounding conductors shall be extended to the panel supplying the circuit and solidly grounded to the ship structure.

Minimum receptacles shall be as shown in the table below, and shall be in addition to receptacles dedicated to specific appliances such as coffee makers, televisions, or the microwave oven. As a baseline requirement, receptacles shall be arranged along the bulkheads in finished interior spaces, Stores Workshop, and engine room at intervals not greater than 6ft. Each bulkhead two feet long or greater shall be outfitted with at least one receptacle. Prior to installation, the Contractor shall develop a receptacle drawing or diagram incorporating all receptacle locations in relation to final equipment and furniture configurations, and submit to the Owner for approval. Identify the feeder circuit for each receptacle on the drawing.

Table 3: Minimum receptacles for appliances

Space	Qty	Notes
Upper Deckhouse Top	1	Aft face of pilothouse.
Pilothouse	5	Three on forward console, one at desk, one in settee face, one above settee near window sill.
Upper Deck Passageway	3	
Upper Deck Exterior	1	Aft face of deckhouse.
Heads	1 ea	At mirror in each head.
Upper Deck Crawl Space	1	Adjacent door.
Bosun's Locker	1	
Mess	9	Behind settee, 24in max spacing.
Galley	5	At counters, 24in max spacing.
Pantry	1	
Main Deck passage	2	Along centerline bulkhead.
Staterooms		At head of each berth, plus along each wall greater than 2ft length. 6ft max spacing.
Mud Room	1	Every 6ft along bulkheads and counters. Mount at least 48in above deck surface. Split across two 20A circuits.
Main Deck exterior	3	Aft face of deckhouse, angled facet of forward port corner of deckhouse. Aft face of foc'sle, dedicated to skiff.

Space	Qty	Notes
Void	1	
Engine Room	19	Every 6ft around perimeter bulkheads, plus one in center overhead for reel mounted extension cord. Receptacles spread across at least two 20A circuit breakers. Bulkhead receptacles mounted at least 48in above grating level.
Stores Workshop	10	Two at work bench. Every 6ft around perimeter bulkheads, plus one in center overhead for reel mounted extension cord. Receptacles spread across at least two 20A circuit breakers. Bulkhead receptacles mounted at least 48in above grating level.
Steering Gear Room	1	

Receptacles shall be placed so that all interior areas may be reached by a 25ft extension cord.

Each space and the workbench shall have at least one unassigned receptacle.

Unless noted otherwise, receptacles shall generally be located approximately 18in above the finished floor or deck surface; however, receptacles on the main deck exterior shall be located at least 24in above the deck or wear deck surface. Where receptacles are located at tables, counters, consoles, seating, or workbenches, they shall be placed above that surface.

All receptacles installed in machinery spaces, the main deck, or in exterior areas shall be watertight.

Provide receptacles with GFCI protection in spaces below the Main Deck, in the Galley, heads, and exterior spaces. GFCI protection may be provided via the branch circuit breaker, or with individual GFCI receptacles.

Receptacles mounted in lining panels or non-structural bulkheads shall be mounted with cover plates flush with the surface of the lining panel or non-structural bulkhead wherever possible. Use corrosion resistant fasteners to attach the wiring device enclosure to the plate.

Provide and install dedicated circuits with receptacles for appliances, including refrigerators, freezers, washing machine, dryer, toaster, microwave, coffee makers, and bulkhead mounted televisions. Provide a dedicated 120V circuit and receptacle for skiff support (battery charger, engine block heater, space heater, etc.); receptacle shall be located on the port bulwark.

Install two 208V welding receptacles, one adjacent to the workbench and the other in the Bosun's Locker. Install an additional NEMA 6-50R receptacle adjacent to the work bench, fed from a dedicated circuit. Label the receptacle as 208V single phase.

317 Shore Power

A shore power connection shall be provided. The connection shall consist of a pair of 208V three phase three wire inlets connected via a pair of interlocked circuit breakers to the isolation transformer. One inlet shall be rated at 100A, the other at 50A. The grounding conductor from the shore power inlets shall be carried through the transfer switch arrangement to the galvanic shield within the transformer. The inlets, the transfer switch arrangement, their enclosures, and the interconnecting cabling shall be isolated from the vessel structure to prevent bypassing the isolation transformer. Mount the inlets on

the aft face of the deckhouse on main deck. The inlets and transfer switch arrangement shall include enclosures providing the degree of protection required for their location.

Provide mating connectors for each of the shore power inlets, along with appropriately sized portable shore power cords. Cord shall be type G, SOOW, or W per NEC Article 400. Cords shall be 50 feet long.

318 Lighting

318.1 General

Provide and install a complete, functional, operational lighting system, including all wiring, fixtures, switches, controllers, junction boxes, cable transits, cable glands, foundations, fasteners, and other items and devices.

Light fixtures in machinery spaces shall be mounted in plane with or below the overhead structure, ducting, piping, and cableways, to avoid significant light obstruction. However, consideration shall also be given to adequate headroom along primary walking paths.

The Contractor shall develop a lighting plan to identify light locations. The plan shall ensure adequate lighting throughout the vessel, with focus on safety around stairs and doorways, and efficient use of the working deck and mechanical spaces.

318.2 Interior Lighting

The interior of the vessel shall be adequately lit throughout with marine-type LED fixtures. In addition to area lighting, lights shall be provided at each desk and workspace. Lighting shall be arranged to provide even and consistent illumination, with minimal dark spots.

Each interior space shall be served by 120 VAC lighting, switched near the entrance to the space. In addition, the mud room, stores workshop, and engine room shall be provided with 24V DC lighting supplied from the battery bank within the engine room. This lighting shall be switched near the mud room exterior door. The 24V lighting shall illuminate the path from the door to the generator sets and switchboard.

The interior shall be outfitted with an egress light system supplied from the DC battery banks. These lights shall be equipped to illuminate automatically upon AC power failure, though shall include a switching arrangement to allow them to be turned off during periods of intentional vessel layup. Egress lights shall serve the pilothouse, heads, passageways, stairways, galley, mess, mud room, stores workshop, and engine room. The thruster and bosun room shall be equipped with egress lighting which may be a part of the above described system, or a bulkhead mounted stand-alone unit with integral battery.

The fresh water tank void space shall include at least one light fixture, switched near the hatch.

Finished interior spaces with suspended ceiling systems shall have light fixtures integrated into the ceilings to provide an aesthetic finished product. Upper cabinets in the galley shall be equipped with under cabinet lighting.

A linear fixture shall be placed directly above the work bench.

The crawlspace below the pilothouse shall include lighting to facilitate movement through the whole space and servicing of all equipment within.

The pilothouse and the upper deck passageway and head shall be provided with both white and night vision red lighting, separately switched.

Each bunk shall be equipped with an LED bunk light with integral 120 VAC receptacle.

318.3 Exterior Lighting

A complete exterior lighting system shall be installed. The quantity, type, and arrangement of lighting fixtures shall provide illumination to exterior walkways, the working deck area, foc'sle deck, and areas adjacent the vessel where the skiff may be moored. In general, exterior lighting which could affect the pilot's night vision shall be controlled from the pilothouse. Any miscellaneous switches shall be watertight if in weather locations.

Provide 'jelly jar' or similar compact walkway lights on the main deck and upper deck walkways, and along the aft face of the foc'sle and foc'sle deck. Forward lights shall be separately switched from the pilothouse, and lights along the aft walkways shall be fitted with shields as necessary to avoid affecting the pilot's night vision.

Provide five flood light installations with separate switch controls:

- On the forward side of the deckhouse to illuminate the port side of the working deck.
- On the forward side of the deckhouse to illuminate the starboard side of the working deck.
- On the port forward corner of the deckhouse to illuminate the water adjacent the port side of the vessel where the skiff will moor
- On the aft upper deck top or upper deck handrail, to illuminate the area aft of the swim step where the skiff will moor.
- In cutouts in the forward bulwarks to illuminate the area forward of the vessel.

Each of the four floodlight installations shall be switched separately from the pilothouse.

See section 422 for navigation lights and section 422.1 for the searchlight.

318.4 Light Fixtures

120 V fixtures shall meet UL 1598A, and 24 V fixtures shall me marine industrial grade. Lights shall be as provided by Phoenix Lighting or equal. Each fixture shall feature the degree of protection (IP rating) invoked by Subchapter T for its location. Fixtures generally should be as follows:

Table 4: Lighting fixture options and their locations

Location	Phoenix Lighting series
Below main deck, mud room, bosun's locker, aft decks	ReadiLED
Crawl space	ReadiLED or Cube-Light
Finished interior areas	RDL or LRMC
Exterior side decks, main deck perimeter	Wayfinder 2
Aft face of foc'sle, foc'sle deck	Metallic LED VP (Hazardous rated near gasoline tank)
Flood lights	EcoMod or Command Flood
Aft deck to gensets and switchboard; other battery lights	Cube-Light, DC powered; or compatible with ceiling system
Bunk lights, head mirror lights	LEDBM

Group 400 – Command and Monitoring

400 General

400.1 Introduction

This section describes requirements for the vessel's command and monitoring systems. The Contractor shall provide a system of command, communication, control, and navigation electronics and equipment which is complete and functional in all respects. Components which are not explicitly identified in this Specification, but which would typically be required for a complete system shall be provided as part of the Contract. See section 638.6 for description of pilothouse console cabinetry.

Several electronic systems were defined during the contract design phase of the project by a dedicated marine electronics vendor. Those specifications are contained in reference (S).

421 Navigational Aids

Provide and install the following navigation equipment.

421.1 Horn

One complete air-horn system shall be installed. The system shall consist of an electrically driven air horn, Kahlenberg model S-330-ENC, or equal. The horn system shall feature freeze protection, push button control from each helm station, and a signal controller with fog timer. The signal controllers shall provide at-will and automatic control of the horn, with programmed horn signals for various navigational conditions. The controller shall be Kahlenberg brand.

421.2 Bell

One 12in diameter cast bronze fog bell shall be provided. The bell shall be mounted with a bracket on the side of the pilothouse in an Owner approved location. The bell shall have a polished finish with a preservative coating. The clapper shall be provided with a lanyard.

421.3 Magnetic Compass

Provide and install a magnetic compass designed for marine use per 46 CFR §184.402. Compass shall be Ritchie Navigation Globemaster F-600, flush mount, or equal. Compass diameter shall be at least 6in, and it shall include illumination. DC supply to illumination shall use twisted wires to reduce magnetic interference. Mount the compass on the pilothouse console in an Owner approved location forward of one of the helm stations.

422 Navigation Lights

Provide and install a navigation light system per the COLREGS and all applicable USCG requirements. Navigation lights shall be commercial marine grade using LEDs, Glamox Aqua Signal Series 60 Arctic, or equal. Navigation lights shall operate on 24V DC and shall include anti-icing capability. Lights shall have a black polycarbonate fiber reinforced body, dual LED lights capable of 100,000 operating hours, and integral heater with thermostat. The light manufacturer shall provide documentation indicating the lights have been accepted by the US Coast Guard as equivalent to meeting the testing requirements of UL 1104.

Provide and install navigation light controls as part of the system, as follows:

- Navigation Light Display Panel: Prime Mover Controls Series 8014 LED Navigation Light Display Panel, or equal. Panel shall provide primary and backup power control for 10 navigation lights, have four programable light functions, adjustable alarm horn, and dimmable buttons and labels.
  - Navigation Light Control Panel: Prime Mover Controls Series 8014 LED Navigation Light Control, or equal. Panel shall receive input from the display panel and provide 24V DC primary and backup power for 10 navigation lights. All power, lamp, network, and control wiring is terminated at this panel. Panel shall monitor primary and secondary feeds, have an independent alarm relay, and NMEA 0183 output.

  One possible supplier of these panels is:
  Prime Mover Controls, Chris Wiegand, 603-433-4644

  info@pmc-controls.com

Install the navigation light display panel in the pilothouse in an Owner approved location. Install the navigation light control panel within the pilothouse console or crawl space below the pilothouse in an Owner approved location. Provide all interconnecting cabling, cable glands, hardware, and components to provide a functional installation.

422.1 Searchlight

Provide and install a searchlight system as described in reference (S).

423 Electrical Navigation Systems

423.1 General

The electronic systems shall be in accordance with the applicable regulations of the Federal Communications Commission, Part 83, and USCG regulations. The installation and testing of equipment shall be supervised by the equipment manufacturer's representative. All antennae shall be installed to avoid interference with each other and provide maximum clear reception.

The Contractor shall be responsible for accomplishing FCC inspection and obtaining certification. The systems shall be considered complete only when the FCC inspection and certification has been accomplished. All equipment shall be of commercial marine grade quality. Additionally, the Contractor shall obtain AWT's approval of the selected equipment prior to purchasing.

423.2 Radar and GPS System

Specifications for radar and GPS systems are contained in reference (S).

423.3 Chart Plotters

Specifications for the chart plotter system are contained in reference (S).

423.4 Depth Sounder

Specifications for the depth sounder system are contained in reference (S). Contractor shall plan on up to two transducer wells in the vessel bottom in locations agreed upon with the Owner and electronics vendor. Approximate well dimensions are 16"x12"x12". Well installation to be in accordance with USCG Subchapter T, ABS structural, and vendor requirements.

432 Communications

432.1 Internal Communications

Specifications for the internal communications systems are contained in reference (S).

432.2 External Communications

Specifications for the internal communication systems are contained in reference (S).

436 Alarm and Monitoring Systems

436.1 Machinery Alarm and Monitoring System

An alarm and monitoring system shall be supplied and installed by the Contractor. The contractor may contact the vendor listed below to obtain the alarm and monitoring system:

Michael Combs
Prime Mover Controls, Inc.
3600 Gilmore Way
Burnaby, British Columbia V5G 4R8
T +1 604.433.4644
michael.combs@pmc-controls.com

All alarm systems shall comply with all applicable USCG regulations. The system shall include displays in the pilothouse and engine room or workshop/stores space as agreed upon with the Owner. In general, the machinery alarm and monitoring system shall monitor bilge levels within each compartment, tank levels as described in 436.2, and any other vessel machinery which produces individual or grouped alarms such as HPUs, water makers, fire detection system, or the boiler. Main engines, generator set engines, switchboard, and steering gear which have dedicated manufacturer provided alarm panels for the pilothouse and engine room need not be integrated into the alarm and monitoring system described here.

Bilge alarms should be labeled, indicating which space has high water levels. Bilge level alarms shall be GEMS brand LS-270 Series, or equal.

Alarm system logic shall be such that the alarms are self-monitoring and fail safe.

The alarm system shall have time delay with the capability to prevent nuisance alarms from occurring when transient alarm conditions exist. Alarms shall not occur during normal startup or shutdown of equipment, or during normal maneuvering operations such as rapid throttle and direction changes from the operator. The Contractor shall demonstrate this capability during trials.

436.2 Tank Level Indication

Provide and install a remote tank level indication (TLI) system, level alarm system, and visual tank level indicators (GEMS SureSite or equal). The TLI system shall be comprised of a series of individual sensors for continuous or discrete measurement of the liquid level in vessel tanks with displays located in the engine room and pilothouse. Continuous measurement shall be provided for fuel and fresh water tanks; the sewage tank may use continuous or discrete level sensors. Measurement shall cover as much of the tank level range as practicable.

Tank level indication shall be coordinated with the overall machinery alarm and monitoring system as described in 436.1. Indication may be part of an overall software based display screen system, or individual physical indication units in the pilothouse and engine room. The remote displays shall indicate fuel oil tank, black water tank, and potable water tank levels.

The machinery alarms and monitoring system shall display high and low level alarms for the various tanks. Alarm set points and time delays shall be adjustable by the vessel owner.

436.3 Fire Detection and Alarm System

A USCG type approved and UL listed fire detection and alarm system shall be provided and installed. Remote smoke detectors, heat detectors, manual pull boxes, and alarm annunciation devices shall be located in the vessel as required and interfaced with the system in accordance with the manufacturer's type approved manual.

Suggested fire detection system is a Sea-Fire FireStop detection system, or equal. Fire detection system shall include an alarm silence switch and modular configuration to support the necessary number of detectors, pull stations, and alarms. System shall include an alarm panel in the bridge that independently identifies the status of each detector zone and manual pull station. System shall be supplied with USCG type approved smoke detectors, heat detectors, visual and audible alarms, manual pull stations, and all other supporting components. Provide and install alarm annunciators so that they can be heard throughout the vessel, and awaken individuals sleeping in staterooms.

System shall be serviceable by Southeast Fire Extinguisher Service, Inc. in Juneau, Alaska.

One possible supplier of the fire detection system components is:

Western Fire and Safety Co./Hiller, Seattle WA; (206) 782-7825; kevin.hein@hillercompanies.com.

439 CCTV and Thermal Imaging Systems

439.1 CCTV System

Specifications for the CCTV system are contained in reference (S).

439.2 Thermal Imaging System

Specifications for the thermal imaging system are contained in reference (S).

Group 500 – Auxiliary Systems

500 General

500.1 Introduction

This section describes requirements for the vessel's auxiliary systems. The general requirements for all piping systems are addressed herein.

500.2 System Design

Piping systems shall be designed and installed in accordance with the requirements of the USCG 46 CFR Subchapter T.

Pipe, valves, and fitting materials shall conform to the material schedules on the Contract Guidance Drawings. Piping sizes indicated on the Contract Guidance Drawings are given for reference purposes. Final selection of pipe sizes for fabrication and installation is the responsibility of the Contractor. Fluid velocity criteria given below shall be used in piping system sizing.

Table 5: Fluid velocity criteria for piping system sizing

Service	Nominal Velocity (ft/sec)	Maximum Velocity (ft/sec)
Fuel Oil Suction	$2D^{1/2}$	7
Fuel Oil Discharge	$5D^{1/2}$	12
Sea Water Suction, Steel	$3D^{1/2}$	12
Sea Water Discharge, Steel	$5D^{1/2}$	9
Sea Water Discharge, CuNi	$5D^{1/2}$	10
Fresh Water Suction	$3D^{1/2}$	15
Fresh Water Discharge	$5D^{1/2}$	20

Approved mechanical fitting systems may be substituted for welded or brazed joints in water and sea water systems. Such fittings shall only be used where permitted by the USCG regulations and in accordance with their approvals. The Contractor shall submit details of proposed fittings to the Owner for approval prior to detail design of the system.

Exercise care to develop the system arrangements and installation of piping aboard the vessel to permit the following:

- Free passage along walkways and ladders
- Free access to perform maintenance
- Free access to all doors, hatches, and openings
- Ready removal of the vessel's equipment and system components

503 Pumps

The Contractor shall provide pumps complying with the performance requirements and construction features described herein and elsewhere in this Specification. Pumps shall be commercial marine pump built in accordance with the standards of the Hydraulic Institute and ASTM F-998.

Pumps shall be provided with ensured suctions either through submergence, foot valves, or priming systems so that pump operation is immediate and positive. The Contractor shall verify that the installed pumps have sufficient Net Positive Suction Head (NPSH) for the selected service and system.

The performance requirements listed on the Contract Guidance Drawings are based upon preliminary equipment selection, pipe size and estimated system routing. The Contractor shall supply pumps meeting the required flow and head requirements of the installed piping systems.

Where two or more pumps of the same size and type are specified, they shall be duplicates. Where two metal parts not of cast iron are in sliding contact, they shall be of dissimilar metals. For cast iron parts of pumps in corrosive services, which require disassembly when servicing pumps, through-bolts or studs shall be used instead of cap bolts. In general, the use of through-bolts and studs is required for securing pump parts where thread corrosion or seizure may be expected in service. Fasteners shall be stainless steel with threads coated with a compatible anti-seize compound.

For horizontal units, except close-coupled pumps, the pump and its driver shall be mounted on a common base of rugged construction. Dowels or fitted bolts shall be fitted where necessary to ensure proper alignment.

Generally, each pump shall have a pressure gauge connected on the discharge side and a compound pressure gauge on the suction side. Where pump nozzles are of a different size than the connected piping, a tapered transition piece of adequate length shall be used.

Casings for rotating pumps, except for small motor driven close-coupled pumps, shall be split so that the rotor can be removed without disturbing the driver or the suction and discharge connections.

A valved vent tube shall be located at the top of the casing on all centrifugal pumps that require venting during start-up. Alternatively, where it is not possible to provide a vent line directly from the top of the casing, the vent line may be located at the discharge from the pump. Vents on sea water pumps shall be fitted with a tube directed to the bilge to permit continuous venting. Valves shall be ball type, 1/4in to 1/2in with stainless steel body and tubes.

Mechanical seals shall be provided for all pumps. Where possible, pumps shall be balanced hydraulically. All pumps shall be equipped with suitable thrust bearings to absorb any primary residual thrust that may occur during operation, or when the pump loses suction. In general, pumps shall be equipped with sealed ball bearings contained in the housings and removable as a unit with the pump shaft.

Centrifugal pumps shall be selected to operate at, or near, the maximum efficiency point on the head-capacity curve. The pumps shall have non-overloading power characteristics, and the driver rated horsepower shall at least equal the maximum power requirement of the pump at rated speed without allowance for a service factor.

Horizontal pumps of the coupled type shall be driven through flexible couplings.

Close coupled pumps shall be heavy duty type and shall be suitable for horizontal or vertical mounting with thrust bearings provided.

Wearing rings and casing bushings shall be provided of different hardness than adjacent wearing parts. Impellers shall have removable wearing rings where practicable.

505 Piping

505.1 General

Piping system requirements shall be as described in the various sections of this Specification and as shown on the Contract Guidance Drawings.

Unions shall not be installed in piping located behind linings, false ceilings, or in other inaccessible locations.

Piping in each system shall be arranged to drain naturally to the tank.

Piping systems that require drainage during start-up or relatively frequent manual drainage in service shall be provided with drain lines fitted with valves. Screwed plugs shall be installed where drainage is required on an infrequent basis such as for periodic inspection, maintenance, or drydocking. Flanged or bossed drainage fittings shall be installed where an unavoidable low point or pocket exists in a pipe run. Vent fittings shall be provided for removal of air in piping installed with unavoidable high points. The quantity, location, and arrangement of all such fittings shall be approved by the Owner.

Flexible connections shall be provided where required to isolate vibration and to accommodate thermal growth. Flexible connections shall also be provided between piping assemblies and resiliently mounted equipment. The Contractor shall ensure that all flexible connections are sufficiently flexible to avoid overstressing the equipment, connected piping, or the flex assembly itself.

In general, fluid piping systems shall use flexible hose assemblies with 37° flare, swivel end connections on both ends for connections 2in and smaller, and Garlock Style 206 or equal flanged flexible connections for larger sizes. Hose assemblies conveying fuel or lube oil shall be USCG-approved, flame-resistant type. In general, flexible hose assemblies shall not be less than 9in in length or greater than 30in in length. Flexible hose runs shall not substitute for pipe or tube.

Piping systems shall be insulated in accordance with Section 508.

Drip pans shall be provided to collect normal oil leakage under filters, pumps, strainers, and similar equipment. Drip pans shall be fabricated from stainless steel sheet metal and equipped with drain valves.

Where piping penetrates a watertight bulkhead, a deck, or tank top, an approved penetration fitting shall be used to ensure the tightness of the structure. Penetration details shall be developed as shown on the Contract Guidance Drawings or in compliance with USCG Subchapter T regulations. In no case shall the plating form part of a joint or piping.

To prevent damage to piping and joints at bulkheads and decks, expansion bends shall be provided, as necessary, to allow for sufficient piping movement due to the working of the ship's structure. Expansion joints shall not be used except in engine exhaust.

Ferrous pipe and fittings required to be galvanized shall be galvanized by the hot dip process after fabrication when welding is necessary. Where screwed fittings are called for, galvanized pipe and fittings shall be used. Where galvanizing is damaged during installation, a cold galvanized coating for repairs shall be applied.

Where joints of ferrous and non-ferrous materials cannot be avoided, the connection shall be made with a flanged take down joint fully isolated with gasket and sleeved fasteners using isolating washers under the fasteners.

Pipe welding shall comply with the rules and regulations of the USCG Subchapter T and the details of ASTM Volume 01.07 "Shipbuilding" Standard F722-82.

Piping systems containing oils shall be installed so that flanged connectors are located remotely from exposed surfaces having a temperature more than 450°F. Protective shielding shall be provided around flanged connections to prevent the possibility of spray onto exposed hot surfaces. Piping shall be located at least 18in away from surfaces that have temperatures under the insulation more than 450°F.

The Contractor shall avoid routing piping directly over or within 2ft of electrical equipment, insofar as possible, and in no case shall flanges or joints be located over electrical equipment.

Piping shall not be routed directly over engines, except for systems connected to the engine. Piping shall not obstruct manholes, hatches or accesses.

505.2 Valves, Fittings, and Instrument Piping

Valves shall be accessible from the grating level whenever possible. Where valves must be located out of easy reach, the Contractor shall install reach rods, remote operators, or some other suitable means of access.

Hand wheels for sea valves shall be easily accessible.

Manually operated valves shall be readily operable by one person, directly or through mechanical advantage type operators. Valves and valve handwheels shall be located so that the operator's hand may easily pass between the handwheel and any interference, with the handwheel open, closed, or in between.

Except when mounted overhead and arranged for operation from below, manually operated valve stems shall be installed with the valve stem rotated above the horizontal plane. Ball and butterfly valves shall be installed in such a manner that the valve opens and the handle lines up with the piping under normal operating conditions.

Valves shall be right hand closing and shall have either a rising stem, or an indicator to show whether the valve is open or closed.

Spindles, seats, and disks of valves shall be corrosion-resistant material.

Unless otherwise noted in this Specification or Contract Guidance Drawings, valves that are 2 1/2in and larger, except butterfly valves, shall be flanged with bolted bonnets and packing glands. Valves that are 2in and smaller may have union ends and bonnets, socket weld ends, or threaded ends.

The use of threaded valves and fittings in systems containing fuel oil, lube oil or hydraulic oil shall be limited to equipment connections and small fittings such as gauge piping and drain plugs to minimize the potential for leakage.

Check valves shall be installed wherever flow reversal in a system would be detrimental to operational requirements.

Stop check valves shall be installed wherever flow reversals could flood a space.

Swing check valves shall be installed in a horizontal plane and in a fore and aft orientation where possible.

Relief valves shall be provided on the discharge side of all positive displacement pumps and air compressors which do not have built-in relief valves.

In general, gate or ball valves shall be used where shut-off only is required. Globe or angle valves shall be used where throttling is required.

Butterfly valves may be used in pipe 3in and over if the seat material suits the maximum operating temperature of the system, only where approved by the Owner. Butterfly valves shall not be substituted for gate valves or globe valves shown on the Contract Guidance Drawings, and shall not be used on sea chests and overboard shell connections.

Butterfly valves shall use lugged bodies. Bodies and disk materials shall be as noted in the materials schedule on the diagrams. Valve stems shall be stainless steel. Valve seats shall be Buna N, Viton, or metallic as required to suit the service.

Where pressure reducing valves are installed, a bypass with globe valve shall be provided around the reducing valves with a pressure gauge and relief valve on the low-pressure side.

Connections for thermometers with dry wells, and pressure gauges with snubbers, shall be provided to check proper operation of piping and equipment.

Pressure gauges shall be provided with a compound type at the suction side and a pressure type at the discharge side of all pumps. Differential pressure gauges shall be provided at all strainers and filters. The gauges shall be 2 1/2in diameter, liquid filled. Pressure gauges shall be provided with shut-off valves and

snubbers and shall be mounted on each pump. Gauge piping assemblies shall meet the requirements of ASTM F721.

Valve locking devices shall meet the requirements of ASTM F993, Type II.

505.3 Remote Valve Operating Gear

Remote operating gear shall terminate at the main deck or outside the space as required by USCG Subchapter T. Operating gear shall be rigid or flexible shafting with universal joints.

Deck boxes shall be commercially manufactured of stainless-steel construction. Each shall be provided with a stainless steel or bronze flush cap, permanently stamped or engraved with its function on the cap and on the rim. The deck box shall indicate whether the valves served are open or closed. Deck boxes for the systems described herein and elsewhere in this Specification shall be of identical manufacture. Provide four identical T-wrenches per vessel, which serve all deck boxes. Mount the wrenches as directed by the Owner.

505.4 Takedown Joints

Unless otherwise noted in this Specification or Contract Guidance Drawings, flanged takedown joints shall be provided in piping 2 1/2in and over, and unions may be used in piping 2in and smaller. Takedown joints shall be provided to allow removal of all in line equipment, or to allow removal of equipment normally blocked by the piping.

Where joints of ferrous and nonferrous materials cannot be avoided, the connections shall be made with flanged takedown joints fully isolated with a gasket, sleeved fasteners and isolating washers under the fasteners. All metal-to-metal connections between the hull and the keel coolers are to be isolated with non-metallic gaskets, washers, and bolt hole inserts.

Flanges in piping shall conform to ANSI standards for the appropriate service.

Where a steel flange is used with a cast iron flange, CPVC or bronze flange, the steel flange shall have a flat face, and a full flange gasket shall be used. Flange gaskets shall be asbestos free.

Flange gaskets shall be compatible with the piping material, fluid conveyed, design pressure and temperature of the systems in which they are installed and shall meet all USCG Subchapter T requirements. Unions in metal piping shall be ground joint type.

Takedown joints in soft copper tubing shall be SAE 45° flare type, with long nuts.

506 Fills, Vents, and Sounds

Arrange fills, vents and sounding tubes generally as shown on Reference (K).

Fuel and oil vents, fills, and discharges shall be surrounded by a spill containment. Spill containment shall be a minimum volume of 5 gallons and shall be constructed of 1/4in steel plate. Containments shall be welded watertight to the deck and intersecting bulkhead and provided with a 1in NPS bronze plug drain, location to be confirmed with the Owner. The top edge of the containment shall be stiffened with 3/4in round bar.

Access shall be provided through the wear deck for the sounding tubes located below the wear deck.

506.1 Tank Level Indication System

Provide and install a tank level indication (TLI) system. The system shall comprise a series of discrete instruments and remote displays which will provide both local and remote continuous level indication. See Section 436.2 for additional requirements.

For tanks containing fuel oil, local sight gauges shall be metallic float style level indicators, GEMS Suresite or equal. Level indicators shall be constructed of stainless steel with welded joints and flanged upper and lower process connections. The indicators shall read to within 6in of the top and bottom boundaries of the tanks.

506.2 Tank Sounding Tables

Tanks sounding tables for all tanks and shall be prepared by the party responsible for completing the stability analysis for the vessel Section 843.2. Tank sounding tables shall be configured for the exact location of the corresponding sight glass or sounding tube, including internal low stop in the top or glass.

508 Piping and Machinery Insulation

All insulation material and installation details shall be in accordance with ASTM F683-10, except as modified by this Specification.

Prior to installation of any insulation and/or lagging, the applicable piping installation must have all tests and inspections completed.

Provide piping insulation for hot and cold fluid piping including:

- Diesel engine exhaust pipes and silencers (See Section 259)
- Low temperature services below 65°F including cold-water piping such as sanitary, potable, fresh water cooling, sea water cooling, and drains where dripping condensate could cause damage
- High temperature services over 120°F including hot water piping, valves, and pump casings
- HVAC ducting

512 Heating, Ventilation, and Air Conditioning Requirements

512.1 General

The Contractor shall design, provide, and install complete HVAC systems for the vessel, including machinery, void, and crew space systems. In addition to any equipment or system operating instructions and maintenance manuals, a system schematic of the HVAC system including materials, piping, ducting, air flow rates, and equipment details with sufficient detail for system maintenance shall be provided with the submittal of the as-built drawings.

Systems shall include all components, controls, and appurtenances required for proper operation. Equipment shall be sized and installed to the satisfaction of the Owner.

Contractor shall secure the assistance of a vendor qualified in marine HVAC systems to design, install, and test the central air handling system.

512.2 Design Conditions

HVAC equipment shall maintain the indoor design conditions at the environmental conditions noted in Table 6.

Winter conditions assume spaces are unoccupied, with no credit for heat from lighting or equipment. Winter temperatures are intended to mitigate snow, ice, and freezing concerns.

Table 6: Environment conditions for HVAC design

Design Condition	Winter	Summer
Outdoor Air	-10°F	80°F
Crew Spaces	65°F	75°F
Engine Room	60°F	100°F
Voids	35°F	90°F
Sea Water	28°F	70°F

The Contractor shall provide HVAC systems for all occupied crew spaces within the vessel superstructure in accordance with SNAME T&R Bulletin 4-16, 46 CFR Subchapter T, and good commercial marine practice.

Ventilation airflow rates shall be based on the greater of the following requirements:

- Occupancy based outdoor air requirements (CFM per person)
- Air change rate (ACH) based on space volume
- Equipment heat dissipation and applicable code requirements

Minimum ventilation rates for typical crew spaces shall be as indicated in Table 7.

Table 7: Minimum ventilation rates for typical crew spaces

Space	Minimum CFM	Minimum ACH
Stateroom	100	8
Galley	300	8
Mess	300	8
Head	60 (exhaust)	10
Mudroom	100	10

512.3 Heating

Heating shall be provided by the central AHU distribution system, local Pic-A-Watt electric heaters, and local hydronic space heaters. The AHU shall provide baseline heat, Pic-A-Watt heaters shall provide local thermostatically controlled heat in habitable spaces, and hydronic heaters shall serve below deck spaces and the mudroom.

512.4 Hydronic Heating Unit

The Contractor shall provide a closed loop, diesel fired, hot water hydronic heating system for heating loads, including potable hot water. The hydronic heating unit water output shall not exceed 185°F output and shall function at about 15 psi. The system shall provide flow distribution, temperature control, and maintainability across all major load branches. At minimum, two circulating pumps shall be provided to support distribution and hydraulic separation, although additional zone pumps may be required to prevent branch starvation during differential pressure variations. Makeup water shall be provided by dedicated makeup tank such as Axiom MF200 Pressure Pal, or equal.

The Contractor shall provide all hydronic heater support systems, such as diesel oil supply, exhaust piping, expansion tanks, relief valves, zone valves, alarms, and controls. All ancillary hydronic

components shall have a quality and duty cycle consistent with light commercial duty. Normal service for key boiler components, such as the oil burner, shall be available in Juneau, Alaska.

512.5 Hydronic Heaters

The Contractor shall provide and install hydronic heaters to maintain comfortable working temperatures in working spaces and to keep below deck spaces above freezing during winter conditions. The mudroom heater shall support drying of wet clothing and gear. A large hydronic heater will be supplied and located in the AHU under the wheelhouse to support heating the central air system. The AHU will be sized by the HVAC vendor.

Hydronic unit heaters shall be supplied as follows: one unit in the thruster room, one unit in the void, two units in the engine room, one unit in the stores workshop, one unit in the steering gear room, and one unit in the mudroom. Hydronic heaters shall be Modine HC 18 or equal, except for the mudroom where the hydronic heater shall be a REAL Hydronic heater, or equal. Units shall be mounted from the overhead in each space in a location approved by the Owner. Each unit shall be supplied with a fan and thermostatic control mounted in the space.

Piping to hydronic heaters shall be Type K copper tubing and copper Viega Pro-Press fittings, or equal. All hydronic piping in manned spaces and inaccessible locations shall be insulated. Copper tubing penetrations through WT bulkheads and decks shall occur with a dedicated collar and an approved fire and watertight putty system.

512.6 Pic-A-Watt Heaters

The Contractor shall provide and install marine rated electric heaters to provide thermostatically controlled "top off" heat in each habitable space. Generally, electric heaters are intended to supplement other heating systems, such as the Central Air Handling system, and to provide thermostatic control of a space's temperature.

Heater shall be Pic-A-Watt (PAW) King Electric SS or equal heaters marine rated, USCG approved forced fan electric heaters with adjustable wattage output. Head heaters shall include integrated adjustable timers set to automatically shut off after 60 minutes.

Electric heaters shall be installed in: each stateroom, each head, pantry, galley, mess, mudroom, and two units in the wheelhouse.

512.7 Cooling

The Contractor shall supply refrigerated cooling air in the Central Air Handling system and in the wheelhouse using a standalone HVAC unit.

The AHU shall include a fin and tube cooling coil sized for required design temperatures and airflow and designed for marine service.. The coil shall drain to a sloped stainless steel condensate pan and be accessible for maintenance. The Contractor shall submit coil selection data showing cooling capacity, airflow, entering and leaving air conditions, fluid flow rate, and airside and fluid pressure drops.

Condensate drains from the packaged unit shall be routed to the nearest deck drain with continuous slope. The unit and condensate piping shall not be located over or near electrical equipment. Except for a short flexible connection at the unit, condensate drains shall be copper tubing with approved mechanical or brazed fittings. The unit shall be selected and installed for low noise and vibration, meet the requirements of Section 073, and provide access for inspection, filter replacement, coil cleaning, and maintenance.

512.8 Central Air Handling System

Contractor shall design, procure, install, and test a central air handling system with an integrated air handling unit (AHU) to provide conditioned air to most habitable crew spaces, excluding the pilothouse. Outside air and recirculated air from above the galley shall mix beneath the pilothouse, run through the AHU to be filtered and heated or cooled, then be distributed through the center duct system to the staterooms, mess, and galley. Return air shall be drawn through the recirculation uptake above the mess, or from outside air, using a controllable ducting system.

The AHU shall be a Carrier AREO 39L or equal. AHU shall be fitted with independent heating and cooling coils and filters. AHU shall have a variable speed fan. Installation of the AHU unit shall allow for proper installation of required duct work while maintaining access for service and maintenance.

The central air handling system shall supply heated air at not less than 65°F. Local electric heaters shall provide the final amount of heat to bring spaces up to required temperature, to avoid the need for complicated air mixing and control devices.

The system shall include a recirculation mode to reduce outside air intake during inclement weather while maintaining required ventilation rates. There shall also be a summer recirculation mode that allows for 100% outside air. The air distribution system shall be routed to provide effective airflow to the spaces served. The central air handling distribution ducting shall generally be located in the main deck overhead and arranged to serve both the main deck and upper deck levels, as shown in the suggested duct routing sketch (below). Air handling equipment and ducting shall not prevent access to electrical equipment mounted in same space.

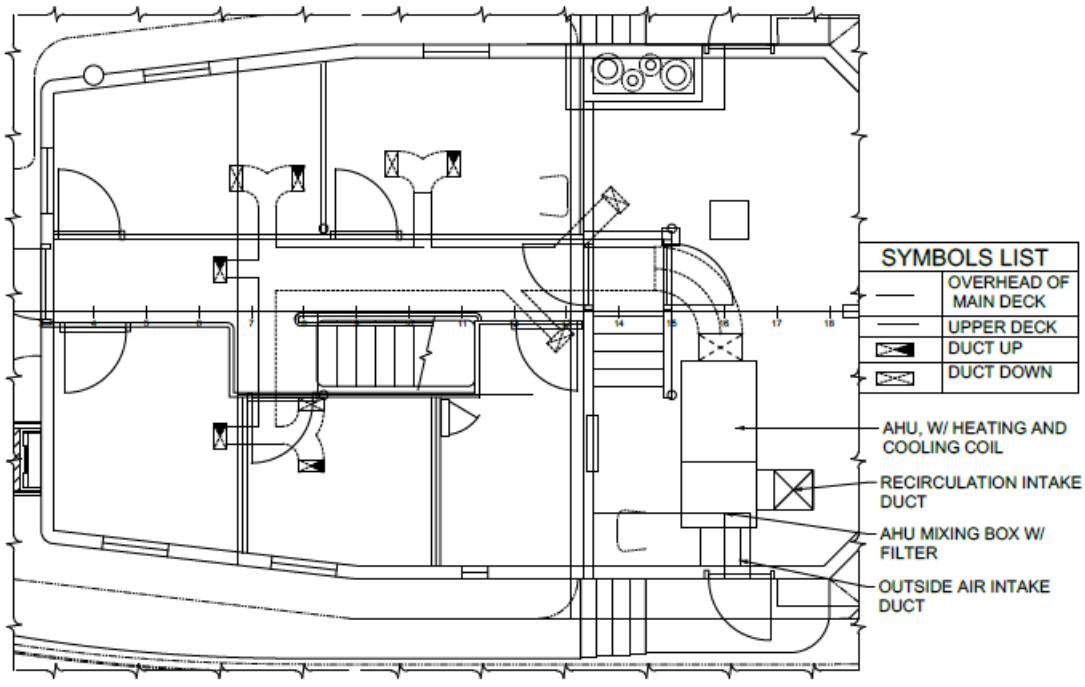


Figure 1: Notional duct routing to serve main and upper decks

512.9 Wheelhouse Standalone HVAC Unit

The wheelhouse shall be provided a standalone HVAC unit mounted in the overhead to supply refrigerated air conditioning and heat to the wheelhouse space, independent of the central air handling

system. The wheelhouse air conditioning unit shall be the Coleman Mach Marine SeaMach 13,500 BTU unit, or approved equal. The unit shall be marine rated and selected to maintain wheelhouse design temperatures.

512.10 Hold Level Ventilation

The Contractor shall design, provide, and install forced mechanical air supply and natural exhaust ventilation in hold level spaces to support safe access for personnel. Location of all components in this ventilation system shall be approved by the Owner, with special emphasis on the ability to make these systems tight during heavy weather.

Each of the following spaces shall be provided with hold level supply ventilation: thruster room, void, stores workshop, and steering gear room. Engine room ventilation is addressed separately. Hold level ventilation fans shall provide a minimum of 400 CFM using Centek Delta T 500-808XL 8in diameter inline fans or equal. Fans shall be provided with manual on/off controls located outside of the space served. Duct closures and shutdowns shall be provided in the stores workshop to support the fixed fire extinguishing system. Fans shall be installed close to weather inlets, such as just below the main deck, and shall be provided with corrosion resistant ducts to supply air to low in the space, near bilge level. Supply vents and ducting shall match the section area of the 8in fan, at least 50 square inches.

Natural exhaust vents, of at least 50 square inches sectional area, shall be placed across the vessel from the supply point to ensure cross flow. Rain and weather protection (such as goose necks), stainless insect screens, and weather tight covers are required for all weather deck supply and exhaust vents.

512.11 Noise

The Contractor shall ensure installed HVAC systems meet reasonable noise limits, suitable for the intended service of the space and in keeping with good marine practice for commercial vessels. Excessive noise, whistling, etc. that keeps the crew from meeting their mission shall be deemed unacceptable and shall be resolved by the Contractor at no extra cost to the Owner.

512.12 Ducting

The Contractor shall size ductwork such that air velocity does not exceed 3,000ft per minute for machinery and hold spaces. Ducting velocities in crew spaces shall generally be limited to 2,000ft per minute.

Contractor shall fabricate machinery space ventilation ducts from 16 gauge G90 hot dipped galvanized sheet steel in accordance with the standards of the Sheet Metal and Air Conditioning Contractor's National Association (SMACNA). Break large panels to prevent panting. Ducts shall be smooth inside with no protruding edges. All ducts shall be airtight and fitted with access ports suitable for maintenance and thorough duct cleaning.

Install ducting as close to the overhead as possible. Ducting shall be provided with rigid supports spaced in accordance with SMACNA rules.

All ducts shall be fitted with removable access panels as necessary to regularly maintain and clean the ducting. Duct access panels shall be located in readily accessible locations clear of interferences. Where duct access panels are located behind decorative or finish wall or overhead panels, the concealed access location shall be clearly marked. Finish panels shall be removable without damage and installed in a manner that provides ready access to the duct access panel for inspection, maintenance, and cleaning.

The Contractor shall minimize the number of ducts penetrating decks, structural bulkheads, girders or other strength members. Ducts shall not penetrate watertight decks and bulkheads unless specifically required by contract and with the approval of the Owner. Where penetrations are required, provide suitable strength compensation such as sleeves or doublers.

Crew space diffusers shall be round or square ceiling type, with balancing dampers and noise damping plenums. Diffusers shall be integrated with the ceiling system.

512.13 Weather Louvers and Mist Eliminators

Air inlets leading directly from the weather shall be fitted with mist eliminators, or weather louvers such as those produced by Zazz Engineering or Centek Marine Systems, or approved equal. Inlet velocities through mist eliminators shall not exceed 1,300ft per minute based on the face area of the mist eliminator. Inlet velocities through inlet louvers shall not exceed 500ft per minute based on the gross inlet face area.

Air exhausts to the weather shall be fitted with aluminum weather louvers. Weather louvers shall be removable and held in place with stainless steel screens. Velocities across exhaust louvers shall be limited to 750ft per minute based on gross face area to the greatest extent possible under all operating conditions.

Weather louvers and mist eliminators shall be fitted with corrosion resistant drains to weather deck drains or to weather. Structure supporting louvers and mist eliminators and attached plenums shall also be arranged for complete drainage to prevent corrosion. Drain lines running straight to weather shall run inside structure to within 6in of the deck.

Gooseneck ventilators may also be used for intake and exhaust terminals, as indicated in the Contract Guidance Drawings and where approved by the Owner. At a minimum, these openings shall be supplied with stainless steel rat screens and weathertight closures.

512.14 Ventilation Insulation and Lagging

Ventilation ducting serving only the space in which it is located need not be insulated. Otherwise, ducting, including equipment, access panels, flanges, and recirculation ducts, for air-conditioned crew spaces shall be insulated and lagged as follows.

Insulation shall be 1in thick fibrous glass board with minimum density of 3lb per cubic foot for rectangular duct. Insulation on round or flat oval ducts and bends shall be 1in thick flexible fibrous glass with a minimum density of 1.5lb per cubic foot. Vapor barrier shall be factory applied aluminum foil, at least 0.002in thick. Joints in the vapor barrier shall be overlapped a minimum of 2in and coated with approved vapor sealing compound. All insulation shall be noncombustible.

520 Sea Water Systems

520.1 Sea Chest

Reference

Reference (L): 24065-200-521-0 Bilge and Fire Main Piping System

Scope

The Contractor shall provide, fabricate, and install two sea chests as shown on Reference (L).

Installation

Sea chest shall be vented to the main deck as far outboard as possible and shall be equipped with a gooseneck.

Provide wake deflection bars on the forward side of the sea chest.

520.2 Salt Water Flushing System

Scope

The Contractor shall design, provide, fabricate, and install a salt water flushing system for the two toilets on the vessel.

Design

The system shall operate between 30-40 psi and shall include an accumulator tank. For redundancy, the piping system shall have a stub and valve where a fresh water hose can be connected if necessary for emergency water supply.

Each toilet shall be fitted with a manual flush valve with an integrated back flow preventor and cutout valves in the supply line so that the water service can be secured at the fixture for maintenance, repair, or replacement of the fixture.

Installation

All materials required for this installation shall be provided by the Contractor. In general piping in the hull shall be Copper Nickel 90/10 Class 200 and piping in the house shall be Pex (see Reference (N) for material schedule). The Contractor shall minimize the number of deck and watertight bulkhead penetrations and associated material changes. The Contractor shall provide and install a combined pump and accumulator such as the Flojet water booster system model 02840000A BST 1G 115V S/E SW40 QC US, or equal. The system shall draw sea water from the sea chest as shown on Reference (L).

521 Fire Main System

Reference (L): 24065-200-521-0 Bilge and Fire Main Piping System

The Contractor shall provide, fabricate, and install a fire main system as shown in Reference (L).

Ensure that the fire pump and fire monitor pump will prime under all trim and heel conditions by providing a flooded suction or installing a priming system. The fire pump shall be controlled locally and from the pilothouse. Provide a fire pump control panel with start/stop buttons with running lights in the pilothouse console.

Fire stations shall be located such that every area of the vessel shall be reachable using a single length of firehose.

Owner shall confirm the location of the fire monitor and deck railings prior to installation.

522 Deck Washdown

The Contractor shall design, fabricate and install a deck washdown system. Piping materials shall be the same as the fire main system. The pump suction shall connect to the sea chest cross over as shown on Reference (L). The pump shall be suitable for use with salt water, operate around 40 psi and be capable

of outputting a high volume of water suitable for washing down the deck and crab pots. The pump shall be approved by the Owner prior to purchase.

The system shall be fitted with one 50ft of 1 1/2in rubber hose for deck washdown mounted on a hose reel on the main deck near the front of the house as directed by the Owner.

526 Weather Deck Drains

The Contractor shall design, procure, fabricate and install a weather deck drain system to prevent water pooling on all exterior decks. Locate deck drains to effectively drain any exterior deck surface to prevent standing water. Slope weather deck drain piping for complete drainage.

Where practical, route weather deck drains inside the structure, behind linings, down to the deck below, then penetrating the house side at 45° and discharge to the weather just above the deck. Otherwise, route weather deck drains outside the structure down to the deck below, where the drain shall discharge near the deck. Provide and route sufficient drains to ultimately discharge on the main deck in way of the nearest freeing port.

All drain piping shall be pitched not less than 1/8in per foot longitudinally or 1/4in per foot transversely. All drains shall terminate well above the design load waterline.

Drains above the main deck shall be fabricated from 2in Schedule 40 PVC pipe, with no takedown joints and as few bends as possible. Drains at or below the main deck shall use 2in Schedule 80 A53 steel. Joints between aluminum and steel pipes shall be galvanically isolated.

Upper deck and house top drains shall be commercially manufactured, heavy-wall aluminum, weld in style deck drains with removable strainer plates. Drains shall be welded flush with the finished deck surface with no weld or other protrusions that would prevent water from flowing into the drain.

528 Black and Gray Water System

Reference (M): 24065-200-528-0 Black and Gray Water System Schematic

The Contractor shall provide, fabricate, and install a black and gray water system in the vessel in accordance with Reference (M).

The Contractor shall provide and install a single polyethylene black water tank with a 500-gallon capacity, Enduraplas ST500FS, or equal.

Furnish lavatory fixtures complete with valves, faucets, stops, drain fittings, vents, and hangers. Install fixtures and accessories to the vessel's structure in a manner that does not impair the integrity or damage decorative linings.

Main deck drains shall be commercially manufactured, heavy-wall steel, weld-in style deck drains with removable bronze strainer plates and integral traps. Upper deck drains shall be commercially manufactured, heavy-wall aluminum, weld in style deck drains with removable strainer plates and integral traps. All drains shall be flush with the finished deck surface with no protrusions that would prevent water from flowing into the drain.

Deck drains shall be provided in the galley, mess, pantry, mudroom, in front of the washer/dryer, and in each head.

The black water discharge pump shall have local and remote control from the pilothouse.

529 Bilge System

Reference (L): 24065-200-521-0 Bilge and Fire Main Piping Diagram

The Contractor shall provide, fabricate, and install a bilge system in the vessel in accordance with USCG requirements and Reference (L).

Ensure that the pumps will prime under all trim and heel conditions by providing a flooded suction or installing a priming system.

533 Potable Water System

Reference (K): 24065-200-506-0 Vents, Fills, and Sounds
Reference (N): 24065-200-533-0 Fresh Water Schematic

The Contractor shall provide, fabricate, and install a potable water system in the vessel in accordance with Reference (N).

533.1 Materials

All materials required for this installation shall be provided by the Contractor.

533.2 Installation

Two potable water tanks shall be provided and located in the void as shown on Reference (B). Each potable water tank shall be an independent polyethylene tank with a capacity of 500 gallons, Enduraplas ST500FS, or equal.

Watertight bulkhead and deck penetrations shall be minimized.

Provide a filling station for the potable water system on the main deck as shown on Reference (K). The fill connection shall be a minimum of 24in above the deck fitted with a threaded cap. Mark with an engraved label stating POTABLE WATER ONLY. The filling station must meet the requirements of FDA.

The water maker shall be supplied with a commercial pre-filter a remote display. The remote display shall be mounted in the pilothouse.

The shower heads shall be mounted a minimum of 80in above the finished deck.

A 3/4in frost free hose bibb shall be installed on the main deck and the upper deck where directed by the Owner.

Water hammer arrestors shall be installed at fixtures or groups of fixtures to reduce pressure pulses on branch piping.

541 Fuel Piping

Reference (O): 24065-200-541-0 Fuel Piping Diagram

The Contractor shall provide, fabricate, and install a fuel oil system as shown on Reference (O).

541.1 Gasoline System

The Contractor shall provide, fabricate, and install a gasoline fuel system with an external independent 500 gallon fuel tank located as shown on Reference (B). The fuel tank shall be outfitted with DOT or OSHA approved electric pump, pump hose, fill, fill gauge, and vent to the satisfaction of the Owner.

551 Compressed Air

The Contractor shall design, provide, and install a 90 psi compressed air system for the ship's tools. All materials required for this installation shall be provided by the Contractor.

Piping materials shall be 1/2in schedule 80 carbon steel, ASTM A53 Grade B, with 3000# socket weld couplings.

The system shall include an Ingersoll Rand SS5L5 single stage air compressor or equal and distribution piping. Air compressor/tank shall be in the stores workshop. Tank outlet shall be provided with a filter and moisture eliminator.

At minimum the ship's tool air system shall have the following air supply ports:

- Stores workshop – 1
- Engine room – 2
- Main deck – 3 (one aft of house and one forward and one aft of the wear deck)
- Foc's'le deck – 1
- Upper deck aft of house - 1

All supply ports shall be installed where directed by the Owner and shall be under cover and protected from the weather.

Contractor shall install distribution piping below the main deck to the air supply ports. Penetration of galvanized pipe through WT bulkheads and decks shall occur with dedicated steel collars and fire and water rated putty system.

Contractor shall supply a 1/2in diameter by 50ft compressed air hose on a reel at the engine room supply ports.

555 Fixed Fire Extinguishing Systems

The Contractor shall work with a qualified vendor to design, provide, and install a fixed fire extinguishing system in the engine room and stores workshop. The system must be able to be serviced and recertified in Juneau, AK. The fixed fire systems shall meet the requirements of 46 CFR Subchapter T.

555.1 Design and Installation

The fixed fire system shall utilize a USCG approved Clean Agent fire suppression system that is electrically non-conducting and non-hazardous at design concentrations.

The design, installation, testing, and maintenance of the clean agent fire extinguishing systems shall be in accordance with USCG and NFPA 2001 Rules and Regulations. Agent quantities shall meet the vendor specified minimum design concentrations.

Suppression system components shall be manufactured by a major US fire equipment manufacturer (such as Kidde) and shall have service support in Southeast Alaska.

All components of the fire extinguishing system shall be products of the same manufacturer or listed by the manufacturer as compatible with those devices, components, and equipment. The Contractor shall utilize the manufacturer's authorized technicians for final connections and system tests of the fire extinguishing systems.

The clean agent storage cylinders shall be stowed in the stores workshop, and in accordance with USCG regulations.

Clean agent cylinders shall be new, fully charged, and fitted with level indicators. When required to protect discharge heads during handling and transportation, safety caps shall be provided.

Mount all fixed clean agent cylinders on elevated foundations and securely fastened in a vertical position. Secure cylinders with circumferential band/steel strap type bolted clamps around the cylinder body. Use individual band clamps for each bottle to permit maintenance service and removal.

The system shall include all necessary storage cylinders, piping and control systems, alarms, warning lights, relief valves, discharge nozzles, solenoid shutdown and pressure release cylinders, and interfaces with engine, damper, and ventilation controls.

Arrange nozzles to evenly distribute and diffuse the clean agent throughout the protected spaces. Design size and flow requirements per the manufacturer's approved design manual and USCG requirements.

The shut down system shall correctly turn off engines, generators, fans, fuel pumps, lube oil pump, fuel centrifuge, boiler, and shall close intake and outlet dampers upon system activation, and shall not require power to operate closure devices. The shut down system shall activate automatically upon fire suppression system release, and also shall allow manual activation from the pilothouse. The shutdown system shall function if the vessel is supplied by shore power. See section 810.2 for documentation requirements.

The remote manual release for each space shall be located immediately outside the space served, in a location approved by the Owner.

The Contractor's design shall be provided to the Owner for approval, prior to ordering components.

556 Hydraulic Systems

The Contractor shall work with a qualified vendor to design, provide, and install a central hydraulic oil system designed to service the vessel's crane, anchor winch, and pot working deck gear. The system and components shall comply with all applicable USCG requirements and be to the satisfaction of the owner. In addition to any equipment or system operating instructions and maintenance manuals, a system schematic of the hydraulic system including materials, piping, and equipment details with sufficient detail for system maintenance shall be provided with the submittal of the as-built drawings.

Steering gear for each rudder shall be supplied with their own HPU and controls as specified in section 562.

556.1 Design and Installation

The system shall be comprised of one central hydraulic reservoir, two hydraulic pumps powered by 30 HP electric motors, associated filters and fittings, and distribution piping. The reservoir shall be sized to have a capacity of at least 5 times the volume of working fluid and be capable of operating without a cooler. Pumps, reservoir, and primary piping controls (valves), and electric starters shall be in the thruster room on the aft bulkhead.

Hydraulic pumps shall be arranged such that either pump can be energized and supply the central hydraulic system without valve operation. The system must also be capable of operating with any of the hydraulic pumps out of operation, fully isolated from hydraulic pressure. Location of pumps shall provide flooded suction or minimal suction head.

Each HPU shall be equipped with local Hand/Off motor starters and remote On/Off switches in the pilothouse.

Piping shall be arranged to supply each piece of equipment as directly as possible. Each piece of equipment shall be provided with separate pressure, return, and drain lines. Anchor and pot working gear will be controlled manually at each device, however crane will have a set of manual controls on the main deck (location to be determined the Owner) and a set of remote control valves for the wireless controller.

Piping below the main deck shall be sch 80 black steel with 3000# socket weld fittings. Piping shall be sized to keep liquid flow at a nominal velocity of 1.3ft/sec for suction and 7.0ft/sec for discharge, except minimum pipe size below main deck shall be 3/4in. Piping above main deck and piping exposed to weather shall be stainless steel pipe and socket weld fittings. Stainless tube, instead of pipe, may be proposed for above deck/weather service if adequate material properties are demonstrated.

Each piece of equipment shall be supplied with pressure compensated flow control valve and an isolation ball valve. Each pressure compensated control valve is to be sized as appropriate to limit flow and relive pressure in accordance with the individual piece of equipment's rated design operating flows and pressures.

Hydraulic motors, HPU pumps, and tanks shall be fitted with 2in deep drip pans to avoid spilling during maintenance.

562 Maneuvering Systems

Contractor shall provide and install a complete steering system in the vessel. The steering system shall be in compliance with USCG Subchapter T requirements including all regulatory documentation, failure modes analysis, and testing and verification procedures.

562.1 Rudders

The Contractor shall provide and install two complete rudders, as shown in Reference (P), to the satisfaction of the owner.

The rudders shall have the following salient features:

- Rudder Blades
  - Profile and Section shape as shown in Reference (P)
  - Welded construction with ABS Grade A or better
  - Fully sealed and air-pressure tested at 3 psi bar for 30 minutes
  - Provided with stainless drain plugs in top and bottom
  - Interior coated with float coat tar-free epoxy coating
  - Exterior coated to match adjacent bottom paint system
- Rudder Trunk
  - Welded construction with ABS Grade A or better
  - Section of trunk to match upper section of rudder
  - Structure of trunk to be greater than adjacent hull structure and sufficient to support lower end of bearing housing
  - Provided with stainless drain plugs in top and bottom
  - Interior coated with float coat tar-free epoxy coating
  - Exterior coated to match adjacent bottom paint system
- Rudder Stock
  - Rudder stock shall be created from 316 stainless steel shaft stock, in accordance with Reference (P). Final machining dimensions shall be provided to the owner for the purpose of creating new rudders, if necessary

    - The exposed interior end of the rudder stock shall be prominently engraved with a line corresponding to the rudder in a position parallel to vessel centerline
- Rudder Tube, Bearings, and Fittings
    - Contractor shall supply and install the rudder tube, bearing, and other required fittings and components in accordance with Reference (P)
    - Materials shall be in accordance with Reference (P). All final machining dimensions of components shall be provided to Owner for purpose of creating new rudder components, if necessary
    - Support of rudder tube to vessel structure is only notionally described in Reference (P). The Contractor shall create a detailed rudder tube support plan and provide it to the owner for approval, prior to installation

562.2 Steering Gear

Contractor shall supply all steering gear, structure, piping, hoses, and wiring as required to make the system fully functional in accordance with Reference (P) and to the satisfaction of the USCG and Owner.

All steering gear components, unless otherwise noted, shall be provided by Jastram, or equal. Contact Sean Curtis of Palmer Johnson (360) 280-0283 for a description and quote JQ261053B-PJ for this system. Prior to purchasing Jastram system, Contractor shall provide Jastram System Diagram, Cylinder sheet, and System wiring diagram to owner for approval.

The system shall consist of:

- 6,000 FTLB Total Torque (3,000 FTLB per rudder)
- Maximum hardcover angle of +/- 35°. Rudder stops shall be installed at +/-37°
- Two On/Off 3 HP HPU (one for main steering and one for backup) with each pump/motor/manifold assembly on a stand alone reservoir.
- Rudder turning rate 35/35° in 12 seconds.
- Two Motor Starter Assemblies (MSA) in the steering compartment
- Four alarm panels, two in the steering compartment, and two in the wheelhouse station
- Three control stations:
- One pilothouse centerline station with FFU (full follow up) LC lever, one RAI, one control panel CP-375, and one manual helm pump steering wheel. Starting and stopping of the hydraulic power units shall be accomplished by the operator from the centerline pilothouse console.
- Two pilothouse wing stations (port and stbd) with FFU LC lever, one RAI, and one STANDBY/FFU/NFU/AUTOPILOT, and TOS (take over switches) at each station.
- Emergency steering shall occur through the manual helm pump in the pilothouse
- "B" Series brass hydraulic cylinders, with spherical bearings
- Spherical bearings for ends of tie rod, to be installed on a 3" sch 80 tie rod fabricated by Contractor
- Tiller arms and connection to hydraulic cylinders and tie rod
- Rudder angle indicators

562.3 Bow Thruster

Provide and install a 60 HP tunnel type bow thruster, Imtra/Sleipner SAC700/412-C-2H or equal. The intent is for the bow thruster to operate only when two generators are running. The unit shall feature horizontal mounting with structural foundations and integration to vessel structure. Provide adjustable

mounts or chocking as recommended by the manufacturer. Perform final alignment and coupling connection with the vessel afloat.

Electric drive motor shall be TEFC type and inverter rated, operating at 208V three phase. Provide VFD drive for variable speed two directional operation, and accessories to allow control and speed/direction monitoring from the pilothouse. Provide a drip shield over the VFD, along with all required cables, bulkhead and enclosure penetrations, fasteners, fittings, gaskets, and sealants.

Provide and install lubrication piping and grease systems as recommended by the manufacturer, along with necessary lubricants. Provide and install sacrificial anodes on the unit per manufacturer recommendation, as well as one on the tunnel interior on each side of the thruster. Provide bolted gratings across the tunnel openings on both ends. Provide sheet metal guards to protect exposed couplings or other components from contact with personnel or other objects.

572 Lifting Equipment

Reference (B): 24065-200-101-1, Profiles and Arrangements

Provide and install the two purpose cranes shown on Reference (B).

The working deck crane shall be a North Pacific Crane Company MCK-1130, or equal, capable of lifting 8,000lb at a 30ft radius. The working deck crane shall be compatible with and powered by the hydraulic system defined in Section 556. The crane shall be provided with local controls located per Owner preference as well as remote controls. The crane vendor shall be capable of providing regular service at common Alaska ports. The crane shall be capable of 360° slewing range (continuous) at a slewing speed of up to 1.0rpm. The crane shall be coated in accordance with the color specified in Section 631.

The roof deck shall be equipped with a stores davit, Steelhead Marine E1000, or equal, capable of lifting 1000lb at a 10ft radius. This crane shall be powered by a local, vendor supplied hydraulic power pack designed to run off the 208V 3phase power. The crane shall be coated in accordance with the color specified in Section 631.

The crane and stores davit shall be tested in accordance with manufacturer's recommendations including a demonstration of lifting up to safe working load.

573 Crab Pot Gear

Reference (B): 24065-200-101-1, Profiles and Arrangements

Provide and install the following crab pot handling equipment as generally shown in Reference (B). All equipment to be approved by Owner prior to fabrication or purchase. Pot launching table and retrieval davit shall not obstruct skiff launching off starboard side.

- Pot Launching Table:
  - Kolstrand or equivalent.
  - Table to be of aluminum construction, of roughly 6ftx6ft dimensions. Connections between aluminum table and steel structure shall be properly isolated.
  - Designed to be easily removable with bolted connections.
  - Table to be installed aligned with top of solid bulwark. Bulwark rail to be terminated on either side of the table.
- Pot Retrieval Davit
  - Kolstrand or equivalent.

    - Designed to retrieve 1,000lb crab pots with a nominal 5,000lb rated pull, or as approved by Owner.
    - Designed to be removable with bolted connections.
    - Provide adequate support through deck to support dynamic loads.
    - Arranged to swing forward when not in use to reduce clearance issues for moving objects on deck with working deck crane.
    - Owner to provide power block specification.
        - Power block to be powered off vessel's hydraulic power unit.
- Hull Pot Guard
    - Provide shell protection from swinging pots during crab pot retrieval.
        - Below deck edge, provide diagonal pipe guard of 3in sch 40 pipe.
        - Above deck edge, provide protection utilizing 1/2in UHMW appropriately affixed to the bulwark. Any fasteners used to affix the UHMW shall be of 316 stainless steel.
        - Hull pot guards and attachments shall be arranged to prevent crab pots from getting snagged on the guards during retrieval.
- House Front Pot Guard
    - Provide a grid constructed of aluminum pipe (square tube is acceptable if it has radiused corners)mounted to the front of the house to prevent damage to house front from swinging crab pots or other gear lifted by the working deck crane.

581 Anchor Handling and Storage Systems

Reference (B): 24065-200-101-1, Profiles and Arrangements
Reference (D): 24065-200-120-0, Hull Structure

Provide and install the anchoring arrangement and supporting structure as shown in References (B) and (D) and in compliance with all applicable USCG requirements. The anchor shall be installed in a hawse pipe on the port side of the vessel. The Contractor shall verify that arrangements and hawse pipe dimensions allow for easy deployment and retrieval of the contractor provided, roughly 315kg Type N Pool anchor and rode.

The anchor shall have a 42° fluke. The Contractor shall provide the appropriate shackle, swivel, and connecting link with the anchor.

Rode shall be 800ft of 5/8in 6x19 IWRC galvanized wire rope and at least 41ft of 5/8in galvanized stud link Grade 3 chain (equivalent to one full wrapping of chain around the winch drum). Anchor, chain and wire rope shall be connected as required by the manufacturers.

The Contractor shall provide and install one hydraulicly powered single drum anchor winch (Coastal Marine Equipment 550693 or equal) sized for 5/8in wire rope with levelwind designed to accommodate cable and chain. The winch shall be fitted with a lever operated jaw clutch, hand wheel operated band brake, and manual drum dog. Winch control shall be housed in a stainless steel or plastic waterproof box local to the winch. Design and install a suitable foundation based on certified winch plans and specifications. The winch shall be coated in accordance with the color specified in Section 631.

The rode shall be run from the winch over a sheave and through the hawsepipe. The sheave shall be designed to accommodate both the wire and chain with accessible, easily lubricated bearings. The sheave shall be welded to the deck and adequately supported to withstand anchoring loads. The sheave shall be provided with a removable cover to prevent the rode from jumping off the sheave.

Secure the bitter end of the wire rope to the winch drum by a connection designed to fail in shear at a load less than the breaking strength of the wire rope, but greater than the proof load of the wire rope without failure of any other member and without damage to the winch or its supporting structure. The connection shall be accessible with all of the rope on the drum. The design shall preclude sharp bending of the wire rope.

Provide a quick release arrangement, complete with a pelican hook, devil's claw, two safety shackles, and a turnbuckle with two eyes. All fittings shall be galvanized.

Provide stainless trough under the chain so that the anchor may be held stowed in place underway with the devil's claw while the chain can be slacked to lay in the trough. The trough may be made from 16ga or thicker stainless steel and is intended to contain the slack chain and prevent wear on the deck coatings.

Hawse pipe shall be adequately supported at shell and deck. Hawse pipe shall be sized and oriented to allow efficient anchor retrieval.

582 Mooring Systems

Reference (B): 24065-200-101-1, Profiles and Arrangements

Provide and install the mooring components as shown in Reference (B).

At delivery, the vessel shall be equipped with six new, unused mooring lines. Mooring lines shall be 1-1/4in double braided nylon rope or equal. All six lines shall be 100ft in length. Each mooring line shall be provided with an eye splice on one end sized for the installed cleats.

At delivery, the vessel shall be equipped with 8 new, unused polyform F-13 grey fenders equipped with 8ft long 1/2in nylon double braded fender whips.

The Contractor shall provide and install nine chocks and nine cleats in accordance with the General Arrangement. The Contractor shall provided adequate deck reinforcement under deck-mounted cleats. The chocks and cleats shall have a nominal safe working load appropriate to match the mooring lines. Chocks shall be 8in x 12in closed ring steel chocks, or equivalent. Cleats shall be 16-18in weld-down mooring cleats.

Group 600 – Outfitting

602 Signage, Markings, and Displays

This section describes requirements for nameplates, labels, signage, markings, posted notices and instructions, and other displays throughout the vessel.

Nameplates, signage, markings, notices and instructions required by the regulatory bodies and otherwise specified herein by the Owner shall be provided. All such items shall reflect the "as-built" conditions of the vessel.

Stenciling may only be used to mark piping and ventilation duct in accordance with this section. All other signage, nameplates and other markings shall be provided on phenolic, brass, stainless steel or other material as specified throughout this section or otherwise recommended by the Contractor and approved by the Owner.

Lettering shall be clear, concise and have a minimum of abbreviations.

Contractor shall create a schedule of signage, markings, and displays and submit it to Owner for approval, prior to installing signs.

602.1 Ship's Name, Hailing Port, and Stack Markings

The ship’s name shall be placed on both sides of the bow, and the ship’s name and hailing port shall be placed across the stern. Each letter shall be of raised steel, affixed to the ship using continuous weld around the letter. The letter style, letter sizes and material thickness shall be recommended by the Contractor and approved by the Owner during construction, after the vessel name is selected. ASTM Standard F906-85 (latest revision) shall be consulted in recommending the appropriate letter style based on the length of the ship’s name and in establishing letter dimensions and appropriate spacing between letters.

602.2 Builder's Nameplate

The builder's plaque shall be approximately 18 inches wide × 24 inches high and shall be engraved on polished bronze plate with enamel filled letters. The nameplate shall be mounted on 3/4in thick varnished hardwood (mahogany or teak) pad and shall be located as directed by the Owner. Builder's nameplate shall include the vessel name, Owner's name and location, the Naval Architect's name and location (Elliott Bay Design Group, LLC, Seattle, WA), Contractor's name and location, hull number, and date of build.

602.3 Notices, Licenses, and Certificates

Aluminum frames with plexiglass fronts or semi-rigid plastic placards, as appropriate, shall be provided and installed for all certificates, licenses, and notices identified herein or otherwise required by the regulatory agencies. The aluminum front frames shall be colors and finishes approved by the Owner and appropriately sized for the documents and/or notices to be displayed. If suitable to the location, notices provided on placards produced from semi-rigid plastic material may be mounted directly on bulkheads with suitable adhesive and without frames.

Where licenses or notices of a similar type are to be displayed, a single large plexiglass fronted display case may be provided with sufficient display area to accommodate all licenses or notices of the type intended for display in that case. The front of any such cases shall be hinged or sliding, allowing access to change notices. Locations for the displays and notices shall be approved by the Owner.

Items to be provided and displayed in accordance with these provisions may include the following and any others required by the Owner or regulatory bodies:

Crew licenses, FCC licenses and certificates, emergency broadcast placards, emergency instructions, station bill, shipboard waste management placards, oil transfer procedures, and oil discharge placard.

602.4 Service System Labels and Nameplates

General

The Contractor is responsible for identifying, providing, and installing all system and equipment nameplates, tags, and markings throughout the vessel. Except as specified herein, nameplates and tags shall be black engraved phenolic with white lettering 3/16in high or greater as needed for legibility. Primary information shall be in lettering of a larger size than secondary information. Labels and nameplates shall be permanently mounted using 3M 200MP adhesive tape, or equal. Tags shall be hung with swaged stainless-steel wire tag fasteners.

Heating and Ventilation Systems

Labels or nameplates shall be provided to clearly identify each fire damper, fan, controller, heater, motor, access plate, thermostat, damper, weather supply, exhaust outlet, and other major components of the heating and ventilation systems throughout the vessel.

Labels for fire dampers shall have a red background and white lettering.

Electrical Systems

Identifying nameplates or labels shall be provided for each piece of electrical equipment and for each electrical cable installed in the vessel.

Equipment labels shall identify the item by name and its power source by circuit number. Operating instructions or precautions shall be included on the label plate or a separate plate mounted adjacent to the nameplate.

All wiring cables shall be labeled with aluminum embossed tags secured to cable at sufficient intervals to allow ready identification of cable and circuit if it should become necessary to trace circuits after shipboard installation is complete. Where wires and cables penetrate decks or bulkheads, tags shall be attached on both sides. Wire tags shall be aluminum with raised lettering and clamped to wiring with metal bands approved by the owner.

Any device or enclosure with more than one power source shall be provided with a red warning label. Circuit numbers of the power sources shall clearly be indicated on the label plate. Label plates for precautionary notices and emergency operations shall also have a red background.

Emergency light fixtures shall be labeled with an "E" on a red phenolic label plate.

Electrical distribution panels shall have nameplates showing space/apparatus/circuits controlled, type of service (power, lighting, etc.), circuit designation shown on wiring diagram, and feeder designation. Each circuit breaker on a distribution panel shall have a label plate showing the circuit designation and number, the circuit breaker trip setting, and the breaker frame size.

Piping Systems

Operating systems, associated components and/or equipment, piping, and appurtenances shall be readily identifiable.

Metal engraved label plates shall be affixed to all tanks.

Except where the function of a valve or component is obvious, such as a freshwater cutout valve immediately adjacent to a lavatory fixture, each valve throughout the vessel shall be identified as to its service and function.

Exposed piping shall be stenciled or labeled to indicate the system, such as "LO Filling", "Cold FW", "Fire Main", etc. and the normal direction of flow at least once between takedown joints, on each side of bulkhead penetrations, and at least once in each compartment through which the pipe passes. The letters and numerals shall be proportional to the diameter of the pipe, and the color of the figures shall provide a sharp contrast to the background (normally black letters on white pipe). Pipe exposed to weather shall be marked by brass label plates. 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 obvious.

Fire dampers and closers in the ventilation system shall be labeled as to open and closed position and as to the compartment or system affected.

Additionally, pipe in the engine room shall be color banded to describe its function with the color coding listed below for the system use. Fire main piping shall be painted red throughout the vessel.

System Color Coding

Ventilation duct.....black
Boiler hot water feed, returns & feedwater ..... silver
Potable water.....blue
Ship service air ..... gray
Sea water .....green
Fuel oil.....black
Lube oil..... yellow
Fresh water cooling.....light blue
Hydraulic oil .....orange
Fire extinguishing water and clean agent .....red
Deck drains.....white
Plumbing drains and sewage .....brown

The Contractor shall create a letter sized key placard that clearly describes the color coding of pipe and vents and shall post a placard in each machinery space. Placards shall be engraved phenolic or some other waterproof permanent signage board, printed in full color.

Valve handwheels and remote operator handwheels shall be painted to match above color code. Valves shall have label plates conforming to ASTM F992 and indicating the function of the valve (e.g, "Pot. Wtr, Pump Disch."). In general, valve label plates shall be of Type VI (engraved brass), Grade D (secured by handwheel nut), Class 2 (16 gauge) or thicker, with engraved letters and numbers filled with black enamel. Other non-corrosive metal types and grades may be substituted for specific applications where better suited to the situation and subject to Owner approval.

Valves concealed behind ceiling systems and bulkhead panels and lining shall have rectangular label plates at the exposed side of the associated access panel in addition to the labels on the valves themselves. Valves located beneath grating or floor plates shall have a rectangular label plate secured to nearby structure above the grating/floor plates or on the access section so that they may be easily seen but out of the way of foot traffic or other potential cause of damage. These remote label plates shall provide information identical to that given on the valve's local label plate.

Provide labels identifying the service and/or space served for each remote valve operator, fill, discharge, and vent. Text for each label shall be deeply engraved on a 3/16in stainless steel plate label and continuously welded in place.

Provide and install a 5in × 8in oil waste discharge placard suitably photo-etched or epoxy painted on anodized aluminum. Placard shall be fixed adjacent to bilge pump control station in a conspicuous place and be in accordance with 33 CFR Part 155.450.

Fire Extinguishing Equipment

Each fire hydrant shall be marked in red letters, at least 2in high: "FIRE STATION NO. 1" (or "NO. 2," "NO. 3," etc).

Each hand portable fire extinguisher shall be marked with a number and stowage location, at least 1/2in high.

Fire axes and hoses, etc. shall bear the vessel's name.

All markings shall be engraved or phenolic plates unless otherwise approved by the Owner.

Instructions and Related Markings

Operating instructions and emergency procedures required to safely navigate and operate the vessel shall be provided including, but not limited to:

- Steering gear
- Emergency response systems (life raft and work skiff)
- Fire extinguishing systems operation (fire pump, fire monitor, clean agent system)
- Refueling
- Main propulsion light-off and securing
- Electrical power systems light-off, paralleling, and transfer (including ship/shore transfers and emergency transfers)

Operating instructions posted on the interior of the vessel shall be provided on laminated paper or semi-rigid plastic. Operating instructions posted in areas exposed to weather shall be provided on waterproof semi-rigid plastic.

These instructions shall also be provided electronically such that the Owner can modify the information if necessary and reprint if they become unserviceable. The Contractor shall prepare sample Operating Instructions for review by the Owner prior to producing the instructions and shall propose a mounting method to be used for displaying them.

602.5 Door, Hatch, and Manhole Markings

A label that identifies the compartment or space being accessed shall be provided on every door, hatch, and manhole cover. Door labels shall be affixed to the center of the outside of each door approximately 66in above deck. Labels shall be at least 1in tall stainless-steel with deeply engraved black lettering at least 1/2in tall; printed letters will not be accepted. Labels shall be permanently mounted using 3M 200MP adhesive tape, or equal.

602.6 Miscellaneous Markings and Signage

The following markings and signage shall be provided as directed by the Owner:

- No smoking signs
- Fire damper markings
- Embarkation direction signs to survival equipment
- Means-of-escape and egress
- Life jacket markings, donning, and use instructions
- Life jacket and immersion suit container/locker/stowage markings
- Immersion suit markings
- EPIRB markings
- Survival equipment markings and instructions

- Life ring buoy and buoyant apparatus markings
- Emergency exit markings
- Remote fuel shutoff stations
- Clean agent system operating instructions, schematic diagram and component markings
- Distress flare/smoke signal container(s)

603 Interior and Exterior Railings

603.1 Interior Railings

Interior grab rails shall be installed in passageways, stairwells, and as directed by the Owner. Interior grab rails shall use stainless steel satin finish 1 1/4in rail with stand-offs and smooth returns. Commercial grade grab rails may be used in lieu of fabricated pipe rails.

Railing shall remain unpainted.

603.2 Exterior Railings and Bulwarks

Locations of exterior railings are shown on Reference (B). Exterior railings mounted to steel structures shall be Sch 40 1 1/2in stainless steel pipe. Exterior railings mounted to aluminum structures shall be 1 1/2in sch 40 aluminum pipe.

Handrails on the upper deck, upper deck top, and bridge deck are notionally shown in Reference (E). Contractor may propose alternative railing details subject to approval by Owner.

Supports for vertical stanchions shall be aligned with underdeck structure. Stanchions shall be fitted at approximately 4ft intervals.

The top of the railing on the bulwarks shall be a minimum of 40in above deck.

Stainless steel railing shall remain unpainted.

622 Floor Plates

Floor plates, grating, steps, and short vertical ladders shall be provided in all compartments below deck for convenient access for operation and maintenance of all machinery, and safe access to escape ladders and stairs.

Floor plates shall be supported by a gridwork of 2-1/2in × 2-1/2in × 3/16in steel angles stood off the hull framing with the same. Floor plate boundaries shall be supported by inverted angle coamings. Floor plates shall be 1/4in aluminum with a raised anti-slip pattern, installed in panels that are no more than 6 square feet in size. In general, floor plates are to be secured to their support structure with countersunk stainless-steel Allen-head machine screws in each corner of each panel. The Contractor shall provide hinged floor plates with flush grabs where required for access to valves and any equipment under the floor plates that require inspection, maintenance, or manual operation. Floor plates at the base of ladders shall have grip tape to prevent slips.

In the thruster and bosun rooms the floor plates shall be provided as necessary to provide a walking surface throughout the space to all installed equipment and the void access hatch. In the void and engine room the floor plates shall extend to the fuel oil storage tanks and shall provide a walking surface to vertical ladders and all installed equipment. In the sStores workshop the floor plates shall extend to the non-tight voids and shall provide a walking surface that provides access to the stairs and all installed equipment. The height of the grating in all spaces shall be as shown on Reference (B).

623 Ladders and Stairways

623.1 General

The Contractor must detail and provide all required ladders and stairways. Ladders and stairs are generally shown on Reference (B).

623.2 Interior Ladders and Stairways

The Contractor shall detail, fabricate, and install a steel vertical ladder with non-skid rungs under the main deck in way of each hatch as shown on Reference (B). Each ladder shall be stood off the bulkhead such a distance that the top rung of the ladder is below the clear opening of the hatch.

The Contractor shall provide steel ladder rungs and hand holds in way of manhole openings for safe and convenient access to tanks. The Contractor to provide typical detail for Owner approval prior to fabricating.

The Contractor shall detail, fabricate, and install interior stairways to provide below deck access from the main deck to the stores workshop, bosun's locker, and thruster and bosun rooms as shown on Reference (B). Stairways shall be 28in minimum width and shall be of steel construction. Bolted, hot dip galvanized McNichols Quality Tread Type B (1in x 3/16in) serrated stair treads, or equal, are to be provided for all machinery space included ladders. Fit sheet metal dirt shields on the underside of the inclined ladders. Inclined access ladders shall be fitted with 1-1/4in NPS stainless steel pipe handrails. Stairs and handrails to the stores workshop, and thruster and bosun rooms shall be removeable without hot work.

The Contractor shall detail, fabricate, and install inclined stairways in the interior of the house to access each deck. Stairways shall be 30in minimum width and shall be fabricated plate style construction with non-skid rubber treads with nose.

623.3 Exterior Ladders and Stairways

The Contractor shall detail, fabricate, and install exterior ladders and stairways as shown on Reference (B). Stairways shall be 30in minimum width and shall be of steel construction. Bolted, galvanized McNichols PERF-O-GRIP stair treads, or equal, are to be provided for all exterior stairs.

Fabricated vertical ladders are to use 1in square bar, rotated 45°, for rungs. Where the ladder does not have integrated side rails, the square bar is to be U-shaped to prevent slips. When installed on a bulkhead, or flush vertical surface, rungs shall be a minimum of 5-1/4in away from the bulkhead to provide toe clearance. The clear opening between the ladder sides shall be a minimum of 18in. Rung spacing shall be a maximum of 12in.

Ladders to swim step and port side skiff access notch to be built inset in the hull, provided with stainless grip-strut plank steps and stainless 1 1/4in NPS pipe handrails.

625 Doors, Windows, and Hatches

Reference (B): 24065-200-101-1, Profiles and Arrangements
Reference (D): 24065-200-120-0, Hull Structure
Reference (E): 24065-200-150-0, Deck House Structure

The Contractor shall provide, and install the doors, windows, and hatches as shown in Reference (B). Prior to ordering any components, Contractor is to prepare a detailed schedule and arrangement of the doors, windows, and hatches and submit to the Owner for review and approval. Rough door and window

dimensions are provided in References (D) and (E) and shall be verified by Contractor. Any changes to the size, location, or specifications of any door or window shall be submitted to the Owner for review and approval.

625.1 Doors

General

The top of each door clear opening shall be 6' 8" above the finished deck. Door swing shall be as shown on Reference (B). Door hardware shall be heavy duty marine type, stainless steel with satin finish, unless otherwise specified. The Contractor shall ensure that hardware not specifically mentioned by the Specification or the Contract Guidance Drawings shall be of no less quality than that described herein. The Contractor shall ensure that all cutouts on doors and frames for hardware and locksets are done in accordance with the hardware manufacturer's instructions.

Doors shall be operable from both sides, complete with hardware, latches, locks, holdbacks, and doorstops, as required for the application. The Contractor shall prepare and submit a hardware list, along with manufacturer's drawings or catalogue sheets to the Owner for review prior to issuing a purchase order.

All locksets and door hardware shall have a satin chrome or stainless-steel finish, unless otherwise specified.

Doors requiring keyed locks shall have common keys. Contractor shall provide 6 keys. Keys shall be delivered to Owner. Keys shall be stamped "DO NOT DUPLICATE". Identify keys with the name of the vessel inscribed on a metal or plastic tag attached to the key.

All doors exposed to weather shall have the closers installed on the interior side. All closers shall have a "back-check" safety feature built in to slow the door when it reaches approximately 70° open. Closer covers shall have a stainless steel or satin chrome finish.

Details

- Watertight doors
  - The door between the main engine room and the workshop shall be a manual dogged watertight door Freeman 1212 series or equal
  - The door to the bosun/bow thruster compartment from the foredeck shall be a manual dogged watertight door Freeman 1212 series or equal
- Weathertight doors
  - All house exterior doors shall
    - Be weld-in weathertight Freeman 1120 series or equal
    - be equipped with minimum 12inx12in glazing
    - have a 6in sill
    - be keyed with the same key
  - The door from the mud room to the engine room shall be a gasketed weathertight door to reduce vapors and noise escaping the workshop
- Joinery doors
  - All stateroom, head, and interior pilothouse doors shall be
    - Compatible with the joinery systems
    - Equipped with a privacy lock
    - Equipped with a kick-out ventilation louver

- Norac N-MC series or equal
- At least 28in wide

625.2 Windows

General

All windows shall be thermal double-pane except those noted to be heated below. All glass shall be tempered and have a low-E coating.

All windows shall be fitted in compression glazed clamp-in type welded aluminum frames with an anodized finish and radiused corners. Window frame design shall allow for replacement of glass without removing the frame. Windows shall be installed in accordance with manufacturer guidance.

Manufacturers' drawings of all proposed windows shall be submitted to the Owner for review and approval prior to procurement.

- All windows to be Advantec 600 series or equal
- Windows in heads and staterooms shall be openable
- Pilothouse forward facing windows shall be heated and equipped with wipers.

625.3 Hatches

Flush quick-acting watertight hatches with stainless steel deck rings and compression stops shall be provided and installed in the main deck for egress from and access to the hull compartments as shown on Reference (B). Hatches shall be operable from both sides.

625.4 Manholes

The Contractor shall provide access to all integral tanks with raised, bolted 15in x 23in fabricated manhole covers and installed in accordance with the standards of ASTM Volume 01.07 F1142 and F1143. The manhole covers shall be fitted with round bar lifting handles and gaskets compatible with the tank contents. Grab bars shall be installed on two sides of each manhole opening.

Access to forepeak void shall be provided by flush 20in bolted hatch.

631 Painting

631.1 Scope

The vessel will operate in a demanding climate and the Owner requires an excellent paint job. Contractor is cautioned to read all portions of this Section and closely monitor and document Contractor’s preparation and painting efforts. Failure to comply with all this Section shall result in the vessel being re-blasted and re-painted at no cost to the Owner.

631.2 Preparation

Contractor shall prepare all surfaces prior to painting. Additional requirements on preparation protection, blasting hold times, inspection, documentation, etc. are described below.

Steel Surfaces in Way of Anti-fouling Paint and Unprimed Steel

Degrease to remove all oils and grease.

Blast to SSPC-SP-10.

Primed Steel Surfaces

Degrease to remove all oils and grease.

Blast welds and areas of rust and weld contamination to SSPC-SPC-6.

Brush off blast remaining areas to SSPC-SP-7.

Aluminum Surfaces to be Painted

Contractor shall blast aluminum surfaces with walnut shell blasting media to a profile of 1.5mil profile. Other, aluminum compatible, blasting material is not authorized without Owner approval.

Aluminum Surfaces Not Painted

No preparation required.

631.3 Painting

Contractor shall paint all steel surfaces in accordance with this Section and the paint schedule table in this Section, except: stainless steel and galvanized steel surfaces, any side or bottom surface inside a fuel or lube tank, and any surface inside a steel pipe. Otherwise all steel surfaces shall be coated, including: steel surfaces of explosion bonded bimetallic strip, pipes, ducts, foundations, mounting brackets, underside of all angles, and all welds.

Contractor shall paint all exterior aluminum surfaces of the house and stacks in accordance with this Section and the paint schedule table in this Section. Exterior aluminum handrails and interior aluminum surfaces shall not be painted.

Inaccessible voids shall be provided with drain plugs top and bottom and after pressure testing provided with a non-tar float coat system.

Additional requirements on painting protection, coating application, inspection, documentation, etc. are described below.

631.4 Paint Schedule Table

Table 8: Schedule of paint and markings

Paint and Markings Schedule

Item	Coating System	Layer #	Coat Type	Paint Type (Iternational Paint)	Color	WFT (mils)	DFT (mils)	Thinner (If Needed)	Notes
	.....Steel.....			.....Steel.....		.....Steel.....			
A	Primer	1	Full	Dimetcoat 302H			2	None	
B	Exterior Freeboard and Bulwarks	1	Full	Amercoat 240LT	Buff	7-8	5-6	Amercoat #65	
		2	Full	Amercoat 240LT	Gray	7-8	5-6	Amercoat #65	
		3	Full	Amershield VOC	Freeboard: 15055 blue Exterior Bulwarks: 15055 Interior Bulwarks: grey Interior Bulwarks Foscle dk: flat black Badge stripe: 71026 sky blue Stripe trim: 109-L metallic gold Names/draft Marks: White	3-4	2-3	Amercoat #65	Previous coat must be tacky, or mist coat applied. Colors are Federal Government 595, unless noted otherwise.
				Pitthane Ultra Polyurethane	Interior bulwarks Foscle DK: flat black Cap rail/guards: flat black				
C	Decks	1	Stripe	Amercoat 240LT	Gray	7-8	5-6	Amercoat #65	Perimeter of bulwark connection to main dk and at base of bulwark supports and both sides of house explosion bonded strip, including all welding.
		2	Full	Amercoat 240LT	Buff	7-8	5-6	Amercoat #65	
		3	Full Broadcast	480 Silica Sand					Broadcast sand into prior coat while still wet.
		4	Full	Amercoat 240LT	Gray	7-8	5-6	Amercoat #65	
		5	Full	Amershield VOC	Haze Gray	3-4	2-3	Amercoat #65	Previous coat must be tacky, or mist coat applied
				Pitthane Ultra Polyurethane	Foscle Deck: flat black		2-4		Previous coat must be tacky, or mist coat applied
D	Underwater Hull	1	Full	Amercoat 240LT	Buff	7-8	5-6	Amercoat #65	
		2	Full	Amercoat 240LT	Gray	7-8	5-6	Amercoat #65	
		3	Full	Amercoat ABC 3	Red	8.0	5.0	Amercoat T10	
		4	Full	Americaot ABC 3	Black	8.0	5.0	Amercoat T10	
E	Ballast Tanks, Voids, Machinery Spaces, Steel Pipes	1	Full	Amercoat 240LT	Buff	7-8	5-6	Amercoat #65	
		2	Stripe	Amercoat 240LT	Gray	7-8	5-6	Amercoat #65	
		3	Full	Amercoat 240LT	White	7-8	5-06	Amercoat #65	
F	N/A								
G	Mooring equipment, crane, davit, and high wear Surfaces	1	Full	Amercoat 240LT	Buff	7-8	5-6	Amercoat #65	Omit these two coats if equipment is OEM primed and epoxy coated.
		2	Full	Amercoat 240LT	Gray	7-8	5-6	Amercoat #65	
		3	Full	Pitthane Ultra Polyurethane	Flat black		2-4		
	..... Aluminum			..... Aluminum.....		..... Aluminum			
H	louse, Mast, and Stack	1	Full	Amercoat 240LT	Buff	7-8	5-6	Amercoat #65	
		2	Full	Amercoat 240LT	Gray	7-8	5-6	Amercoat #65	
		3	Full	Pitthane Ultra Polyurethane	House: White Mast: flat black		2-4		Previous coat must be tacky or mist coat applied
I	Decks	1	Full	Amercoat 240LT	Gray	7-8	5-6	Amercoat #65	
		2	Full Broadcast	480 Silica Sand					Broadcast silica sand to prior coat hile still wet.
		3	Full	Amercoat 240LT	Buff	7-8	5-6	Amercoat #65	
		4	Full	Amershield VOC	Haze Gray	3-4	2-3	Amercoat #65	Previous coat must be tacky or mist coat applied

631.5 General Preparation and Painting Requirements

The Contractor shall accomplish all required painting and paint preparations in accordance with the items in this Section.

Preparation and Coating of New Steel Prior to Shipment

All new steel shall be prepared to at least "near white" SSPC-SP-10 standard and coated with a two component, weld-through primer at the steel manufacturers' or suppliers' facilities prior to shipment to the Contractor's facility. Interplate Nippe Ceramo NQA997 pre-construction primer is the preferred primer. In this case, the pre-construction primer should be applied at 0.6-1.0 MDFT.

Prerequisites to Coating Application

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 Owner.

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.

Prior to any surface preparation or coating, all adjacent surfaces, fittings, ducts, wiring, components, equipment, etc. shall be fully protected to the satisfaction of the Owner. Protection shall be specifically provided for all bearings, shafts, stocks, transducers, keel coolers, zincs, and any other underwater appendages that may be damaged or affected by preparation or paint. Protection shall be provided for windows, doors, hinges/dogs, hoses, hydraulic fittings, and any machinery or electronic components on the exterior of the vessel that may be damaged or affected by preparation or paint. The Contractor shall protect all interior portions of the vessel at all times from blast grit, dust, and paint. The protection of ventilation systems shall be specifically addressed by the Contractor prior to preparation or painting.

Vessel equipment and sensitive surfaces shall typically be protected from blasting by first wrapping the items with a dust tight plastic layer and then sealing the items with a second layer of wood/rubber to prevent any ingress of blasting grit and damage. After completion of blasting, and during removal of protection, the protection shall be inspected by the Owner. If blasting grit penetrated the dust tight plastic layer, Contractor shall refurbish the equipment at no additional cost to the Owner.

Protection from sand blasting shall be inspected and approved by the Owner prior to blasting.

Steel Blast Duration

The Contractor shall have the paint manufacturer's local representative approve surface preparation and paint application methodology for hull and deck painting. Safe staging and adequate lighting shall be provided for inspection of surfaces and coating work.

Aluminum Blast Duration

During a multi-day aluminum blasting effort, no freshly blasted aluminum surface may be left for more than 48 hours without painting. Should freshly blasted aluminum be left for more than 48 hours, surfaces shall be re-blasted.

All welds and weld affected or burned areas not blasted shall be power ground to bare metal and prepared and painted in accordance with the paint schedule.

Any delays or damage to the vessel or its systems as a result of poor paint protection, shall be immediately corrected to "like new" status, at no cost to the Owner.

Requirements During Coating Application and Curing

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.

All products shall be applied, mixed, and thinned according to manufacturer's recommendations.

All surfaces shall be prepared according to published recommendations from the manufacturer. Coating application shall be completed in a professional workmanlike manner. All coatings shall be applied to clean, dry surfaces.

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. 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.

For each coat applied, the Contractor shall take readings and produce a record of the ambient, surface, and dew point temperature as measured 1) before starting the coat application, 2) upon completion of the application, and 3) for every 4 hours in between (if applicable to the coat). The Contractor shall also take wet and dry film thickness measurements during and following coating applications and maintain records that map these readings to the coated areas and indicate compliance or non-compliance with intended millage (for wet film) and required millage (for dry film).

All paint coats and required thickness of coatings shall be confirmed through spot checks in the presence of the Owner after each coat is applied.

The Contractor shall provide a copy of the temperature and wet film thickness records, including notations regarding compliance and non-compliance with requirements, to the Owner within 24 hours after the coating event. The Contractor shall provide a copy of the dry film thickness measurements, including notations regarding compliance and non-compliance with requirements, to the Owner and review the results with the Owner prior to application of the next coat. Timing between coats shall also be specifically addressed at this time.

Should the Contractor choose to paint hull structures or attachments which may be affected by condensation caused by the vessel being waterborne or another 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.

A copy of the paint manufacturer's preparation and applications guidelines applicable to each coating system shall be provided to the Owner prior to application of any coatings.

Paints applied to piping, machinery, and equipment that operates at temperatures over 120°F shall be of approved heat-resistant grades.

Correction of Damage from Paint Overspray and Grit Blasting

Any paint overspray applied to any of the equipment and surfaces shall be immediately and carefully removed.

Affected spaces and surfaces shall be cleaned free of grit and residue immediately after grit blasting.

Machinery, equipment and surfaces damaged, marred or contaminated shall be promptly repaired, replaced or cleaned to pre-existing condition at the Contractor's expense.

Inspection

The Owner shall be allowed to inspect all protection, preparation, and painting processes. Contractor shall provide a schedule of preparation and painting activities to the Owner, with sufficient advance notice to allow the Owner to travel to the vessel. Owner may delegate the preparation and painting inspection activities to other qualified individuals.

Documentation

Contractor shall maintain a current copy of the coating manufacturer’s preparation and application guidelines, on-site, for use by the paint crew and review by Owner.

Contractor shall maintain a paint application log. The log shall contain a clear record of the application of specific paint coats, coating thickness, detailed environmental information (dry bulb temperature, wet bulb temperature, precipitation, relative humidity), date and time and catalog numbers and colors. Paint application log shall be available for Owner review upon request and a copy of the log shall be provided to the Owner upon paint completion.

631.6 Paint Manufacturer and Technical Representative

To maintain paint type and color compatibility for maintenance in Juneau, Alaska, all paint, accelerators, and thinners used on this project shall be manufactured by the companies called out in the paint schedule table. The Contractor shall use the latest paint products and all stock utilized shall not be more than six months old.

Contractor shall obtain the services of a Pacific Northwest located manufacturer certified paint technical representative to confirm coating numbers and to oversee paint application procedures. Technical representative shall confer with Owner prior to any coating application.

Suggested technical representative is:

Mr. Kurt Mensing, Pittsburgh Paints/Ameron Coatings, (206) 595-6095

Suggested contact for topcoat color and compatibility:

Mr. Charlie Williams, Valley Paint Center, (907) 789-9875

631.7 Piping, Machinery, and Electrical

Piping

All steel piping shall be prepared and coated in accordance with the paint schedule table. In general, final piping coat and color shall match the paint requirements for the area through which the piping passes or is installed. Paint rigid pipe insulations as described herein for piping. Do not paint insulation blankets.

Pipes shall be marked in accordance with Section 602.

Do not paint flexible hoses, hose sleeves, and flexible connections. Mask all electrical cable to prevent coating and overspray. Flexible hoses, hose sleeves, and flexible connections with paint or overspray shall be rejected and require replacement.

Machinery

New machinery and equipment in non-weather spaces shall retain the coating supplied by the factory, provided the coat is a finish coat, and shall not be further coated to match the above paint schemes. Where machinery coating is damaged during construction, carefully feather the edges and paint to match factory coating. Equipment that is delivered with only a factory-applied primer coat shall be coated with two coats of high performance, self-priming surface tolerant epoxy, per the paint schedule table.

Contractor shall paint deck machinery and equipment installed in the weather or in exterior spaces in accordance with the paint schedule table to the satisfaction of the Owner, or Contractor may require machinery vendor to provide a paint system compatible with the paint schedule table.

Electrical

In general, do not paint cable or other electrical components unless as part of manufacturer provided installation procedure.

Repair of Damaged Coatings

Where any coating has been damaged by welding, burning, or any other cause, the damaged area shall be repaired by abrasive blasting or power tool cleaning, degreased, and cleaned as needed, and a full coating system applied in way of the damage. Care shall be exercised that the edges are feathered and that no sanding swirls or other marks will remain after the final coat is applied. Colors shall match the adjacent pre-existing coatings.

631.8 Boot Stripe and Hull Markings

The Contractor shall provide a paint line at 6in above deep load waterline shall be marked the length of the hull on both sides at intervals of 3ft with 1/8in weld beads 2in long for guidance in repainting bottom.

The Contractor shall submit a hull marking and docking plan as described in Section 810.5. In addition to the layout of hull markings required on that plan, the Contractor shall submit a layout of the vessel name, stripe, Trooper decal, and hailing port as described in Section 603.1. Hull markings shall be outlined in punch marks except where plate letters and numbers are used. Owner must verify and approve of all hull markings prior to paint or decal application.

633 Cathodic Protection

Sacrificial zinc anodes shall be provided by the Contractor and installed on the hull bottom, sides, and skeg. Anodes shall be 6in x 12in bolt through with SS studs welded to the hull. The quantity (N) and distribution of the anodes shall be calculated (using N=6.5 times area divided by 1,000) and submitted to the Owner for review. Assume 20 anodes for bidding purposes. The anodes shall be electrically bonded to the structure, and their location should consider future drydocking and maintenance.

See Section 256 of this Specification for cathodic protection of the grid coolers. See Section 243 for cathodic protection of the shaft and propeller. See section 562.3 for cathodic protection on the bow thruster.

635 Insulation

The Contractor shall insulate the vessel in accordance with this section.

To furthest extent possible, the Contractor shall plan routing of mechanical and electrical systems to allow adequate room to install, inspect, and maintain insulation systems. Insulation shall not be installed to conceal wireways, piping, and other vessels systems.

635.1 Areas to be Insulated

Engine Room, Stores Workshop, Steering Gear Room

The Contractor shall insulate the following areas using the Steel Hull Insulation materials and methods (see Section 635.2).

- Underside of main deck between frames 13 and 27, excluding wing tanks, including NT voids
- Underside of the main deck between frames 6 and 13, under house
- Underside of main deck between frames 3 and 6, under house

Insulation shall be placed between plate support structure; frames/girders/stiffeners within 12 inches of plate shall be wrapped.

Exterior House Surfaces

The Contractor shall insulate the following bulkheads and decks of the house using the Aluminum Thermal Insulation materials and methods (see Section 635.2).

- Interior side of all exterior bulkheads
- All stack bulkheads

Any aluminum house surface that is common to the engine room (such as the uptake) shall receive mineral wool insulation and a Myler sheathing instead of fiberglass to improve fire protection and noise. Insulation shall be placed between stiffeners and girders; interior stiffeners and girders shall not be wrapped, except in way of aluminum areas common to the engine room and engine room air intake and exhaust. Exterior stiffeners and girders shall be wrapped.

Interior House Surfaces

The Contractor shall insulate the following bulkheads and decks of the house using the Interior Acoustical Insulation materials and methods.

- Interior bulkheads enclosing all staterooms, unless otherwise insulated

635.2 Insulation Materials and Methods

Steel Hull Insulation

The Contractor shall use the following materials for all steel hull insulation:

- Steel welding pins with speed clips
- 1 layer of 5.5 lb/ft^3 mineral wool at 2in thick with a mylar facing, on plate
- 1 layer of 2.75 lb/ft^3 mineral wool at 1in thick with a mylar facing, on stiffeners/frames/girders

Steel welding pins on which insulation will be impaled shall be installed with spacings of not over 16in on bulkheads and 9in on overheads and shall be a maximum of 4in from the edges of the insulation. Steel surfaces shall be painted in accordance with Section 631 after installation of pins, but prior to insulating.

Insulation shall be impaled on the steel welding pins and secured with speed clips, which are to be brought even with the insulation surfaces without depressing or cutting the insulation.

At intersection with non-insulated bulkheads, the insulation shall be extended 12in onto the uninsulated bulkhead.

All seams shall be sealed with fiberglass cloth strips or with minimum 2in-wide fibrous glass tape as recommended by the manufacturer. All cut and exposed edges shall be taped and sealed and a suitable sealer applied. Insulation facing and taping shall form a continuous vapor barrier between the inside of the vessel and any exterior steel surface.

Aluminum Thermal Insulation

The Contractor shall use the following materials for all aluminum thermal insulation:

- Aluminum welding pins with aluminum speed clips
- Johns Manville 800 series spin-glass fiberglass rigid board insulation
  - For exterior bulkheads, use:
    - 1 layer at 2in thickness with Ultra facing
    - 1 layer 1in flexible glass batt
  - For underside of decks, use:
    - 1 layer at 1-1/2in thickness with no facing and
    - 1 layer at 3in thickness with Ultra facing

Aluminum welding pins on which the insulation will be impaled shall be installed with spacing of not over 24in on bulkheads and 12in on overheads and shall be a maximum of 4in from the edges of the insulation.

Insulation shall be impaled on the aluminum welding pins and secured with speed clips, which are to be brought even with the insulation surfaces without depressing or cutting the insulation. Bi-metallic pins are not acceptable.

At intersections with non-insulated bulkheads, the insulation shall be extended 12in onto the uninsulated bulkhead.

All seams and exposed edges (including seams between structure and insulation) shall be sealed with ASJ tape (as recommended by the manufacturer) to form a continuous vapor barrier between the inside of the vessel and any exterior aluminum surface.

Interior Acoustical Insulation

The Contractor shall use the following materials for all interior acoustical insulation:

- Johns Manville 800 series spin-glass fiberglass rigid board insulation
  - For interior structural bulkheads, use:
    - 1 layer at 1 1/2in thickness, with no facing, between aluminum structure
    - 1 layer at 1 1/2in thickness, with no facing, in joiner framing spaces
  - For joiner bulkhead, use:
    - Fill interstitial space, if applicable, with fiberglass insulation

- For sandwich board joiner construction, other insulation materials may be acceptable subject to Owner approval

Insulation shall be installed between the aluminum stiffeners or between joiner framing without depressing the insulation. Joiner shall be installed directly over the insulation with no vapor barrier.

637 Sheathing

Reference (B): 24065-200-101-1, Profiles and Arrangements

The arrangement of the house is shown in Reference (B), however house outfitting details are not provided. The Contractor shall design, supply, and install all house sheathing.

637.1 Design

The Contractor shall develop final design solutions and related details and identify and provide the necessary planning to outfit the house of the vessel so that the vessel will meet its mission requirements and be approved by the Owner.

It is the Contractor's responsibility to verify quantities and dimensions; provide additional details, working drawings, color selection, and sketches, and obtain approval of working drawings from the Owner.

The Contractor shall submit Contractor design information to the Owner for approval, prior to ordering material or beginning construction. The Owner will not accept any element of the Contractor's design that fails to meet contract document requirements, such as the design requirements in this section, or which compromises the ability of the completed vessel to perform its intended service.

Contractor design information can be informal, such as sketches, marked up photos from sample vessels, subcontractor information, and color chips, so long as the Owner can determine what the Contractor intends to do and if it meets the terms of the contract.

637.2 Materials

Joinery Systems

In general, interior walls and joiner systems shall be of good commercial marine quality for tug boats and other high quality work boats. Non-bearing interior walls may be framed or furred with wood; however, the Contractor is encouraged to consider joinery panels such as Norac wall systems for improved noise control and constructability. Joiner panels shall be fire resistant to the best extent possible. Joiner systems shall be designed to contain the insulation required in Section 635 and any necessary wiring and plumbing. Joiner system shall be designed and selected to provide noise mitigation between spaces. Joiner systems shall be installed without cracks or bends and shall not move or rattle when the vessel is in a seaway. Hard corners in panel openings shall be stress relieved with radius corners. Final installation of joiner systems shall appear clean and professional and shall be designed to stay looking good with a minimum of cleaning and maintenance.

Floor Coverings

The Contractor shall provide floor coverings for all interior floors. Selected matting shall be submitted to the Owner for approval prior to purchase. The Contractor shall make every attempt to flatten construction deformation in floor structure to minimize the quantity of floor leveling compound needed. Before any deck covering is installed, the decks shall be free of rust, grease, oil, scale, loose paint, and

other extraneous matter. Attachments to, and penetrations of, the structure to be covered shall be complete and the structure tested, as required, before applying coverings.

Coverings of floors in wet spaces (heads and mudroom) shall be poured epoxy, such as Dexotex. Flooring system in wet spaces shall utilize a cove height of 4-6in to prevent water from wicking into the joinery system or the insulation behind it. Floor coatings in other spaces shall be proposed by the Contractor for Owner approval. The interior stairs between the main deck and the upper deck shall have non-skid rubber treads with nose. Staterooms and pilothouse shall have marine grade glue-down carpet tile. All floor coverings shall be applied in accordance with manufacturer's recommendations.

The Contractor shall provide a 36in wide mat in front of the switchboard of length to match the full length of the switchboard. Matting shall meet the requirements of ASTM D-178 and Mil Spec M-15562F.

Ceilings

The Contractor shall provide ceiling systems for all spaces in the house (main deck and upper deck) and wheelhouse. The ceiling system above the main deck shall be easily and fully removable to access the wiring and fixtures beneath the upper deck, similar to a drop or locking channel ceiling. The ceiling system in the wheelhouse overhead shall be painted matte black (nonreflecting), and have separate, dedicated panels over cable runs. Panels over cable runs shall have machine type fasteners suitable for multiple cycles of removal and replacement. In general, ceiling systems shall be non-flammable. Ceiling systems shall be marine grade and not rattle, move, or drop dust while the vessel is moving in a seaway.

638 Furnishings and Fixtures

Reference (B): 24065-200-101-1, Profiles and Arrangements

This section provides guidance on the Owner's preferred furnishings and fixtures. Unless otherwise noted, materials specified may be substituted for equal alternatives subject to the requirements of Section 044. The arrangement of the house is shown in Reference (B), however not all house furnishing details are provided. The Contractor shall select, supply, and install all house furnishings.

All equipment shall be good residential grade and readily replaceable in Juneau, Alaska. Equipment cutsheets shall be provided to the Owner for review and approval prior to purchase.

638.1 Galley

The galley is to be provided with the following equipment and features:

- 30in electric convection range with air fry
  - 4 or 5 burners
  - Slide In
  - Fingerprint resistant stainless steel
  - Sea rail
- Stainless steel hood above the range
- 33in drop-in workstation, 16 gauge stainless steel deep single bow kitchen sink with the following accessories:
  - Heavy-duty wood composite cutting board
  - Roll-up dish drying rack
  - Protective stainless steel bottom grid
  - Drain assembly
  - Decorative drain cover

- 1.15 GPM wall-mounted pre-rinse faucet with 8in centers and 8in add-on faucet similar to Regency item number 600PRW88.
- Side-by-side refrigerator/freezer
  - Minimum capacity 27 cubic feet
  - Fingerprint resistant stainless steel
  - Energy star rated
  - Counter depth
  - LED lighting
  - Two humidity-controlled full width drawers
- Microwave
  - Minimum 1.7 cubic foot capacity
  - Stainless steel
  - Air fry and convection capabilities
  - Sensor cooking controls to automatically adjust time and power
- Marine/commercial grade stainless steel cabinetry for storing standard compliment of cookware and tableware

638.2 Pantry

The pantry is to be provided with the following equipment and features:

- Shelving with doors with sufficient capacity to store enough food for 5 crew for 10 days
  - Shelving and cabinets shall match galley cabinets and mess bench
- Side-by-side refrigerator/freezer
  - Minimum capacity 27 cubic feet
  - Fingerprint resistant stainless steel
  - Energy star rated
  - Counter depth

638.3 Mess

The mess shall be provided with:

- Bench seating for at least 8 people
- Bean to cup coffee machine
  - Capable of being mounted
  - Integrated grinder
  - Automatic dosing and tamping
  - Adjustable grind and strength settings
  - Lockable bean container and water tank
  - Milk frothing system
- Cabinet for coffee/tea storage
- Bulkhead-mounted 55-65in TV

638.4 Heads

Each head shall be provided with:

- Elongated floor-mount flushometer valve and toilet with seat
  - Suitable for use with saltwater flushing system.
- Wall-mounted stainless steel bathroom sink plumbed with hot and cold water

- Medicine cabinet with mirror
- Hand towel ring
- Two bath towel bars
- Two hooks mounted to back of door
- Bathroom storage cabinet over toilet
- Fiberglass shower

638.5 Mudroom

The mudroom shall be provided with:

- 8 x Hallowell, HERL442-1B-G-HG, wardrobe locker, 24in x 24in x 90in, steel, 5 shelves, and a foot locker
- Williams Direct Dryers, W12, wall mounted 12 pr boot dryer or as fits the space (minimum three pair boots and gloves)
- Stacked LG 4.5 cubic foot graphite steel front load washer and 7.4 cubic foot dryer set. Set shall include:
  - LG Washer Model WM3400CV
  - LG Dryer Model DLE3400V
  - Stacking kit

638.6 Pilothouse

The pilothouse shall be provided with:

- 2 x Llebroc Tradewinds CX High Back Series 2 Helm Chair
  - Material and color shall be as directed by the Owner
  - Shall include manual pump lumbar back support

Each chair shall be fitted with the following:

- Llebroc Elite aluminum gas adjustable pedestal
  - Size and finish shall be as directed by the Owner
- Llebroc Mariner 2 Slider with internal swivel mechanism
  - Finish and slider type shall be as directed by the Owner
- Llebrox Tradewinds EZ Adjustable footrest
  - Finish shall be as directed by the Owner
- Llebrox Floor Slider (optional, dependent on final wheelhouse arrangement)
  - Recessed mount
  - Size shall be as directed by the Owner

The layout and design of the pilothouse console and overhead equipment areas shall be developed in coordination with the Owner. The intent is an end product with ready accessibility to all components mounted within. The console shall feature a combination of full height opening doors or lift off panels and hinged or lift off top panels to permit ready access to interior components. In way of access doors or panels, toe kick boards shall be attached to the doors or panels, easily removable, or omitted to provide continuous flat deck access to the console interior.

Equipment layout shall be developed in coordination with the Owner to create an ergonomic installation. User interfaces shall prioritize more commonly used equipment in nearer proximity and line of sight from the helm positions than less commonly used equipment. Remote pump controls and run indicators

for various systems with pilothouse control shall be grouped together, arranged, and labeled in a logical fashion.

The Contractor shall build a full-scale physical mockup of the console to confirm final component configuration with the Owner. The mockup shall include accurate angles of the console surfaces and three-dimensional representations of any components which project greater than 1in from the console surfaces. Placement of window mullions shall be represented on the mockup.

To the extent practical, minimize the quantity of components and wire connections located within the pilothouse control console. Preference shall be given to locating equipment in the crawl space below the pilothouse where ergonomic access is simplified.

If electrical or electronic components are mounted on the console face, those face panels shall be hinge mounted to allow opening of the panel by at least 120° to allow access to wiring connections. In this installation, suitable wire loops shall be provided to allow opening of the panels.

Include a settee in the port aft corner of the pilothouse. Settee shall include cushioned and upholstered seat and back, and interior shall be utilized for storage, HVAC routing, or other productive use. Build the settee at a height to allow a seated person a navigational view forward.

638.7 Staterooms

The Contractor is to equip all staterooms with:

- Double bunks sized for and equipped with twin XL mattresses
  - Upper bunks to be fold down so that they may be stowed when not in use
    - Upper bunk weight limit must be 300lbs or higher
  - Minimum head clearance is 2.5ft
- Two hanging lockers
  - Lockers should match the make and quality of the cabinets in the galley
- Storage drawers under the lower bunk
- Black out curtains

Master's stateroom to also be equipped with a small desk and desk chair.

638.8 Stores Workshop

The equipment shall be able to fit down the stairs to the stores workshop area. The Contractor is to provide and install the following in the stores workshop:

- Two upright freezers
  - Minimum 20 cubic foot capacity
  - Frost free
  - Fingerprint resistant
  - Audible temperature alarm
  - Slide-out freezer bin
  - Turbo freeze
  - LED interior lighting
  - Lock with key
  - Exterior electronic temperature control
- One 873 piece MEGAMOD model MEGAMOD873 mechanics tool set with storage

- Workbench similar to One Badass Industries 3BAYSDCA-Block 3 Bay SD Workbench, alternatively the Contractor may purchase and install the referenced table. The workbench shall be outfitted with
  - One Wilton model 1780 A reversible, heavy duty, combination vise
  - One Grizzly G7945 34in benchtop radial drill press
  - One Jet Tool JGB-8W shop grinder with griding wheel and wire wheel
- Shelving on the starboard side of the stairs as directed by the Owner

638.9 Starboard Side Aft Deck

The Contractor is to fabricate and install a 4ft minimum length fold up fish cleaning table with slotted drains. Table shall be mounted to the bulwark aft and shall not prevent access to mooring gear. The table shall be capable of being fully secured when folded up and sturdy when in use. The tabletop shall have replaceable UV resistant UHMW or similar appropriate cuttingsurface, installed. Proposed arrangement subject to Owner approval.

681 Fire and Safety Equipment

Reference (C): 24065-200-101-2 Fire and Safety Plan

At minimum, the Contractor shall provide and install the fire and safety equipment as identified and located in Reference (C) and as required by applicable rules and regulations [1].

The Contractor-provided USCG-approved portable fire extinguishers shall be tagged with the date of the initial inspection conducted by a qualified service representative.

Group 800 – Management and Engineering

810 Engineering and Working Drawings, Calculations, Review

810.1 General Review Process

The Contract Documents describe the functional, performance, and technical requirements applicable to the vessel's construction, without benefit of knowing the Contractor's production methods and detailed layout plans. The Contractor shall develop final design solutions and related details and identify and provide the necessary planning to construct the vessel so it will meet its mission requirements (as stated in section 011.2) to the satisfaction of the Owner.

It is the Contractor's responsibility to verify quantities and dimensions; provide additional details, working drawings, and sketches, and to obtain the approval of working drawings from the Owner.

While the majority of the vessel is defined by the Technical Specifications and Contract Design, some portions of the vessel construction work will require the Contractor to design, or finish the design, of some vessel components. The Contractor shall at its expense produce and/or provide any further plans, drawings, and technical services not contained within or provided with the Contract Documents, but otherwise necessary to construct, complete, launch, test, trial, and deliver the vessel to the Owner; all such items shall be deemed included within the scope of work. The Contractor shall conduct all required design elements, in accordance with the Contract Documents, and as necessary to successfully complete this project.

The Contractor shall submit Contract Design information to the Owner for approval, prior to ordering material or beginning construction. The Owner will not accept any element of the Contractor's design

that fails to meet contract design requirements, or which compromises the ability of the completed vessel to perform its intended service.

The Contractor design information can be informal, such as sketches, marked up photos, and subcontractor information, as long as the Owner can determine what the Contractor intends to do and if it meets the terms of the agreement and Contract Design.

If the Contractor desires engineering input or review of the Contractor proposed designs, the Contractor may require engineering assistance from the Owner upon written request.

The Owner will review the Contractor's detailed design to determine compliance with this Specification, Contract Plans, and Contract. The Owner's review will not relieve the Contractor of responsibility for deviations from the Specification or Contract Plans unless the Contractor has, in writing, called attention to the deviation, and received approval in writing from the Owner, at the time of drawing submittal.

If the Contractor develops a 3D production model of the vessel, the Contractor shall provide a viewable, digital version of the 3D production model for Owner reference at regular (at least monthly during lofting phase) intervals during development and in its final state.

Owner approval of a deviation from the Specification will not relieve the Contractor of the responsibility for satisfactory operation of the system or equipment. Work performed by the Contractor prior to the Owner's review and approval of the Contractor's drawings will be at the Contractor's risk.

810.2 As-Built Drawings

The Contractor shall update all contract documents and other drawings identified in Section 000.0 to an as-built condition and stamp "AS-BUILT FINAL" in the title block. The final drawings shall reflect systems and arrangements of the vessel as finally completed and approved.

The Contractor shall develop the following as-built documents:

A cable schedule, identifying each electrical cable aboard the vessel. The cable schedule shall be coordinated with the cable labeling effort described in section 602.4 and the cable installation planning effort described in section 312. The schedule shall list each cable, cable name as listed on cable labels, cable type (conductor size and quantity, manufacturer, part number, jacket material, UL, ASTM, or IEEE construction standard), end locations, and description of cable function if not obvious. The aforementioned cable parameters may be listed directly in the cable schedule or may be referenced to as-built drawings, vendor provided drawings, cable catalogs, cut sheets, or other documents. The Contractor shall ensure all referenced documents are included within the technical data package provided from the Contractor to the Owner. Provide the cable schedule both as a .pdf document and as an editable document for lifecycle vessel support.

A wiring diagram of the fixed fire suppression shut down system. Include power sources, button and relay locations, relay configuration, wiring connections, cable identification, and controlled equipment. See section 555.1 for system requirements.

No later than four weeks prior to the Contract Performance Survey, the Contractor shall deliver as-built drawings to the Owner for review. These shall be provided as three sets in paper format and in electronic format with files in both native AutoCAD or Rhino (.dwg/.3dm) and PDF file format to the Owner.

810.3 Vendor System Diagrams

All vendor supplied systems are to include system diagrams (mechanical, piping and electrical) providing ship specific system configurations. Wiring and cabling diagrams shall include the cable type and unique

designations for each cable. As-built versions of these diagrams shall be provided by the Contractor prior to sea trials for review by the Owner.

810.4 Display Drawings for Mounting Onboard

One laminated color copy each of the as-built Fire and Safety Plan shall be provided for ready reference during emergencies. One storage tube made of PVC, with chained cap, shall be installed on the vessel to hold the set of laminated plans. One tube shall be bulkhead-mounted on the port side main deck near the boarding gate. Final tube location shall be approved by the Owner prior to installation.

810.5 Hull Marking and Docking Plan

The Contractor shall provide a hull marking and docking plan which will be used by the Owner when dry docking the vessel. This plan shall include locations of propellers, drain plugs, sea chests, keel coolers, anodes, over boards and through-hull appurtenances such as depth transducer and draft marks. A primary and secondary block arrangement shall be shown. Keel and bilge block size and locations shall be shown, including the required keel block height, minimum block contact area for all blocks, and keel block loads at full fuel load displacement. Cross sections of the hull, with views of the bilge keels, shall be shown in way of bilge blocks to facilitate their construction. Locations of all items shall be with dimensions to physical common reference points. All overboard and hull projections, and vessel particulars such as major dimensions, tank capacities, draft and lightship weight shall also be provided on this plan. The plan shall be submitted to the Owner for approval.

835 Tonnage Admeasurement

If tonnage admeasurement is required, it will be addressed by change order.

843 Stability

843.1 Stability Test

The Contractor shall be responsible for conducting a stability test in accordance with the requirements and procedures of the current revisions of ASTM F1321-14, Standard Guide for Conducting a Stability Test (Lightweight Survey and Inclining Experiment) to determine the lightweight displacement and centers of gravity of the vessel to the satisfaction of the Owner. The Contractor shall be responsible for all equipment, inclining weights, measures, cranes, and services.

The Contractor shall be responsible for planning and scheduling the inclining experiment and obtaining approval of its proposed procedures from the Owner. Prior to conducting the stability test, the Contractor shall prepare and submit to the Owner for approval a stability test procedure. The Contractor shall notify the Owner, of the date of the inclining experiment at least thirty days in advance.

At the time the stability test is conducted, the vessel shall be afloat at the Contractor's dock and fully complete, with all systems functional. Appropriate tankage for the test shall be confirmed with the Naval Architect. The Owner and the Naval Architect's representatives shall witness the inclining experiment.

Using the results of the stability test, the Contractor shall prepare a stability test report and establish the vessel's light ship weight and center of gravity. The stability test report shall be submitted to the Owner for review.

843.2 Stability Assessment and Documentation

The Owner intends to prepare their own stability assessment based on the results of the stability test report.

843.3 Permanent Ballast

The vessel shall be delivered with less than 0.5° of inherent list in the lightship condition, no more than 6in of bow down trim (measured over waterline length), and shall have enough aft draft in all loading conditions to maintain sufficient propeller immersion. The departure condition is assumed to be with fuel tanks loaded to 95%, freshwater tanks at 100%, sewage tank empty, and other tanks at operating conditions. In this condition, the crab pot retrieval davit and launch table shall be installed and all davits stowed in their stowed positions.

Contractor shall work with Owner to forecast final heel and trim using the weight estimating process described in Section 093.

Permanent ballast, in the form of lead ingots may be used to correct trim issues. Where required, ingots must be installed in structural containers designed to prevent shifting of weights in accordance with USCG requirements for passenger vessels. Detailed documentation of weight quantity and location shall be provided in the stability assessment.

851 Training

Introductory training shall be provided by the Contractor to the Owner operators. Contractor shall procure the services of qualified technical representatives for each major equipment vendor to conduct the training. For example, a main engine technical service representative shall conduct the main engine training. The training shall provide an overview of the operation of the vessel, its equipment, and systems. The training shall include start up procedures, operating procedures, and shutdown procedures. The training shall include personnel safety procedures. The training shall also include basic maintenance and trouble-shooting procedures and good practice. Training shall be conducted onboard at a time during the contract agreed upon with the Owner. The Contractor shall assume a total of up to 16 hours of instruction time, scheduled to accommodate Owner crew schedule.

856 Installation Instructions, Operating Manuals, and Parts Lists

The Contractor shall obtain from the manufacturer, installation instructions, parts lists, and operating manuals for all machinery, equipment, and systems provided by the Contractor for the vessel. In the case such documentation cannot be obtained from the manufacturer, the Contractor shall develop this documentation. The combination of these documents shall provide complete installation, maintenance, operating, parts lists, troubleshooting, and repair instructions and parts lists in sufficient detail for the operating personnel to operate, maintain, and repair all equipment. The parts lists shall be complete with the parts described so that required spare repair parts may be easily identified and ordered by the operating personnel.

The Contractor shall submit to the Owner for review and approval, a complete draft set of instructions, manuals, parts lists, and data sheets no later than two weeks prior to the Contract Performance Survey. Receipt and approval of a final set of documents will be a prerequisite for substantial completion.

The Contractor shall not use operating manuals intended for final delivery to the Owner as working manuals for use in installing and operating the equipment. If the Contractor requires this information,

then additional information must be ordered for that use with the attendant cost borne by the Contractor. Instruction manuals and books clearly showing misuse shall not be accepted.

Items that are merely advertisements shall not be included in the books.

Each instruction book will be complete with factory or manufacturer original information. The cost incurred from the purchase of original manufacturer manuals shall be borne by the Contractor.

Instruction books shall contain information at least equivalent to that available to mechanics at an authorized overhaul facility of the manufacturer of the machinery or equipment covered. Omission of information due to reasons such as "not normally furnished by the manufacturer" or "factory only" are not acceptable.

The Contractor shall deliver two hard copies of all instruction, manuals, and parts lists, in a format approved by the Owner. Additionally, the Contractor shall furnish a legible and searchable combined PDF file of the furnished information.

Group 900 – Shipyard Contract Services

857 Tests and Trials

The Contractor shall develop and conduct a testing program to demonstrate the installation, capability, operation, and performance of all ship systems, and to prove compliance with the Specification, Contract Plans, to the satisfaction of the owner.

The Contractor shall develop a complete testing and trials plan and schedule not less than 120 days prior to the commencement of any testing. The Contractor shall develop, and submit for Owner review and acceptance, a test plan indicating the tests to be performed and test procedures for use during testing. Test procedures shall include descriptions of tested item, test method, pass/fail criteria, and measured or observed results. Test date, personnel, instrumentation, and instrumentation calibration or certification as applicable shall also be listed.

Tests that are not completed successfully, do not meet manufacturer or supplier specifications, or do not pass the criteria delineated within this Specification or test procedure on the first attempt shall be repeated until such deficiencies are cleared. Record the date of each test, testing deficiencies, and corrections made for each test through satisfactory completion of each test. All shop tests, ship installation tests, and trial tests shall be scheduled and completed to the satisfaction of the Owner and Regulatory Bodies.

Presence at and witnessing of tests by the Owner shall in no way relieve the Contractor of their full responsibility to successfully complete and document all testing.

The Contractor shall prepare and submit test procedures containing complete results of each test to the Owner for approval. Legible, easily readable scanned PDF files of each completed test memorandum, test report, and trials report shall be submitted to the Owner.

The Contractor shall bear all expenses, be responsible for pilotage, furnish the crew, fuel, water, lubricating oil, all other consumables, special instruments, and supplies required for all tests and for all trials. Where required, the Contractor shall hire specialist subcontractors, or field service representatives, and/or utilize such additional equipment as necessary to accomplish the objectives of system testing at no additional cost to the Owner.

The Contractor shall ensure that manufacturer's technical representatives attend commissioning, testing, and trials for major equipment and systems, including:

- Generator sets
- Propulsion engines
- Ship service switchboard
- Propulsion controls
- Steering and steering controls
- Navigation and communication equipment
- Bow thruster
- Crane
- Auxiliary equipment HPUs and hydraulic systems
- Anchoring equipment
- Boiler and hydronic system
- HVAC cooling system

Testing shall occur in the following sequence:

1. Installation Tests and Inspections Including
    a. Hull Tests
    b. Machinery Tests
    c. Electrical Tests
    d. Propulsion Machinery Tests
2. Operational Tests
3. Dock and Builder's Trials
4. Sea Trials (Contract Performance Trials)

857.1 Hull Tests

The purpose of hull tests is to demonstrate the watertightness and fairness of the structure and fittings. It is further intended that the Contractor demonstrate the satisfactory installation and operation, where applicable, of all items of outfit.

Structure

The hull, watertight bulkheads, main deck, superstructure, and watertight closures shall be air box or air jet tested to prove tight all exterior surfaces. All watertight tests shall be performed prior to paint out.

Integrated Fuel Tanks

The integrated fuel tanks shall be hydrostatically tested to a pressure of 5psig. The tests shall be made after air pipes, sounding tubes, and all other connections have been fitted but prior to paint out.

Doors, Scuttles, Manholes, and Closures

Doors, scuttles, manholes, and similar closures which are gasketed shall be chalk tested to prove full gasket contact. Visually inspect other doors, scuttles, manholes, and closures to demonstrate proper workmanship and operation.

Windows and Fixed Lights

Windows and fixed lights shall be hose tested in conjunction with the testing of the adjacent plating. Hose testing shall be accomplished by directing a stream of fresh water against the structure at a

pressure of not less than 30 psig from a minimum 1/2in inside diameter nozzle held at a distance of 5ft from the structure.

857.2 Machinery Tests

The Contractor shall test machinery, equipment, piping, and systems according to the following procedures:

Heating and Ventilation

Test the electrical circuits of the fans.

Balance and test each system to ensure delivery of designed air quantities. Before testing and balancing, the following conditions shall exist:

- Systems shall be clean
- Normally open closures and dampers shall be open
- Fans and motors shall run in the proper direction of rotation with correct speed

Operate each system at full design capacity and measure air flow and sound levels throughout the system.

Operate all ventilation system weather closures and fire dampers to demonstrate free operation without binding.

Test to confirm the proper operation of all heating, ventilation, and cooling control systems for all spaces to the satisfaction of the system supplier(s) and the Owner. Ensure the ventilation shutdowns operate properly. Fans and dampers that are interlocked with fixed fire extinguishing systems shall use acceptable methods to simulate actuation of system release.

Piping

After installation onboard but prior to operation the vessel's vital piping systems shall be hydrostatically tested:

- Fuel system
- Fire main
- Clean agent
- Bilge system
- Steering system
- Propulsion system and its necessary auxiliaries and controls
- Ship service and emergency electrical generation systems and its necessary auxiliaries.

Test pressures and test fluids for piping systems shall be in accordance with Table 9. Pressure shall be maintained long enough to check thoroughly for leaks. The Contractor shall retest after any leaks have been repaired to prove each system tight. Vents must be provided at all high points of the piping subassembly or system in the position in which the test is to be conducted to purge air pockets while the component or system is filling.

The test of each system shall be recorded on the appropriate test procedure.

Pipe segments may be painted after successful completion of hydrostatic testing. Untested segments shall be left unpainted and un-insulated until successful completion of all installation and operational testing procedures.

Pneumatic testing in lieu of hydrostatic tests is only acceptable when approved by the Owner.

After hydrostatic testing, each piping system shall be thoroughly cleaned and flushed of all foreign matter with the applicable system's medium or an Owner approved substitute.

Systems conveying hydraulic oil shall be flushed with a pickling solution or hot oil bath until flushing filters run clean.

The test fluid used shall be compatible with the system being tested.

Table 9: System test pressures and fluids for piping systems

System	Test Pressure (PSIG)	Test Fluid
Fire main	150	Fresh water
Bilge	Operating Pressure	Fresh water
Interior and exterior deck drains	Fill system to top fixture or vent	Fresh water
Vents and overflows	Fill system to top fixture or vent	Fresh water
Fresh water cooling	Operating Pressure	Fresh water
Fuel oil service	40	Oil
Lube oil systems	Operating Pressure	Oil
Hydraulic oil systems	1.5x MAWP	Oil
Sanitary drains	Fill system to first fixture or vent	Fresh water
Potable water	Operating Pressure	Fresh water
Clean agent	Per the vendors recommendation	Per vendors recommendation

All piping systems shall be operationally tested to demonstrate the proper operation of each piping system in accordance with Owner approved test procedures.

Manually operate all valves from stop to stop to demonstrate free operation without binding. Valve identification tags shall be checked for accuracy.

All relief valves and pressure safety devices shall be demonstrated that they operate at their set pressure or shall be provided with current test certification. All pressure gauges shall be provided with lab calibration test and certification stickers along with certifying documents provided to the Owner.

All hydraulic, fuel, and oil hose assemblies shall be hydrostatically tested and provided with metal tags attached showing their test date and pressures.

Diesel Generator Sets

Each engine and generator set shall be checked after installation for proper alignment and clearances, including alignment of exhaust piping and expansion joints within manufacturer's recommendations. Expansion joints shall not be used to make up for angular or axial misalignment of piping.

Auxiliary Machinery

Each pump shall be tested with its respective system, both hydrostatically to determine tightness, and in operation. The Contractor shall confirm that pump shaft seals are rated for the test pressure. Check each item for proper installation, alignment, and rotation prior to the operating test. Data shall be recorded such that equipment performance can be evaluated and compared with the requirements of the Specification. Generally, the required data shall include the pressure change across the machine, rpm, power consumption, and, where applicable, the performance of controls and functions.

After data collection as listed above, and before acceptance, auxiliary machinery, and related equipment susceptible to cyclic operations shall be operationally tested for five full, rapid cycles to the satisfaction of the Owner.

Independent Tanks

Independent tanks shall be tested in accordance with 46 CFR Subchapter T.

857.3 Electrical Power, Controls, and Monitoring Tests

General

Inspect the electrical installation for completeness, including tagging, cable support and banding, labeling, chafe protection, penetration sealing, and phase balancing of single-phase loads. Operate circuit breakers manually to demonstration proper action.

Insulation Resistance

For cables which did not receive insulation resistance testing before installation, measure and record the insulation resistance of each power system circuit between conductors and to ground with branch and main circuit breakers open for all AC power circuits and for DC power circuits over 20 AT protection. Where applicable, the main neutral conductor shall be temporarily ungrounded. Also see section 312.1

Disconnect the equipment from each circuit to enable satisfactory resistance values to be obtained and to protect the equipment. The test does not apply to signal and control circuits.

Voltage Drop

For power distribution circuits, steady state voltage drop shall be measured at the point of longest cable run. Voltage drop tests shall be performed with the served equipment operating at maximum load. The tests may be dismissed for circuits for which it can be established that a more severe combination of load, conductor size, and cable length exists and has been tested. Results shall be compared to regulatory requirements, and any non-compliant installations rectified.

Ground Impedance

Test each installed item for ground impedance between the item frame or enclosure and the vessel structure. Where impedance measures greater than 0.1 ohm, the Contractor shall take steps to reduce ground impedance to less than 0.1 ohm. Document tests and their results and present to the owner.

Operational Tests

Check all switches, light fixtures, convenience receptacles, control devices, etc., for proper function. Calibrate and check automatic thermal control devices, alarm, and indicator devices. Record the date, any deficiencies and corrections, and the date of satisfactory completion of each test. Perform a thermographic image inspection of the generator, ship's service switchboard, and all power distribution circuits under load, results of which shall be provided to the Owner as an interpreted color report.

If the switchboard and generator sets were not shop tested, perform testing as described in section 314

Verify function of all battery chargers. Verify function of all ancillary electrical equipment including anti-condensation heaters, block or jacket water heaters, and thermostats. Check aiming and any adjustments of general area lights, flood lights, navigation lights, and navigation panel alarms and features. Test all search light functions.

Check HVAC systems, including programming, set points, and manual controls. Check the function of heated windows and defrosters.

Check electronic equipment under the supervision of the equipment manufacturer's representative. Test all navigation, internal communication, and external communication equipment and their interfaces. The electronic system shall not be considered complete until the FCC certification has been accomplished or addressed to the satisfaction of the Owner.

Check alarm and monitoring system function, including processing, annunciation, and interfacing switches and sensors. Test steering system and propulsion controls, indications, and alarms.

Check function of the fire detection system and its associated detectors, pull stations, and annunciators.

Verify function of internal and external communication systems, including each microphone, speaker, and bell.

Check all audio visual and data equipment to confirm functionality. These systems shall not be considered complete until functionality has been demonstrated to the Owner's satisfaction.

Test all motor driven appliances under normal operating load conditions. Record operating volts and amps for each motor for each phase. Check all operating pushbuttons, selector switches, pilot lights, remote pushbuttons, pressure switches, and control devices to ensure their proper operation. Check overload-tripping devices for the proper size heater element or setting and freedom of operation. Observe equipment for excessive noise or vibration.

Check shore power connection and safe transfer of power from shore power to vessel power and vice versa.

Test all domestic appliance equipment and any setting or adjustments, such as laundry washer and dryer, refrigerators and freezers, range, and water heater.

857.4 Propulsion Machinery

Operate engines, gears, and shafting over a range of speed. The exact speed and duration that are applied during this test evolution shall be agreed upon by the manufacturers' representatives.

After equipment has reached a consistent operating temperature, inspect all engine, gear, and shafting components. Measure and record operating temperatures at all main shaft bearings, gear outputs, engine cooling, and exhaust points. Test for any unusual vibration. Measure pressure in engine room during operation at various fan speeds. Separately from the Contractor, engine representatives should run OEM certified engine testing and provide detailed results to Owner, including operation of electronic engine control, monitoring, and alarm systems.

Verify that all supporting auxiliary systems achieve steady state flow, temperature, and pressure during engine operation.

857.5 Dock and Builder's Trials

Following the completion of all preliminary testing, the Contractor shall perform a series of dockside trials prior to sea trials. Testing shall be carried out in accordance with the recommendations of Reference [10] and shall be used to demonstrate satisfactory operation of all ship systems. Run the main engines in opposition at maximum RPM safe for facilities. Check the steering, control, and navigational equipment to verify their readiness for builder's trials.

Upon satisfactory completion of dock trials, the Contractor shall conduct a builder's trial in accordance with Reference [11] to demonstrate that the vessel will satisfactorily perform all requirements, and to ensure operating and trial personnel are adequately trained, and trial equipment and instrumentation are properly set up and calibrated. The Contractor shall employ a crew with appropriate experience for builder's trials, to the satisfaction of the Owner. Owner shall be allowed to attend builder's trial.

Builder's sea trials shall be conducted at sea prior to contract performance 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 contract performance trials. Builder's sea trials shall be performed in accordance with these Specifications and supplemented by recommendations of the equipment manufacturers. At minimum, the builder's sea trials shall consist of:

(A) Machinery Plant Control System Tests. Control tests shall include local and remote stations and emergency controls.

(B) 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 steering system and vessel's navigational system elements, including sonar, radar, and compass.

(C) Thermographic Testing. The thermographic testing that could not be done safely at full power during dock trials shall be completed or repeated.

(D) 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.

(E) Auxiliary System Test. Auxiliary systems and components that could not be fully tested during dock trials shall be tested, including safety equipment, lifting equipment, anchor/mooring and deck equipment.

857.6 Sea Trials

Upon satisfactory completion of the dock and builder's trials, the vessel shall be taken on sea trials. The sea trials shall be conducted in open water under fair weather conditions and calm sea for a sufficient length of time to accomplish the following tests and trials.

The Contractor is responsible for conducting sea trials with a clean bottom and clean sea chests. The Owner shall have the option to attend all sea trials. The Contractor shall provide ten days advance notice to the Owner for all sea trials. The Contractor shall employ a crew with patrol vessel experience for builder's trials.

Sea trials shall be conducted in water deeper than 40ft and per the guidelines of Reference [10] and in accordance with the accepted sea trials agenda. The trial draft shall be within 2in of the design load waterline with minimal list and trim. The Contractor shall submit to the Owner a vessel loading plan for sea trials for review. The trials shall consist of:

(A) Endurance run of four hours at sustained maximum shaft rpm. Operating data shall be taken and recorded for all vessel systems at 15-minute intervals. Shaft torque and horsepower shall be recorded at 30-minute intervals. The following parameters shall be measured and recorded:

Shaft RPM	Shaft torque
Shaft bearing temperatures	Fuel consumption (each engine)
Vessel speed through water	Jacket water circuit press/temp
Aftercooler circuit press/temp	Exhaust system temperatures/back pressure
Lube oil system temp/press	Fuel oil system temp/press
Reduction gear lube oil temp/press	

(B) Propulsion Plant Economy Trials – The vessel is to be operated at the vessel service speed of 10 knots for a minimum of one hour. Operating data shall be recorded for all vessel systems at five-minute intervals. Fuel consumption shall be monitored and recorded throughout the trial.

(C) Progressive speed trial over a measured mile for four different speeds: 30%, 60%, 90%, and full power. Propulsion motor power outputs shall be recorded for each run.

(D) Crash stops as follows, measuring and recording the shaft torque and horsepower.

a. Ahead to astern

b. Astern to ahead

(E) Machinery Plant Control System Tests. Control system test shall include local and remote stations and emergency controls.

(F) 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.

(G) Steering and maneuvering

(H) "Crabbing" and "pivoting" with both propellers thrusting in opposition.

(I) Verification of resonance frequency avoidance

(J) Night trials

(K) Commensurate with the above sea trials the following system-specific trials shall be carried out:

a. Engine auxiliary systems shall be monitored (cooling water, exhaust, fuel oil) with the engine under load. Verify steady state conditions are achieved, and temperatures and pressures are within manufacturer specifications

b. Measure engine exhaust backpressure at the turbocharger outlet to verify the pressure is within the manufacturer's stated limits.

857.7 Test and Trial Instruments

The Contractor shall furnish instruments for operational tests to provide sufficient data to analyze the performance of systems, machinery, and equipment.

Ship's gauges and instruments may be used for tests of the systems they serve. The Contractor shall furnish test instruments and means of connection, as necessary, for additional readings required to test machinery and systems.

Instruments used for the tests shall have current calibration certification. Where used, the vessel's instruments shall be calibrated before use in any tests. Copies of all such certification shall be available for viewing, if requested, before, during, and after testing. Instruments shall be checked against standards at the beginning and end of the test program. If readings taken during a test appear unreasonable, the Owner shall require the Contractor to check all the instruments, gauges, and thermometers used on the test in question.

858 Delivery, Acceptance, and Substantial Completion

Delivery and acceptance of the vessel are subject to the details of the Owner's general provisions. Substantial completion shall be when the vessel is completed with respect to the technical requirements of this specification. At substantial completion, the complete and functioning vessel is provided with all necessary spares and documentation. A contract performance survey must be completed to document the completion of the vessel and all contract requirements.

858.1 Vessel Documentation

The following list is intended to highlight the documentation that will be provided to the Owner prior to substantial completion. This list may not be all-inclusive.

- All Equipment Documentation, including the following (see Section 856):
  - Installation Instructions
  - Operating manuals
  - Technical data sheets
  - As-built drawings
  - Full 3D model of vessel lofting, including CAD and PDF Assembly and Nested plate drawings
- Detail construction drawings (the following list may not be all-inclusive)
  - (073) Weld Schedule, Welding Procedure Specifications, Procedure Qualification Records (PQR), and Non-Destructive Testing Plan
  - (078) Steel and aluminum material certifications
  - (091) Quality Assurance Program
  - (093) Weight control plan and estimate updates (periodically during construction)
  - (100.3) Weld inspection and testing plan
  - (243.1)
    - Propeller design documentation
    - Fabrication sketches of shafting components
    - Propulsion system vibration analysis
  - (264) Lube and Waste Oil System Schematics
  - (305) Voltage Drop Calculations
  - (310) Emergency Shutdown System
  - (312)

        - Cable and Wiring Installation Plan
        - Cable Penetration Sealing System
    - (314.3) Switchboard drawing package
    - (315.3) DC One-Line and System Details
    - (316) Receptacle Plan
    - (318.1) Lighting Plan
    - (423.1) Electronics Equipment Selection
        - (S) Electronics Wiring/Interconnection Diagram
    - (512.1) HVAC System Schematic
    - (555.1) Fixed Fire Extinguishing System Design
    - (556) Hydraulic System Schematic
    - (562)
        - Steering Hydraulic Diagram
        - Steering Wiring Diagram
        - Rudder shaft and tiller arm machining details
    - (602) Schedule of Signage
    - (602.4) Operating Instructions
    - (625) Schedule of Doors, Windows, and Hatches
    - (637) Joinery and Outfitting Materials Selection Plan
    - (638) Furnishings Cutsheets
    - (638.6) Pilothouse Console Arrangement and mockup
    - (810.1) 3D Production Model
    - (810.5, 631.8) Hull Marking and Docking Plan
    - (843) Stability test procedure, Stability Test Report
    - (843.3) Permanent Ballast Arrangement
    - (857) Test and Trials Plan and Schedule
- Builder's Certificate
- FCC Radio Station Authorization
- FCC Communications Act Safety Radio Telephony Certificate
- Portable Fire Extinguisher Certificates
- Clean Agent Fire Suppression System Certificates

858.2 Spare Parts

Contractor shall develop a list of manufacturer's recommended spare parts for all machinery and submit to Owner for review. Purchase of Owner-approved spares may be addressed via change order. Equipment to in spares list to include, but no be limited to:

- Main Engines
- Generators
- Switchboards
- Steering Gear
- Crane and davit
- HPUs
- Watermaker
- HVAC filters
- Shaft
- Propeller

- Circuit breakers of each type aboard the vessel
- Shore power inlet
- Light fixtures of each type aboard the vessel
- Windshield wipers
- Bilge float switch

858.3 Contract Performance Survey

A Contract Performance Survey, including compartment sign off, shall be conducted following sea trials. This survey is to be conducted jointly by the Contractor and Owner to affirm that the construction of the vessel is complete; the form, fit, and function of installed materials and equipment is satisfactory, and the vessel is clean and clear of rubbish, excessive material, etc. The Contractor shall prepare and submit for Owner approval, a survey checklist to include all vessel compartments and operational areas, survey items, criteria, and related documentation.

The existence of any uncorrected deficiency affecting the safety, operation, performance, or immediate efficient use of the vessel for its intended service will be sufficient cause for rejection and delay acceptance of substantial completion. Likewise, the existence of a significant number of uncorrected deficiencies will be a cause for rejection.

The Contractor shall immediately take appropriate action to correct and complete any work that is determined to be unsatisfactory or incomplete and shall be responsible for any delay in the project associated with correcting deficiencies. The cost of such delay and required retesting shall be at the Contractor's expense. Owner acceptance of the Contract Performance Survey shall be obtained by the Contractor as a condition of substantial completion.

996 Launching and Drydocking

The Contractor shall be responsible for the satisfactory launching of the vessel. Launching of the vessel shall be scheduled at a time mutually agreed upon by all parties concerned. Prior to launching, Contractor shall provide launching block pressures and stability calculations to the owner for approval, demonstrating the safety margins of the launch. All expenses connected with the launching shall be borne by the Contractor.