MARITIME ADMINISTRATION GUIDELINE SPECIFICATIONS FOR MERCHANT SHIP CONSTRUCTION

Prepared by the
Office of Ship Construction
November 1995

Provided as a service of the
National Maritime Resource and Education Center
(NMREC)

PREFACE

The "Maritime Administration Guideline Specifications for Merchant Ship Construction" are intended to provide assistance to the maritime industry as a service provided through the National Maritime Resource and Education Center (NMREC). It is intended that these Specifications be useful as a guide for preparation of specific specifications for building competitive commercial ships in the United States of America for domestic or export markets. They cover all aspects of potential contract work, but may require modifications, as appropriate, to the ship design being contemplated.

These Specifications can be used as starting points for the preparation of construction specifications for any type of ship. No parts of these Specifications are intended to be mandatory. The Owner and Contractor are, therefore, free to use as much or as little of these Specifications as they consider appropriate to suit their mutual needs.

It is the intent of these Specifications to define a ship powered by a slow speed diesel engine and built to international standards. They provide for the construction of a ship to soundly conceived engineering practices to ensure that the completed ship will conform to the intended purpose/mission.

The "Executive Summary of the Maritime Administration Guideline Specifications for Merchant Ship Construction" is intended to be a stand-alone document provided for the same purpose as the Guideline Specifications, but in less detail.

These documents are not intended to restrict design features of construction, materials, equipment, systems, etc., to those that are specifically delineated herein. Substitutions consistent with Regulatory Body(ies) requirements and basic international standards of quality are acceptable.

It is requested that MARAD be notified of any errors herein. Also, comments and suggestions for improving these Specifications and updating to the latest vessel design practices and developments in international standards will be welcomed, for inclusion in future editions. Please use the comments sheets provided and address your suggestions to:

Maritime Administration
Office of Ship Construction
Division of Naval Architecture
MAR-724 Room 2109
400 Seventh Street, SW
Washington, DC 20590-0001

November 1995

COMMENTS/SUGGESTIONS FORM FOR THE GUIDELINE SPECIFICATIONS

SECTION	PAGE NO.	LINE(S)	COMMENT/SUGGESTION

COMMENTS/SUGGESTIONS FORM FOR THE GUIDELINE SPECIFICATIONS

SECTION	PAGE NO.	LINE(S)	COMMENT/SUGGESTION

MARITIME ADMINISTRATION
GUIDELINE SPECIFICATIONS FOR
MERCHANT SHIP CONSTRUCTION

PART I - HULL

Office of Ship Construction

November 1995

TABLE OF CONTENTS

PART I - HULL

SECTION 1

GENERAL

1.1. DEFINITIONS

The term "Contract" means the shipbuilding contract between the Owner and the Contractor and includes these Specifications and the accompanying Contract Drawings.

Wherever the terms "Classification Society(ies)" or "Regulatory Body(ies)" are used, they shall be read, if appropriate, interchangeably and are to mean the appropriate vessel flag Classification Society and cognizant national and international maritime authorities which have rules or regulations which shall be applied to a vessel of this type, service, nationality, and size.

The term "provide" means "furnish and install" to the Contractor's account.

The term "approved" means approval by the Owner or Regulatory Body(ies), as appropriate, unless otherwise indicated.

The term "marine grade" means material that is suitable for the marine environment.

The abbreviation "CRES" means corrosion resistant steel.

The acronym "AC" means alternating current.

The acronym "SOLAS" means the International Convention for Safety of Life at Sea, and all Protocols and Amendments as appropriate.

Metric symbols are as follows:

Unit	Symbol	Unit	Symbol
ampere	A	metric ton	t
degree Celsius	°C	milliliter	mL
cubic meter	m^3	millimeter	mm
hertz	Hz	millipascal	mPa
kilogram	kg	newton	N
kilopascal	kPa	pascal	Pa
liter	L	square meter	m^2
megapascal	MPa	volt	V
meter	m	watt	W
meters per second	m/s	watt/meter	W/m

The following organizations were used in the preparation of this Specification, and may appear herein as references:

- Air Movement & Control Association Inc. (AMCA)
- American Bureau of Shipping (ABS)
- American Iron and Steel Institute (AISI)
- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE)
- American Society of Mechanical Engineers (ASME)
- British Standards Institution (BSI)
- Bureau Veritas (BV)
- Det Norske Veritas (DNV)
- Deutsches Institut fur Normung E.V. (DIN)
- Institute of Electrical and Electronics Engineers (IEEE)
- International Electrotechnical Commission (IEC)
- International Maritime Organization (IMO)
- International Standards Organization (ISO)
- Japanese Industrial Standards (JIS)
- Lloyd's Register of Shipping
- National Electrical Manufacturers Association (NEMA)
- Society of Automotive Engineers, Inc. (SAE)
- Society of Naval Architects and Marine Engineers (SNAME)
- Underwriters Laboratories Inc. (UL)

1.2. GENERAL SPECIFICATIONS REQUIREMENTS

The ship shall be constructed with the principal characteristics set out herein and in compliance with all applicable requirements of the vessel flag of registration, Classification Society, and Regulatory Body(ies). In addition, the ship shall meet the most recent issues including all amendments to the following rules and regulations:

(a) Classification Society, as appropriate

(b) U.S. Coast Guard regulations, as appropriate, or, U.S. Coast Guard regulations applicable to non-U.S.-Flag vessels

(c) International Convention for the Safety of Life at Sea (SOLAS), 1974, and Protocol of 1978, including all subsequent amendments

(d) International Convention for the Prevention of Pollution from Ships (MARPOL), 1973, Protocol of 1978, including all subsequent amendments

(e) International Convention on Load Lines, 1966

(f) International Tele-communication Convention, and Radio Regulation, 1974 and 1982

(g) International Regulations for Preventing Collision at Sea, 1972

(h) International Convention on Tonnage Measurement of Ships, 1969

(i) International Labor Organization

(j) International Electricity Commission

(k) Suez Canal and Panama Canal Regulations

(l) U.S. Public Health Service requirements, as appropriate

(m) All other rules and regulations, as appropriate

All necessary certifications and/or documents covering the approval and indicating compliance shall be obtained by the Contractor.

The Contractor shall be ISO 9000 registered.

Where requirements of the Contract Drawings and/or these Specifications are in excess of Regulatory Body(ies) requirements, the Contract Drawings and/or these Specifications shall prevail.

Unless specifically stated otherwise in the Contract, work in excess of the Contract Drawings and these Specifications, which is required by any Regulatory Body(ies) requirement, law, or change in any existing Regulatory Body(ies) requirement or law, shall be included in the Contract work and Contract price if such requirement or change was published and effective 30 days prior to the date of execution of the Contract (in the case of a negotiated Contract), or 30 days prior to bid opening (in the case of a competitive bid Contract). When any such new requirement or change in an existing requirement is published prior to the preceding date but becomes effective after such date, work required by the new requirement or change shall also be included in the Contract work and Contract price if: (1) the publication occurs prior to the preceding date, (2) the effective date of the new requirement or change occurs before the actual delivery date of the vessel, or (3) compliance with such new requirement or change is necessary to obtain the approval of any Regulatory Body(ies).

1.3. PRINCIPAL CHARACTERISTICS

Length Overall	________	m
Length Between Perpendiculars	________	m
Beam, Molded	________	m
Depth, Molded	________	m
Draft, Summer Freeboard	________	m
Draft, Design Full Load, Molded	________	m
Light Ship Weight	________	t

Total Deadweight at Full Load Draft	________	t
Total Displacement at Full Load Draft	________	t
Liquid Cargo Volume	________	m^3
Segregated Ballast Volume	________	m^3
Fuel Oil Volume	________	m^3
Lube Oil Volume	________	m^3
Number of Cargo Tanks	________	
Number of Segregated Ballast Tanks	________	
Type of Machinery	________	
No. of Propeller(s)	________	
Shaft Power	________	kW
Propeller Revolutions	________	rpm
Speed	________	kts
Fuel Consumption at Sea at 85% MCR	________	t per day
Fuel Consumption in Port	________	t per day
Endurance at Full Load Draft	________	nautical miles
Gross Tonnage	________	
Net Tonnage	________	
Container Capacity	________	TEU
Bale Cubic	________	m^3

Accommodations	Licensed	Unlicensed	Total
Deck Department	______	______	______
Engine Department	______	______	______
Stewards Department	______	______	______
Other	______	______	______
Total Accommodations	______	______	______

1.4. DRAWINGS

The ship shall be constructed per these Specifications and the following Contract Drawings:

- Lines
- General Arrangement Drawings and Profiles
- Machinery Arrangement Drawings, Sections, and Elevations
- Midship Section
- Energy Balance Diagram

1.5. WEIGHT AND CENTER OF GRAVITY

Within [90, 60, 45, 30] calendar days after date of award, the Contractor shall submit for approval an independently prepared estimate of light ship weight and center of gravity. This estimate shall describe the weight and center of gravity of the ship in comprehensive detail.

Approval action shall consist of reaching a mutual agreement between the Contractor and the Owner, as quickly as possible on the light ship weight and center of gravity. Thereafter, the Contractor shall be responsible for obtaining in the completed vessel the approved weight and center of gravity characteristics adjusted for authorized departures from the construction contemplated in the approved estimate.

Departures from the construction contemplated in the approved estimate which affect the light ship weight and center of gravity shall not be undertaken until the Contractor has submitted to the Owner, its estimate of the effect on weight and center of gravity of the ship, and obtained written approval to proceed with the departure. Departures, the total effects of which change any weight group by less than [0.0001, 0.0002, 0.0003, 0.0004] of the light ship weight, shall be considered negligible and will not require written approval with respect to weight.

The Contractor shall submit to the Owner a tabulation of approved departures and their cumulative effect on weight and center of gravity of the approved light ship. In addition, when submitting drawings that involve departures from the type of construction contemplated in the estimate, the Contractor shall itemize such departures and their effect on light ship weight and center of gravity in its report. This report should be submitted at the time of delivery to bring the estimated light ship weight and center of gravity into reasonable agreement with the deadweight survey or inclining results.

1.6. STABILITY AND SUBDIVISION

The ship must meet all applicable IMO and Regulatory Body(ies) requirements for intact stability, and for damage stability and subdivision, including those of SOLAS. Intact and damage stability analyses shall be submitted to the Owner and Regulatory Body(ies) for approval. These shall establish the required GM curves (i.e., GM, GZ) to meet all criteria, and include preliminary calculations of trim and stability adequately covering the full range of operating conditions.

A stability test on the first ship of this Contract shall be performed by the Contractor at its expense per ASTM F1321, "Standard Guide for Conducting a Stability Test (Lightweight Survey and Inclining Experiment) to Determine the Light Ship Displacement and Centers of Gravity of a Vessel". Approximately 2 weeks prior to the stability test, the Contractor shall prepare and submit to the Owner and Regulatory Body(ies) for approval the stability test procedure. Based on the approved stability test, the Contractor shall prepare, secure Regulatory Body(ies) approval, and submit to the Owner and Regulatory Body(ies), the report of the stability test establishing the ship's light weight and center of gravity. The construction of the ship at the time of the stability test shall be as complete as possible. The Contractor shall secure instructions from the Regulatory Body(ies) concerning the requirement for stability tests on subsequent sisterships.

Based on the results of the stability test, the Contractor shall prepare a Trim and Stability Booklet which sets forth the stability data necessary to permit safe and efficient handling of the ship. The Booklet shall include operating instructions to identify any loading restrictions which must be maintained to assure that the ship will safely meet the required intact and damage stability criteria over the entire operating range. These instructions shall be as clear and concise as practicable and shall be approved by the Regulatory Body(ies) and Owner.

For bulk carriers, oil carriers, containerships, barge carriers, and liquefied natural gas carriers, a loading manual covering the feasible range of loading for cargo and ballast shall be developed for the guidance of the operator. Also, for the types of vessels listed above, a loading instrument shall be provided.

1.7. VIBRATION AND NOISE

Special attention shall be given in the design and construction of the vessel to minimize vibration and noise.

The Contractor shall make every effort to locate and correct unsatisfactory vibration conditions arising during tests and trials, or subsequently during the guarantee period. Where such measurements are desired, ISO 4867, "Code for the Measurement and Reporting of Shipboard Vibration Data", provides guidance on conducting hull vibration surveys, and on the reporting of results; ISO 6954, "Mechanical Vibration and Shock - Guidelines for the Overall Evaluation of Vibration in Merchant Ships", contains guidelines for the acceptance criteria of vibration levels in normally attended spaces and elsewhere.

Sound insulation and isolation shall be provided as necessary to keep noise levels within practical limits. Every effort shall be made to eliminate all rattles detected in accommodation spaces emanating from doors, joiner panels, furniture, and other sources. Guidance on the performance of sound surveys is given in ISO 2923, "Acoustics - Measurement of Noise on Board Vessels"; guidelines for acceptance criteria of noise levels in normally manned spaces is given in the Annex to IMO Resolution A.468 (XII), "Code On Noise Levels On Board Ships". The Code applies to new ships of 1,600 tons gross tonnage and over.

The following maximum levels are offered as general guidance:

Location	Noise Level, dBA
Work Spaces	
Machinery Spaces (continuously manned)	90
Machinery Spaces (not continuously manned)	110
Machinery Control Rooms	75

Workshops	85
Non-specified Work Spaces	90

Navigation Spaces

Navigation Bridge and Chart Rooms	65
Listening Post, including Navigation Bridge Wings and Windows	70
Radio Rooms (with radio equipment operating but not producing audio signals)	60
Radar Rooms	65

Accommodation Spaces

Cabins and Hospitals	60
Mess Rooms	65
Recreation Rooms	65
Open Recreation Areas	75
Offices	65

Service Spaces

Galleys, without food processing equipment operating	75
Serveries and Pantries	75

Normally Unoccupied Spaces

Spaces not specified	90

If noise levels exceed 85 dBA anywhere in the machinery space, signs shall be posted reading, "DANGER - HIGH NOISE LEVEL - HEARING PROTECTION MUST BE WORN" at each entrance, and sufficient approved protective hearing devices shall be provided for all crew members in this area.

1.8. HEADROOM

Clear headroom in accommodations, working, navigation spaces, passageways, toilet, and shower spaces shall be as high as practical but shall not be less than 2050 mm. Clear headroom under local points such as ducts, piping, lights, and girders, shall not be less than 2000 mm in the above spaces and will be the subject of individual approval.

1.9. ACCESS AND MAINTENANCE REQUIREMENTS

The structure and layout of the machinery and equipment shall be designed and constructed to permit ready access to all parts for operation, inspection, maintenance and repair with minimum disturbance of other structure or equipment.

Battens and gratings in Storerooms and other spaces and protective casings around pipes shall be made readily removable.

Restriction of access openings by pipes, valves, and heating coils shall be avoided and ladders shall be located in line with openings. All accesses shall be large enough to facilitate servicing of contents. All areas of all spaces within the ship shall be accessible.

Provisions shall be made for the removal of items such as shafting, machinery parts, and boiler casings, which provisions may consist of area of decks, and bulkheads, so arranged that when a section so designated on working drawings is removed, the remaining structure will be self-supporting.

1.10. INSPECTION

See provisions of the Contract(s).

1.11. MATERIALS AND WORKMANSHIP

All material, machinery, and equipment shall be of new manufacture and shall be suitable for the marine service intended, and spare parts and service shall be readily obtainable.

All material, unless otherwise specified herein, shall be in compliance with all applicable requirements of the Classification Society(ies), and shall be so designated in a bill of material on the drawings.

During construction and before delivery, the Contractor shall be responsible for protection of all material and equipment intended for the ship.

All welding and welder qualifications shall be per Regulatory Body(ies) requirements.

All welding of high tensile and notch tough steel shall be performed per the manufacturer's recommendations.

The overweight tolerance of steel members shall be within limits defined by ASTM A6/A6M - 93b, "Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use".

All machinery, structure, and outfit shall be designed to withstand the resultant forces from the following ship conditions:

_____° Roll (each side) Full period ___ sec.
_____° Pitch (bow up to bow down) Full period ___ sec.

Equipment operated at sea shall be designed to operate under any of the following conditions:

Above dynamic conditions plus:

_____° List
_____° Trim - (by bow or stern)

The emergency generator set shall conform to list and trim requirements of the Regulatory Body(ies). Performance criteria for equipment not operated at sea shall be as required by individual sections of this Specification.

All materials shall be free from imperfections of manufacture and from defects which adversely affect appearance or serviceability. All sharp edges or projections which constitute a personnel hazard shall be removed.

All pressure grease fittings shall be of non-corrodible material where exposed to weather, and zinc or cadmium coated steel elsewhere.

Zinc silicate coating may be substituted for galvanizing.

All bolt heads and nuts shall be of hexagonal standard type. Where required by the Regulatory Body(ies) or Safety Codes they shall be of the Heavy Series.

Except as otherwise specified, stainless steel called for herein shall be AISI 304 or 316, Finish No. 4 for interior applications. Weather applications shall be AISI 316.

(a) Asbestos

There shall be no asbestos in any form installed on the ship.

1.12. HULL PROTECTION DURING OUTFITTING PERIOD

Rigid control of welding and electrical grounding shall be maintained for the protection of the hull, stern tube, and other hull appendages. The Contractor shall adequately protect the underwater part of the hull prior to ship delivery.

An approved impressed current cathodic protection system shall be provided for the hull immediately after launching and until delivery of the ship. The potential of the hull shall be held in the range of -750 to -850 mV (silver-silver chloride cell) in order to provide protection against corrosion of the hull. The Contractor shall log the hull potentials daily for the first 3 weeks after the ship has been launched and weekly thereafter. The Contractor shall verify that the cathodic protection used is compatible with the underwater paint system applied.

1.13. LAUNCHING AND DRYDOCKING

The Contractor shall be responsible for the satisfactory launching of the ship.

If at any time prior to formal acceptance of the ship there is warrantable reason for believing the underwater portion of the ship to have been seriously impaired, the Contractor shall place the ship in drydock and adequately inspect, repair, clean, and paint the damaged areas at its own expense. A protest or notice, by the Owner filed with the Classification Society and sustained by them, shall be deemed a "warrantable reason" for requesting drydocking. Inspection for damage may be by diver if mutually agreed upon.

1.14. DELIVERY

The Contractor shall deliver the ship(s) per the Contract, after successful sea trials and an Acceptance Survey, ready to receive cargo. All parts of the ship shall be thoroughly cleaned. All tanks and accommodations shall be ready to be immediately put to use without further preparation or cleaning. Reserve feed and potable water tanks shall be filled by the Contractor prior to delivery.

A major deficiency is any item affecting the safe navigation or the immediate, efficient use of the ship. The existence of any major, uncorrected Contractor-responsible deficiency will be sufficient cause to reject delivery of the ship. The delay in delivery resulting therefrom shall be a matter of Contractor responsibility. All tests shall be completed prior to delivery of the ship. The existence of a large number of uncorrected minor deficiencies may be a cause for rejection of delivery.

To ensure that the ship is in a proper condition for delivery, a final joint survey of the ship will be made by the Owner and the Contractor. The survey shall take place at least 3 days prior to the scheduled delivery date. Based on this survey, an agreement shall be reached between the Contractor and the Owner as to the extent and schedule of further cleaning and correction of deficiencies.

SECTION 2

STRUCTURE - HULL

2.1. GENERAL

The use of high tensile or notch tough steel shall be as indicated in the Contract Drawings. All materials used in the fabrication of the hull are to be in accordance with Regulatory Body(ies) requirements.

2.2. WORKMANSHIP

All workmanship shall be of a standard of quality consistent to ensure that the requisite tightness is obtained, exposed surfaces are smooth, proper fit and alignment accomplished, and stress concentrations minimized.

All surfaces shall be reasonably fair, without buckles, kinks, or other surface irregularities in excess of the tolerances given in ASTM F1053/F1053M, "Standard Guide for Steel Hull Construction Tolerances (Metric)".

All cutting, flanging, edge preparation and temperature control of high tensile and notch tough steels shall be performed per the manufacturer's recommendation and guidance.

Lifting eyes and staging clips which are welded completely around may be left in place or cut off beyond the weld provided they will not be unsafe, will not interfere with the intended function of the vessel, and will not create stress concentrations.

2.3. TESTING AND INSPECTION OF WELDS

All testing and inspection shall be to the satisfaction of the Regulatory Body(ies). Should the Regulatory Body(ies), due to unsatisfactory welding, deem it necessary to increase the percentage or area of examination, it, and repairs needed as a result of the inspection, shall be done at the Contractor's expense.

2.4. WELDING

Unless noted otherwise, all steel construction shall be of welded design. The weld sizes and types shall be per Regulatory Body(ies) requirements or engineering stress calculations that are approved by the Regulatory Body(ies).

2.5. STEM

The shell plating and seams shall present a flush exterior surface below the deep waterline. If a casting is used, it shall be butt welded to the shell plating with full penetration welds. Flat bar backing strips shall be used where one-sided welding is done.

2.6. STERN FRAME

The stern frame shall be of streamline configuration indicated on the Contract Drawings with scantling as prescribed by Classification Society(ies) and shall be designed to minimize vibration. The structure shall be made up of a series of weldments, or castings.

The stern frame shall be butt welded to the shell plating with full penetration welds presenting a flush surface below the deep water line. Flat bar backing strips shall be used where one-sided welding is done.

2.7. RUDDER AND CARRIER

The rudder shall be streamlined in horizontal section and of the type, area and contour suitable for the intended service. Positive hardover stops shall be provided to limit the travel of the rudder.

The rudder stock nut and the pintle nut shall be designed to use the same wrench, provided by the Contractor.

Provisions shall be made for clearances necessary to permit the rudder to be shipped and unshipped with the stock detached.

The whole of the rudder shall be made watertight by welding, and tested. The internal surfaces shall be coated with a suitable protective compound. Drain and vent plugs shall be provided for testing and draining rudder during docking.

The rudder and rudder stock shall be provided with means for handling.

2.8. MOLDING AND RUBBING STRIPS

Smooth welded steel, extra heavy or double extra heavy pipe molding, or half-round bars shall be fitted in way of and for a generous distance each side of mooring fittings.

2.9. BILGE KEELS, WHEN FITTED

The bilge keels shall be of scantlings and extent as shown on Midship Section or Lines Drawing. The body of the bilge keel shall be designed to tear away under destructive stress without damaging the shell connection. The extreme ends shall be tapered gradually for at least 3 m.

2.10. DOUBLE BOTTOM - ENGINE ROOM

Double bottoms shall be fitted as shown on the Contract Drawings.

2.11. WEB FRAMES

The extent, location, and scantlings of the web frame shall be as indicated on the Contract Drawings.

2.12. DECK GIRDERS

Girders shall be provided generally as indicated on the Contract Drawings and elsewhere as required to adequately support and distribute loads as indicated during the development of the detailed design.

2.13. PILLARS AND STANCHIONS

Pillars and stanchions shall be fitted, as necessary, to properly support structural loads.

2.14. BULKHEADS

Bulkheads shall be provided with continuity and with tightness as necessary to provide hull integrity. All watertight steel bulkheads forming boundaries shall be proven watertight by appropriate test before paint, insulation, or other covering is provided.

Structural projections in holds shall be kept to a minimum so that the holds will be as smooth as possible.

Deep tanks or other bulkheads adjacent to dry cargo holds which are required to be fitted with either insulation or cargo battens shall have their stiffeners on the dry cargo side where practicable.

2.15. DEEP TANKS

Structure within cargo oil tanks shall be minimized; where required it shall permit easy drainage and cleaning. Deck beams and girders shall be selected to facilitate cleaning.

At no time, prior to delivery, shall cargo oil tanks be filled or ballasted with salt or muddy fresh water unless specifically authorized by the Owner. If such ballasting is authorized, cleaning and draining is required prior to delivery.

2.16. DECKS

Decks shall be provided with continuity and with tightness as necessary to provide hull integrity. Weather Decks and all interior steel decks, coamings and deck connections of steel bulkheads, in way of toilets, washrooms, and other wet spaces, including refrigerated spaces, shall be proven tight. Appropriate testing shall be done prior to application of any paint or deck or bulkhead covering and after all preparatory work involving watertightness has been completed.

All working areas of decks or flats, in way of machinery spaces, shall be plated with raised pattern non-skid plating or open grating, as applicable.

Coamings, not otherwise specified by Regulatory Body(ies), shall be of 100 mm in height above the plate or top of the deck covering and fitted at all deck openings in trunks that are not otherwise protected by hatch covers. Coamings may be omitted where the vertical opening is in the immediate way of inclined ladders or stairs to avoid a tripping hazard provided that down-flooding cannot occur as a result.

2.17. FOUNDATIONS

The shaft stools and foundation structures for auxiliary machinery shall be of material similar to that of the main engine foundations. The shafting of each unit connected by coupling shall be proven in alignment and the bases shall be doweled.

Foundations shall be designed to act as complete supports against vertical and racking loads independent of the casing, frame, bedplate, or other part of the supported unit. They shall be designed to preclude development of thermal stresses in either the foundation or in the heat producing unit being supported. All foundations shall be designed to withstand the resultants of the static and dynamic loads due to the roll, pitch, list and trim called out in these Specifications.

2.18. TRUNKS

The minimum size of access trunks shall be 750 mm x 750 mm. Where trunks (such as used for escape, dumbwaiter, access, elevators, conveyors, chutes) pierce decks, the deck cuts shall have rounded corners.

2.19. BREAKWATER

Where the freeboard forward is such that green water can be shipped, a steel plate breakwater shall be fitted across the Weather Deck in extent and disposition as indicated in the General Arrangement/Contract Drawings.

2.20. CARGO HATCH COAMINGS

The coamings for the Weather Deck hatches shall be of steel. The coamings shall be at least 750 mm high above the deck in order to prevent personnel from accidentally falling into the hatch while handling cargo. Where coamings are over 1200 mm high, permanent platforms shall be provided for visibility and access. Horizontal stiffening members on top of coamings shall be channels or other shapes or plate to suit the hatch covers which they support, subject to Owner's approval.

For container holds, the height of the coamings shall be as required by the Regulatory Body(ies) or as determined by the height required for the stowage of containers below (see Capacity Drawing). There shall be a clearance of at least 75 mm between the lowest projection on the hatch cover and the uppermost container.

2.21. STRUTS AND BOSSINGS

Where necessary for support or to minimize vibration, extended propeller shafts shall be properly supported.

SECTION 3

HOUSES, INTERIOR BULKHEADS, AND MISCELLANEOUS STRUCTURES

3.1. GENERAL

The applicable parts of SECTION 2, STRUCTURE - HULL, shall apply here, in addition to the following:

The boundaries of all Deckhouses shall be of watertight construction and shall be hose tested for tightness. The tightness tests shall be performed per Regulatory Body(ies) requirements. Casings, houses, bulkheads, and other surfaces, shall be reasonably fair, without buckles, kinks, or other objectionable surface irregularities in excess of the tolerances given in ASTM F1053/F1053M, "Standard Guide for Steel Hull Construction Tolerances (Metric)".

Casings and Deckhouses shall have outside corners formed to a minimum 200 mm radius.

Where interior bulkheads are required to be of steel, they may be utilized as deck supports in lieu of pillars and girders. Conversely, structural members shall be made a part of divisional bulkheads wherever possible.

All welded non-structural steel bulkheads shall be of lightest practicable structure. Non-structural steel or joiner bulkheads surrounding wet spaces shall have 6 mm minimum all welded steel coaming extending about 100 mm above the deck covering.

All portions of the unstiffened side of metal bulkheads exposed to view outside or in accommodation spaces shall be flush plated and all welding and fastenings shall be of pleasing appearance.

3.2. INTERIOR BULKHEADS

Outside corners of interior steel bulkheads in way of living and working spaces which might present a hazard to personnel shall have a radius of not less than 75 mm. Longitudinal and transverse bulkheads shall be arranged in continuous vertical planes, deck-to-deck, as much as possible, to resist racking and vibration.

The boundaries of gas or odor producing spaces shall be continuously welded and fumetight. The periphery of other divisional steel bulkheads shall also be continuously welded or sealed with an approved compound unless the periphery is covered by sheathing, ceiling, or deck covering so as to make it effectively light, dust, and sound tight. Galvanized wire mesh or expanded metal bulkheads shall be fitted as required.

3.3. BULWARKS AND WINDSHIELDS

Bulwarks shall be provided generally as shown on the Contract Drawings and as required by Regulatory Body(ies).

3.4. CHAIN LOCKERS

Chain lockers shall be constructed in locations as indicated on the Contract drawings. Each locker shall be designed for self-stowing of the chain and of adequate capacity, with at least 2000 mm of clear headroom over the stowed chain. Sumps, accessible from the Weather Deck, shall be provided at the bottom of each locker separated therefrom by a heavy perforated plate or approved equivalent 750 mm above the bottom of the sump.

The bitter end connections shall be located at top of the lockers, in protected but accessible locations to permit emergency release of the chain. The bitter end connection shall be designed for shear failure under a runaway chain load equal to the breaking strength of the anchor chain.

Access to chain lockers shall be via watertight hinged manholes and footholds in the bulkhead dividing the lockers.

SECTION 4

SIDEPORTS, DOORS, HATCHES, AND MANHOLES

4.1. GENERAL

Closures shall be appropriate to the location, use and watertight integrity of the space served, and shall be equivalent in strength to the adjacent structure.

All mechanical parts shall be equipped with rugged non-corrodible bearings and pins and shall be provided with means for proper lubrication.

4.2. SIDEPORTS

Watertight sideport doors and fittings shall fit flush with the outer shell of the vessel when closed.

Doors shall be complete with strongbacks, hinges, dogs, dog wrenches, gaskets, ring bolts, and holdback arrangements. The doors shall be opened and closed by mechanical means, as appropriate. An emergency method of operating the doors shall be provided.

The door frame gaskets shall be rubber or neoprene resting against corrosion resistant steel seal bars.

4.3. DOORS

(a) General

Exterior doors shall have watersheds over them, where not otherwise protected.

(b) Sizes

(1) Heights (Headroom)

Tops of doors shall be at least 1980 mm above tops of deck covering or step, with the exception of the reefer stores doors 1830 mm, and at least 1600 mm clear opening above the coamings.

(2) Widths (Clear Opening), Minimum

Double (Interior & Exterior)	1070 mm
Exterior W.T. & Weathertight, Interior W.T.	760 mm
Galley & Pantry, Public Rooms, Passages, Shops, Storerooms, Other General Utility Spaces	760 mm
Messing Spaces	915 mm
T&S (Private & Semi-Private)	610 mm

T&S (Public)	760 mm
Wardrobe	560 mm
Double Wardrobe	915 mm
Fire	760 mm
Medical Treatment Room	760 mm
Staterooms	660 mm
Other Interior	660 mm

(3) Coaming Heights

Watertight/Weathertight Companionway	As required by Regulatory Body(ies) and to suit installation.
Interior	No coaming required except T&S, Laundries and Crew Staterooms on Main & 2nd Decks.
Toilet Spaces	50 mm above T&S deck covering.
Shower Enclosures	150 mm above shower deck covering.
Laundry Space	150 mm above laundry space deck covering.
Staterooms	50 mm above deck covering.

(c) Watertight and Weathertight Doors

Except when otherwise allowed by the Regulatory Body(ies), all watertight doors shall be per ASTM F1196, "Sliding Watertight Door Assemblies", and ASTM F1197, "Sliding Watertight Door Control Systems". When allowed by the Regulatory Body(ies), other watertight doors shall be per ASTM F1069, "Doors, Watertight, Gastight/Airtight and Weathertight, Individually Dogged, For Marine Use, Class A or Class B".

Weathertight doors shall be per ASTM F1069, "Doors, Watertight, Gastight/Airtight and Weathertight, Individually Dogged, For Marine Use, Class D". Sliding type wheelhouse doors shall have stainless steel tracks and rollers.

(d) Joiner Doors

Joiner doors shall be per ASTM F821, "Doors and Frames, Steel, Interior, Marine" and shall satisfy test requirements contained in IMO Resolution A.754. Kickout panels shall be provided where there are no secondary means of escape.

(e) Non-tight Doors

Non-tight doors shall be per ASTM F1070, "Doors, Non-tight, For Marine Use".

(f) Gastight and Fumetight Doors

Gastight and fumetight doors shall be per ASTM F1069, "Doors, Watertight, Gastight/Airtight and Weathertight, Individually Dogged, For Marine Use, Class C".

(g) Fire Doors

These shall be similar in appearance to doors in adjacent areas and meet the Regulatory Body(ies) requirements.

(h) Elevator and Dumbwaiter Trunk Doors

These shall be similar in appearance to doors in adjacent areas.

(i) Wire Mesh or Expanded Metal Doors

Wire mesh or expanded metal rectangular doors shall be per ASTM F1072, "Expanded-Metal Doors".

(j) Refrigeration Space Doors

Refrigerated store space doors and frames shall be of fire retardant light weight fiberglass or stainless steel construction. They shall be an approved marine type, factory aligned, with frame and single seal. Refrigerated doors forming part of a fire protection boundary shall meet the Regulatory Body(ies) fire protection requirements.

Hardware shall be of galvanized steel. There shall be three hinges to each door and a latch and opening device so arranged that the door can be opened from the inside and outside by handle, but with no through metal. Bronze bushings and steel hinge pins with brass bearing washers shall be fitted in the hinges. Doors shall be fitted with heavy galvanized steel hasp for padlocking, along with an approved type emergency release which will open the door from the inside when padlocked on the outside.

All refrigerator doors shall be fitted with approved automatic self-engaging holdback hooks.

Refrigeration cargo space doors shall be insulated and constructed similar to their surrounding boundaries.

4.4. CARGO HATCH COVERS

(a) General

Hatch covers shall meet the requirements of the Classification Society(ies) rules and any special requirements of SECTION 2.

(b) Quick-Acting Hinged Hatch Covers for General Cargo Ships

Quick-acting power operated steel covers shall be provided at all locations as shown on the General Arrangement Drawings. Actuation shall be by remote control, with control stations located so that the operator can readily observe the hatch cover operation when any section is opened and the remaining section is overstowed with cargo.

The hatch covers shall be simple in operation and shall be capable of operating at a list of 6° and trim of 2°. There shall be emergency provisions so that in the event of actuation system failure, the rate of cover closing will be restricted to prevent damage, and the covers may be opened and closed by cargo whip or other approved means.

Holdback latches and resilient bumpers shall be provided for vertical stowages of all hatch cover sections. Holdbacks shall be easily accessible, operable simultaneously by one person, positive in action, and self-locking where possible.

Hinge mounting arrangements shall allow leveling and alignment to ensure a flush surface where necessary, and smooth operation.

Steel wheels of rugged design shall be fitted to the folding covers, which shall roll on stainless steel tracks during opening and closing. Means shall be provided to prevent side motion.

Spare parts and special tools shall be provided as recommended by the hatch cover manufacturer. Spare parts shall be for 1 year's service.

Details of the power operating system shall be as described in SECTION 81.

Painting shall be as specified in SECTION 14.

Insulation of hatch covers shall provide the same insulation values and anti-sweat properties as the insulation specified for the surrounding deck.

Guard rail stanchion sockets shall be fitted as required by SECTION 5.

For containership(s), raised weathertight hatch covers on the Weather Decks shall be designed according to the above general requirements, plus the following:

(1) Covers shall be constructed of ___ type steel and be capable of supporting fully loaded containers over their entire area ___ tiers high. Containers are ___ mm long x ___ mm wide x ___ mm high and ___ t gross, fully loaded. Additional containers as indicated on the Contract Drawings shall be ___ mm long x ___ mm wide x ___ mm high and ___ t gross, fully loaded. Containers shall be supported at their four corners for design purposes.

(2) Provide container stowage corner fittings which will not interfere with opening and closing of covers.

(3) Hatch covers that open both forward and aft shall have no interference between fore and aft sections when one section is opening or closing and the other is loaded to capacity.

(4) Fit quick-acting securing dogs designed for simple and rapid operation and adjustment, to ensure watertightness with proper gasketing, arranged so that they cannot foul the roller tracks at any time. The gaskets shall be protected from excessive compression by metal-to-metal contact between covers and coaming when covers are closed, from abrasion when opening and closing, and from cargo damage when hatches are open.

(5) Irregularly shaped steel hardware items in areas where special coating is required shall be galvanized.

Design criteria for flush weathertight covers shall be similar to the raised type, but with the following differences:

(1) Covers shall be fitted flush with surrounding deck plating within 6 mm, with any wheel tracks, hinges, and other fittings, below the deck level. Covers shall stow entirely within the deck opening.

(2) The gaps between top plating of any two connected panels or between the top plating and surrounding deck shall not exceed 20 mm. The gaps between top plating of unconnected panels shall not exceed 38 mm.

(3) Where recesses in way of hinges, wheels, and other fittings, are necessary, they shall have extra heavy hinged covers which will operate automatically with the hatch cover operation. In no case shall it be possible to have a deck opening in excess of that described above.

(4) Hinge cover plates shall be capable of supporting loads as required for hatch covers and surrounding decks.

(5) Means shall be provided to drain water overboard or to bilges that is trapped in recesses for gaskets and dogs.

Non-tight hatch covers shall be similar to the flush weathertight type, except that dogging, gasketing, and drains shall be omitted.

'Tween Deck oiltight covers shall be fitted flush with the surrounding deck plating within +6 mm. The gaps between covers and decks shall not exceed 20 mm, and the size of pockets and recesses shall be minimized. A flush access manhole with flush or recessed ullage opening shall be fitted in each cover. The covers shall be designed to withstand a hydraulic head pressure of ___ kPa. They shall be fitted with recessed dogs and gaskets to ensure an absolutely oiltight joint under design head pressure and dynamic loads. The gaskets shall be suitable for all liquids to be carried in the ship's trade, at whatever temperatures are required. Dogs shall be designed such that they cannot be damaged when closing the cover. The covers shall be of smooth-bottom, box type construction and oiltight on the underside.

(c) Welded Steel Pontoon Hatch Covers (Alternate for Containerships)

Welded steel pontoon hatch covers shall be provided as shown on the Contract Drawing.

Covers shall be provided with fittings which permit stacking and securing of containers and lifting by the container crane automatic spreaders. They shall be constructed of ___ type steel and be capable of supporting fully loaded containers in ___ tiers as shown on the Contract Drawings. Containers are ___ mm long x ___ mm wide x ___ mm high and ___ t gross, fully loaded. Loads imposed on the covers shall be evenly transmitted to the hatch coamings by metal-to-metal contact between the skirt plates of the covers and the coamings.

Weather Deck hatch covers shall be fitted with gaskets and sufficient quick-acting dogs to ensure weathertightness.

Shear chocks to prevent fore/aft and longitudinal sliding of the hatch cover and containers as a unit shall be provided.

Painting shall be as specified in SECTION 14.

Insulation of hatch covers shall provide the same insulation values and anti-sweat properties as the insulation specified for the surrounding deck.

(d) Welded Steel Pontoon Hatch Covers (Alternate for LASH Type Barge Carriers)

Lift-off one-piece pontoon hatch covers shall be provided as shown on the Contract Drawing, complete with all fittings required for lifting by the lighter crane automatic spreader, stacking on top of each other or on top of a lighter forward or aft of the open hatch, securing themselves against movement under the most severe dynamic conditions and for securing a lower tier of lighters by their bottom corners. They shall be constructed of ___ type steel and be capable of supporting two fully-loaded lighters at sea.

Loads imposed on the corners shall be evenly transmitted to the hatch coamings by metal-to-metal contact between the skirt plates of the covers and the coamings. The covers shall be fitted with gaskets and sufficient quick-acting dogs to ensure watertightness.

Painting shall be as specified in SECTION 14.

(e) Side Rolling Hatch Covers (Alternate for OBO Ships)

Hatch covers of the horizontal sliding type shall be provided for each cargo hatch on the Upper Deck.

The covers shall have parting joints on centerline and shall roll outboard port and starboard on wheels and tracks. The parting joints and periphery of covers shall be dogged and gasketed. The covers shall be smooth on bottom and oiltight, with the bottoms recessed for overhead stowage of portable cargo oil heating coils. They shall be fitted with a mechanism to secure the coils in the stowed position when dry cargo is carried and lower them to the bottom when oil cargo is carried. The tops of the covers shall be pitched from centerline for drainage. The entire assembly shall be sufficiently rugged to ensure watertightness from without and oiltightness and gastightness from within under the most extreme dynamic conditions.

Covers shall be rolled outboard by mechanical or hydraulic means. The gaskets shall be protected from excessive compression, from abrasion when opening and closing and from cargo damage when hatches are open. The securing dogs shall be quick-acting and designed for simple and rapid manual operation.

Hatch covers shall be fitted with means for ullage, butterworthing, venting, and trimming as necessary.

(f) Feeder Hatches (Alternate for OBO Ships)

Watertight feeder hatches shall be fitted over the upper wing tanks intended for grain stowage. Feeder openings shall be fitted along the lower edge of the wing tank bulkheads to allow grain to feed into the center holds during grain unloading operations. These openings shall be covered by oiltight bolted plates when other cargo or ballast is carried.

4.5. ACCESS HATCHES

Covers shall be complete with gaskets, dogs, ring bolts and spring counterbalance for lifting, and steel rests with positive holdbacks for the open position.

All other access hatches shall be as shown on the Contract Drawings, with coamings, oiltight, watertight, or non-tight covers as required. Hinged covers shall be complete with gaskets, dogs, ring bolts, counterbalance for lifting and be so arranged that they will be secure from falling or moving in any condition of service.

4.6. MANHOLES

Manholes shall be provided for access to all tanks, voids, and other spaces without previously specified openings, in location and of the type that the spaces may require. Access to potable water tanks shall be through bulkheads, and access to other tanks from the deck over.

Manholes shall be oiltight, watertight, or non-tight, as required, with a minimum of 380 mm x 585 mm clear opening.

Bolted watertight and oiltight manholes shall be per ASTM F1142, "Manhole Cover Assembly Bolted, Semi-flush, Oiltight, and Watertight" or ASTM F1143, "Manhole Cover Assembly, Raised, Oiltight, and Watertight".

Hinged watertight and oiltight manhole, shall be per ASTM F1144, "Manhole Cover Assembly, Bolted Hinged, Semi-Flush, Oiltight, and Watertight".

In weather-exposed locations, studs shall be of stainless steel and nuts of bronze. Tank cleaning openings in Weather Deck shall have stainless steel studs and bronze nuts of the cap type. Gaskets shall be provided for all manholes. Gaskets for watertight manholes shall be neoprene, oiltight shall be cork/rubber.

4.7. SCUTTLES

A 460 mm diameter watertight scuttle, with rollers, operable from both sides, shall be fitted on Weather Deck over each rope stowage space.

SECTION 5

HULL FITTINGS

5.1. AIRPORTS, FIXED LIGHTS, WINDOWS

(a) General

All glass shall be heat treated and shall be readily replaceable aboard ship, and shall be in steel frames. All fixed rectangular windows shall be per ISO 3434, "Shipbuilding and Marine Structures - Heated Glass Panes for Ships' Rectangular Windows", and shall be tested and certified as passing IMO Fire Test A.754. Dead lights and black out curtains shall be fitted as required. Provide a watershed over all exterior windows.

(b) Fixed Lights and Airports

No fixed light is to be fitted in a position so that its sill is below a line drawn parallel to the freeboard deck at side and having its lowest point 2.5 percent of the breadth above the load waterline, or 500 mm whichever is greater.

Fixed lights in doors shall be 250 mm in diameter. Fixed lights elsewhere and airports shall be 400 mm in diameter. All shall be centered 1600 mm above finished deck.

(c) Windows

Windows shall be per ISO 3903, "Shipbuilding and Marine Structures - Ship's Ordinary Rectangular Windows".

Wheelhouse front windows shall be sloped aft at bottom at an angle of not less than 10° nor more than 25° for protection against reflections. These windows shall not be polarized or tinted. The opening type windows shall be weathertight, by use of dogs if necessary. Vertical sliding windows shall be fitted with window pockets of non-corrodible material and shall have operating gear, portable cover panels, and drains, as required. A minimum of three fixed windows, including the centerline windows, shall be electrically heated.

Fixed windows similar to those in adjacent bulkheads shall be fitted in Wheelhouse doors. Door windows and adjacent bulkhead windows shall line up when doors are open.

Windows on passenger vessels facing survival craft or in way of the lowering area shall be "A-60" windows, or otherwise satisfy Regulatory Body(ies) requirements.

Fixed and opening windows shall be similar in appearance.

Exterior windows elsewhere shall be similar in type to Wheelhouse windows.

5.2. WINDOW WIPERS

Standard marine type automatic window wipers shall be fitted on the heated Wheelhouse windows. A window washing installation capable of providing fresh water spray or anti-freeze solution shall be provided for each wiper-equipped window.

5.3. LADDERS AND STAIRWAYS

(a) General

Ladder and stair tread spacing shall be approximated according to the following formula:

2R + 6/7T = 600 mm, where:
R = riser height in millimeters and
T = projected tread depth in millimeters

Clear width of exterior inclined ladder treads shall not be less than 600 mm and the slope shall not be greater than 50° except at the ends of the ship where necessary and upon approval by the Owner.

Interior stairways, lifeboat, and life raft embarkation ladders, and pilot ladders shall be according to regulations. Lifeboat ladders shall be provided such that a person in a stretcher can be easily embarked into the survival craft.

Machinery space ladders shall be as specified in SECTION 79.

A minimum headroom of 2000 mm shall be maintained over ladders and stairways.

(b) Accommodation Ladders

The accommodation ladders shall be per ISO 5488, "Shipbuilding - Accommodation Ladders". The accommodation ladders shall be long enough to reach 750 mm above light operating draft at an angle of 50° and shall have upper platforms of the 180° rotating type, feathering or curved non-skid type treads, and all other equipment necessary for operation. Winch controls for power operation shall be located so operator has clear view of ladder overboard.

The ladders and all practicable fittings shall be aluminum, with non-skid grating for the walking areas. Shafts, bolts, and miscellaneous hardware shall be stainless steel. Dock roller shall be extra heavy galvanized steel pipe.

(c) Inclined Ladders

Inclined ladders shall be of steel, bolted to the structure so as to allow relative motion between supporting fastenings at head and foot. Where they are attached to deck coamings, the coamings shall be cut away to eliminate a tripping hazard. Inclined ladders over stowage spaces or over other inclined ladders shall have metal shields underneath.

Safety treads as specified in SECTION 6 shall be provided, except in tanks.

(d) Vertical Ladders

Steel vertical ladders shall be provided under escape windows and airports as necessary, elsewhere for access as necessary, and as shown on the Contract Drawings. Where practical, they shall be staggered from deck to deck.

Vertical ladders shall be constructed per ASTM F840, "Standard Specification for Ladders, Fixed, Vertical, Steel, Ship's", Type 1. Where subject to damage in cargo holds, ladders shall be per ASTM F840, "Standard Specification for Ladders, Fixed, Vertical, Steel, Ship's", Type III.

Where practicable, ladders may be constructed of separate rungs per ISO 9519, "Shipbuilding and Marine Structures - Rungs for Dog-Step Ladders" and welded to the structures. All vertical ladders shall be bolted in place except for individual rungs welded to the structure. All vertical ladders and individual rungs shall have at least 125 mm of toe room.

Ladders in chain locker shall consist of 150 mm diameter semicircular footholes in the divisional bulkhead, spaced 230 mm horizontally and 300 mm vertically, staggered. Other alternative access will be considered.

Hand grabs shall be provided in way of all access manholes, as necessary.

(e) Cargo Hold Ladders (for General Cargo Ships)

There shall be one vertical ladder at each end or at each side near the end of each cargo hatch just clear of the hatch opening, and in each hatch trunk, in diagonally opposite corners extending in an unbroken vertical line to bottom of hold. They shall be per ASTM F840, "Standard Specification for Ladders, Fixed, Vertical, Steel, Ship's", Type II. Access shall accord with IMO Resolutions A.272 (VIII), "Recommendation on Safe Access to and Working in Large Tanks" and A.330 (IX), "Recommendation on Safe Access to and Working in Large Cargo Holds of Bulk Carriers".

(f) Cargo Hold Ladders (Alternate for OBO Ships)

Vertical access ladders in holds shall be 20 mm square or round bar rungs recessed in transverse bulkhead vertical flutes to preclude damage by bulk cargo handling equipment, and welded to the structure.

(g) Cargo Hold Ladders (Alternate for Bulk Oil Ships)

Access to cargo oil tanks shall be by inclined ladders with intermediate non-skid platforms.

(h) Pilots' Ladders - Hoist or Manual

(1) Where freeboard at minimum operating draft is 9000 mm or greater, two portable powered pilots' ladders shall be provided to be fitted port and starboard on permanent platform locations. They shall have suitable protected stowages located as near to the platform locations as possible. The pilots' ladder shall be per ISO 799, "Shipbuilding - Pilot Ladders", or,

(2) A manual ladder shall be provided as per IMO Resolutions A.667 "Pilot Transfer Arrangements".

(i) Stairways, Platforms, and Landings

Stairways, platforms, and landings shall be as shown on the Contract Drawings.

5.4. RAILS

Railings shall be located as shown on the Contract Drawings and as required and be per ISO 5480, "Shipbuilding - Guardrails for Cargo Ships".

Railings, stanchions, and associated fittings in exterior and utility spaces shall be galvanized steel, except within 3000 mm of the compass, where they shall be non-magnetic material. Rails in interior accommodation areas shall be anodized aluminum tubing or architectural vinyl covered type.

Portable guard rails of 10 mm closed link chain and stanchions shall be provided around all low coamings or flush hatches, and elsewhere as necessary for protection of personnel.

Stowage shall be provided in areas served, for portable rails and stanchions. Stanchion sockets shall have weep holes.

Round bar railings and hand grabs shall be provided in way of all gear aloft.

Rails shall be turned around corners. Access openings shall be provided as required. Single-course rails shall be fitted on both sides of inclined ladders and stairways. A single rail shall be provided around the steering gear.

Storm rails and hand grabs shall be fitted to bulkheads in all exterior and interior passage areas, and elsewhere, as necessary. Railings shall be on both sides of passage 2000 mm or greater in width or when railing on one side of passage is interrupted by doors, and interferences.

5.5. MOORING FITTINGS

Mooring fittings shall be provided as shown on the Contract Drawings and shall be of steel construction. Bearing surfaces shall be smooth to minimize wear on rope. Rollers shall have stainless steel pins, grooved bronze bushings, and be fitted for pressure grease lubrication.

Towing bitts as required shall be recessed in the hull and located port and starboard on the bow and on the quarter above the deepest load line so that tugs and/or barges may tie up in mooring and bunkering operations and lines will have a minimal vertical component. (Number and location shall be as required for specific operation.)

5.6. PADEYES

Padeyes shall be provided on Weather Decks as necessary for securing deck cargo. They shall also be provided as required for cargo handling, access to and maintenance of cargo gear, handling propellers and rudder, handling gangways, over provided machinery and for handling heavy equipment in way of Store Room access hatches, and elsewhere as necessary for securing or lifting purposes.

Padeyes shall be steel and shall be of strength to the purpose intended, except that those in close proximity shall all be of equal strength for interchangeability.

5.7. CLEATS AND STOPPERS

Cleats and/or stoppers shall be provided as required for securing cargo handling running rigging, store handling running rigging, halyards, nets, service craft alongside, and for other general deck use. Cleats shall be per ASTM F1074, "Standard Specification for Cleats, Welded Horn Type".

5.8. RAMPS

Portable steel ramps shall be provided in way of side ports, refrigerated cargo space doors, ship store space doors, and other irregular deck spaces where lift trucks or other wheeled vehicles are used. Surfaces shall be non-skid, and the structure shall be designed for the greatest load contemplated. Tackle shall be provided for handling, if necessary. Means for securing in place when in use and stowage near in-use location shall be provided.

SECTION 6

DECK COVERINGS

6.1. GENERAL

The Contractor shall provide deck coverings per the Schedule of Deck Coverings herein.

Prior to the installation of any deck covering, all steel installations shall have been completed, tested, and the decks cleaned so as to be free of all rust, scale, dirt, grease, and all other extraneous matter.

Preparation of surfaces and use of underlayment to receive deck coverings (including safety treads) shall be per the manufacturer's instructions. Deck coverings (including cove base) shall be provided per the manufacturer's instructions for the intended environment.

Prior to procurement of the deck coverings the Contractor shall provide the Owner with samples of coverings from which the Owner can make specific selections.

Coverings of ceramic tile, latex mastic, vinyl composition, or other similar materials shall have a minimum 100 mm high cove base suitable for the use environment around all boundaries.

Deck painting shall be per SECTION 14.

Deck covering shall be adequately protected so as to prevent wear or indentation prior to ship delivery.

6.2. GRATINGS

Steel gratings shall be galvanized, with a maximum height of 25 mm.

Wood gratings shall be slatted type, made of Douglas Fir, oak, ash, or maple, with chamfered edges, with a max. height of 50 mm. Fastenings shall be of corrosion resistant material.

Fiberglass gratings shall have a maximum height of 40 mm, and shall have a highly slip-resistant walking surface.

Aluminum gratings shall be constructed of 6063-T6 aluminum alloy, with a height of 50 mm.

Non-steel gratings shall not be used in spaces where their failure could hinder escape or firefighter access.

Each section of portable grating shall be easily handled and shall be permanently marked as indicated in location diagrams, metal photo or equal, which shall be provided.

Gratings shall be constructed so as not to tilt when one corner is stepped on.

6.3. UNDERLAYMENT

Underlayment shall be approved by the Owner. Thickness for ceramic tile shall not exceed 6 mm except where necessary to provide slope in finish covering for proper drainage. A slope as recommended by the manufacturer shall be provided for drainage. Thickness for resilient coverings shall be 6 mm nominal. (Form a smooth surface and prevent irregularities which would cause wear points in the finished decking.)

6.4. CERAMIC TILE (NON-SKID)

Unglazed ceramic mosaic tile shall be non-skid type of approximately 6 mm thick by 150 mm square. It shall be provided over an approved underlayment to which it is attached by an adhesive, both of which are acceptable to the tile manufacturer. A ceramic cove base of a minimum 100 mm high shall be provided around all boundaries. Portland cement, or equal, grout shall be used, with the grout sealed after curing.

6.5. QUARRY TILE (NON-SKID)

Quarry tile shall be a non-skid type of approximately 13 mm thick by 150 mm square, with a minimum 100 mm high cove base around all boundaries. The tile shall be provided over an approved underlayment to which it is attached by an adhesive, both of which are acceptable to the tile manufacturer. Portland cement, or equal, grout shall be used, with the grout sealed after curing.

6.6 TERRAZZO TYPE EPOXY

Epoxy shall be trowel applied, minimum 6 mm thick, non-skid, resin system consisting of a two component epoxy resin binder and properly graded marble aggregate, finished with clear resin coats. A cove base of the same materials and minimum 100 mm height shall be provided around all boundaries. An underlayment shall be provided as recommended by the manufacturer of the epoxy.

6.7 LATEX MASTIC

Latex mastic shall be a trowel applied, minimum 6 mm thick, system consisting of resin mixed with dry components, properly graded aggregates, and mineral oxide pigments. A cove base of the same materials and minimum

100 mm height shall be provided around all boundaries. An underlayment shall be provided as recommended by the manufacturer of the latex mastic.

6.8. VINYL TILE

The vinyl tile shall be 3 mm thick.

6.9. CARPET

Carpet that is acceptable to Regulatory Body(ies) shall be provided over a 19 mm thick fire retardant urethane cushion.

6.10. STAIR TREADS

Treads on interior stairways shall be covered with resilient deck material similar to that on adjoining decks. Tread edges shall have nosings of cast aluminum, non-skid, abrasive filled.

6.11. SAFETY TREADS

Commercially available safety treads shall be of the fiberglass reinforced resin or metal abrasive insert type. Each shall be weather resistant with a non-skid surface. Treads shall be located at the head and foot of all inclined ladders, both sides of entrance doors having coamings, in way of all refrigerated space doors, and approximately the entire area of each step on inclined ladders. One tread shall be provided in way of the above doors on each side which shall be 150 mm deep, the full width of the doors and located to suit traffic conditions. Treads shall not be provided where non-slip material, i.e., rubber matting, gratings, or where a non-slip decking is required. The fiberglass treads shall consist of three plys of Fiberglass No. 1000 cloth bounded by a fire-retardant resin, with each ply being impregnated on its upper surface with aluminum oxide. The treads shall be adhered to metal by applying an approved epoxy adhesive to all faying surfaces.

6.12. RUBBER MATTING, RIBBED

Rubber matting of commercial grades of proven performance shall be provided in front and rear of all switchboards, control consoles, group control boards, and over deck areas on which personnel stand when servicing or turning energized electrical equipment or when shock hazards exist. A 1 m wide runner, minimum 5 mm thick, shall be provided in the athwartship walkway at the forward part of the Wheelhouse.

6.13. SCHEDULE OF DECK COVERINGS

Baggage Room Bridge Wings Butcher Shop	Paint/aluminum grating

Captain's Office (Day Rm.)	
Captain's Stateroom	Carpet
Central Control Room	
Chart Room - Separate from Wheelhouse	
Chief Engineer Office (Day Rm.)	Carpet
CO_2 Room	Paint
Crew's Mess	Vinyl Tile
Officers' Dining Rm.	
Emergency Gen. Rm.	
Fan Rooms	Paint
Galley and Scullery	Quarry Tile
Gyro Rm.	
Hawser Rm.	
Hospital	Latex Mastic
Laundries	Latex Mastic
Lockers	
Battery	
Bosun's	
Deck	Latex Mastic
Gear	Latex Mastic
Linen (clean or dirty)	Paint
Oilskin	Paint & wood gratings
Service	Paint
Lounge (Officers')	Vinyl Tile
Passageways in Accommodation Areas	Vinyl Tile
Passageways in Service Areas	Paint
Radio Rm.	
Recreation Rm.	
Crew	Vinyl Tile
Officers'	Vinyl Tile
Reefer Stores	Paint & Alum. Grating
Resistor Rooms	
Shops	
Deck Maintenance	
Electrical	Paint & Matting
Slop Chest	
Staterooms	
Crew	Vinyl Tile
Officer	Vinyl Tile
Store Rooms	Paint and Aluminum gratings in way of shelving
T/S	
Crew	Terrazzo Type Epoxy
Officer	Terrazzo Type Epoxy

Stevedore	Terrazzo Type Epoxy
Wardrobes, Off. & Crew	Vinyl Tile
Wheelhouse	

SECTION 7

INSULATION, LININGS, AND BATTENS

7.1. INSULATING MATERIALS AND INSTALLATION

(a) Insulating Materials

Insulating materials shall be approved by the Owner, and shall satisfy Regulatory Body(ies) requirements.

(b) Installation, General

All blanket or fibrous type insulation material shall be impaled on welded studs, spaced on not over 300 mm staggered centers and a maximum of 75 mm from the edge of the insulation and held in place by "speed clips", or approved equal.

Where polystyrene, polyurethane, cellular glass board or block is installed in more than one layer, each following layer shall be staggered and hard against the preceding layer, bedded and jointed with adhesives per insulation material manufacturer's recommendations.

7.2. INSULATION AND SHEATHING, TANKS

The dry cargo hold side of distilled water tanks, cargo oil tanks, and fuel oil settling tanks shall be sheathed with 50 mm (nominal size) thick construction grade lumber fastened on 100 mm face of 50 mm x 100 mm (nominal size) sleepers. Sleepers shall be securely bolted to clips welded on bulkhead. Mineral fiber, blanket type insulation shall be provided to completely fill spaces between the sleepers. Wood sheathing shall be covered with 2 mm galvanized sheet steel.

Vertical surfaces of water tanks and fuel oil settling tanks shall be sheathed and insulated with approved hard faced thermal fibrous glass insulating board similar to machinery space insulation.

Horizontal surfaces or decks over water tanks or fuel oil settling tanks shall be provided with equivalent insulation having sufficient load bearing characteristics as within accommodation and service spaces.

Decks over liquid cargo tanks shall be provided with equivalent insulation. Piping and ventilation lines serving liquid cargo spaces shall be insulated in way of runs in adjacent dry cargo spaces to limit heating effects to an acceptable value.

7.3. INSULATION, VENTILATION, AND AIR CONDITIONING DUCTS AND PIPING

Insulation of vent and air conditioning ducts and piping shall be as required by SECTIONS 12 and 75 of these Specifications.

7.4. INSULATION, REFRIGERATED SPACES

(a) General

Refrigerated spaces shall be insulated so as to maintain the specified temperature with an outside temperature of 38°C and without sweating on the warm side exposed surfaces of decks, bulkheads, or shell in way of the refrigerated spaces, at a relative humidity of 80 percent over an ambient air temperature range of 4°C to 38°C in still air.

Where insulation is provided on stiffener side of decks or bulkheads, the thickness of insulation in way of stiffener flanges shall be at least the thickness required to prevent condensation on warm side under design conditions. Deep structural members shall be boxed with insulation.

The framing for each side of division bulkheads between refrigerated compartments shall be made independent of that for the other side by staggering supports. Single through framing is not permitted.

(b) Refrigerated Space Doors

Refrigerated space doors shall be as specified in SECTION 4.

(c) Hangers, Rods, Hooks, Shelving, and Spacers

Hangers, rods, hooks, shelving, and spacers shall be supported on insulated flat bars in such a way that no load is placed on the sheathing.

(d) Thickness of Insulation

The minimum insulation thickness for the respective refrigerated space boundaries shall be per the Contractor's practice.

(e) Decks

The decks of each compartment shall be coated with an approved asphalt emulsion prior to providing the first course of either cellular glass, polyurethane or polystyrene material. The top of each course, including the final course, shall be coated with asphalt emulsion per manufacturer's recommendations. The asphalt emulsion shall be suppressed odor type which will not affect butter and other odor sensitive products adversely. The insulation shall extend up the vertical sides 450 mm above the final thickness of decking and be flush with the full thickness of the vertical insulation. The final layer of insulation shall be completely coated with asphalt emulsion prior to laying down a 3-layer vapor seal membrane of 6.7 kg felt paper. Each layer of paper shall be laid down with overlapping joints and provided with asphalt emulsion and flashed 450 mm up the sides. The finished decking over the felt paper shall be a 50 mm layer of mastic composition coved up the sides a height of 150 mm and reinforced by 50 mm x 50 mm x 2 mm galvanized wire mesh. The mastic mix shall be allowed to set thoroughly before the refrigerated spaces are pulled down in temperature. A 150 mm high coved curbing shall be provided in way of Cooler Room cribbing.

In way of deck drains, a 3 kg lead sheet approximately 0.5 m^2 shall be inserted between the layers of felt paper and soldered watertight to the deck drain.

(f) Bulkheads, Linings, and Overhead Ceilings

For bulkheads and deck overhead the insulation shall be of material specified in SECTION 7.1.(a) herein. This insulation, together with lining and ceilings, shall be supported by a system of fire retardant furring and framing. The furring and framing shall be Douglas Fir, Construction Grade, either air or kiln dried. The thickness, width, and length of furring and framing shall be as developed, bolted to 6 mm flat bar clips welded to steel structure or webs of frames, stiffeners, or deck beams. This furring shall be treated to retain a minimum of 1.6 kg dry salt retention per cubic meter of lumber. Fastenings such as but not limited to bolts, lag screws, wood screws, and hardware, shall be inorganic zinc coated and be isolated to prevent metal-to-metal contact between sheathing or framing and the structure.

Joints on finished reefer linings and ceiling shall be covered with 40 mm wide aluminum strips on flat surfaces, with 25 mm x 25 mm aluminum angles at corners, with 25 mm aluminum Z shapes at the bottom edge where the panel meets the coved base. The aluminum flat strips, angles and Z shapes shall be No. 16 gauge, fastened to the furring and framing with stainless steel screws.

Note: Alternate materials or joiner systems, including asbestos-free core products meeting the intent and requirements of this SECTION and which have been certified and approved by the Regulatory Body(ies), shall be acceptable.

(g) Refrigeration Spaces and Cooler Rooms

Each compartment or group of compartments shall be so insulated that it may operate at its specified temperature independent of all other compartments and without condensation on adjacent structure under the specified humidity conditions.

Insulated plugs, identified by permanent nameplates, shall be provided in way of manholes, concealed valves, or other fittings behind the insulation.

Divisional non-insulated steel surfaces of bulkheads and decks in refrigerated spaces shall be insulated for a minimum distance of 1 m from the shell, bulkhead or deck insulation. The 1 m ribband around the deck shall have 10 mm thick steel coaming bar welded to the deck. The space between the coaming bar and shell or bulkhead insulation shall be filled with 50 mm of approved insulation material and sheathed with wood planking sloped from 50 mm at the coaming bar to 75 mm at the face of vertical insulation.

Ribbands fitted on vertical uninsulated surfaces shall be sheathed with the linings specified in paragraph (f) of this article.

7.5. INSULATION, TEMPERATURE

All insulation thicknesses shall be per the Contractor's practice.

For insulation purposes, unheated spaces are considered to be those compartments with temperatures of 13°C or less and which form a common boundary to a heated space.

All living, working, and public spaces which have a common boundary with heat producing spaces shall be insulated on the heated side.

Boundaries between air conditioned and non-air conditioned spaces shall be thermally insulated. Where joiner bulkheads separate such spaces, insulation with double bulkhead construction shall be provided. Where structural steel bulkheads with joiner lining form the boundary, insulation shall be fitted. Decks between air conditioned and non-air conditioned spaces shall be fitted with insulation.

Boundary surfaces of all spaces including bathrooms and toilet and shower spaces, except Steering Gear Room, which are heated or air conditioned, as provided for in SECTION 12, and which are exposed to the weather or are adjacent to unheated spaces shall have such exposed portions covered with thermal insulation material. The insulation shall cover the inside surface of the bulkhead and overhead plating and shall extend at least 300 mm beyond the exposed area.

Galley and pantry deckheads and vertical surfaces, including beams and stiffeners shall be insulated.

Machinery space deckheads and vertical surfaces including beams and stiffeners in the Engine Room as well as in the casing shall be thermal insulated. Shell insulation shall be provided from the deckhead down to the next deck level, generally the 2nd Deck and further extended to 915 mm below that line. Forward and aft Engine Room bulkheads shall be insulated to suit requirements of adjacent spaces.

The machinery space shall be insulated with approved hard faced thermal fibrous glass insulation board.

7.6. FIRE SAFETY INSULATION

Insulation shall be fitted to suit the Regulatory Body(ies) requirements for fire safety within accommodation areas, control stations, and service areas. Joiner bulkheads, linings, and ceilings, as well as insulating materials, shall be of approved non-combustible material.

7.7. INSULATION, ACOUSTICAL AND SOUND

Sound absorption shall be provided in Passenger Public Rooms, Wheelhouse, Mess Rooms and Lounges, Lobbies, and similar spaces.

In addition to absorption of sound originating within Public Rooms and similar spaces, provision shall be made to attenuate the transmission of sound through decks in the accommodation area to a comfortable level. Also, the transmission of sound between adjacent Staterooms of all types or between Staterooms and passageways shall be attenuated to the level required for privacy at normal conversational levels with particular attention to blocking the transmission of sound over the tops of bulkheads through the space between ceiling and the deckhead. Sound attenuating ventilation ducts shall be employed as necessary, in addition except where fire insulation is required.

Sound levels are given in SECTION 1.7, Vibration and Noise.

7.8. SHEATHING

(a) General

Sheathing of insulating board or sheet metal shall be attached to all surfaces required to be insulated on the face of frames and stiffeners or to a system of steel furring in an approved manner. Deckheads which are partially insulated shall be completely sheathed to present a uniform appearance.

Portable sections of sheathing shall be provided where required for accessibility in way of wiring, ducts, piping, air conditioning controls, filters at unit air conditioners, and other accessories. They shall be hinged and fitted with quick acting catches where frequent access is necessary, and clearly labeled as to the concealed equipment.

(b) Insulating Board

For joiner linings and ceilings, see SECTION 25.

(c) Sheet Metal

Where sheathing and insulation are subject to damage in machinery spaces, heat producing spaces, laundries or other spaces not otherwise covered herein, the sheathing shall be of galvanized sheet metal, lap jointed and sealed with an approved seam sealing compound. Vertical surfaces (linings) shall be 1.5 mm, horizontal surfaces (ceilings) shall be 0.8 mm for interior locations and 2 mm where exposed to weather.

Galley and pantry spaces shall be sheathed with satin finish stainless steel. Linings shall be 1.5 mm and ceilings shall be 0.9 mm.

7.9. BATTENS AND SPARRING

(a) Dry Cargo Spaces

Cargo battens shall be of Douglas Fir or Western Hemlock, Construction Grade. Battens shall be 50 mm x 150 mm nominal size, dressed four sides. Corners shall be chamfered. They shall be fitted horizontally, spaced 380 mm on centers, except where shape of hull makes vertical battens necessary.

(b) Storerooms

Shelving shall be provided in a manner permitting proper air circulation. In way of bulkhead mounted cooling coils, battens shall be provided to permit air circulation and to keep stowed items, other than shelf stowage, clear of coils.

All Storerooms shall have vertical wood sparring 75 mm x 75 mm nominal size, finished, spaced 230 mm on centers on bulkheads and shell except where the construction of bins and shelving is such as to prevent contact of stores therewith.

Deck gratings where noted shall be as specified in SECTION 6.2.

(c) Refrigerated Spaces

Vertical battens of Douglas Fir, 50 mm x 75 mm nominal size, finished, spaced 410 mm on centers shall be provided on the lining of all refrigerated spaces to prevent stowage contact with the lining and to permit proper circulation of cooling air. Shelving shall be fitted so as to permit proper air circulation. Battens shall be mounted with flush screws, or screw recess shall be plugged.

Shifting battens in Storerooms shall be spring loaded adjustable aluminum type (which fit into aluminum portable gratings on deck and expanded metal at overhead).

(d) Cooler and Diffuser Rooms

Vertical portable cribbing between Cooler Rooms and refrigerated cargo spaces shall be clear Douglas Fir 50 mm x 150 mm nominal size, finished, on edge on 200 mm centers.

SECTION 8

KINGPOSTS, BOOMS, MASTS, AND DAVITS

8.1. GENERAL

Kingposts, booms, masts, gaffs, staffs, and davits shall be as shown on the Contract Drawings and per applicable Regulatory Body(ies) requirements.

As hereinafter referred to, light booms shall be those mounted on kingposts port and starboard and heavy lift booms shall be those mounted on the ship centerline.

The design of cargo gear shall take into consideration a 5° list for light gear and a 10° list for heavy lift gear. The trim for all gear shall be the maximum practicable for the ship in an undamaged condition.

The light booms shall have at least 6000 mm outreach over the extreme beam of the ship when topped at 35° opposite the near quarter length of the hatch, and a minimum vertical hook clearance of 7500 mm above all obstructions whether rigged for swinging or burtoning. When rigged for burtoning (with hook at specified clearance) the angle between hoisting purchases shall not exceed 120°.

The heavy lift boom shall have at least 4500 mm outreach over the extreme beam of the ship when topped at 35° opposite the near quarter length of the hatch.

All moving parts shall be fitted for pressure-grease lubrication (see SECTION 1), or shall be fitted with pre-lubricated, sealed anti-friction bearings and grease retaining seals of a type proven in service. Lubrication fittings shall be accessible when the gear is in its normal stowed position or normal maintenance position. The quantity of lubrication fittings requiring servicing aloft shall be held to a minimum.

8.2. KINGPOSTS AND VANG POSTS

Kingposts shall be freestanding under all design loading conditions. Kingposts and top trusses shall be of the most efficient shapes practicable, with minimum weight and/or lowest center of gravity.

Kingposts, when used as ventilators, shall be provided with drip pans fitted with drain lines under and around the bottom to trap moisture.

Where vang posts are required they shall be designed to the same standard as kingposts. They may be incorporated in the bulwark structure and shall not obstruct the Deck Cargo stowage area.

8.3. BOOMS AND FITTINGS

(a) Booms

Every effort shall be made to arrange stowage of heavy lift booms in a vertical position with hooks and lower cargo tackle secured at deck level.

Cargo booms shall be of the most efficient and lightest sections and shall be standardized for interchangeability where practicable.

(b) Boom Steps

Boom steps for light booms shall be steel of the bracket flanged hanger type, with gooseneck and pin. Goosenecks shall be offset type, of extra heavy forged steel. Offset shall be sufficient to overcome binding in the boom step at extreme positions. A means shall be provided on the gooseneck assembly for the attachment of the self-adjuster heel block. Pivot pins shall be steel, and bushings shall be bronze.

The heavy lift boom shall be mounted on a steel pedestal at centerline of ship. The gooseneck pin shall be steel and shall be seated on and supported by self-adjusting anti-friction bearings. A ball type gooseneck arrangement will be acceptable to provide transverse freedom of movement if required.

(c) Boom Rests

Boom rests with linings and positive securing devices shall be provided.

The heavy lift boom shall normally stow vertically with its rigging, except it will be lowered to the deck when being serviced.

8.4. MASTS

Masts, yards, spreaders, and gaffs, with platforms and brackets shall be provided as necessary for all navigation, communication, and signal equipment. They shall be of steel pipe and plate and be designed to be completely self-supporting with all equipment in place.

8.5. JACK AND ENSIGN STAFFS

The staffs shall be constructed of galvanized steel pipe and shall be hinged at the deck. They shall be fitted with trucks of halyard sheaves, light brackets, cleats, braces, and any other necessary fittings.

8.6. DAVITS

Portable davits shall be fitted as shown on the Contract Drawings, with provisions for stowage in the area of use. The davit at the bosun's store hatch shall be of at least 450 kg capacity.

Davits shall be provided as required for handling accommodation ladders, and shall stow flush with the hull when not in use.

SECTION 9

RIGGING AND LINES

9.1. GENERAL

All rigging and pertinent fittings shall be provided for the masts, kingposts, topmasts, radar masts, booms, davits, radio antennas, signal stays, portable "towing" and "not under command" lights, and emergency hatch cover, refueling hose, and accommodation ladder handling, and other equipment, to produce a thoroughly workable installation complete for the service intended and as necessary to facilitate maintenance and repair. All cargo rigging except the heavy-lift gear shall be rigged for single whip burtoning before delivery of the ship.

9.2. RUNNING RIGGING

Wire rope for cargo hoists except heavy lift shall be 6 x 37, black preformed improved plow steel. Wire rope for topping lifts, vangs, schooner guys and heavy lift hoists, shall be 6 x 37 preformed improved plow steel, galvanized or aluminized. Fixed length pendants shall be 6 x 19 galvanized or aluminized improved plow steel.

Cargo hoists shall be of sufficient lengths to reach all areas of the lowest holds served, with a minimum of four turns of wire rope remaining on the winch drums.

Topping lifts shall be capable of topping the booms under load. Vangs and schooner guys where used shall be capable of positioning and swinging the loaded booms and restraining them during burtoning operations. A minimum of four turns of wire rope shall remain on the winch drums, with the booms in any extreme working, maintenance, or stowed position.

9.3. BLOCKS

(a) General

Blocks shall be of the best commercial marine quality.

All straps and connections shall be forged steel. Non-wearing ferrous surfaces shall be galvanized. Wire rope blocks shall have steel shells and sheaves. Sheaves shall be at least 15 times the rope diameter and shall be shrouded to keep the rope in place at all times. Blocks shall be marked as required.

Forged steel links, shackles, swivels, beckets, and other hardware, shall be fitted.

(b) Light Booms

Blocks for cargo falls shall have pressure-greased roller bearings. Blocks for other running ropes shall have pressure-greased bronze bushings. Where doubling-up of cargo falls is anticipated, cargo blocks shall be of the deep throated type to allow passage of a spliced eye over the sheave. Lower cargo blocks shall have anti-toppling guards, and shall have sufficient weight to overhaul the maximum number of parts used with the block. Fairlead blocks shall be fitted with anti-toppling features where required.

Fairleaders shall be provided where slack rope might occur.

Snatch blocks shall be positive locking. "Drop link" type is not acceptable.

(c) Heavy-lift Boom

All bearings shall be a suitable anti-friction type. Provision shall be made for pressure-grease lubrication, or pre-lubricated and sealed anti-friction bearings may be used if fitted with grease retaining seals of a type previously proven in service.

9.4. MISCELLANEOUS

All wire rope rigging not stowed in working position shall be stowed, fully protected from the weather, on galvanized reels of the frame and drum type, geared if necessary and fitted with hand brakes.

SECTION 10

GROUND TACKLE

10.1. HAWSE PIPES

Steel hawse pipes with built-in washdown system shall be provided for the anchors. Their design shall ensure positive starting of the anchors and overhaul of the chain upon release under ordinary conditions of list and trim. The anchor flukes shall be self-stowing whether the anchor is raised with the flukes inboard or outboard and shall have 3 point minimum contact for tight stowage in a seaway. Pipes shall have bolsters as necessary. Alternately, anchor chain fairlead rollers shall be fitted on deck with no deck bolster necessary. Surfaces subject to wear by chain shall be approximately the same hardness as the chain.

The tops of hawse pipes shall be provided with closely fitted, portable dogged metal covers to take green water impacts without deformation or dislodgement.

Shell plating to be reinforced in way of hawse pipes and to be fitted with heavy hawse pipe rings.

10.2. CHAIN PIPES

Chain pipes shall extend from the windlass bedplate to the approximate center of the chain locker, with large bellmouths on bottom and deck bolsters as supplied or recommended by the windlass manufacturer on top. The tops of the chain pipes shall be made as nearly watertight as possible by means of a cover with rubber gaskets and quick acting clamps.

10.3. ANCHORS

Approved Classification Society(ies) certified stockless anchors shall be provided, each with a bolt shackle. All anchors shall be of the same size. They shall be minimum weight allowable by the Classification Society(ies) for lightweight type, in lieu of tabular weight given under the numeral.

10.4. CHAINS

Anchor chains of high-strength steel stud link shall be provided in equal lengths, one for each anchor. The length of the chain and the grade of material shall be to Regulatory Body(ies) requirements. They shall be made up of 27.5 m shots joined together with kenter type joining shackles. The outboard shots of each anchor shall be provided with swivels and kenter type joining shackles for attaching to the anchor bolt shackles.

The bitter end of each chain shall be secured by a pin designed to carry away in shear at a load less than the breaking strength of the chain but greater than the proof load of the chain, without failure of any other member and without injury to or permanent deflection of the main hull structure. The pin shall be accessible from outside the chain locker for manual removal when all the chain is stowed, and the access plate shall be completely watertight.

Six spare kenter type joining shackles and two spare detachable anchor bolt shackles shall be provided.

See SECTION 14 for color marking of anchor chains.

10.5. CHAIN STOPPERS

Chain stopper pawls of the riding tongue type shall be provided designed to withstand the breaking strength of the chain. "Devil's claw" or scissors clamp chain stoppers shall also be provided, of a type that will not disengage in the event that the chains should slacken in a seaway.

10.6. HAWSER

Wire rope and/or fiber hawsers shall be fitted to mooring and first-line-ashore winches specified in the Machinery List. Additional fiber hawsers shall be supplied so that total number equals approved Classification Society(ies) recommendations.

Hawsers shall be synthetic braided or plaited non-hockling type. Each shall be provided with one end whipped and a large eye spliced in the other end. Rope diameter to be reduced, as allowed by approved Classification Society(ies), from the tabular value for manila.

Wire rope for constant tension winches shall be 6 x 37 IWRC galvanized or aluminized with characteristics and in quantity as stated in the Machinery List.

Two spring lines shall be provided. They shall be 6 x 24, or 6 x 3 x 19 spring lay, improved plow steel, preformed and galvanized or aluminized of sufficient strength for the application.

10.7. RAT GUARDS

Rat guards per ASTM F1099, "Rat Guards, Ships" shall be provided for each hawser and spring line.

10.8. HEAVING LINES

One nylon heaving line with leather covered weight attached to one end and the other end whipped, shall be provided for each hawser and spring line.

10.9. STOWAGE

Spare anchor, if carried, shall be stowed in chocks on Weather Deck, preferably in a vertical position against a bulkhead, secured in place by bolted flat bars. Lashings will not be acceptable. 5

Stowage of rope and other equipment shall be as specified in SECTION 23.

SECTION 11

PIPING - HULL SYSTEMS

11.1. GENERAL

All piping systems covered by this SECTION shall be complete with the necessary valves, fittings, and appropriate hardware, for proper operation, including a sufficient number of flanges or unions to facilitate removal, and as approved by Regulatory Bodies.

All piping shall be concealed in accommodation spaces having ceilings and sheathing, except normally exposed piping to fixtures, and shall be kept to a minimum. In order to maintain maximum headroom, all piping shall be kept behind framing and as close as practical to deck beams, bulkheads, and the underside of decks.

Pipes conveying steam or liquids shall not be led overhead through the Emergency Generator Room, Chart Room, Battery Lockers, Radio Room, Refrigerated Spaces, Stores, Dry Cargo Holds or in the vicinity of Switchboards; nor pipes conveying liquids, in food preparation spaces, Mess Rooms, Dispensary, and similar spaces, where avoidable. Where this is not practical, the piping shall have all joints welded or brazed.

All piping subject to mechanical injury shall be adequately protected. All guards shall be bolted in place so that they may be removed for repairs to piping.

Flexible couplings may be used in lieu of flanges in overflows, plumbing, and deck drains.

See SECTION 74 for additional general requirements and SECTION 75 for insulation and lagging requirements.

11.2. SCUPPERS AND DRAINS

(a) General

Scuppers and drains shall be per ASTM F994, "Standard Specification for Design and Installation of Overboard Discharge Hull Penetration Connections".

All scupper valves shall be arranged to open and close in a fore and aft direction at the ship's side and shall be located for easy access for the removal of the clapper and hinge pin. Skin gate valves shall be located outboard of each scupper.

Swing check valves shall be provided at main watertight bulkheads in all drain lines passing through same. Where the drain line is within one-fifth of the beam of the ship from the ship's side, or if the drain line drains a space or fixture located below the bulkhead deck, a stop valve in addition to the swing check valve shall be fitted at the watertight bulkhead, and shall be operable locally and from above the bulkhead deck.

Sufficient deck drains of adequate size shall be provided and located to prevent water standing on the decks under ordinary conditions of list and trim.

Drains, unless otherwise noted herein, shall discharge overboard by gravity at the load waterline.

Deck drains shall be fitted with removable brass strainers having a free area of at least twice the area of the drain pipe. Strainers shall be adequately secured and shall be flush with the deck.

Drain pipes throughout the ship, except from plumbing fixtures, shall not be less than 50 mm Iron Pipe Size (IPS) except as noted herein.

A coaming enclosure, with deck drain(s), shall be provided around equipment which may have oil, sewage, or water leakage or spillage under normal operating conditions as required by Regulatory Body(ies).

All drain pipes shall be led as direct as possible. They shall be pitched to about 20 mm per meter when draining aft, 33 mm per meter when draining forward and 42 mm per meter when draining athwartship. They shall be provided with a sufficient number of accessible cleanout connections not less than 40 mm for clearing the drain pipes by use of plumber's snake, or with steam or water hose. Deck and fixture drain lines shall be arranged so as to provide positive drainage when the ship is under design conditions of list, up to 5° port and starboard, and trim at sea or in port.

In general, where drains are combined with other drains, "Y" or "TY" branches or fittings shall be used, where practicable, to facilitate flow. Branch connections to athwartship drains, which discharge to both sides of the vessel, shall be made at an angle of 90° and preferably by double sweep type fittings. Wherever possible, pipe bends rather than elbows shall be used.

Drain pipes from plumbing fixtures or deck drains combined with other drains located at higher elevation shall be fitted with non-return valves where necessary to prevent back flooding.

(b) Plumbing Drains

Drains from lavatories, showers, and sinks shall have traps and accessible cleanout connections. Two but not more than six adjacent lavatories may be fitted with one trap.

Drains from lavatories, sinks, showers, and drinking fountains, from spaces below the Main Deck, when not practical to drain overboard, shall drain to the marine sanitation device specified in SECTION 70.

The minimum size of all lavatory and drinking drains shall be 40 mm IPS.

Fixture and deck drains in spaces normally used for Dispensary or Hospital services shall be independent of other drains.

Soil pipes from water closets shall be independent of other drains and shall be collected in groups into mains; the mains being led to the marine sanitation device. Clean-out plugs shall be fitted as necessary, and sharp bends and pockets shall be avoided.

Where the length of run and the number of changes in direction are not excessive and satisfactory drainage will result, it will be satisfactory to connect water closets and urinals as follows:

2 - fixtures on a 80 mm IPS horizontal run

12 - fixtures on a 100 mm IPS horizontal run

30 - fixtures on a 125 mm IPS horizontal run

28 - fixtures on a 100 mm IPS vertical rise

(c) Interior Deck Drains

Space drains below the Main Deck, when it is not practical to drain overboard by gravity, unless otherwise noted, shall be provided with drain wells as required, or discharge to drain wells below. Drain wells shall be drained by the bilge system or salt water eductors.

Deck drains shall be provided in all Fan Rooms, Commissary spaces, refrigerated spaces, Garbage Room, Toilets, Showers, Toilet and Shower Rooms, air plenums, Laundry Spaces, entrance areas from the weather, enclosed spaces under outside ladders, Emergency Generator Room, Oil Skin Locker, sideport gutters, dumbwaiter pits, machinery space platforms, extreme ends of passageways on the 2nd Deck, and similar spaces where water may collect. Deck drains in all spaces indicated shall provide drainage in all areas under design conditions of list and trim. Drains from Fan Rooms, plenum chambers and other spaces with openings to the weather, which are not located in vicinity of weather or plumbing drain lines, shall spill on the deck via bulkhead check valves.

A drain shall be fitted to the lower end of masts and kingposts when used for ventilation. Drains shall be provided from ventilation ducts, where necessary.

Central air conditioning units and/or cooling coils in Fan Rooms shall be provided with drains. These drains shall be directly connected to plumbing drains and be fitted with a self-sealing trap, or shall discharge into an open funnel to a Fan Room deck drain. Drains shall be lagged to prevent condensation.

Window pockets shall be provided with 25 mm IPS normal impact rigid polyvinylchloride (PVC), or equivalent, drain pipe and fittings spilling on deck, outboard. The number of house drain penetrations shall be kept to a minimum.

Interior deck drains, which connect to drains from plumbing spaces, shall be trapped.

(d) Weather Deck Drains

The top of house deck drains shall be not less than 40 mm IPS. The scupper drain pipe on each lower deck shall be increased by 15 mm IPS over that of the deck above, with an 80 mm IPS maximum, except that the port and starboard deck drains just forward of the Main Deckhouse shall be 100 mm IPS. Drains from decks above shall be led to gutterways adjacent to scuppers where possible.

Deck fittings and strainer plates shall be a common size, for 80 mm pipe and smaller.

The total capacity of the drainage system shall be sufficient to drain all decks, without progressive accumulation of water, at a rainfall rate of 13 mm per hour.

Main Deck scuppers shall discharge overboard through 45° radius or mitered elbows, hot-dipped galvanized after fabrication, fitted in the deck stringer and shell sheerstrake. Weather Deck drains shall not connect with interior drains.

Provisions shall be made for drainage inside of catch-alls enclosing machinery on Weather Decks.

(e) Miscellaneous Drains

Deck drains shall be provided for efficiently draining the Steering Gear Flat, Bosun's Stores, Anchor Windlass Room, Hawser Room, Cargo Holds, Marine Sanitation Device space, Machine Shop, and similar spaces.

Hold drains shall employ flanged connections for easy removal for cleaning purposes.

The steering gear flat drains shall be combined into a single drain which shall be led to the oily bilge collecting tank.

Leakage from the rudder stuffing box shall be confined by a coaming and have a drain.

Flush removable strainer plates shall be fitted over drain wells and plates for blanking off drainwells when carrying liquid or bulk cargo shall be provided as required. The blanking plates shall be marked to identify the drainwell served and provisions made for rattle proof stowage of the plates, when not used, on the bulkhead adjacent to the drainwells on which fitted. Drain wells shall be located clear of stowage locations.

Other compartments, which are not practical to drain by suction or gravity, shall be drained by a hand operated salt water eductor equipped with a compound (press/vac) gage.

Drain piping, necessarily led through oil or water tanks, shall be extra heavy and fully welded within the tank. Provision for thermal expansion shall be provided.

(f) Refrigeration Compartments and Food Preparation Space and Equipment Drains

Deck drains for food preparation spaces shall be provided in number and location so that complete drainage is possible under normal conditions of list or trim. These drains shall not be connected with plumbing or deck drains from other spaces.

The garbage grinder drains shall discharge to the marine sanitation device. A vacuum breaker or other means shall be taken to avoid contamination.

Deck and equipment drains in food preparation spaces shall be trapped and shall have accessible cleanout plugs.

11.3. SOUNDING TUBES, VENTS, AND OVERFLOWS

(a) General

Sounding tubes, vents, and overflows shall be provided in locations as required by the Regulatory Body(ies).

All tanks, except fuel oil storage tanks which are subject to pump pressure, shall be fitted with independent overflows.

Sounding tubes shall be provided for all tanks including those having level indicators. Location of sounding tube shall be approximately the same as for level indicating device except where access is inadequate.

Where sounding, vents, and overflow pipes penetrate integral hull tank tops, flats, and decks, they shall be fitted with Schedule 80 sleeves at all locations where pipes are subject to damage from corrosion due to standing water or from physical abuse. Pipes shall pass through sleeves which are continuously welded on both sides of the plating. Sleeves shall extend 152 mm above and 25 mm below the plating. Pipes shall be continuously welded to the sleeve top and bottom.

Flanged take-down connections shall be provided in vent and overflow lines, in accessible locations for the fitting of blanks to isolate tanks for individual tank air-testing or for other reasons.

(b) Sounding Tubes

Sounding tubes shall be per ASTM F1386, "Standard Guide for Construction of a Sounding Tube and Striker Plate for Tank Sounding". The addition of small holes in piping inside of tank to prevent a back pressure shall be provided.

(c) Vent Pipes

The IPS of each vent pipe shall be not less than 65 mm for oil tanks, 50 mm for water ballast tanks and 40 mm for fresh water and reserve deep tanks, cofferdams, and voids. However, in no case shall the area of the vent pipe be less than 1300 square mm or 1/10 the area of the suction or pressure filling connection, whichever is greater.

Where practicable, vent pipes from tanks of a similar fluid shall be combined above the test head level of the tanks, into a common header with a single outlet to the atmosphere above the Weather Deck in protected locations. At least one flange connection shall be included before the common header to isolate tanks for testing.

Vent pipes common to two or more vents from the same tank shall be the same size as the largest branch. Headers common to two or more vents from tanks having common suction and filling mains shall not be less than 10 percent of the area of the filling main serving the tanks involved. Low point drains shall be provided.

Vents shall be fitted at the high points of standpipe overflows to act as vacuum breakers.

When necessary, the size of vent pipes shall be increased to compensate for long runs, bends, and other frictional resistance.

Except for headers, horizontal leads in vent pipes should be avoided and the inclination shall not be less than 30°. Both ends of headers shall be adequately drained to a tank.

A satisfactory system shall be provided for venting all drains from lavatories, drinking fountains and sinks, and other plumbing fixtures.

Water closets, lavatories, drinking fountains, and sinks shall be vented to the weather.

All soil pipes from water closets shall be vented. Vents from soil pipes for water closet or groups of water closets shall be not less than 50 mm internal diameter. Where practical, soil pipe vents shall be a continuation of the vertical drop of the soil pipe and shall terminate at the side of a Deckhouse above the Weather Deck or with a gooseneck in an unobjectionable exterior location. In addition to stack vents, water closets shall be back vented when necessary.

(d) Vent Terminals

Vent terminals above the Weather Deck shall terminate in the atmosphere with approved gooseneck fittings located so as not to interfere with equipment, cargo or boat handling and embarkation operations and shall not be located abreast of hatches. The number of vent terminals above the Weather Deck shall be kept to a minimum.

Vent terminal screens shall be well protected against mechanical injury and so arranged as to prevent painting of the mesh. The clear area through the mesh shall not be less than 150 percent of the area of the vent pipe for screens having 0.8 mm square openings and less. The clear area through other screens shall not be less than the area of the vent pipe.

Vents may be taken from the top of tank overflows but terminals shall not be used for the dual purpose of tank venting and overflow. All vents must extend above the top of overflows to a height where overflow cannot discharge through the vent terminals. All fuel oil tank vent terminals shall meet Regulatory Body(ies) containment regulations.

Automatic valves shall be provided at the terminals of vents that are liable to be washed by the sea, so arranged as to allow the ingress and egress of air and automatically close by action of the sea. Automatic valves will not be required on vent openings that terminate 2000 mm or more above the Weather Deck or inside enclosed spaces.

Vent terminals for oil tanks shall be fitted with double screens, which shall be removable for cleaning. The inner screen shall be light gauge non-corrodible wire. The outer screen shall be fitted 13 mm from the inner screen and shall have 6 mm square openings. Means for manual closing in case of fire shall be provided. All oil tank vents shall have a fitting that will prevent or trap the slug flow of oil during normal venting. Said fitting to be designed and constructed per Regulatory Body(ies) requirements.

Vent pipes for potable and distilled water tanks shall terminate above the test head of the tanks in ventilated service spaces, passageways, shops or similar spaces. The terminals shall be fitted with double screens which shall be removable for cleaning. The inner screen shall have 0.8 mm square openings. The outer screen shall be fitted 13 mm from the inner screen and shall have 6 mm square openings. Other water tanks shall vent in ventilated spaces above the test head level of the tanks or above the Main Deck to the atmosphere, and shall be fitted with a screen having 6 mm square openings.

All metal vent terminal screens shall be of non-corrodible wire.

Vent terminals which may emit objectionable odors or flammable volatiles shall terminate clear of airports and ventilation intakes, and openings to living quarters.

Where water closet vents terminate at the side of the Deckhouse, a horizontal one-half round pipe shall be welded to the side of the house to prevent wind blowing down the vent. The internal sectional area of the half-round pipe shall be equal to the area of the vent and the length shall be four times the diameter of the vent.

Vent terminals shall be suitably labeled to indicate the tank(s) or space(s) served.

(e) Overflows

Clean ballast tanks shall have independent overflows.

Fuel oil storage tanks shall have overflow piping directed to the aft most fuel oil storage tanks.

Overflows from potable, distilled, and reserve feed water tanks shall be led up to a height 1000 mm below the test head of the tank and discharge to the bilge via a visible open funnel or sight flow fitting located eye level above the deck.

The area of overflow pipes shall be sufficient to prevent the development of pressures (static and dynamic) in excess of the test head of the tanks, but shall not be less than 125 percent of the area of the tank filling connections.

11.4. EQUALIZER PIPES

Equalizer pipes, where required, shall be provided to eliminate unsymmetrical flooding as necessary to meet requirements for stability control. The ends of the equalizer pipes shall be fitted with oiltight cover plates and stowage provided for the same when tanks are used for dry cargo.

Equalizer pipes shall be so located that the bottom of the pipe is at a distance above the bottom of the compartment not greater than one-half the diameter of the pipe.

Minimum size of cross connections shall be determined from the equation:

$$A = \frac{V}{1103\sqrt{H}}$$

Where: A = Cross connection area in square meters
V = Volume of one tank in cubic meters
H = Height from center of pipe to top of tank in meters

11.5. BLEEDER PLUGS

Bleeder plugs of 38 mm IPS monel shall be provided for rudder and all tanks adjacent to the shell below the load waterline for draining when in dry dock. Two additional bleeder plugs shall be provided as spares.

Bleeder plugs for water tanks shall be square head, and hexagon head for fuel tanks.

11.6. CHAIN LOCKER DRAINS

The chain locker shall drain into a sump tank constructed below the chain locker. The sump shall be drained with a self drainage system overboard or by means of a hand operated salt water eductor or jet pump actuated by fire main pressure. The discharge shall be carried to the load waterline and shall be fitted with a non-return valve and a sea gate valve adjacent to the shell connection. The gate valve shall be operable at the valve and from the bulkhead deck.

11.7. GARBAGE CHUTE

One garbage chute may be provided from the Garbage Room where environmental laws permit. The chute shall discharge overboard at the load waterline and shall be fitted with a flap valve at the ship's side. The chute shall be 460 mm IPS steel pipe flanged. Bends where required shall have a 1500 mm radius.

Flushing connections, controlled by one valve, shall be fitted at the top of the chute. The chute shall be provided with a hopper, with flushing rings on the inside and so arranged that the flushing water will spray downward. A watertight cover, provided with a rugged locking device and spring hinge, shall be fitted to the hopper. A clean out shall be provided at bottom of chute.

For garbage chute corrosion protection requirements, see SECTION 14. In lieu of a garbage chute, garbage may be processed by a compactor described in SECTION 18.

11.8. OPERATING GEAR (MECHANICAL)

Mechanical operating gear shall be provided for all valves in locations inaccessible for local operation, unless otherwise noted. Operating gear which terminates on the open deck or in passageways shall be fitted with composition flush deck boxes fitted with "open" and "closed" indicators. Valves shall operate by hand without undue force applied. Those terminating in passageways shall be located close to the bulkhead. Deck box wrenches shall be provided stowed in close proximity and shall be capable of removing the deck box plug as well as operating the gear. Remote operating gear, not terminating in deck boxes, shall be fitted with hand wheels.

Valves in the bilge, ballast, and fuel oil systems requiring mechanical remote control shall be of the direct operated type. Provisions shall be made for a quick disconnect of the gear at the valve to permit local operation in case the gear becomes jammed.

Where universal joints are used, the angle between the lines of the shaft shall not exceed 40°. Bevel gears shall be enclosed in a non-corrodible case complete with grease fittings. Universal joints and operating rods used within a salt water ballast tank shall be fabricated using corrosion resistant material. All reach rod bearing surfaces shall be constructed of "Teflon", "Turkon", or equal.

11.9. SEA CHESTS

Sea chest anodes, where required, shall be sacrificial zinc or aluminum alloy.

The number of sea chests shall be kept to a minimum. Sea valves shall be attached directly at the side of the chest.

Sea chests shall be of cast steel or welded plate construction. Double plates shall be fitted where necessary. Sea chests, boundaries, and strainer plates are to be to Regulatory Body(ies) requirements. The sea chest shell cut out may have to be compensated due to hull girder requirements.

Suction sea chests shall be fitted with portable non-ferrous or approved reinforced plastic strainer plates perforated with 13 mm x 76 mm or 102 mm long slots placed in a fore and aft direction. The collective area of the slots shall not be less than twice the combined area of all the sea valves connected to the sea chest. For small sea chests, strainer plates with perforations not less than 13 mm in diameter may be used to minimize the possibility of fouling flow passages. Strainers shall be of approved thickness and be secured in place with monel studs and nuts in such a manner as to be removable with no part projecting beyond the shell. Nuts shall be lock wired with monel wire.

Suction sea chests shall be arranged and located so as not to take in air trapped under bilge keels or from emergence, on a 30° roll of the ship at minimum operating draft, and to avoid pickup of effluent from overboard discharges.

All suction sea chests shall be fitted with vent lines from the top of the chest terminating in the weather, with goosenecks. Each vent shall not be less than 50 mm in diameter and shall be fitted with a gate valve at the top of the sea chest. The individual vents may be connected together into one vent terminal.

SECTION 12

AIR CONDITIONING, HEATING, AND VENTILATION

12.1. GENERAL

This SECTION applies to all spaces, including the machinery space, and it is the intent that all systems shall be complete and adequate for the intended service. Air Conditioning Equipment Rooms and Fan Rooms shall not be used as plenums unless specifically approved.

Air conditioning ducts and equipment shall be suitably insulated and isolated from all structure, joiner work, and supporting hangers to prevent the formation of condensation.

Air conditioning equipment, system components, and associated hardware shall be protected from the weather and shall be centrally located with respect to the spaces served in order to reduce the runs of ducts, wiring, piping, and miscellaneous hardware to a minimum consistent with efficient design.

Particular attention should be directed toward designing air conditioning, heating, and ventilation systems to reduce airborne and structure borne sound transmission to the maximum extent possible. Acoustic dampening shall be accomplished by proper equipment layout, insulation, sound dampening devices, and proper balancing of air flows in the various spaces.

12.2. SYSTEMS

(a) General

Systems shall be complete including filters, fans, preheaters, cooling dehumidifying coils, reheaters, air mixing boxes, duct work, terminals, closures, louvers, dampers, thermostatic controls, drains, insulation (acoustic and thermal), vapor sealing and lagging, label plates, and operating instructions, necessary for satisfactory operation and performance.

Systems shall be designed to prevent contamination from dissimilar spaces. Weather supply terminals shall be located so as to avoid intake from weather exhaust terminals, smoke stack, or any other source of contamination. Systems shall be designed to function properly, without buildup of pressure, when weather and normally closed doors, hatches, and similar accesses are closed. Air conditioning systems will generally not be used to serve spaces requiring only heating and ventilation.

(b) Air Conditioning

(1) Design Criteria

All Staterooms, Lounges, Recreation Rooms, Mess Rooms, Dining Rooms, Offices, Slopchest, Dispensary, Wheelhouse, Chart Room, Radio Room, Radar Transmission Room, Electronics Room, enclosed Engine Control Room, and Cargo Control shall be air conditioned. The use of self-contained air conditioning units (water or air cooled) will be considered for spaces such as Chart Rooms, Radio/Radar/Electronics Rooms, Cargo Control and Engine Control Rooms, and where the self-contained units are more practicable due to location or other design configurations of the individual spaces.

All air conditioned spaces with doors opening to the weather shall have a slight positive pressure to prevent infiltration.

Air conditioning systems design shall be per the applicable portions of ISO 7547, "Air-Conditioning and Ventilation of Accommodation Spaces On Board Ships - Design Conditions and Basis of Calculations", ISO 8864, "Air-Conditioning and Ventilation of Wheelhouse On Board Ships - Design Conditions and Basis of Calculations", ISO 9099, "Air-Conditioning and Ventilation of Dry Provision Rooms On Board Ships - Design Conditions and Basis of Calculations", and ISO 8862, "Air-Conditioning and Ventilation of Machinery Control-Rooms On Board Ships - Design Conditions and Basis of Calculations" with all Annexes. However, the following design temperatures are recommended for use in the calculation of ventilation and air conditioning loads for vessels operating in warm or tropical climates.

Design shall satisfy all applicable Regulatory Body(ies) regulations, and shall be based on the following conditions:

Summer Temperatures and Humidities

Outside Air: +35°C and 70% relative humidity.

Indoor Air: +24°C and 50% relative humidity.

Winter Temperatures

Outdoor Air: -20°C

Inside Air: +20°C

NOTE - All temperatures stated are dry bulb temperatures.

The reheat schedule for the air conditioning system shall be established by a detailed analysis of the load calculations so that all air conditioned spaces can be maintained at design temperatures. The heater schedules shall be selected for economical design and operation.

The effect on air conditioning plant capacity, changeover temperature, fan heat, duct heat rise, and air requirements shall be carefully considered when selecting the terminal temperature difference for each system.

In general, passageways and stairways within an air conditioned zone shall be used for recirculation air return. The air velocity within the same shall not exceed 0.8 m/s.

Each plant shall contain an automatic or manual, renewable, dry media air filter, steam or electric preheater, cooling coil, high efficiency supply fan with motor and starter. Necessary transition pieces between preheater and cooling coil, cooling coil and fan intake together with flexible connections and vibration eliminators for the supply fan shall be provided.

(2) Classes of Air Conditioning Systems

In general, air conditioned spaces shall be served by central systems with cooling being provided by chilled water or direct expansion coils and heating provided by steam or electric heaters.

The principal types of systems recommended are Dual Duct Systems, Terminal Reheat Systems and Self-contained or Unitary Systems. For typical system arrangements, refer to Plates I and II at the end of this SECTION.

The use of air balance ducts or jumper ducts between an enclosed space and a passageway should be avoided.

Consideration will also be given to high pressure air systems.

<u>Dual Duct System</u>

The dewpoint of air leaving the central coil during the entire cooling cycle shall be constant and equal to design conditions.

The chilled air mains and branches shall be sized for full cooling requirements. The hot air mains and branches shall be sized for approximately 65 percent of the volume.

Air may be recirculated from the public spaces and shall, where necessary, be ducted directly from each space.

When recirculation is provided, changeover dampers (outside, recirculation, and exhaust air) shall be the multi-blade type, automatically operated by the control system. The dampers should modulate so as to provide a maximum of 100 percent fresh air during the interim cooling condition and a minimum fresh air requirement when the maximum design requirement is reached. Damper stops shall be provided to ensure minimum design fresh (outdoor) air requirements. A manually-operated diverting switch shall be provided so that the changeover dampers may be properly controlled in the event of a failure of the main control thermostat.

Two central type fan-coil units, located in the Fan Room, shall cool, dehumidify, heat, and distribute the air to the air mixing boxes located in the individual spaces. Cold and warm air mains and branches shall be insulated as necessary to control or prevent condensation. Air mixing boxes and damper controls shall be readily accessible for maintenance through a door or panel in the room side of the equipment.

The dual duct system shall be fully automatic and shall be designed for automatic changeover from cooling to heating and securing of the refrigeration plant with changeover point selected at approximately 4.4°C. See Plate I for typical system and control layout. Various preheater, reheater, cooling coil, and control arrangements may be used as indicated by Plate I. For intermediate cycle operation, the system shall be capable of satisfying simultaneous cooling and heating requirements of the individual spaces.

Air conditioning systems should be designed for operation with a constant off-coil dewpoint temperature during the entire cooling cycle.

The final outside air volume requirements of the system shall be in balance with the exhaust air volume requirement and shall be adjusted accordingly. Passageways shall be maintained at a slight positive pressure for the purpose of reducing infiltration through weather doors, from dissimilar spaces (such as machinery spaces). Positive air pressure shall also be maintained in spaces as identified in ISO Standards referred to previously herein.

Terminal Reheat System

The single duct, terminal reheat system with room control is similar to the dual duct system. Terminal reheat systems may be high, medium, or low velocity (pressure) types.

The room dry bulb temperature is controlled by means of reheat in which a room thermostat automatically controls the heating media (steam, hot water, or electric coil) which is supplied to the reheat coil for each controlled space. A mixture of outside and return air is filtered, conditioned (preheated or dehumidified and cooled as required) in Central Fan Rooms and distributed to individual reheaters at the spaces served. Conditioned air is supplied to each space to accommodate maximum design cooling load requirements.

Recirculation damper requirements are the same as specified for dual duct systems.

Sound attenuation boxes shall be provided, as necessary, for each air conditioned space or terminal. The space terminal heater may be integral with or installed on to the discharge side of the box.

Inside design conditions for cooling may be slightly adjusted to suit the load characteristics of the particular spaces involved, providing the same effective temperature and other requirements are complied with.

The total air delivered to each space shall be constant at all times.

Necessary motorized steam or electric control devices complete with control thermostats, bypass valves, traps and strainers where necessary shall be supplied for the preheaters together with necessary controls including automatic summer-winter changeover thermostats for use with the refrigeration machinery.

The supply air shall be either preheated or cooled, depending upon the climatic conditions, and circulated throughout the various spaces served via the ductwork, terminating in each area served with a reheat/attenuator box.

The reheater attenuator boxes shall be provided complete with suitably sized reheater elements and necessary over-temperature protection.

Each reheater attenuator box shall be individually controlled by its own bulkhead mounted thermostat. The thermostats shall be wired through reheater control panels, which shall house contactors, fuses, and control voltage transformers.

Safety conductor panels shall be provided and interlocked with each fan starter, preventing any equipment from being in operation without the associated fan.

For typical system arrangement see Plate II at the end of this SECTION.

Unitary Air Conditioning Equipment

A unitary air conditioner generally consists of one or more factory-made assemblies which should include an evaporator or cooling coil, a compressor and condenser combination, and may have provision for a heating function as well.

Where unitary type equipment is provided in more than one unit (assembly), the separate units shall be so designed to be used in conjunction with each other, and the rating requirements shall be based on the combined use of the matched units.

Unitary assemblies, either separately or in combination with a heating plant, shall be designed to provide the functions of air circulation, air cleaning, air cooling with controlled temperature, and dehumidification, and may optionally include provision of the functions of heating and/or humidifying the various spaces.

The requirements specified for the other air conditioning systems described shall also be applicable to unitary air conditioning equipment.

(c) Heating and Ventilation

Spaces not air conditioned shall be heated and/or ventilated per the requirements of the following table. Spaces not mentioned in the table shall be treated the same as similar spaces.

Heating and ventilation load calculations shall be based on outside temperatures of 35°C dry bulb at 70 percent relative humidity in summer and -20°C dry bulb in winter. Designs of the systems shall be per the applicable portions of ISO 9943, "Shipbuilding - Ventilation and Air-Treatment of Galleys and Pantries with Cooking Appliances", ISO 9785, "Shipbuilding - Ventilation of Cargo Spaces Where Internal Combustion Engine Vehicles May Be Driven - Calculation of Theoretical Total Airflow Required", and ISO 8861, "Shipbuilding - Engine Room Ventilation of Diesel-Engined Ships - Design Requirements and Basis of Calculations" with all Annexes. Design shall satisfy all applicable Regulatory Body(ies) requirements.

Air changes in ventilated spaces only shall be based on gross volume calculated from molded dimensions (with no deductions for ceilings, sheathing, furnishings, and miscellaneous equipment).

The Galley, Pantries, and Laundries shall have a slight negative pressure to confine heat and odors generated therein. Surplus air from adjacent air conditioned areas may be exhausted through Galley, Pantries, Small Laundries, and Lockers, when practicable.

The air change for Galley and Main Pantry is based upon mechanical exhaust. The mechanical supply shall equal the exhaust quantity minus the make-up air available from surrounding spaces. The Galley's exhaust system should be ducted directly to the weather near the top of the house.

Heating shall be provided for spaces as required by duct heaters, convector heaters or individual unit heaters.

Mechanical ventilation should be provided to all non-air conditioned spaces, wherever necessary, to maintain the required air change. Spaces to be ventilated, for example, are Battery Rooms, Toilets, Shower Rooms, Machinery spaces, Steering Gear Rooms, Pump Rooms, Bow Thruster Rooms, barge loading areas, cargo spaces, and pipe tunnels.

The Steering Gear Room heating load calculation shall be based on heat transmission losses and a fresh air infiltration rate of 102 cubic meters per hour with the fan secured and ventilation weather supply and exhaust dampers closed.

Spaces requiring natural supply or exhaust ventilation, without direct connection to the weather, shall have doors fitted with undercuts or louvers in the lower panel. Where door louvers or undercuts are not desired or are impractical, a bulkhead opening fitted with fixed louver, wire mesh or deflection grilles, may be used. The type of bulkhead opening shall be suitable for the space served and shall be per Regulatory Body(ies) requirements. The maximum air velocity through free openings (louvers and undercuts) shall not exceed 2 m/s. Louvers should be provided where air capacity transferred exceeds 127 cubic meters per hour.

Any one system should serve only spaces which are similar with respect to seasonal heating and ventilation requirements.

Battery Rooms, lockers, and boxes for stowage of batteries shall be ventilated per Regulatory Body(ies) requirements. All Battery Room ventilation duct surfaces exposed to storage battery fumes shall be coated with a paint resistant to the type of fumes emitted by storage batteries as described in SECTION 14 of these Specifications.

Natural ventilation supply shall be provided to meet the emergency diesel generator's combustion and radiator cooling requirements. The emergency generator diesel engine radiator fan shall have sufficient capacity to induce air into the room from the weather, blow the air through the radiator and discharge it to a duct directly to the weather. The diesel engine's weather supply and discharge openings shall be provided with automatic, motor operated, multi-louvered dampers, energized from the emergency generator output. The multi-louvered dampers shall have provisions for quick disconnect to facilitate emergency manual operation.

Care should be taken to balance the supply, exhaust, and recirculation air flows of each conditioned area in order to prevent the migration of fouled air to adjoining spaces. Weathertight doors and boundary doors between systems should normally be kept closed.

Ventilation and heating requirements for the various spaces shall be per the following table:

VENTILATION AND HEATING REQUIREMENTS FOR NON-AIR CONDITIONED SPACES

Type Space	Mechanical Sup.	Mechanical Exh.	Natural Sup.	Natural Exh.	Temp. Rise C°	Max. Air Change in Mins.	Heating Temp. Type	C°	Remarks
Air Cond. Equip. and Fan Rooms	Either		Either		8		TA	4	See Note #1.
Baggage		Yes			8	15	C/FP	16	Heat req. only in passenger baggage rm. See Note #12.
Battery Rm.		Yes	Yes			2	C/FP	4	See Note #6.
Bonded Stores	Either		Either		8	10			See Notes #10 and #18.
Bosn's Stores	Yes			Yes		20			
Bow Thruster Rm.		Yes	Yes		8	6	C/UH	4	
Butcher Shop	Yes			Yes	6	4	TA	4	
Canvas Rm.	Yes			Yes		6	C/FP EH	4	See Note #17.
Capstan Mach. Rm.	Yes			Yes	8	6			See Note #19.
Cargo Control Rm.	Yes	Yes				10		21	Recommended air conditioned space.
Cargo Spaces	Yes			Yes		10			See Note #21.
Carpenter Shop	Yes			Yes	6	6	C/FP EH	16	See Note #17.
Clean Gear Locker		Yes				4			

VENTILATION AND HEATING REQUIREMENTS
FOR NON-AIR CONDITIONED SPACES (continued)

Type Space	Mechanical Sup.	Mechanical Exh.	Natural Sup.	Natural Exh.	Temp. Rise C°	Max. Air Change in Mins.	Heating Temp. Type	Heating Temp. C°	Remarks
CO_2 Room		Yes	Yes		8	6			See Note #5.
Deck Lockers, Deck Stores	Either		Either		8				See Notes #10 & #18.
Deck Toilet (if provided)		Yes	Yes			6	C/FP EH	16	
Dry Stores	Yes			Yes		15	TA		
Elec. & Engrs. Workshops	Yes				6	6	C/FP	16	
Elev. Machy. Room	Yes	Yes			8	6			See Note #19.
Engrs. Stores	Yes				11	20			
Emer. Gen. Room	Yes			Yes	8	10	C/FP	4	For space vent. See Notes #7 & #19.
F.O. Filling Station		Yes	Yes			6			
Galley and Galley Pantry		Yes	Yes		6	1	TA		See Art. 2(c)., Notes #9 & #22.
Garbage Room		Yes			6	1			
Gyro Room		Yes			6	4	C/FP	4	Nat. Sup. from adjoining spaces. See Note #4.
Hawser Room	Yes			Yes		20			See Note #17.
Lateral Thruster Com't.	Yes			Yes	8	6			See Note #19.

VENTILATION AND HEATING REQUIREMENTS
FOR NON-AIR CONDITIONED SPACES (continued)

Type Space	Mechanical Sup.	Mechanical Exh.	Natural Sup.	Natural Exh.	Temp. Rise C°	Max. Air Change in Mins.	Heating Temp. Type	Heating Temp. C°	Remarks
Laundries Service		Yes			6	4	TA C/FP	21	See Note #14.
Linen Room Clean	Yes				6	5	TA C/FP	16	
Linen Room Soiled		Yes			6	5			
Linen Lockers, Daily Service				Yes		15			
Machine Shop	Yes				8	6	C/FP	16	
Main Mach'y Space	Yes	Yes							See SECTION 64 and ISO.
Oil Skin Lockers		Yes				4			
Paint Rooms Deck and Engr's.	Yes			Yes	6	6			
Pantries Service		Yes			6	4			Nat. Sup. from adjoining spaces.
Passageway, Stores		Yes	Yes						3,400 m^3/hr. min. (2,000 cfm) min. See Note #18.
Pipe Tunnels	Yes	Yes				7			
Pump Room		Yes	Yes		8	3	UH	4	See Note #19 and text.
Shaft Alley		Yes	Yes			10			See Note #13.

VENTILATION AND HEATING REQUIREMENTS
FOR NON-AIR CONDITIONED SPACES (continued)

Type Space	Mechanical Sup.	Mechanical Exh.	Natural Sup.	Natural Exh.	Temp. Rise C°	Max. Air Change in Mins.	Heating Temp. Type	Heating Temp. C°	Remarks
Slop Chest	Yes		Yes		6	6		16	Recommend this be an air conditioned space.
Steering Gear Room	Yes			Yes	8	6	UH	4	See Notes #17 & #18.
Stores-Ship's Dry Daily Galley and Bulk Food	Yes				6	4	TA		
Stores-Steward's and Misc.	Yes				6	4	TA		
Stevedores' Toilets			Yes			6	EH/ FR/ C	16	Nat. or Mech. Exh. Depending on location. See Notes #9 & #22.
Sewage Tank Space	Yes	Yes			8	6	TA		
Toilet and Showers		Yes			6	4	C/ FP/	21	If fresh air limited, A.C. may be 6. See Notes #2 & #3.
Winch M.G.		Yes	Yes		8	6			See Note #19.
Windlass Machinery Rm.		Yes	Yes		8	6			See Note #19.

C - Convectors (steam, hot water, electric)
EH - Electric Heater
FP - Finned Pipe Heating Element
TA - Tempered Air / UH - Unit Heater (steam or electric)

The word "Yes" under "Natural" means that a separate ventilator to the weather shall be provided. Minimum mechanical supply or exhaust volume shall be 60 cubic meters per hour.

Temperature rise as used in the table is the maximum allowable dry bulb temperature difference between the outside air design condition and the inside air leaving the space.

Notes

1. Fan Rooms shall be heated only if equipment may be endangered by freezing.

2. Heating temperature for Toilets and Showers in medical service spaces to be 22°C.

3. Convectors or finned pipe heating elements may be omitted except in medical service spaces, if the exposure loss does not lower the space temperature more than 1°C at heating design outside temperature.

4. Only if independent of the Radar Transmission Room. If gyro and radar occupy the same room, the space shall be air conditioned.

5. The exhaust terminal shall be located not more than 460 mm above the deck.

6. Fan shall be non-sparking if volume exhausted from battery space is over 10 percent of total system volume.

7. This ventilation and heat required only when generator is not operating, and does not include generator combustion and cooling requirement described in preceding paragraphs of this SECTION.

8. Supply from convenient air conditioning system; also use for heating.

9. Discharge exhaust to weather above top of house, i.e., highest deck.

10. Either mechanical exhaust with natural supply or vice versa.

11. Systems to operate when winch motor generator is operating.

12. Mechanical ventilation not required for spaces with less than 9.29 m^2 of deck area.

13. 8,494 cubic meters per hour minimum exhaust via escape trunk, natural supply from Machinery Space.

14. Exhaust tumbler dryer direct to weather.

15. Use air conditioning supply systems for ventilating spaces containing air conditioning equipment, 100 percent recirculation.

16. Both natural supply and exhaust may be used where neither mechanical supply nor exhaust is close by, or mark-up air is limited.

17. Exhaust via Capstan Machinery Spaces, if fitted, where convenient.

18. Balance with supply from adjacent spaces.

19. Lower "Temp. Rise" shall be used if ambient of equipment is less than 49°C.

20. Supply terminal shall be not over 305 mm above deck, and exhaust terminal at deckhead.

21. Base ventilation (air change) for container and unitized cargo holds on gross cubic volume. For RO/RO vessels carrying vehicles with fuel in their tanks maximum air change in minute may be 6.

22. Air change is exhaust; mechanical supply to equal exhaust minus make-up from surrounding spaces.

12.3. CARGO HOLD

<u>Ventilation</u>

(a) Breakbulk

Those portions of the cargo holds suitable for carrying dry cargo, including hatch trunks and dry cargo deep tanks, shall be mechanically ventilated with independent systems for each cargo hold.

The supply air shall be distributed from one end of the hold and exhausted at the opposite end. Supply and exhaust terminals, sized for 5 m/s net velocity, shall be provided in number and locations so as to assure uniform air distribution without dead air pockets.

(b) Roll-On/Roll-Off (RO/RO)

Ventilation for RO/RO type vessels shall be provided in sufficient quantity to dilute the concentrations of carbon monoxide (CO) to a maximum of 50 ppm on a time weighted average. At 75 ppm the hold shall be cleared with alarms initiated by a CO detection and sensing system. At sea, an air supply of 1.7 cubic meters per hour per square meter of deck area shall be provided where fueled (gasoline) vehicles are stowed. The requirements shall be per Regulatory Body(ies).

Ventilation intakes and outlets shall be designed so as not to interfere with hatch cover or crane operation.

Cargo hold ventilation fans shall be interlocked with the CO_2 smothering system such that fans shut down automatically when the CO_2 system is activated.

12.4. REFRIGERATED CARGO SPACES

Refrigerated cargo spaces shall be provided with a mechanical fresh air supply system and natural foul air exhaust system. The fan shall have 50 percent speed reduction with local and remote manual control. Manual volume control dampers shall be provided for each system in accessible locations. The terminals of each system within the spaces shall be equipped with airtight insulated hinged plugs. The fresh air shall discharge in the vicinity of the cooling coil air inlets.

All insulation thicknesses for refrigerated cargo spaces shall be per the Contractor's practice.

Refrigerated cargo spaces shall be insulated so as to maintain the specified temperature with an outside temperature of 38°C db and without sweating on the warm side exposed surfaces of decks, bulkheads, or shell in way of the refrigerated spaces, at a relative humidity of 80 percent over an ambient air temperature range of 2°C db to 38°C db in still air.

Refrigerated machinery spaces (including fan coil units) shall be effectively ventilated and drained.

12.5. STEAM HEATING AND AIR CONDITIONING WATER SYSTEMS

(a) Steam Heating Systems, Where Required

A 241 kPa system shall be provided to supply steam to heating coils, convectors, unit heaters, finned pipe heating elements, commissary equipment, and cargo hold dehumidification equipment, if required. An independent condensate return shall discharge as required in SECTION 60. The above steam system may be served from the ship's steam system, auxiliary boiler, exhaust gas boiler or other suitable steam source.

Steam pressure gages shall be provided in mains to each Air Conditioning Equipment and Fan Room, at hot water heaters, Commissary spaces, and cargo dehumidification equipment requiring steam.

Steam cooking appliances shall be fitted with a shut-off valve in the supply connection, and thermostatic trap, horizontal swing check valve, and gate valve in the return connection. In addition, the supply to steam tables shall have a thermostatic control valve, preceded by a wye strainer.

Steam heaters shall be provided with a thermostatic control valve, preceded by a wye strainer with blowout valve, and a stop valve, on the supply side and a manual vent, dirt leg, combination float-thermostatic trap, and cut-out valve in the order named, on the return side. Cooling legs shall be led bare for a distance of at least 610 mm preceding the trap.

Unit steam heaters shall be provided with a stop valve on the supply side and the same hook-up as for steam heaters on the return side.

Steam convectors and fin-pipe elements shall be provided with an approved type radiator stop valve on the supply side and wye strainer thermostatic trap, and cut-out valve on the return side. The cooling leg shall be led bare beneath the unit for a distance of at least 610 mm, looped if necessary, preceding the trap. The trap shall be located, wherever possible, beneath the unit.

(b) Air Conditioning Water and Drain System

Chilled water shall be supplied to cooling coils from the air conditioning refrigeration plant described in SECTION 65.

The air conditioning chilled water system shall be the two pipe, reverse return, self-balancing type.

Direct expansion cooling coils will be considered as an acceptable alternative to the chilled water coils described above. Construction details for direct expansion cooling coils are listed in the following paragraphs.

12.6. CONVECTORS, FIN-PIPE ELEMENTS, UNIT HEATERS, ELECTRIC HEATERS, BLAST HEATERS, WATER COILS, AND AIR MIXING UNITS

(a) Convectors

Convectors shall be of good commercial quality. The casing and elements shall be of the same manufacturer. Steam convectors shall be selected for 241 kPa steam or other pressures as approved.

The entire convector, exclusive of the heating element assembly, shall be given a hot-dipped phosphate treatment or other approved treatment and painted inside and out with one coat primer and two coats of finish paint as approved.

(b) Fin-Pipe Elements

Fin-pipe elements of good commercial quality shall be selected for 241 kPa steam and shall be constructed of 13 mm nominal IPS steel elements with steel fins or 1.4 mm thick copper tubing with copper or aluminum fins.

Fin-pipe element performance ratings shall be assumed to be 962 W/m for 32 mm IPS steel elements, and 1115 W/m for 38 mm and 1673 W/m for 50 mm copper elements, based on 241 kPa steam.

(c) Unit Heaters

Unit heaters shall be of good commercial quality and selected for 241 kPa or other pressure as approved and a final air temperature of 52°C.

A warning plate shall be attached to the steam supply valve for each unit heater in the Steering Gear Room directing that the ventilation fan shall be shutdown and duct supply and exhaust dampers closed before the unit heater steam supply valve is open.

(d) Electric Heaters

Electric heaters, in general, shall be of good commercial quality and constructed per the requirements of the Regulatory Body(ies) applicable regulations and the electrical sections (such as SECTION 90) of these Specifications.

Electric Convection Heaters

Electric convection heaters should be of the surface bulkhead mounted type and be provided with integral, adjustable temperature control (thermostat), automatic reset and manual reset thermal cutouts for single phase heaters or integral control transformer and contactor with holding coils for three phase heaters. Each heater shall comply with Regulatory Body(ies) requirements.

Electric Air Duct Preheaters and Reheaters

Electric tempered air heaters should have casings of at least 1.5 mm steel or equivalent and should be reinforced to provide adequate strength. Heater casings should be hot-dipped galvanized, electro-galvanized, or equivalently treated after construction. Tempered air heaters shall be suitable for marine use and constructed in conformance with Regulatory Body(ies) requirements. Heater controls shall be provided with an interlock with the fan motor so that the heater cannot be energized unless the fan motor is also energized.

Electric Unit Heaters

Electric unit heaters shall be of quality suitable for marine use per the Regulatory Body(ies) requirements.

Automatic reset and manual reset type thermal overheat protection and an adjustable thermostat should be provided for each heater.

Electric Strip Heaters

Electric strip and panel heaters shall also be of quality suitable for marine use, meeting the requirements of the Regulatory Body(ies).

(e) Blast Heaters

Heaters shall be of good commercial quality with copper tubes, fins, and brass or copper headers. Casing shall be of galvanized or stainless steel.

Preheaters and tempering heaters shall be of the internal steam distributing tube construction.

Preheaters and tempering heaters shall be installed before the fan inlet and shall not be oversized. Preheaters for ventilation systems shall be selected for a design final temperature between 13-16°C and tempering heaters, between 10-22°C with outside air temperature of -20°C. Preheaters for air conditioning systems shall be selected to suit design requirements. When using 100 percent outside air at -20°C, the discharge temperature shall not be less than 7°C. An anti-freeze thermostat shall be provided to prevent freeze-up when using 100 percent outside air.

(f) Cooling and Heating Water Coils

Water coils shall be of good commercial quality.

Central cooling coils shall have the number of rows of tubes per the American Refrigeration Institute certified rated coils and shall be based on an inlet water temperature of 6°C with a temperature rise of about 5.6°C.

Water coils shall be sized for a face velocity of 2.5 m/s maximum. The maximum wet coil air friction shall not exceed 249 Pa.

(g) Direct Expansion Cooling Coils

The construction of the coils shall be similar to that specified for steam coils, except that they shall be provided with tubes horizontal and shall have tubes 16 to 19 mm outside diameter arranged for serpentine counterflow circulation. The liquid and suction connections shall be on the same side of the coil and shall be of the header type construction. Access to both sides of the coil is required and should be of the hinged door type located in the coil transformation sections.

The size of the coils shall be based on a maximum face velocity of 2.5 m/s. The fin spacing shall not be more than 12 fins per 25 mm and the maximum air pressure drop shall not exceed 124 Pa at the wet coil condition.

The drain pan shall be an integral part of the cooling coil assembly. The pan shall be externally covered with 25 mm thick approved insulation and sheathed with 1.50 mm sheet steel. All steel components shall be galvanized, stainless steel or be equivalently corrosion resistant treated after fabrication.

(h) Air Mixing Boxes

The air mixing boxes shall have a hot and a cold air proportioning valve or valves actuated by a room thermostat and shall have a constant volume regulator to control the flow of air.

12.7. AIR FILTERS

All supply systems having cooling and/or heating coils shall be provided with manual renewable marine type air filters.

Hinged doors shall be provided for access to plenums adjacent to filters. The plenums and access shall be of ample size to facilitate replacement of filter media.

Air filters shall be designed for a velocity not to exceed 2.5 m/s. They shall be of renewable manual, or automatic marine type.

12.8. THERMOSTATIC CONTROLS AND THERMOMETERS

All control valves shall be of the modulating type, sized for actual design requirements rather than for maximum coil capacity, and with ratio plugs or similar devices for accurately metering flow.

Thermostats in public spaces shall have degree markings, thermometers, and be key operated. All other thermostats shall be external knob operated, as approved, with degree markings but without thermometers.

Weather air, recirculation, and exhaust dampers shall be pneumatically operated. Damper operators (motors), including those for the emergency generator air dampers, shall be sized for a torque 100 percent in excess of actual requirements as established by catalog ratings.

Thermometers of the remote dial type, and air pressure gages (at all mains and branch connections to the thermostats), shall be provided for checking the outside air and performance of all heaters, coils, and controls, except those serving small spaces such as Staterooms and Offices where only air gage connections are required. Thermometers shall have 90 mm diameter dials with range suitable for the application, and have 1°C graduation except for hot water which may have 2°C graduations.

One repair kit for testing and calibrating control instruments shall be provided for each vessel.

12.9. FANS AND MOTORS

Fans with total pressure greater than 933 Pa shall meet AMCA Class II or III construction requirements as applicable.

Belt drives shall be sized for 150 percent of the motor name plate rating. The motor shall be mounted on an approved adjustable base.

Propeller fans shall not be used when static pressures are in excess of 124 Pa.

Non-sparking type fans shall conform with the requirements of AMCA Bulletin 99, Type "B" AS401. The non-ferrous material shall be Regulatory Body(ies) approved.

Centrifugal fan and driving motor shall be mounted on the same foundation. Centrifugal and axial flow fans located in the vicinity of or serving living and working spaces shall be mounted on approved type vibration eliminators.

Flexible duct connectors, properly rat-proofed, shall be provided at the fan inlet and discharge of each centrifugal fan and those axial flow fans mounted on vibration eliminators, except for Pump Room vent fans.

12.10. TRUNKS, DUCTS, ACCESSES, AND HOODS

Duct Air Velocities

(a) Air Conditioning Systems

Same velocities as specified for Mechanical Ventilation Systems where quiet operation is essential. However, velocities as high as 25 m/s may be used provided the system is provided with acoustical treatment to confine and absorb generated noise (both vibration and airborne) to meet the sound levels specified in SECTION 1.

(b) Mechanical Ventilation Systems (Supply and Exhaust)

18 m/s if quiet operation can be maintained. Corresponding decreases in velocity may be necessary in areas where quiet operation of system is necessary. In areas where quiet operation is essential, 10 m/s maximum unless specifically approved.

(c) Machinery Ventilation Systems (Supply and Exhaust)

18 m/s maximum

(d) Natural Vent Ducts Serving Naturally Ventilated Spaces

4 m/s maximum

Trunks, ducts, covers, louvers, and miscellaneous hardware, exposed to the weather shall not be less than 3 mm steel plate and shall be watertight. Built-in trunk construction shall not be used for ducts having less than 0.09 square meter cross-sectional area, and minimum dimension less than 230 mm.

Vertical trunks or ducts in shops, stores, and other locations where ducts are subject to damage, shall not be less than 3 mm thick. All vertical trunks or ducts in dry cargo holds shall not be less than 6 mm thick. All horizontal ducts in dry cargo holds shall not be less than 5 mm thick.

Factory fabricated spiral duct (round and flat oval (F.O.)) up to 300 mm in diameter may be 0.6 mm and ducts up to 610 mm may be 0.8 mm. Factory fabricated fittings shall be at least 1 mm.

All ducts in machinery spaces shall not be less than 1.5 mm in thickness.

Circular or F.O. duct section shall be used in lieu of rectangular when passing through beams, girders, or other strength members.

Access holes with bolted plates shall be provided for cleaning and maintenance of equipment and ducts.

Hinged doors for access shall be provided as follows:

(1) Entrance to plenums for servicing filters.

(2) Both sides of cooling coils.

(3) In ducts at inlet and discharge sides of axial fans.

(4) In joiner ceiling for access to concealed equipment (heaters, access plates, valves, vents, controls, and dampers) size shall be at least 600 mm and location shall favor equipment most frequently requiring inspection and servicing.

All ducts which must pass over electrical equipment shall be made watertight and insulated to prevent condensation from dripping upon electrical equipment. Ducts should not, if possible, be located above electrical equipment.

Exhaust ventilators of the latest design (including quick release automatic fire damper, automatic hot water cleaning facilities, necessary hot water and drain piping, and grease extracting facilities) shall be provided over the ranges, fryers, griddles, steam kettles, steam cookers, and bake ovens.

12.11. TERMINALS, GRILLES, WIRE MESH SCREENS, AND DAMPERS

All air terminals shall meet Regulatory Body(ies) requirements. They shall be of a type and size suitable for the intended service. All supply terminals, except directional type, shall be capable of properly ventilating the space involved without creating drafts. Diffusing/blast terminals shall be used in Galleys, Pantries, and similar ventilated heat producing spaces with joiner ceilings. Machinery space supply terminals, except those behind switchboards, shall be of the adjustable directional type with integral throttling damper.

Fire dampers shall be fitted in locations required by Regulatory Body(ies) regulations. All dampers, including fire dampers, shall be of metal construction and fitted with an indicator to show the position of the damper, and a combined adjusting and locking device so located as to be easily accessible and visible.

12.12. VENTILATION INSULATION AND LAGGING

All insulating materials shall conform with the requirements of the Regulatory Body(ies).

All parts of ventilation, heating and air conditioning systems (including equipment, access covers, flanges, and recirculation ducts) shall be covered with the type of insulations specified to prevent sweating and external heat transfer, as follows:

(1) Air Conditioning Systems - Insulate 25 mm, vapor seal and lag completely.

(2) Recirculation Systems - Insulate entirely 25 mm except exposed portions within areas served and fans. Lag and vapor seal in hot or wet spaces; otherwise lag exposed insulation only.

(3) All Ventilation Supply Systems (concealed or exposed) - Insulate 25 mm except as noted in (6) below. Ducts in spaces served and serving only the same space should be insulated per intended vessel service.

(4) Ventilation Exhaust System (concealed or exposed) - exhausting unheated spaces and passing through heated spaces - Insulate 25 mm. In addition exhausts from heat producing spaces (concealed or exposed) - Insulate 25 mm where passing through heated or air conditioned spaces.

(5) Hot Blast Heating Systems - Insulate entirely 25 mm, except fan and exposed ducts within the space served. Tempered Air Systems - Insulate 25 mm portions within fresh air plenums and where temperature differential exceed 18°C, except fans.

(6) Portions of all supply, air conditioning, and recirculation systems passing through machinery spaces and hooded areas shall be insulated 50 mm. They shall also be vapor sealed and lagged where specified herein. Exposed ventilation ducts serving only the space in which they are located need not be insulated unless it is deemed prudent for the intended service. Trunks and ducts in the casings and uptakes shall be insulated.

Insulation on rectangular ducts carrying cold (chilled) air shall be 25 mm thick fibrous glass board, with minimum density of 48 kg/m^3, and with a factory-applied aluminum foil vapor barrier, minimum thickness of 0.05 mm. Insulation on round and flat oval ducts, and bends, shall be the same as specified for rectangular ducts, except it may be flexible type with a minimum density of 24 kg/m^3. All joints of vapor seal shall be lapped, 50 mm minimum, or sealed with 75 mm wide aluminum foil tape. To ensure integrity of the vapor barrier, all joints shall also be coated with an approved vapor sealing compound, compatible with the aluminum foil vapor barrier.

Insulation (both thermal and acoustic) shall be secured to duct with an approved adhesive. In addition, insulation on rectangular ducts over 610 mm wide, and on equipment and plenums, shall be further secured with metal clips, pins or studs (spacing as approved) secured to the insulated surface. Adhesive shall be chemically compatible with the insulated surface.

12.13. ACOUSTIC INSULATION

Acoustical treatment shall be provided, where required, to attenuate system-generated noise (airborne and transmitted) to levels as specified in SECTION 1, Article 11.

12.14. SPECIAL TOOLS

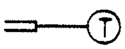
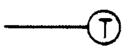
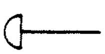
Special tools shall be provided as follows:

	Per Ship
Repair kit for testing and overhaul of thermostats and automatic control valves.	1

12.15. SPARE PARTS

See SECTION 86 of this Specification.

LEGEND FOR PLATES I AND II

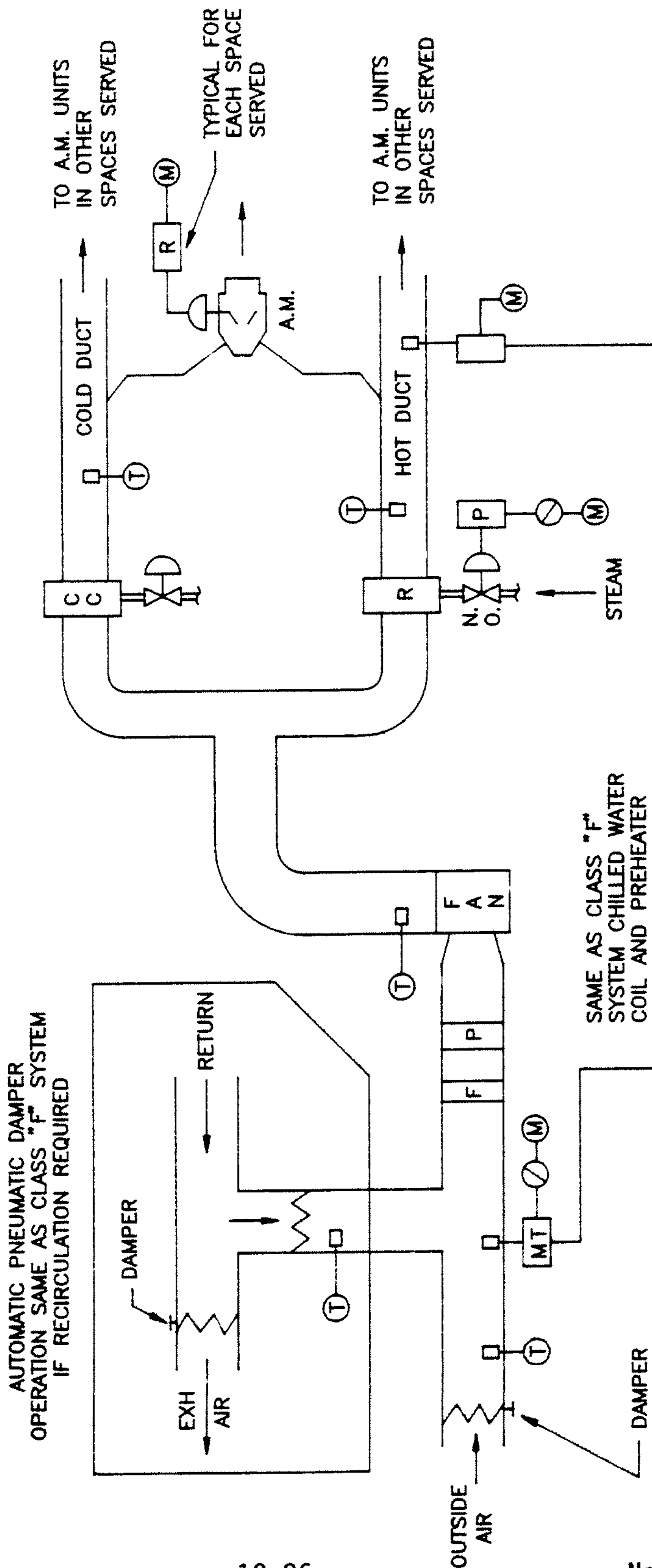
	Air Main
	Pneumatic Piping
	Thermostat-duct Panel mounted or inserted
	Room Thermostat
	Stop Cock
	Pneumatic Control Valve
	Positive Positioning Relay
	Thermometer (Panel Mounted)
	Thermometer with Separable Socket (Panel Mounted)
	Cutout Valve
	Check Valve
	Damper (Multi-Blade except A.M.) and Motor
	Pneumatic Motor
N.O.	Normally Open
N.C.	Normally Closed
L.O.	Locked Open

C	Cooling
H	Heating
R	Reheater Coil
P	Preheater Coil
F	Filter
C.C.	Cooling Coil
C.O.	Change Over Valve
D.A.	Direct Acting
R.A.	Reverse Acting
H.W.	Hot Water
T.S.	Safety Thermostat
A.M.	Dual Duct Air Mixing Unit with Constant Volume Regulator
M.T.	Master Thermostat
S.M.	Sub-master Thermostat
Pres. Cont.	Pressure Control
T.A.	Tempered Air

EH Electric Heater

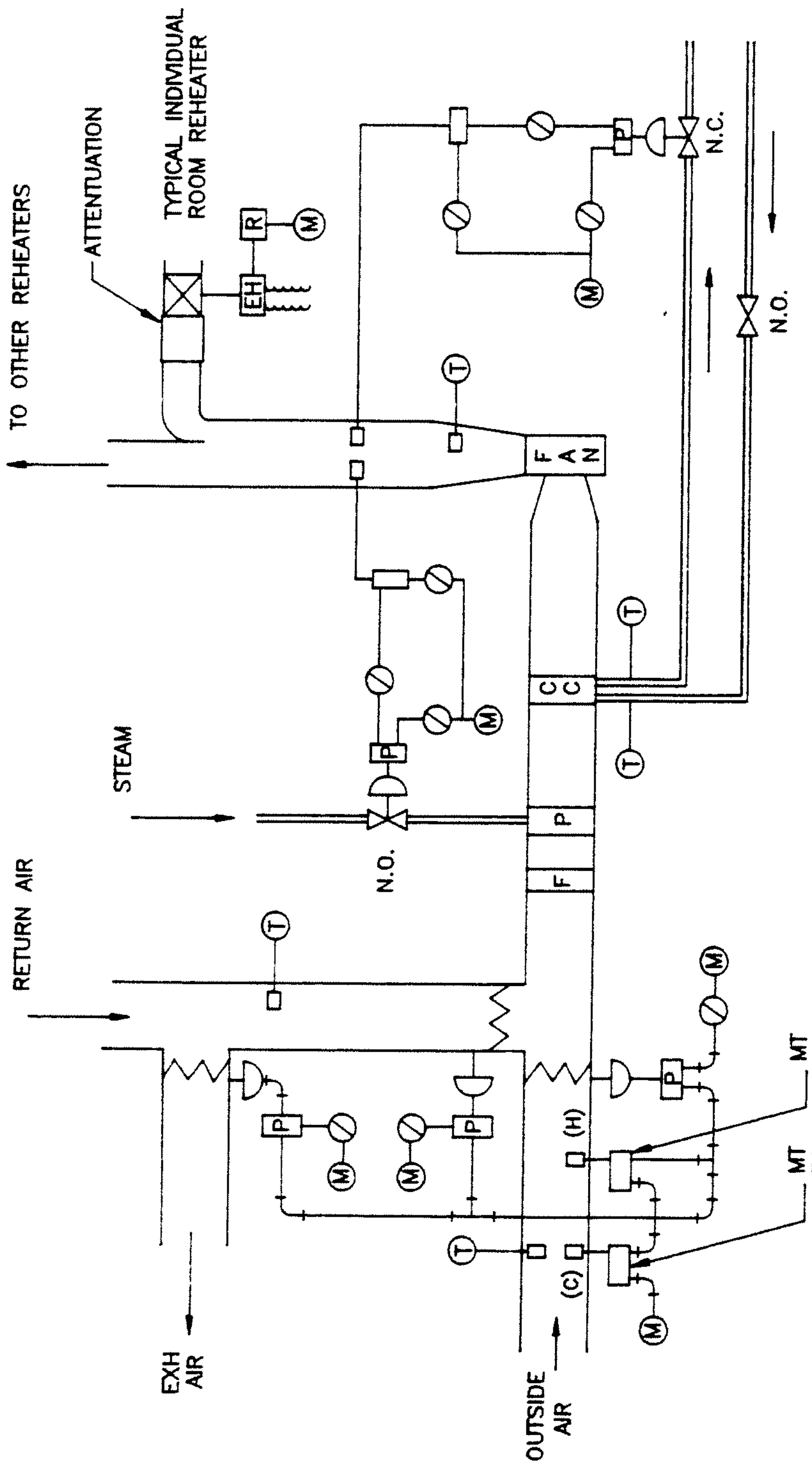
NOTE: Electric or electronic controls having equivalent modulating and sequencing capability may be used in lieu of pneumatic type devices 5
shown.

PLATE I
CLASS "G"
AIR CONDITIONING SYSTEM



NOTES: PREHEATER AND REHEATER MAY BE ELECTRIC TYPES IN LIEU OF STEAM.
COOLING COIL MAY BE DIRECT EXPANSION FREON TYPE OR CHILLED WATER.
DAMPERS MAY BE ELECTRIC POWERED IN LIEU OF PNEUMATIC AS SHOWN.

PLATE II
CLASS "F"
AIR CONDITIONING SYSTEM



NOTES: REHEATER MAY BE ELECTRIC OR STEAM TYPE AS SHOWN ON PLATE I.
PREHEATER MAY BE ELECTRIC TYPE IN LIEU OF STEAM.
COOLING COIL MAY BE DIRECT EXPANSION TYPE OR CHILLED WATER.
DAMPERS MAY BE ELECTRIC POWERED IN LIEU OF PNEUMATIC AS SHOWN.

SECTION 13

FIRE DETECTION AND EXTINGUISHING

13.1. FIRE AND SMOKE DETECTION SYSTEMS

A fixed fire and smoke detection system shall be provided throughout the machinery and accommodation spaces as required by Regulatory Body(ies).

For <u>unattended</u> machinery spaces a fire detection system shall be provided throughout as required by Regulatory Body(ies). Control of all systems relating to fire protection of the machinery space should be centralized in a single accessible location outside the machinery casing. This station should be capable of control of the fixed fire extinguishing system, machinery space ventilation, fuel pumps, fuel oil valves subject to head pressure, remote fire pump, and the bilge system. Remote operating controls shall be duplicated within the Engine Room Control Station.

A smoke detection system of a type approved by the Regulatory Body(ies) complete with cabinet, alarms, and other associated components, shall be provided for audible and visual detection in applicable spaces. The system, complete with detecting cabinet, alarms, piping, and other associated components, shall be provided for audible and visual detection of smoke from all refrigerated and dry cargo holds and 'Tween Deck cargo spaces, combination dry and liquid cargo tanks, Paint Rooms, Shops, Rope Locker, Boatswain's Stores, shaft alley, Steering Gear Room, inaccessible Storerooms, special Cargo Lockers and other spaces as required.

In <u>manned</u> spaces, the system should have a siren, light, and time delay of 30 seconds.

13.2. EXTINGUISHING SYSTEMS

(a) General

Fixed fire extinguishing systems may be selected from the following types for protection of spaces as indicated below:

Accommodation Areas and Main Deck	- Sea Water Fire Main
Engine Room	- Sea Water Fire Main - Foam - Carbon Dioxide - Water Spray

Auxiliary Internal Combustion Engines	- Carbon Dioxide - Dry Chemical - Foam - Water Spray - Sea Water Fire Main
Paint Lockers and Auxiliary Stores	- Water Spray - Foam - Carbon Dioxide - Dry Powder (in Paint Lockers)

This does not preclude dual extinguishing systems such as required in Engine Room or on Main Decks (i.e., sea water in conjunction with a foam system).

Cargo holds intended to carry dangerous goods of IMO Class 1 thru 9 are to comply with SOLAS Chapter 11-2, Regulation 54.

(b) Fire Classification

Class "A" Fires - Wood, Paper, Rubber, and Plastics
Class "B" Fires - Flammable Liquids, Gases, Oil, and Grease
Class "C" Fires - Electrical

<u>Extinguishing Agents (The General Rule)</u>

Fire Class	Water	CO_2	Foam	Dry Chemical
A	X		X	
B		X	X	X
C		X		X

(c) Water System

Fire pumps as required by the regulations shall be provided with at least one pump located outside the Engine Room. Source of power for the two pumps shall be completely independent of each other. Water system shall meet all requirements of Regulatory Body(ies) and shall protect machinery spaces, and accommodations and working spaces in the House and Weather Decks.

Hose racks or reels outside of accommodations shall be located on side of Deckhouses and be enclosed in corrosion resisting steel cabinets recessed where possible, and arranged so that valve is within cabinet. Cabinets shall be fitted with corrosion resistant steel hinges and anti-rattle CRES latches and snubbers. Cabinets in the forward part of the ship shall be so located as to minimize impact by heavy seas and shall be of special extra heavy construction so as to minimize possibility of damage. The location of hose racks or hydrants inside the accommodation spaces shall be as required by Regulatory Body(ies).

Hose racks or hydrants inside the accommodation spaces shall be provided on each deck level and shall be recessed in bulkheads where practicable. No doors or other covers are required.

Fire hoses at all fire stations shall be equipped with combination solid stream and water spray nozzles. In addition to the required fire hose, there shall be provided three 15 m lengths of 40 mm diameter rubber covered deck wash hose. Each length shall be fitted with a smooth bore type nozzle and reducing coupling for connection to the fire hydrants. Storage shall be provided for all wash hoses and spare hoses.

(d) Carbon Dioxide Extinguishing System

Fixed carbon dioxide extinguishing systems employing 35 kg or 45 kg capacity cylinders shall be provided to protect all refrigerated and dry cargo holds, 'Tween Deck cargo spaces, Paint Rooms, machinery spaces, Emergency Generator Room, Bosun's Storerooms, Special Cargo Lockers, and Shops. These systems shall meet all requirements of Regulatory Body(ies).

The carbon dioxide smothering system for the machinery spaces shall be arranged for total flooding of the Boiler Room and Engine Room above and below floor plates.

NOTE: Appropriate warning sign shall be provided to ensure that all closures and ventilating systems are secured and personnel evacuated from stricken areas before carbon dioxide is released.

Other alternate systems meeting the approval of Regulatory Body(ies) are acceptable as fire extinguishing agents for use in machinery spaces.

(e) Portable Fire Extinguishers

The location, type, and quantity of hand portable fire extinguishers as well as spare charges shall be as required by Regulatory Body(ies). Dry chemical extinguishers shall be of cartridge type.

For unattended machinery spaces, in addition to the portable fire extinguishers, there shall be an equal number located in the fire fighting station or other suitable locations.

(f) Foam Extinguishing Systems

For bulk cargo vessels which carry liquid petroleum products in cargo tanks, a deck foam extinguishing system shall be provided for the protection of all cargo tank spaces where required by Regulatory Body(ies).

(g) Water Spray Extinguishing Systems

Where permitted in specified areas, a water spray extinguishing system may be provided in lieu of the carbon dioxide system specified herein.

NOTE: In the event that the Engine Room is protected by other than a carbon dioxide extinguishing system, a separate enclosure shall be provided for the diesel generator(s), if located within that space.

13.3. RESCUE AND BREATHING APPARATUS

Firemen's outfits shall be provided as required by Regulatory Body(ies).

Fire axes shall be provided as required at each fire station. Sand, safety belts, life line, flame safety lamps, and other equipment required by Regulatory Body(ies) shall be provided and stowed in the emergency gear locker.

SECTION 14

PAINTING

14.1. GENERAL

The paints employed in a given coating system shall be from the same manufacturer unless otherwise specified herein or otherwise approved by the manufacturers concerned and the Owner. Each coat of paint shall be compatible with the coat of paint which it will cover, including preconstruction primers (including weld through type) that are to be retained as part of the final coating system.

All paints shall have low Volatile Organic Compounds (VOC) per EPA Standards.

Except for the minimum surface preparation requirements specified herein, all coatings applications shall be per the manufacturer's instructions.

Each coating system proposed for use shall be shown in Items 14.4, 14.5, and 14.6 of this SECTION.

Prior to final coatings selection, each coating being considered shall be fully identified as per ASTM F718, "Standard for Shipbuilders and Marine Paints and Coatings Product/Procedure Data Sheet". One copy each of the Data Sheet shall be provided to the Contractor and Owner. Information given on the Data Sheet shall be a basis for ensuring proper storage, application, and other aspects of each coating.

A pre-construction conference shall be held between the Owner and Contractor for the purpose of establishing criteria and agreements pertaining to coatings application. Subjects of discussion shall include, but not be limited to, the following: role of the coating manufacturer's representative, method of measuring coating thickness, procedure for inspecting each surface prior to its being coated, procedure for informing the Owner when coatings are to be applied outside of the normal working hours of the Owner's coating's inspector, and other aspects of this subject leading to maximum assurance that coatings will be applied successfully and in accordance with these Specifications. The inspection of the coating systems shall be as per the following Standards: ASTM F941, "Standard Practice for Inspection of Marine Surface Preparation and Coating Application"; ASTM F1130, "Standard Practice for Inspecting the Coating System of a Ship's Topside and Superstructure"; ASTM F1131, "Standard Practice for Inspecting the Coating System of a Ship's Tanks and Voids"; ASTM F1132, "Standard Practice for Inspecting the Coating System of a Ship's Decks and Deck Machinery"; and ASTM F1133, "Standard Practice for Inspecting the Coating System of a Ship's Underwater Hull and Boottop During Drydocking".

All paints and coatings used which make pesticidal claims, such as in the case of anti-fouling paints, shall be approved for that use by the appropriate vessel flag institution.

Unless otherwise specified, or approved by the manufacturer's representatives, paint and other coating material shall not be thinned with solvent, nor altered in any manner by the Contractor.

Successive coating applications shall be of noticeably different colors in order to aid the inspection process.

Coatings shall be compatible with cathodic protection systems (if applicable). Anodes of cathodic protection systems shall be temporarily covered in order to protect them from being coated.

Walking and working areas, including, but not limited to staircases, gangways, and platforms shall be coated with "non-slip" type coatings, or shall be finished by other means which will result in a substantially higher coefficient of friction for those surfaces as compared to adjacent surfaces not so treated.

When blasting is performed, the Contractor shall prevent damage to neighboring equipment and intact coatings, by abrasive grains or dross. Blast abrasives shall be of such a configuration as to create a surface profile in accordance with the coating manufacturer's recommendations. Abrasives shall be clean, dry, and free of any material likely to stimulate corrosion of the steel to be blasted.

Blasting of deck machinery, external surfaces of motor housings, and similar equipment, and application of coatings may be accomplished by the equipment manufacturer rather than by the Contractor.

Surfaces shall be free of moisture before the application of coating materials, unless otherwise permitted by the manufacturer in writing.

The shell in way of keel and bilge blocks shall be protected from components in the wood blocking by means of aluminum foil, at least 50 micrometers thick or an alternate protection of oiled paper or vinyl sheets, greased if in contact with vinyl paint. Upon written agreement by the coating's manufacturer, other alternatives may be employed which will result in an acceptable bottom coating.

Damaged galvanized surfaces shall be cleaned and sprayed with 0.67 kg of zinc metal per sq. m., or 86 micrometers thick. Repairs may also be made by using an approved commercial material.

Ferrous piping required to be galvanized shall preferably be galvanized after fabrication. Where this is not practicable, galvanized surfaces destroyed by fabrication shall be repaired by the "metal spray" method, or, as in the case of welds made aboard ship, cleaned by wire brushing with a steel or stainless steel brush followed by a fresh water wash and coating with suitable anti-corrosive cold galvanizing paint. Screwed connections may be made after galvanizing.

Piping systems shall be identified per ANSI A13.1, "Scheme for Identification of Piping Systems".

Safety colors shall be as per NEMA Z535.1 "Safety Color Code", and shall be used to distinguish hatch openings, machinery, moving parts, and fittings which present a hazard.

These Specifications shall specifically identify all areas that are not to be painted. Where not otherwise stated, all structural and non-structural parts, and spaces, doors, fittings, and vendor supplied items which are normally painted shall, after proper surface preparation, be painted to conform to the surroundings or to comparable parts or spaces.

Where abrasive blasting is required, herein, it shall be per ISO 8501-1, "Preparation of Steel Substrates Before Application of Paints and Related Products", as follows:

Sa 3	"White Metal" blasting
Sa 2	"Commercial" blasting
Sa 2 1/2	"Near White" blasting

Where power tool cleaning is specified, herein, it shall be as follows:

St 2	Thorough hand and power tool cleaning
St 3	Very thorough hand and power tool cleaning

Finish colors shall be to the Owner's choice.

Exterior applications of inorganic zinc silicate to decks shall be carefully inspected, cleaned to remove oxidized products and touched-up where required prior to the application of succeeding coats. Inorganic zinc silicates subject to liquid immersion and exterior vertical surfaces shall be allowed to weather for at least 3 months, or as directed otherwise by the coating manufacturer, prior to washing and application of succeeding coats.

14.2. SURFACE PREPARATION

14.2.(a) Cleaning

Prior to the application of coating materials, all surfaces shall be clean and free from foreign matter.

14.2.(b) Abrasive Blasting or Pickling

Weather exposed steel shall be surface abrasive blasted to "near white".

The term "weather exposed steel", as employed in this SECTION, means all steel from keel to the top most area (except: galvanized and stainless steel; interiors of motors, kingposts, and masts; anchor chain and surfaces oiled or greased), which, after erection or installation, is exposed directly or indirectly to the weather. The term includes deck machinery, davits, exteriors of motor and brake housings, and similar installations; interiors of foundations, pedestals, and equipment housings which have openings to the atmosphere; undersides of Weather Decks, hatch covers; interiors of Weather Deck ventilation ducts for a distance of about 2000 mm to 2500 mm from openings; areas between the backs of control boxes and structure if not seal welded; inside of watertight doors including gasket retainers; and, inside Plenums or Fan Rooms open to weather.

Interior steel shall be handled as indicated:

Steel, except as indicated below, shall be:	Pickle, or commercial blast, Sa 2
Interiors of lube oil tanks including stiffeners	Near white blast, Sa 2 1/2
Areas required to have an inorganic zinc silicate, a catalyzed type of coating or Zinc Dust Paint	Near white blast, Sa 2 1/2, except white metal blast, Sa 3 for immersion service.
Areas required to have a deck covering	Shall be per SECTION 6 of these Specifications.
Machinery Units	Commercial practice.

Where surfaces have been cleaned and primed prior to erection, all riveted seams and welded joints resulting from erection shall be blasted or power tool cleaned except that only blasting or needle guns shall be employed where inorganic zinc or catalyzed coatings are required. However, needle guns shall be employed only where blasting is not feasible. All painted areas damaged by fabrication, welding, abrasion, or rusting shall be re-prepared and touched-up before application of the succeeding coat of paint.

14.3. FAYING SURFACES

Faying surfaces of steel to steel, except when formed by continuous welding, shall receive two coats of primer on each faying surface prior to closure. Faying surfaces of aluminum to aluminum, or of dissimilar metals, shall be protected from corrosion by application of two coats of primer in accordance with the paint manufacturer's instructions.

Riveted or bolted faying surfaces exposed to weather or dampness shall be further protected by applying suitable joint sealing material.

14.4. PAINTING OF WEATHER EXPOSED AREAS

PART OF SHIP	SURFACE PREP. (METHOD) Sa ___ (NOTE 1)	SHOP PRIMER (TYPE) (THICKNESS) (NOTES 2&3)	(NOTE 2) COATING		
			COAT 1 (TYPE) (THICK.)	COAT 2 (TYPE) (THICK.)	COAT 3 (TYPE) (THICK.)
Exterior Keel to Light Load Line	Blast Clean Sa 2 1/2	**** SAMPLE ONLY **** ACE PRIME #1 50 micron	ACE #100 75 micron	ACE #200 50 micron	ACE #300 50 micron
At Drydocking Before Delivery (Note 4)					
Boottop					
Deep Load Line to Rail					
Superstructure					
Weather Decks					
Anchors					
Hatch Covers and Coamings					
Piping: Unlagged Lagging					
Continue listing for all other appropriate surfaces.					

NOTES:

1. Method to be "Blast-Clean" or other; finish to Sa 2 1/2 (Min.) or other as appropriate.
2. For type, give generic or mfg. specific coating; give thickness in micrometers.
3. Where shop primer is not to be used, indicate so.

SYSTEM			
COAT 4 (TYPE) (THICK.)	COAT 5 (TYPE) (THICK.)	TOTAL DRY FILM THICKNESS W/O SHOP PRIMER	REMARKS
ACE #400 100 micron	**	**SAMPLE ONLY** ** 275 micron	Remove loose shop primer, intact primer to remain.

4. If vessel is drydocked before delivery, the area from keel to light load line shall have contaminants removed by scraping and high pressure fresh water washing and/or sweep blasting. Damaged or deteriorated areas shall be blasted to Near White, Sa 2 1/2, and the entire system renewed. Follow manufacturer's recommendations concerning allowable time interval between anti-fouling application and vessel immersion.

14.5. PAINTING OF TANK INTERIORS

PART OF SHIP	SURFACE PREP. (METHOD) Sa 2 1/2 (NOTE 1)	SHOP PRIMER (TYPE) (THICKNESS) (NOTES 2&3)	(NOTES 2 & 4) COATING		
			COAT 1 (TYPE) (THICK.)	COAT 2 (TYPE) (THICK.)	COAT 3 (TYPE) (THICK.)
Salt Water Ballast					
Liquid Cargo					
Liquid Cargo/ Ballast					
Potable Water					
Boiler Feed Water					
Fuel Oil					
Fuel Oil Settling					
Sanitary and Sewage					
Lubricating Oil					
Continue listing for all other appropriate surfaces.					

NOTES:

1. Method to be "Blast-Clean" or other; finish to Sa 2 1/2 (Min.) or other as appropriate.
2. For type, give generic or mfg. specific coating; give thickness in micrometers.
3. Where shop primer is not to be used, indicate so.
4. Exterior surface of piping traversing coated tanks shall receive the same coating system as the tank interior.

SYSTEM			
COAT 4 (TYPE) (THICK.)	COAT 5 (TYPE) (THICK.)	TOTAL DRY FILM THICKNESS W/O SHOP PRIMER	REMARKS

14.6. PAINTING OF SELECTED INTERIOR PARTS OR SPACES

PART OF SHIP	SURFACE PREP. (METHOD) Sa 2 1/2 (NOTE 1)	SHOP PRIMER (TYPE) (THICKNESS) (NOTES 2&3)	(NOTES 2 & 4) COATING		
			COAT 1 (TYPE) (THICK.)	COAT 2 (TYPE) (THICK.)	COAT 3 (TYPE) (THICK.)
Exposed Steel in House Interiors					
Steel Behind Joiner and Insulation					
Decks: Walk-Ways/Other Than Walkways					
Piping: Insulated/ Not Insulated					
Rudder Interior					
Hot Metal Surfaces (List as Approp.)					
Machinery (List as Appropriate)					
Metal Joiner Work					
Cargo Holds					
Chain Locker					

NOTES:

1. Method to be "Blast-Clean" or other; finish to Sa 2 1/2 (Min.) or other as appropriate.
2. For type, give generic or mfg. specific coating; give thickness in micrometers.
3. Where shop primer is not to be used, indicate so.
4. Interior areas susceptible to condensation conditions shall be coated with anti-sweat paint.

SYSTEM			
COAT 4 (TYPE) (THICK.)	COAT 5 (TYPE) (THICK.)	TOTAL DRY FILM THICKNESS W/O SHOP PRIMER	REMARKS

14.6. PAINTING OF SELECTED INTERIOR PARTS OR SPACES (Continued)

PART OF SHIP	SURFACE PREP. (METHOD) Sa 2 1/2 (NOTE 1)	SHOP PRIMER (TYPE) (THICKNESS) (NOTES 2&3)	(NOTES 2 & 4) COATING COAT 1 (TYPE) (THICK.)	COAT 2 (TYPE) (THICK.)	COAT 3 (TYPE) (THICK.)
Cofferdams					
Ladders (Metal)					
Elec. Cable Cableways, Hangers					
Elec. Equip. (List as Appropriate)					
Furniture (Metal)					
Machinery Space (List as Appropriate)					
Void Spaces					
Inaccessible Voids					
Wood (List as Appropriate)					
Other Metals (List as Appropriate)					
Continue list for all other surfaces.					

NOTES:

1. Method to be "Blast-Clean" or other; finish to Sa 2 1/2 (Min.) or other as appropriate.
2. For type, give generic or mfg. specific coating; give thickness in micrometers.

SYSTEM			
COAT 4 (TYPE) (THICK.)	COAT 5 (TYPE) (THICK.)	TOTAL DRY FILM THICKNESS W/O SHOP PRIMER	REMARKS

3. Where shop primer is not to be used, indicate so.
4. Interior areas susceptible to condensation conditions shall be coated with anti-sweat paint.

14.7. CATHODIC PROTECTION

Impressed-current system - See SECTION 90.

Sacrificial-anode system - Describe here the system to be used and the 5
areas of the vessel where they will be applied.

SECTION 15

NAVIGATING EQUIPMENT

15.1. DETAILS OF EQUIPMENT

(a) Magnetic Compass, Liquid

The standard compass shall be per ISO 449, "Shipbuilding - Magnetic Compasses and Binnacles, Class A". It shall be positioned per ISO R694, "Positioning of Magnetic Compasses in Ships" and tested per ISO 2269, "Shipbuilding - Class A Magnetic Compasses, Azimuth Reading Devices and Binnacles - Tests and Certification".

Six spare correcting magnets, labeled and boxed, shall be provided. Stowage shall be provided for these magnets.

Only non-magnetic materials having a permeability of two or less shall be used insofar as practicable within the following distances of the magnetic compass:

Fixed material and standing rigging	-	3000 mm
Movable material, small	-	3000 mm
Movable material, large	-	4600 mm

(b) Bells

See SECTION 94, Part 11, Electronic Fog Bell and Gong Signals for additional information.

All bells shall be constructed per ASTM F956, "Standard Specification for Bell, Cast, Sound Signalling", provided complete with mounting brackets, clappers, striking lanyards, and other miscellaneous hardware.

The fog bell shall be engraved or etched with the name of the ship and the year of completion and shall be mounted on a suitable hanger in the forward part of the ship in an area protected from boarding seas.

The size of the bell for each ship shall be the nearest commercial size to that determined from the following formula; with a maximum of 610 mm.

$$\text{Mouth Dia. in mm} = (\text{Length of ship in meters} + 1.5)(2.7)$$

The watch bell shall be 200 mm in diameter complete with sheaves, toggle, and other accessories, as necessary to provide an efficient arrangement for striking the bell from within the Wheelhouse and shall be located on the Navigating Bridge Deck outside of the Wheelhouse near the centerline of the ship.

(c) Clinometers

Clinometers shall be of an approved bubble-in-tube type. One shall be provided in the Wheelhouse and one in the Machinery Space.

(d) Barometers

Barometers shall be the latest non-recording aneroid type. One shall be located in the Wheelhouse and one in the Captain's Office.

(e) Rudder Course Board

A course board modified to read "True", "Standard", and "Gyro" rudder, shall be provided in the Wheelhouse for manually recording the ship's course instructions.

15.2. LOCATION OF EQUIPMENT

(a) Top of Wheelhouse

1 - Standard magnetic compass and binnacle.

(b) Wheelhouse

1 - Steering reflector, or standard magnetic compass and binnacle
1 - Clinometer
1 - Fog horn, mechanical
1 - Barometer
1 - Rudder course board
1 - Watch bell, mounted on outside of Wheelhouse front bulkhead

(c) Forecastle

1 - Fog bell

(d) Poop Deck, Aft

1 - Fog gong

(e) Captain's Office

1 - Barometer

(f) Engine Room

1 - Clinometer

SECTION 16

LIFESAVING EQUIPMENT

16.1. GENERAL

The Contractor shall provide all lifesaving equipment necessary to meet the latest requirements of the Regulatory Body(ies).

Care must be taken that the arrangement in the area of the boat does not interfere with the boat itself and its launching equipment.

Arrangement must be such that the appliance operator is able to watch all the operations.

Care shall be taken that the lifeboats are kept clear of all vents, discharges, gangways, and ladders, or adequately shielded to prevent spilling onto the lifesaving equipment.

All ferrous fittings of boat gear and boat handling equipment including blocks, fairleads, and shackles shall be hot dipped galvanized, or inorganic zinc coated.

16.2. BOATS

Boats shall be constructed of approved reinforced fiberglass fitted with integral plastic floatation units and stainless steel scuffing strips. They shall be fully equipped, marked, and certified as required by the Regulatory Body(ies) for the maximum number of persons on board.

Hulls and rigid-covers must be fire retardant or non combustible.

Gripes shall be of steel, galvanized or Type 316L stainless, fitted with pelican hooks. Protective moisture proof covering shall be fitted at lifeboat contact points.

16.3. DAVITS

Steel gravity type davits shall be provided as required by Regulatory Body(ies).

The davits, blocks, and falls shall be designed with sufficient strength to carry the fully equipped boats specified. Dacron or equal lifelines shall be fitted into a stainless steel wire rope span fitted between the davit heads.

An expanded metal guard shall be provided under each davit trackway. Suitable protection shall be provided for all horizontal and vertical wire rope leads to winches. Vertical leads shall be shielded to a height of

2000 mm. Drip guards shall be installed in way of falls leading from winches for extent of fleet angle.

Winches shall be per SECTION 81.

16.4. BLOCKS

Blocks shall be non-twisting, non-toppling type, with steel shells, cast steel sheaves and permanently sealed or pressure greased roller bearings.

16.5. FALLS

Falls shall be of galvanized 6 x 19 IPSWR, preformed, regular lay, wire filler pre-lubricated with a suitable neutral wire rope lubricant, of a diameter to suit installation of boats.

16.6. MISCELLANEOUS

Three galvanized steel, pointed-top boat hooks, each with a staff 2500 mm long shall be provided. These are in addition to equipment for the lifeboats.

16.7. INFLATABLE LIFE RAFTS

Approved inflatable life rafts shall be provided as required by the Regulatory Body(ies).

SECTION 17

COMMISSARY SPACES

17.1. GENERAL

It is the intent of the Specifications and Contract Drawings that a complete messing system shall be furnished in compliance with the Regulatory Body(ies) requirements and that the equipment shall be of good commercial design modified as needed to suit shipboard conditions.

Stowage shall be provided for all portable equipment, including china, glassware, silverware, utensils, trays, and spare parts.

The Contractor shall provide spare parts as recommended by the manufacturer to assure continued operation of their equipment at sea for a period of 1 year.

(The equipment described herein is based on a conventional messing system. At the Owner's option, modification may be made to suit cafeteria style messing.)

17.2. MATERIALS AND WORKMANSHIP

All heated equipment shall have automatic controls. Steam equipment shall have necessary reducing valves to furnish proper pressures from supply lines.

Surfaces which come in contact with food and drink shall be CRES, AISI 304 Finish No. 4. All welding including field joints shall be flush, ground smooth and polished on exposed surfaces. No solder or rivets shall be used.

See SECTION 20 for faucets on itemized equipment and sinks.

17.3. TOPS

Tops of all dressers, counters, and drain boards, except as otherwise specified, shall be constructed of 2 mm CRES, AISI 304, Finish No. 4. Tops in way of bulkheads, shall be constructed with 300 mm high integral splash-backs, flanged back 25 mm at 30^{o} angle to bulkhead at back and ends. Dish dresser tops shall have front and free ends raised 100 mm and rolled to 19 mm radius. Top edges of splashbacks shall be fitted with finishing strips welded to the bulkhead.

Tops shall be properly braced and supported underneath for rigidity. Where there is a bulkhead stiffener the splash-back shall be splayed back from a point 125 mm in front of stiffener.

Tops shall be securely mounted on "open" and "enclosed" bases, as required, and shall be depressed for griddles. Sinks, drains, and other insets shall be butt-welded to and finished as an integral part of the top. Sinks, drains, and other inserts shall have portable and hinged covers constructed of the same material as the top and set flush with top when closed.

All corners shall be constructed with a 12 mm minimum radius.

All dresser, counter, and drain board tops shall have sound deadening material, of approved quality, applied to the underside except that such treatment shall be omitted in way of food storage compartments.

17.4. BASES

All bases shall be of CRES construction throughout and shall be 915 mm high from finished deck to working top, mounted on a platform to be provided by the Contractor, and shall be welded or bolted securely through a watertight gasket to the platform. All exposed corners shall be rounded.

Bases of all dressers, cabinets, warmers, counters, and sinks, shall be constructed of a framework not less than 38 mm x 38 mm x 5 mm angle with all corners mitered, welded, ground and finished smooth; bases shall be reinforced with cross-angles not over 760 mm on center, with triangular corner gussets welded into intersections for rigidity, and with vertical stiffeners between welded to top and bottom frames. Legs shall be tubular CRES.

Enclosed bases, lockers, cabinets, and counters shall have panels of 1.25 mm CRES, secured to frames and fitted with 1.5 mm sectional removable bottom and intermediate shelves. Sliding doors shall be constructed with 1.25 mm CRES outer pan and 1.0 mm CRES inner pan. All joints shall be ground and polished. The space between shall be filled with an approved insulating material. Sliding doors shall operate on roller bearings suspended overhead from one removable 2.5 mm track and shall be fitted with suitable chrome plated heavy stops and latches of an approved marine design. Hinged doors shall be constructed similarly to sliding doors with hemmed edges all around and shall have CRES hinges, handles, and latches.

Semi-enclosed bases shall be same construction as enclosed dressers and be enclosed at back and ends with 1.25 mm CRES panels.

Open, semi-open, and closed bases shall have drawers, portable CRES battens, creels, slides, and racks as required for the stowage of appropriate equipment and supplies for the space in which the equipment is located. All drawers shall be smooth operating and fitted with stops and flush type combination drawer pull and latch. Stowage drawers in galley and pantries shall have stainless steel inserts for silverware.

Dressers with sliding doors shall be constructed so that there will be no bottom rail to catch dirt or to interfere with cleaning.

Enclosed warmer bases shall have perforated sectional removable shelves and valve compartment with hinged door and shall be heated by 19 mm IPS brass steam coils or heated electrically.

17.5. PLATFORMS

Platforms for the installation of equipment and dressers shall be provided, constructed of 5 mm thick medium steel top plate supported at front by coaming plate, finishing approximately 100 mm above the finished deck, welded to the top plate 115 mm in from the front edge to form toe space. Deck covering material shall be coved up to the platform. Island type dressers may be supported on 200 mm high CRES legs.

17.6. SINKS

Sinks shall be constructed of not less than 1.5 mm CRES and sinks 600 mm x 600 mm and larger of 2 mm CRES. Sinks shall be fitted with 50 mm cast brass chrome plated, externally controlled lever-type waste outlet, connected at back to 1.25 mm brass pipe with union from overflow connection, with CRES perforated strainer. Sinks to have 1.25 mm CRES apron and splashbacks and drain boards, as specified under Article 3, "TOPS". Sinks shall be fitted with dial thermometers and suitable hot water supply.

17.7. STEAM TABLE (IF PROVIDED)

Steam table tops shall be constructed as specified under Article 3 "TOPS", of CRES, fitted with suitable polished CRES inserts, with telescopic roll CRES covers on meat and vegetable pans and spun CRES lift covers on pots.

Steam table hot water pans shall be of 1.25 mm CRES, otherwise the same construction as sinks with over the rim water inlets formed by 13 mm swivel type faucet, and one waste outlet in bottom, with a drain pipe leading from the steam table to a deck drain. Pans shall have suitable splash-baffles to control movement of water in heavy seas, and shall have a water seal around the top. Steam tables shall be mounted in warmer bases.

17.8. DRY HEAT FOOD TABLE (IF PROVIDED)

Electrically heated hot food table shall have stainless steel body, with modifications and optional equipment to suit Owner. Body of unit to be mounted on enclosed sub-base of sufficient height to bring top to dresser top height.

17.9. RACKS, MISCELLANEOUS

Necessary CRES pot and thaw racks of rigid construction shall be provided. CRES stationary dish, cup, and glass racks shall be installed on bulkheads.

17.10. REFRIGERATORS

Galley, Pantry, and Mess Room reach-in and under-dresser type refrigerators shall be CRES exterior and interior, with CRES welded wire shelves and partitions and provided with lights and locks.

17.11. SHELVES

Overhead shelves shall be constructed of 1.25 mm CRES with back and ends turned up 50 mm and hemmed down for 30 mm and front edge turned up 19 mm hemmed down for 40 mm and turned back at 90° for 12 mm. Portable CRES battens shall be provided as required. Shelves shall be supported on 2 mm CRES brackets spaced not over 915 mm on center.

17.12. OVERHEAD CABINETS

Overhead cabinets measuring 380 mm deep x 600 mm high with length as required, shall be constructed with 1.25 mm CRES body and sanitary sloping top. Front shall be fitted with 0.9 mm CRES hinged or sliding doors equipped with suitable latches. Interior shall be fitted with 0.9 mm CRES or welded wire sectional removal shelving.

17.13. TILTING BINS

Tilting bins shall be provided in enclosures similar to enclosed bases and shall be constructed of 2 mm CRES.

17.14. LIST OF MANUFACTURED COMMISSARY EQUIPMENT

(a) Galley

Qty.	Description
1	Electric range, CRES front, with three hot plates, handrail, sea rails, and overhead switch box.
1	Electric oven (if provided), two section, CRES front, complete with stand.
1	Electric convection oven (if provided) CRES front, single deck, complete with stand.
3	Microwave Ovens, all CRES, 1,500 watts, variable power

Qty.	Description
1	Electric griddle, all CRES, counter type.
1	Fry kettle, all CRES, counter type, with full size basket.
1	Combination steam cooker/kettle, consisting of one pressure cooker and one 19 liter stainless steel tilting kettle, with electric steam generator. Stainless steel cabinet base. (Combination jet cooker and 19 liter tilting kettle may be provided as an alternate.)
1	Mixer, bench type, complete with one 19 liter CRES bowl, flat beater, wire whip, meat chopper, knife sharpener, and dough hook.
1	Meat slicer, angle feed, anodized aluminum finish.
1	Proofer, steam or electric, built into baker's dresser.
1	Refrigerator and Freezer, CRES, self-contained, dual temperature, 0.6 cu. m plus 0.6 cu. m.
1	Garbage disposal, 3 phase, built-in under dresser. (Accessories to Owner's approval.)
1	Can opener (table mounted)
1	Baker's scale, 3.5 kg. capacity.

(b) Serving Area

Qty.	Description
1	Dishwasher, with combination automatic and manual control, door lock control, and electric booster heater.
1	Garbage disposal, 3 phase, built-in under dresser. (Accessories to Owner's approval.)
1	Ice cuber.

(c) Passengers' and Officers' Dining Room

Qty.	Description
1	Coffee maker, marine type with brackets.
1	Warmer unit, 2-burner, marine type with brackets, with two CRES decanters.

Qty.	Description
1	Toaster, 4-slice unit, with cord and plug.
1	Refrigerator, 0.2 to 0.3 m^3.

(d) Crew Mess Room

Qty.	Description
1	Coffee maker.
1	Warmer unit, 2-burner, marine type with brackets, with two CRES decanters.
1	Toaster, 4-slice unit, with cord and plug.
1	Refrigerator, 0.2 to 0.4 m^3.

(e) Miscellaneous Items

Qty.	Description
1	Scale, Storeroom, platform type 45 kg.
As Req'd.	Creels, dish, vinyl coated, portable.
As Req'd.	Racks, cup, wire, vinyl coated, portable.
As Req'd.	Racks, glass, wire, vinyl coated, portable.

SECTION 18

UTILITY SPACES AND WORKSHOPS

18.1. GENERAL

Each space shown on the Contract Drawings shall be completely furnished by the Contractor with articles and equipment shown and as specified herein.

18.2. LAUNDRIES

Deck Officers', Engineering Officers', and Crew's (each)

2 - Electric washers, heavy duty type, 6.8 kg dry capacity minimum.

2 - Electric dryers, heavy duty type, 6.8 kg dry capacity minimum.

1 - Laundry tub, see SECTION 20.

1 - Ironing board of best commercial quality, size 1350 mm x 400 mm with suitable padded top, mounted on galvanized steel frame arranged to hinge up and be secured against bulkhead.

1 - Electric iron, with cord, AC, 1.7 kg, 2,500 W.

1 - Shelf for electric iron - CRES.

1 - Locker 450 mm x 900 mm wide by 1750 mm high for supplies.

The electrical items herein shall be compatible with the ship's electrical system.

18.3. UTILITY SPACES

(a) Slop Chest

Galvanized steel shelving 1.5 mm, 600 mm deep with 50 mm flanged lips and portable retaining battens shall be arranged in tiers, about 750 mm, 1050 mm, 1400 mm, and 1750 mm off deck. Supports for shelves shall conform to SECTION 23, Article 1. A dutch door with shelf shall provide access to the space. The door shall be fitted with hasp suitable for padlocking and customs seal.

Two compartmented sheet metal cash drawers with locks.

(b) Bonded Stores Locker (If Provided)

The bonded stores locker shall be outfitted with shelving three-high, arranged with grids for stowing alcoholic beverages in individual bottles and in case lots. Full height vertical shifting tubes with deck and overhead sockets as required. The door shall be fitted with hasp suitable for padlocking the customs seal.

(c) Garbage Room

The Garbage Room shall be outfitted with four garbage cans with covers, galvanized, 75 liters type. Galvanized steel chains and fittings shall be provided for retaining the cans in stowage position. Hot and cold fresh water facilities shall be provided for washing and scrubbing cans and washing down the space. A commercial (industrial sized) trash compactor shall be provided, with adequate storage space in or adjacent to the Garbage Room for compacted trash.

(d) Containerized Marine Incinerator

Provide one complete Containerized Marine Incinerator system per ASTM F1323, "Standard Specifications for Shipboard Incinerator" or IMO Annex 8DE3535, "Standard Specification for Shipboard Incinerators".

18.4. WORKSHOPS

(a) Deck Maintenance Shop (If Provided)

1 - Workbench, galvanized steel frame and top, 900 mm wide, 2 drawers under, 600 mm x 600 mm x 200 mm.

1 - Woodworker's vice, 250 mm automatic locking.

1 - Machinist's vice, 110 mm, swivel base.

1 - Lumber storage rack, galvanized steel.

1 - Locker, 1.5 mm galvanized steel, 1200 mm x 1200 mm x 300 mm, with shelves for storage of small items. Doors shall be fitted with hasp for padlock.

1 - Waste can with cover, galvanized, 75 liter type.

Shelving of galvanized steel for storage of small items.

Vises shall be mounted on workbench.

(b) Electrician's Workshop

See SECTION 80.

(c) Engineer's Workshop and Storerooms

See SECTION 80.

SECTION 19

FURNITURE AND FURNISHINGS

19.1. GENERAL

Each space shown on the Contract Drawings shall be fitted out complete, by the Contractor, as required herein or as indicated on the Contract Drawings. Any and all spaces shown on the Contract Drawings, but not specifically mentioned in the Specifications, shall be suitably furnished and fitted complete as specified for a similar space.

All hardware for connecting knockdown sections shall be stainless steel or brass.

Where resin laminate tops are specified they shall be per ASTM F826, "Standard Specification for Tops, Furniture, Marine, Steel", 1.5 mm nominal thickness with 0.5 mm backing sheet or laminate applied to back face of core.

Fixed furniture shall be secured to decks or bulkheads, as necessary. Securing devices and flush deck sockets shall be provided for lashing all portable furniture.

All berths, desks, and chart tables shall be provided with lights of a type as required by SECTION 92.

All drawers shall have positive means to prevent opening in heavy seas. Springs, bullet magnetic, or bayonet catches will not be permitted.

19.2. FURNITURE

Furniture for officer, crew, and passenger accommodations shall be of steel, aluminum, or hardwood except where specified otherwise. All metal case goods shall be insulated with a mineral base sound-deadening material, at least 1.5 mm thick. All exposed hardware shall be of stainless steel, dull finish; white bronze, satin finish; or aluminum, anodized.

19.3. MIRRORS

Mirrors shall be 6.5 mm thick, silvered, electrolytic copper-backed, covered with prime coat and a heavy coat of waterproof paint. All edges and slightly rounded edge corners shall be ground and polished. Frames shall be 12 mm x 16 mm angle chromium-plated satin finish brass with brazed mitres. Back of mirrors shall be not less than 0.8 mm galvanized sheet metal. All contact edges of mirrors shall be lined with black felt strips. Mirrors shall be arranged for mounting with three concealed hangers welded to back, to receive brackets attached to bulkhead.

19.4. WARDROBES

Wardrobes shall be 600 mm x 600 mm x 1800 mm, minimum, and located as shown on the Contract Drawings. Each wardrobe shall be provided with a shelf, coat rod, six hooks, shoe rack fitted at back near bottom, and the rack on inside of wardrobe door.

19.5. LAMPS

Lamps shall be provided on end cabinets. Desk, table, and Stateroom lamps shall match the decor of the space.

19.6. AIRPORT AND WINDOW CURTAINS

Curtains shall be provided at each airport and window in all accommodation spaces, Radio Room, and Chart Room. See SECTION 25 for material and interior decoration.

19.7. SAFE LOCKERS

Safe lockers 590 mm x 600 mm x 1050 mm shall be provided.

19.8. END TABLE/END CABINET

End tables for Officer and Crew Recreation Rooms shall be provided with a closed section with doors and an open shelf under. Tops shall be per ASTM F826, "Standard Specification for Tops, Furniture, Marine, Steel". End tables shall be fitted for lamps.

19.9. SWIVEL CHAIRS

Swivel chairs of steel or aluminum shall be provided.

19.10. SHOES AND GLIDES

Legs of all portable furniture shall be provided with non-marking, non-skid glides retained in stainless steel cups.

19.11. COFFEE TABLES

Coffee tables as shown on the Contract Drawings shall be steel, aluminum, or hardwood with resin laminate top and binding edge of anodized aluminum.

19.12. PASSENGER STATEROOM BEDS (IF PROVIDED)

The material and construction of beds shall be per Regulatory Body(ies) with life preserver rack under. Lee rails shall be provided.

The dimensions of the bed shall be of the commercial standard twin size 965 mm x 2020 mm.

19.13. BEDSPRINGS

Berths for passengers, officers, and crew shall be provided with mattresses and box springs 180 mm $\pm$ 12 mm overall height, and per ASTM F1085, "Standard Specification for Mattress and Box Springs, Berths".

Hospital berths shall be provided with steel wire spring bottoms, modified to commercial standard twin size 965 mm x 2020 mm.

19.14. MATTRESS

All mattresses shall be innerspring construction, and per ASTM F1085, "Standard Specification for Mattress and Box Springs, Berths", to fit the standard twin size berth of 965 mm x 2020 mm with 12 mm clearance all around. The finished thickness shall be 180 mm $\pm$ 12 mm. Mattresses for the Hospital shall be covered with water-repellant ticking.

19.15. ELECTRIC FANS

Bracket fans, per SECTION 92, shall be provided as follows:

Location	Quantity
Bosun's Stores (each)	1
Galley	4
Workshops (each)	1
Laundries (each)	1
Pantries (each)	1
Wheelhouse	2

19.16. WASTEBASKETS

Wastebaskets in Officer and Crew accommodations shall be provided.

19.17. RADIO SHELF

Shelf for radio at each berth shall be provided in Officers' and Crew's Rooms.

19.18. LOCATION AND TYPE OF FURNITURE

The following schedule indicates, generally, the furniture to be provided in the several typical spaces.

(a) Passenger Spaces (If Provided)

Staterooms - One Person

1 Bed
1 End Table, with Lamp
1 Chest of Drawers
1 Vanity with Drawer
1 Vanity Bench, 380 mm x 480 mm x 460 mm high
1 Coffee Table
* Mirror
1 Wardrobe, built-in
1 Mirror, approx. 350 mm x 1575 mm
  (front of wardrobe door)
1 Chair, Lounge
1 Chair, Side
1 Wastebasket
  Window or Airport Curtains and Rods

Staterooms - Two Persons

2 Beds
2 End Tables with Lamps
2 Chests of Drawers
1 Vanity with Drawer
1 Vanity Bench 380 mm x 480 mm x 460 mm high
1 Coffee Table
* Mirror
2 Chairs, Lounge
2 Chairs, Side
2 Wardrobes, built-in
1 Mirror, approx. 350 mm x 1575 mm
  (front of wardrobe door)
1 Wastebasket
  Window or Airport Curtains and Rods

(b) Officer Spaces

Staterooms

(1) Captain and Chief Engineer (each)

1 Berth, Commercial 1345 mm wide
1 Berth Shelf
2 Chairs, Lounge
1 Chair, Side
1 Chest of Drawers

*Quantity as shown on the Contract Drawings.

1 Mirror, 750 mm x 1140 mm
1 Wardrobe, built-in
1 Safe Locker (Captain only)
1 Safe, provided in Safe Locker
1 Bookrack
1 End Table, with Lamp
1 Wastebasket
1 Window or Airport Curtains and Rods
1 Small Refrigerator

(2) Chief Officer and First Asst. Eng. (each)

1 Berth, Commercial 1345 mm wide
1 Berth Shelf
1 Chair, Lounge
1 Chest of Drawers
1 Chair, Arm
1 Chair, Side
1 Wardrobe, built-in
1 Mirror 750 mm x 1140 mm
1 Bookrack
1 End Table, with Lamp
1 Wastebasket
1 Window or Airport Curtains and Rods

(3) 2nd Asst. Engineer, 2nd Officer, 3rd Asst. Engineer, 3rd Officer, Jr. 3rd Asst. Engr., Jr. 3rd Officer, Radio Operator, Purser, Chief Electrician, Bosun, Chief Cook, Chief Steward, and Cadets in single rooms. For Medical Treatment or Multipurpose Room and when Cadets are accommodated in a double room, all items except the mirror shall be increased to 2.

1 Berth, 965 mm wide for officers, others - commercial standard twin size
1 Berth Shelf
1 Desk, Double Pedestal Typewriter
1 Chiffonnier, without Secretary Drawer
1 End Cabinet, with Lamp
1 File Cabinet
1 Chair, Lounge
1 Chair, Side
1 Bookrack
1 Mirror, 600 mm x 750 mm
3 Key Lockers, 52 keys (Chief Steward, 1st Mate, and Chief Engineer, each space)
1 Wardrobe, built-in
1 Wastebasket
Window or Airport Curtains and Rods

(4) Passengers' and Officers' Dining Room

* Tables
* Chairs, Side
* Transoms
1 Sideboard, with tray for silver and built-in refrigerator
* Server
1 Glass and Castor Racks
1 Wastebasket
1 Bulletin Board, 600 mm x 850 mm
Window or Airport Curtains and Rods

(5) Passengers' and Officers' Lounge

* Sofas
* Chairs, Lounge
* Chairs, Arm
* End Tables, with Lamps
* Card Table, .9 m diam., without rails
* Writing Table
1 Sideboard with locks and self-contained refrigerator
1 Television (see SECTION 95)
1 Entertainment Radio (see SECTION 95)
* Coffee Table
1 Bookcase
1 Magazine Rack
* Wastebasket
Window or Airport Curtains and Rods
1 Video Cassette Recorder

(6) Officers' Recreation Room (Only on ships without passengers or with separate passenger lounge.)

1 Sofa
2 End Tables with Lamps
1 Coffee Table
3 Lounge Chairs
1 Card Table
4 Side Chairs
1 Magazine Rack
1 Bookcase
1 Television (see SECTION 95)
1 Entertainment Radio (see SECTION 95)
1 Wastebasket
Window or Airport Curtains and Rods
1 Video Cassette Recorder

*Quantity as shown on the Contract Drawings.

(c) Crew Spaces

Staterooms

(1) Single Rooms (each)

1 Berth, commercial standard twin size
1 Berth Shelf
1 Desk
1 Chair, Side
1 Lounge Chair
1 Wardrobe, built-in
1 Bookrack
1 Wastebasket
Window or Airport Curtains and Rods

(2) Messroom

* Tables, fixed sea rails
* Chairs, Mess
1 Sideboard, with silver drawer, aluminum binding, and lee rail
1 Shelf, for 2 Toasters, CRES 680 mm x 380 mm bulkhead-mounted, clips for securing toasters
2 Glass and Castor Racks
2 Condiment Racks, CRES, 150 mm x 280 mm approx., to be stowed in sideboard
1 Refrigerator (see SECTION 17)
1 Wastebasket
1 Bulletin Board, 600 mm x 850 mm
Window or Airport Curtains and Rods

(3) Recreation Room

* Transoms
* End Cabinets, with Lamps
* Chairs, Lounge
* Chairs, Arm
* Chairs, Side
1 Table, as shown on drawing, with adjustable lee rails
1 Bookcase
1 Magazine Rack, bulkhead mounted
1 Television (see SECTION 95)
1 Entertainment Radio (see SECTION 95)
1 Wastebasket
1 Bulletin Board, 600 mm x 850 mm
Window or Airport Curtains and Rods
1 Video Cassette Recorder

*Quantity as shown on the Contract Drawings.

(d) Office Spaces

(1) Captain and Chief Engineer (each)

1 Desk, D.P.F.T.
1 Table, with resin laminate top as shown on drawing, w/adjustable lee rail
1 Chair, Swivel, Arm
1 Chair, Lounge (Captain only)
1 Chair, Arm
3 Chairs, Side
1 Sideboard, with locks and self-contained refrigerator
1 Key Locker, 52 keys
1 Transom
2 End Cabinets, with Lamps (Captain only)
1 File Cabinet, with lock
1 Bookrack
1 Bookcase
1 Drawing Cabinet, consisting of 2 units of 3 legal size file cabinet drawers, with resin laminate top, approx., 1200 mm x 750 mm (Chief Engr. only)
1 Wastebasket
Window or Airport Curtains and Rods
1 Computer Desk

(2) Chief Officer and First Asst. Engineer (each) (Only when a ship's office is not provided.)

1 Desk, D.P.F.T.
1 Chair, Swivel, Arm
2 Chairs, Arm
1 Transom
1 Bookcase
1 Bookrack
1 Key Locker, 52 keys
1 File Cabinet, with lock
1 Drawing Cabinet, consisting of 2 units of 3 legal size file cabinet drawers, with resin laminate top, approx., 1200 mm x 750 mm (Chief Engr. only)
1 Wastebasket
Window or Airport Curtains and Rods
1 Computer Desk

(3) Ship's Office (Only when Chief Officer's and First Asst. Engineer's offices are not provided.)

1 Table, Work, resin laminate top, 2 cupboards with 2 adjustable shelves
2 Stools adjustable

2 Bookracks
1 Key Locker, 52 keys
2 File Cabinets, with locks
2 Chairs, Arm
2 Chairs, Swivel, Arm
2 Desks, D.P., Typewriter
1 Wastebasket
1 Bulletin board, 600 mm x 850 mm
1 Drawing Cabinet, consisting of two units of three legal size file cabinet drawers, with resin laminate top, approx., 1200 mm x 750 mm (for First Asst. Engr.)
Window or Airport Curtains and Rods

(e) Navigation Spaces

(1) Wheelhouse

For navigation equipment, see SECTION 15.

2 Tables, Drop-leaf (wall desk)
2 Binocular Boxes (wood)
1 Flag Locker

(2) Chart Room

1 Chart Table
1 Bookrack
1 Stool, Adjustable
1 Locker Stowage
1 Bookcase
1 Transom
1 Wastebasket
Window or Airport Curtains and Rods

(3) For radio equipment, see SECTION 93.

1 Table, Work, linoleum top, to suit equipment
1 File Cabinet, with lock
1 Spare Parts Locker with lock, built-in
1 Chair, Swivel, Arm
1 Chair, Side
1 Bookrack
1 Wastebasket
Window or Airport Curtains and Rods

(f) Hospital Spaces, required when 12 or more members of the crew are accommodated in multiple occupancy rooms.

Berths shall be of metal and may be in double tier provided the upper berth is hinged and arranged to be secured clear of the lower berth when not in use. At least one berth shall be so arranged that it can be made readily accessible from both sides when necessary. Berths shall be Gatch Type (lower) modified as necessary.

1 Bedside Table for each berth, with metal top, 450 mm x 600 mm with drawer and cabinet under.
1 Bookrack, metal, 600 mm x 250 mm x 350 mm high, 2 shelves with guard rail.
1 Clothes Locker for each berth, depth shall be 600 mm min.
1 Tissue Dispenser
1 Chair, Side
1 Waste Receptacle, metal, foot operated cover
1 Hospital Bath. For plumbing fixtures, see SECTION 20.
1 Medicine Locker. Shall be located as shown on drawing.
Window or Airport Curtains and Rods

(g) Medical Treatment or Multipurpose Rooms, may be substituted for the Hospital when less than 12 members of the crew are accommo-dated in multiple occupancy rooms. The items of furniture shall be as given in Officers' Staterooms.

The room must be:

(1) Available for immediate medical use.

(2) Available to stretcher cases.

(3) Arranged so that one berth can be made accessible from both sides when necessary.

(4) Provided with private toilet and shower facilities.

SECTION 20

PLUMBING FIXTURES AND ACCESSORIES

20.1. GENERAL

Provide plumbing fixtures and accessories specified herein. The plumbing fixtures and accessories shall be of marine grade.

Except as otherwise specified, all trim for fixtures and all accessories shall be chrome plated cast or forged brass and shall be of matching design for uniformity.

Fixtures which are liable to injury by excessive bolt tightening shall be mounted with concussion washers between fixtures and metal supports.

Grab rods shall be provided at all showers, bath tubs, and water closets.

20.2. PLUMBING FIXTURES AND FITTINGS

(a) Drainage

All lavatories, laundry tubs, sinks, and other equipment provided with drains shall be trapped at the fixture. Access to traps and overflows shall be arranged to permit maintenance without removal of heavy built-in items.

Traps for fixtures shall be swivel pattern chrome plated cast brass with brass clean-out plug.

(b) Supplies

Vacuum breakers shall be provided wherever back siphonage is possible and shall be located between the discharge side of the control valve of the fixture and the outlet.

Supply pipes to all fixtures shall be equipped with chromium plated loose key or screwdriver brass stops, except for those fixtures with integral stops.

All exposed piping to fixtures in accommodation spaces shall be chrome plated.

20.3. FAUCETS (MISCELLANEOUS)

Brass compression faucets 19 mm for washdown purposes with hose bibb and four-ball indexed handle shall be provided in Butcher Shop, Galley, Pantries, Fan and Filter Cleaning Room, Garbage Room, Stevedores' Toilet and where required for decks and passageways including an outlet for washing down the ship service refrigerated stores space located in the adjacent passageway.

A 13 mm chromium plated brass long arm swinging spout with control valve and spout swivel without soap dish located for convenient operation, shall be provided in the Galley for supplying cold potable water to the stock kettles and pots on the range.

One swinging spout chromium plated brass double faucet with 200 mm spout, without soap dish shall be provided over each pair of Galley and Pantry sinks and over the sink in the baker's dresser in the Galley.

All faucets shall be indexed "H" or "C", indicating service.

All faucets for lavatories shall be of the spring self-closing type.

All shower heads shall be at least 1800 mm above level of drain.

Faucets for lavatories, showers, baths, and sinks as specified hereinafter, shall have replaceable seats and have all moving parts outside the water flow area or have replaceable valve units with a stem operating in a sleeve or center piece. Faucets may also be of the ceramic cartridge type.

20.4. SHOWER STALL ENCLOSURES

Shower enclosures shall not be less than 810 mm x 810 mm inside dimensions.

20.5. SHOWERS AND BATHS

All shower spaces shall have valves and risers concealed where possible.

20.6. DRINKING WATER DISPENSERS

Provide drinking water dispensers, electric with bubbler. They shall be per UL 399, "Standard for Drinking-Water Coolers" or compressor type per JIS C9618, "Drinking-water Coolers". They shall be located as shown on Contract Drawings and in the Schedule of Sanitary Fixtures (SECTION 20.8).

20.7. ACCESSORIES

(a) Mirrors

Provide 400 mm x 500 mm mirrors per SECTION 19.

(b) Toilet Cabinets

Provide double shelf toilet cabinet approx. 400 mm x 650 mm x 100 mm deep with 400 mm x 500 mm mirror similar to Item (j) glass mirror with polished CRES frame with full piano hinge, anti-rattling positive door catch (friction catch not acceptable) and sliding door stop and limit-stop. Two shelves behind mirror and one open shelf below door. Bottom shelf shall be provided with removable tray arranged to extend 20 mm up sides with back and to cover front of shelf. Cabinet arranged for exposed mounting on bulkhead.

20.8. SCHEDULE OF SANITARY FIXTURES

A complete schedule of sanitary fixtures shall be provided by the Contractor for approval by the Owner prior to any procurement and installation of any fixtures.

SECTION 21

HARDWARE

21.1. GENERAL

All hardware covered herein shall be of the commercial marine type. Hardware not specifically covered shall be comparable to that described herein for similar applications.

Aluminum hardware and fittings of comparable strength and hardness shall be used wherever possible in aluminum construction when such hardware comes into direct contact with the structure. Where it is not practical to use aluminum hardware and fittings, the dissimilar materials shall be insulated.

Screws for securing hardware shall be of chrome-plated bronze or stainless steel per SECTION 1.11, and shall have countersunk oval heads where practical.

21.2. LOCKS

All lock sets shall be equipped with cylinders and shall be mortise or rim type, made by one manufacturer.

21.3. PADLOCKS

All watertight doors, weathertight doors, hatches, manholes, and scuttles to compartments for the stowage of equipment or stores shall be provided with hasps, and staples. In addition, wire mesh doors in back of switchboard, doors to Fan Rooms, CO_2 Bottle Storeroom, Steering Gear Room door, Garbage Chute, and all other wire mesh doors, shall have hasps. Slop Chest and Bonded Stores spaces shall be provided with hasps, and staples.

21.4. KEYS

No two sisterships shall be keyed alike.

Each door lock shall be provided with three keys. The keys for each lock shall be different from the keys to other locks, except where there is more than one door to the same compartment, in which case these doors shall be keyed alike.

Door locks and padlocks of the same type shall be master keyed in groups:

N - Navigation Spaces
D - Deck Department
E - Engine Department
S - Steward Department

All passageway doors leading in or out of crew quarters as well as Recreation Rooms and Pantry shall be equipped with locks keyed to the Stateroom doors.

Each group of locks and padlocks shall have three master keys. Three grand master keys which can open all groups of locks and padlocks shall be provided.

All keys including duplicate keys shall be numbered and have a tag of heavy fiber or plastic with the name of the space and ship inscribed thereon.

Wardrobe locks shall be keyed differently from each other and from the locks to the Staterooms in which they are installed. They shall be master-keyed in a separate system.

21.5. KEY LOCKERS

Key lockers, fitted with hooks and names or numbers for readily distinguishing the keys, shall be provided for proper stowage of all keys which come under the supervision of the various ship department heads, in locations designated in SECTION 19. Each locker shall be provided with a lock and key. Key lockers shall have a capacity of 52 keys.

21.6. HINGES

Three hinges shall be fitted on all exterior doors and on interior doors exceeding 610 mm in width and on fire doors.

Fixed pin butt hinges shall be provided for all Staterooms and other spaces having pilferable articles where door to space opens out. Elsewhere, loose pin type butt hinges shall be used. All butt hinges shall have button types on both ends and five knuckles. The hinges for heavy duty doors and all doors in accommodation areas shall have nylon bushings.

Corrosion resisting steel pins shall be provided for all hinges throughout the ship.

Doors to especially protected spaces such as Slop Chest and Medicine Lockers shall have extra strong, tamper-proof hinges.

21.7. DOOR CLOSURES

Exterior doors, vestibule doors, stairway doors, public toilet doors, and passage doors to air-conditioned spaces shall have adjustable surface type door closures of bronze with bronze arms or aluminum with corrosion resistant steel arms. Whenever practicable, the door closures shall be provided on the inside of weather doors.

21.8. DOOR HARDWARE, MISCELLANEOUS

Rubber-tipped bumpers with catch hooks or automatic holdbacks shall be provided for all inside and outside doors except fire doors and wardrobe doors. Where rubber-tipped bumpers cannot be fitted, other means for holding the door in the open position shall be provided.

Each water closet compartment shall be provided with a combination coat hook and bumper.

Dutch doors shall be provided with door locks as for similar doors and with knob operated slide bolt between the halves.

Traffic doors in Commissary and dining spaces shall have both stainless push and kick plates provided.

21.9. MISCELLANEOUS HARDWARE

Locking bars and staples of stainless steel, with padlocks, shall be provided on all Commissary space refrigerators.

Four coat and hat hooks shall be provided in Chart Room, each Office, Hospital, and one hook per occupant in each Crew Stateroom, four per Officer Stateroom, and one each in Deck Toilet and Longshoremen's Toilet. Dining Room, Lounges, Recreation and Crew Mess Rooms shall have a total number of hooks equal to the seating capacity.

SECTION 22

PROTECTIVE COVERS

All protective covers shall be made of commercial marine grade coated nylon cloth.

All covers shall fit neatly, without wrinkles or pockets, and shall be provided with all hooks, lashings, thimbles, and grommets, as may be necessary for a complete installation. Each piece shall have stenciled markings for identification purposes and to indicate its location. Suitable reinforcement shall be provided at all points subject to wear and abrasion.

Suitable storage bags of synthetic fabric, each with stenciled markings for identification purposes, shall be provided for all covers not permanently in place.

Covers of 0.41 kg per m^2 material shall be provided for telegraphs, navigating equipment, and searchlight.

Covers of 0.50 kg per m^2 material shall be provided for ventilators, louvers, steering equipment, winch controls, shelters, hawser reels, and boat winches.

Covers of 0.61 kg per m^2 material shall be provided for weather cloths, dodgers, tarpaulins, and lifeboat covers if open lifeboats are used.

Permanent awnings shall be of suitable materials selected to withstand the elements.

SECTION 23

MISCELLANEOUS EQUIPMENT AND STOWAGE

23.1. GENERAL

Bins, racks, shelves, and other stowage devices, shall be designed and arranged to suit the material and equipment to be stowed.

Spaces not specifically mentioned herein but which normally require stowage devices, shall be suitably equipped in keeping with the requirements for similar spaces.

Requirements for ship stores containers, if provided, are covered in SECTION 27.

23.2. STOWAGE SPACES

(a) CO_2 Bottle Storeroom

The space shall be located such that any entrances are from the open deck, and the access doors open outward.

Stowage racks to suit the bottles used in the CO_2 extinguishing system arranged to permit the ready removal of any cylinder without disturbing any other cylinder and means for securing bottles in place shall be provided.

Suitable beams, one over each row, and a beam scale shall be provided for weighing bottles in place.

(b) Deck Lockers

Shelving and stowage for all deck gear and to suit service intended shall be provided.

(c) Refrigerated Stores

The spaces shall be arranged and outfitted as shown on the Contract Drawings and as follows:

> Shelving three-high, at least 600 mm deep. Suitably equipped with restraining battens and clips. Full height vertical shifting battens with deck and overhead sockets for bulk stowage. Shifting battens to be secured in grating recesses at deck level with upper end inserted in a false ceiling of expanded metal similar to Dry Stores installation.
>
> CRES hooks, rods, hangers, and other supports, as required.

(d) Service Lockers

The following shall be provided:

Clips for stowage of mops and brooms.

Shelving, three-high, with bottom shelf 900 mm above deck.

Racks for buckets under shelving.

One service sink in each locker (see SECTION 20).

Two shelves over sink.

(e) Steward's Stores

Shelving, four-high, approximately 600 mm deep and 600 mm, 1050 mm, 1350 mm, and 1650 mm off the deck, respectively.

23.3. MISCELLANEOUS

(a) General

Suitable boxes and lockers shall be provided and secured for the stowage of pyrotechnics and other deck gear, as required. They shall be of galvanized steel and fitted with suitable rugged bronze hardware and locks. Boxes and lockers exposed to the weather shall be made weathertight with good natural ventilation to avoid condensation and shall be mounted clear of the deck.

All specified outfit, the stowage of which are not specifically mentioned elsewhere, shall be stowed using bins, boxes, shelving, cribs, racks, or hooks, as required.

(b) Special Tools

The following special tools shall be provided and stowed in the general vicinity of the equipment served.

	Per Ship
"T" wrenches for sounding tubes and bleeder plugs	4
Each special equipment wrench required	2
Each size and type of manhole wrench required	2
Special wrench for lifting recessed manholes and covers	2

Wrenches or lever bars for hatch covers, at each coaming	1
Spanner wrenches for airports and deadlights	2

SECTION 24

NAME PLATES, NOTICES, AND MARKINGS

24.1. GENERAL

Name plates and notices shall be plastic, metal photo, or engraved on metal for furniture markings, fan and motor label plates, room, door, hatch and manhole labels, and warning lights; and operating and maintenance instruction plates.

All label plates shall be attached with stainless steel screws or approved adhesives. Aluminum plates shall be insulated to prevent contact with dissimilar materials.

Warning and instruction signs shall be provided in spaces containing electrical equipment with delicate instruments, such as telephone switchboard, and radio transmitting and receiving equipment, prohibiting the use of paints, polishing waxes, or cleaning agents, unless the equipment is effectively sealed.

Safety signs, warning signs, and safety line markings required by stevedore's work rules shall be provided.

Lettering shall be clear and concise with a minimum of abbreviations. Where abbreviations are necessary, they shall conform to accepted standards.

24.2. OWNER'S INSIGNIA

The Owner's insignia shall be painted on each side of the stack as directed. Intermittent bead welding guide strips shall be provided along the lines of color separation.

24.3. SHIP'S NAME

The ship's name, in block letters, shall be painted on both sides of the bow and the ship's name and hailing port on the stern. All letters shall be outlined by continuous welds. In general, the height of the bow letters in meters shall be equal to the length of the ship in meters divided by 240 with a maximum height of 0.6 m. The height of the name on the stern shall be 3/4 of the height of the bow letters, and the height of the hailing port letters shall be 1/2 of the height of the name on the stern.

24.4. NAME BOARDS

Ship's name boards, 400 mm high, shall be provided port and starboard at the Wheelhouse top and may be of hardwood, fiberglass, or metal, with the letters, 280 mm high.

24.5. CONTRACTOR'S NAME PLATE

Contractor's name plate shall include the Builder's Hull No. for identification.

24.6. DRAFT NUMERALS AND LOAD LINE MARKINGS

All draft marks shall be in vertical columns. If possible, forward and aft marks should be equidistant from the plimsol marks and as far forward and aft as practicable.

Draft numerals shall be Arabic 150 mm projected height, the bottom of each figure being the height in even increments above the bottom of the keel or line of keel extended. The range of numerals shall be such as to encompass the extremes in operating drafts. Draft figures and load line markings shall be outlined by a small bead of welding and painted in a contrasting color.

24.7. PROPELLER SIGNS

Two propeller warning signs shall be provided per ship and fastened to the deck handrail immediately above the propeller or propellers. Signs shall be of wood, plastic, or metal. Each sign shall read "DANGER - PROPELLER - KEEP CLEAR" in block letters. Signs shall have white background with black letters except the word "DANGER" which shall be red.

24.8. STATEROOM LABELS

The Stateroom number, affixed on bulkhead on the knob side of each Passenger Stateroom door at about 1600 mm above the deck, shall be about 50 mm high and 3 mm maximum thickness with edges rounded to 0.80 mm thickness.

All Officer and Crew Staterooms shall be provided with label plates per 24.9. herein, designating ratings of occupants of room and with number plates similar to those for Passenger Staterooms.

24.9. SERVICE AND OTHER SPACE LABELS

All spaces not otherwise required to be labeled shall have identification plates at least 25 mm wide. In general, letters shall be 13 mm high. If the plates are of brass they shall be 1.30 mm thick, the characters shall be engraved 0.50 mm deep and filled with black engravers wax, except where designating flammable material storage, in which case the wax shall be red.

24.10. DOOR, HATCH, AND MANHOLE MARKINGS

All oiltight and watertight doors, hatches, and manholes, except main cargo hatches, shall have a label plate similar to identification plates specified for service spaces. It shall designate the compartment to which access is made.

24.11. HATCH COVER MARKINGS

All portable hatch covers shall be plainly marked to indicate the deck and hatch to which they belong and their position therein, except that such position markings will not be required where all covers in ship are interchangeable.

24.12. RIGGING MARKINGS

All rigging, including spares, shall be marked as required by Regulatory Body(ies) rules.

Safe working load shall be conspicuously marked on rigging and lifting gear.

The markings shall be burned, cut, outlined by welding bead, hammered or cast in a conspicuous place in a durable manner.

24.13. VENTILATION, HEATING, AND AIR CONDITIONING LABEL PLATES

Label plates shall be provided to identify clearly each fan, controller, heater, motor, access plate, thermostat, damper, weather supply and exhaust outlet, and other major components of the systems.

Warning plates shall be provided at all doors and other closures which may be required normally to remain closed for effective operation of the ventilation and air conditioning system.

24.14. NOTICE FRAMES, LICENSES, CERTIFICATES, AND RULES

(a) Frames

CRES or aluminum frames shall be provided for each license, certificate, or notice required by the Regulatory Body(ies) to be displayed aboard the ships. Frames shall be glazed, furnished with hinged front and lock, and have a finish to suit the location. Glass or plexiglass shall be 3 mm thick. Each such frame shall be located as directed by the Owner.

Where one frame is provided for the display of more than one document, the construction shall be such as to permit the replacement of each such document individually without affecting the display of others in the same frame.

(b) Mounted Directly to the Ship's Structure

Plates prepared by metal engraving process for direct mounting to the ship's structure shall be provided for the following:

Atomic Attack Instructions

Cloud Formations and Weather Indications

International Code

Life Preserver Instructions and Emergency Signals

Morse Code

No Smoking

Safety First Notices

Sanitary Notices

Ship's Call Letters

Vessel Turning Characteristics

Any other instructions or information charts which would not normally be replaced over short interval of time.

24.15. TANK SOUNDING BOARD

A blackboard lined off for tank soundings and with chalk tray shall be provided in the Machinery Space.

24.16. GANGWAY NOTICES

One gangway notice blackboard of commercial blackboard material, with an aluminum frame, and with provisions for hanging at the gangway, shall be provided.

24.17. SHELL PLATE MARKINGS

Shell plating at bottom and top of boot topping shall be marked by horizontal 50 mm long welded beads, 3 mm thick, at intervals of 3000 mm for guidance in application of paint.

Location of all main athwartship bulkheads shall be indicated by Frame Numbers on the outside of the shell plating at the full load line by small bead markings in Arabic, 150 mm high for use in drydocking.

24.18. MISCELLANEOUS LABELS, SIGNS, AND MARKERS

Electrical equipment nameplates and markings shall be per SECTION 87.3.

Machinery piping and valve markings shall be per SECTION 74.8.

Drawings and operating instructions for mounting shall be per SECTION 28.

SECTION 25

JOINER WORK AND INTERIOR DECORATION

25.1. GENERAL

For deck covering and cove bases see SECTION 6.

For painting materials and preparation of surfaces for painting see SECTION 14.

Where ceiling and/or linings shall be made in portable sections and, where necessary for frequent access or inspection, they shall be provided with approved hinged access panels with latch fastenings. The panels shall be of sufficient size to provide accessibility for service but not generally greater than 610 mm in any dimension and shall be unobtrusive.

The design of joiner work shall be such that sharp edges are avoided. Outside corners shall be formed with a radius of 25 mm.

25.2. CONSTRUCTION AND FINISH

(a) Materials - General

The construction of the joiner work shall be of such design as to conceal conveying items, including electric cables, wiring boxes for switches and receptacles, vent and air conditioning ducts, and piping.

Concealed furring, hangers, molding, and framing used in the erection of bulkheads, linings, and ceilings, shall be of galvanized or phosphate treated steel. Exposed framing and moldings shall be finished, as described in SECTION 14, to blend with the color of the bulkhead finishes in the spaces where installed.

Fasteners shall be zinc coated or corrosion resistant steel.

Heavy items against joiner bulkheads and linings shall be supported by independent strength members, other than the bulkhead and lining panels.

All ceiling framing angles shall be through-bolted to the joiner bulkheads in way of the H-Posts.

Materials for built-in wardrobes shall be of the same material as the room in which they are located.

Panels shall be secured to prevent rattling. The design of overhead furring and its support shall be such as to minimize the transmission of sounds between the deckhead over and the ceiling panels, using sound insulation breaks as necessary to avoid structure-borne sound transmission.

Alternate materials or joiner systems, including asbestos-free core products meeting the intent and requirements of this SECTION and which have been certified and approved by the Regulatory Body(ies), will be acceptable.

(b) Joiner Bulkheads

The Pilothouse, Chart Room, Radio Room, Medical Spaces, Laboratories, and all accommodation and office spaces shall be provided with linings and ceilings to conceal ship's structure and distributive systems.

Joiner panels shall have a lightweight inorganic core faced with high pressure plastic laminate decorative finish. Total thickness shall be a minimum of 22 mm for single bulkhead panels and minimum 17 mm for lining panels and double bulkhead panels. The panels shall be supported by a system of top and bottom channels and vertical H-posts and corner posts. Panels shall be capable of being removed and reinstalled without deterioration.

Stairwell and passageway bulkheads shall be finished with non-combustible materials on both sides.

Ceilings shall be comprised of a suspended system supported by hangers. Ceiling panels shall be securely fastened to prevent rattling. Ceiling fixtures, such as grills, defusers, lights, and speakers, installed in the ceiling, shall be compatible and integral with the ceiling system.

Joiner bulkheads and linings installed in areas subject to wetness, such as sanitary spaces and cleaning gear lockers, shall have the edges caulked waterproof.

Joiner bulkheads shall extend to the deckhead, or have fire stops installed.

(c) Veneers

Combustible veneers on bulkheads, linings, and ceilings shall be limited to a maximum thickness of 2 mm. Where applied to corridors, stairwells, control stations, or concealed spaces, the veneer shall be an approved interior finish material.

(d) Doors

Interior doors shall be as specified in SECTION 4.

The door frames shall be constructed with side jambs fitted to adjacent H-Posts. The H-Posts shall extend from deck to top of joiner bulkhead with support to deckhead and shall be secured top and bottom.

(e) Grilles

The finishes of all exhaust grilles, when installed in accommodation spaces, shall blend with the decorative treatment of the spaces. In general, exhaust grilles shall be made integral with the kick-out panels in entrance doors.

(f) Curtains

Curtains shall be lined and weighted, shall have top hems 50 mm deep, and bottom hems 125 mm deep, full double turn of material, top and bottom; side hems 25 mm wide; and hems turned under before sewing. All headings shall be French pleats, spaced in proportion to the width of the material. Curtains shall traverse; shall have 100 percent fullness in width and shall overlap at least 50 mm. Curtains in the Officers' Lounge and Dining Room shall have draw cords. All curtains, unless otherwise noted, shall extend at least 300 mm beyond the window trim. All curtains shall run on built-in curtain tracks in curtain pockets and shall be secured at the back and to the bulkhead by means of rings and hooks. Linings shall have an opacity of 95 percent.

Curtains in Staterooms shall be sill length. Curtains in the officer lounge shall be full length hanging no more than 25 mm above the finished deck covering.

(g) Curtain Hardware

Curtain tracks shall be recessed heavy duty "I" beam traverse type. Track carriers, and all necessary hardware shall be anodized aluminum. All glides shall be nylon, or equal.

(h) Carpets

Description of carpet and padding are in SECTION 6.

The carpeting shall be fastened on all edges with metal fastening strips. All cut edges of carpet shall be latexed.

(i) Upholstery

Upholstery seating shall be covered with flame-resistant cloth fabric, of high wear resistance. Cloth shall be inherently flame-resistant or shall be treated for flame-resistance and be per ASTM D3597, "Standard Specification for Woven Upholstery Fabrics - Plan, Tufted, or Flocked", or BSI 2543, "Specification for Woven and Knitted Fabrics for Upholstery".

Where artificial leather upholstery covering is selected, it shall be per ASTM D3690, "Standard Performance Specification for Vinyl-Coated and Urethane-Coated Upholstery Fabrics - Indoor", ISO 7617-1, "Plastics-Coated Fabrics for Upholstery - Part 1: Specification for PVC-Coated Knitted Fabrics", ISO 7617-2, "Plastics-Coated Fabrics for Upholstery - Part 2: Specification for PVC-Coated Woven Fabrics", or ISO 7617-3, "Plastics-Coated Fabrics for Upholstery - Part 3: Specification for Polyurethane-Coated Woven Fabrics".

SECTION 26

STABILIZATION SYSTEMS

26.1. PASSIVE ANTI-ROLL TANKS

Anti-roll tanks of the passive or controlled passive type shall be as shown in the locations and general configuration on the General Arrangement and Scantling Drawings. Consideration will be given to alternate locations to improve effectiveness and/or use of tanks controlled by a device responsive to roll motions. In the selection of the design, consideration should be given to the type which will give the best damping of roll at high sea state.

The Contractor shall furnish complete engineering and design, model testing, and instrumentation work necessary for the installation of a complete satisfactory system.

The predicted performance must be approved by the Owner prior to construction of the tanks.

The Contractor shall be responsible for all expenses in connection with design, including royalties where applicable.

The piping and valving shall be so arranged to permit a practical time for emptying and refilling.

A complete instruction manual shall be furnished to provide each vessel with adequate guidance as to the proper use of the tanks.

26.2 ANTI-HEELING SYSTEM

An automatic heel system of the pumping type shall be provided.

The system shall consist of inclination detector, automatic heel controllers, heeling pump, hydraulically operated valves, tanks, and piping. Alternate tanks of the water ballast system may be used as part of the automatic heel system, but remaining components as pump, piping, valves, and control system are to be independent.

The inclination detector and automatic heel controller shall be provided in the Cargo Control Room.

26.3 TRIM CONTROL SYSTEM

An automatic trim control system of the pumping type shall be provided.

The system shall consist of inclination detector, automatic trim controllers, trimming pump, hydraulically operated valves, tanks, and piping. Alternate tanks of the water ballast system may be used as part of the automatic trim control system, but remaining components as pump, piping, valves, and control system are to be independent.

The inclination detector and automatic trim controller shall be provided 5
in the Cargo Control Room.

SECTION 27

SHIP STORES, CONTAINER STOWAGE, AND HANDLING (IF PROVIDED)

27.1. GENERAL

The ship's dry and refrigerated stores shall be carried in containers as shown on the Contract Drawings.

They shall be built to the same structural requirements as cargo containers of the same type and size and shall be fitted for lifting and securing with standard container handling gear. Arrangements, construction, and performance requirements of all components shall be similar to that specified elsewhere in these Specifications for standard built-in dry and refrigerated stores, spaces, equipment, and machinery.

Means shall be provided for landing and securing containers in place without lashings. In addition, necessary services for the containers shall be provided, including electric supply for lighting and refrigeration plant power, deck drains in way of refrigerated containers, and sufficient ventilation to carry off heat generated by electric machinery and compressor.

27.2. SPARES

The Contractor shall furnish 100 percent spare refrigerant medium, spare parts recommended by the refrigeration machinery manufacturer for 1 year's continuous operation, any necessary special tools, and one complete spare refrigeration motor and compressor unit.

SECTION 28

PLANNING AND SCHEDULING, INSTRUCTION BOOKS, AND OTHER DOCUMENTS

28.1. GENERAL

The Contractor shall prepare a Drawing and Correspondence Procedure which sets forth the procedure for handling all material specified in this SECTION. A pro forma Drawing and Correspondence Procedure shall be submitted to the Owner for review and comment.

28.2. PLANNING AND SCHEDULING

The Contractor shall perform planning and scheduling functions as required to establish an orderly and systematic construction program and to facilitate completion of the Contract work. The Contractor shall submit their schedules and progress data to the Owner.

(a) Master Production Schedule/Key Event Schedule

The Schedule shall show the proposed start and completion dates for the fabrication, assembly, erection and/or installation of the principal items and systems which comprise the ship. It shall include, but not be limited to, the major hull structural sections, machinery components, piping systems, electrical items and systems, ventilation and air conditioning systems, and joinery items.

Scheduling information provided shall be in sufficient detail so that critical path(s) to project completion can be identified. The Schedule format shall include baseline (originally planned), revised estimate (Schedule slippage in excess of 15 days), and actual start and finish dates. The Erection Schedule shall be updated and revised monthly.

A separate Key Event Schedule shall be provided by the Contractor and submitted within 45 days after contract signing. The Schedule shall contain dates for Contract start and finish, start of keel laying, and start and finish of all major components, and start and finish of all significant events from award to delivery of vessel. The Schedule format shall include baseline (originally planned), revised estimate (Schedule slippage in excess of 15 days), and actual start and finish dates.

The Contractor shall complete and distribute the initial Schedules within 45 days after award of the Contract. Revisions shall be made as necessary to suit changes in the Contractor's Scheduled key event dates.

(b) Plan Schedule - Working Drawings

Within 30 days after award of the Contract, the Contractor shall submit a Schedule of proposed working drawings including all required installation or arrangement drawings even though prepared by a subcontractor. The Schedule shall contain the following: Contractor's drawing number for each drawing listed, the Scheduled date on which each drawing will be submitted for approval, columns for recording the actual date(s) of the initial submittal, the date(s) of approval of each drawing, and a column to identify the latest alteration (by letter or number) of each drawing. (The Schedule shall identify which drawings are required to be submitted to the Owner and Regulatory Body(ies) for approval, review, or information only.)

The Schedule shall be revised to show all changes, progress, and delays, and submitted monthly during the first 6 months of the Contract and bimonthly thereafter, in time to be received by the Owner no later than the 10th of the month. After delivery of the first ship and when the Drawing Schedule has been essentially completed, submittals can be eliminated and a final copy issued after all changes have been noted.

The Contractor's Drawing Schedule shall list all construction drawings, diagrammatics, design calculations when specifically required by this Contract, and outfitting lists required to construct and outfit the vessels.

28.3. DRAWINGS AND PURCHASE (TECHNICAL) SPECIFICATIONS

The Contractor shall obtain the required approval of all drawings, purchase (technical) specifications, calculations, and other technical documents necessary to perform the Contract work. In submitting an item for approval, the Contractor shall invite attention to all departures from the Contract Drawings and Specifications and subsequent letters of instruction received from the Owner. When this requirement is not complied with, approval of items shall not constitute approval of any departures. Approvals of items shall not in any case relieve the Contractor of the responsibility of satisfactory material, installation, and operation of any items involved.

Drawings submitted shall be folded individually in accordion fashion to approximately a 360 x 230 mm rectangle with title block exposed in lower right-hand corner.

Drawings shall be of such drafting quality and have lettering and number of such size as to provide easy reading and reproduction capability.

All material lists, spare parts lists, replacement parts lists, and all other pertinent information, whether prepared by the Contractor or any subcontractor or vendor shall include applicable ASTM, SAE, or equivalent material specification and shall include the original manufacturer's names and replacement part numbers of all components in addition to vendor's part numbers. Where trade association designations are commonly used, such as AN numbers for "O" rings and AFBMA for bearings, such designations shall be used.

(a) Working Drawings

"Working Drawings" as used herein include all drawings required for the construction of the ship as listed on the Drawing Schedule. Working drawings shall include all required installation drawings even though prepared by a subcontractor.

The Contractor shall furnish to the Owner a copy of all comment letters received from the Regulatory Body(ies).

Alterations on drawings previously approved shall be concisely described in an alteration column and shall be submitted for approval as required. Symbols identifying the alteration shall appear in all areas of the Drawing affected by the alteration. Alterations due to Contract changes, shall be clearly labeled with Contract Change Number in order to distinguish them from design developments and other corrections to drawings due to drawing approval comments. The latest alteration of the drawing shall be clearly marked in the title block of the drawing. Applicability of a particular alteration to a particular hull shall be clearly indicated by noting the hull to which applicable in the alteration column. Alterations applying to only particular hulls of a group should not affect the indication of the original arrangement and details on the drawing for previous hulls.

All materials shown on drawings shall be identified by an appropriate material specification or its equivalent, where applicable.

All standard welding symbols accepted by the Regulatory Body(ies) shall be used exclusively on all drawings.

(b) Diagrammatic Drawings

Diagrammatics shall be submitted for principal shipboard piping, ventilation and air conditioning, and electrical systems, prior to submittal of system arrangement drawings. They shall show the relative location of valves, branches, and equipment as a guide to final arrangement drawings.

Diagrammatic drawings shall be of a size which retains legibility when reduced for insertion and binding in an operating and/or instruction manual. Prior to binding all such drawings, the Contractor shall correct all diagrams to agree with the actual installations and supply bound sets as required.

The diagrammatics shall contain complete information such as pump and fan characteristics, pipe or duct sizes, materials, flows, velocities (normal and maximum), pressure drops, and other pertinent design data such as associated components, identification and operation characteristics, including all control and alarm settings.

(c) Booklet of General Drawings

For the purpose of having the ship's drawings of general arrangements, decks, profiles, bulkheads, fittings, and other pertinent drawings in convenient form, a "Booklet of General Drawings" for ready reference and consulting purposes showing as much accurate and detailed information as practical, shall be prepared using a scale of 1:200 or other appropriate scale. The Booklet shall be revised and submitted every 6 months, reflecting revisions occurring during that period. Each issue and all revisions to the Booklet Drawing shall be submitted to the Owner. Revisions of major proportions shall be transmitted within 60 days following the alteration to the drawing. The first issue shall be submitted within 6 months after signing of Contracts. Drawings comprising the "Booklet of General Drawings" are listed below and shall be arranged in the following order:

- Cover or Title Page
- Data Sheet of general dimensions and data showing:
  - General Characteristics
  - Deadweight, Displacement, and Light Ship Weight
  - Tables of Hold and Tank Capacities
  - Type of Power Plant, Power and Ship Speed
  - Propeller
  - Generating Plant
  - Steering Gear
  - Deck Machinery
  - Regulatory Body(ies) Equipment Numeral
  - Lifeboat and Davits
  - Complement
- Outboard Profile
- Inboard Profile, showing molded deck heights
- Superstructure (Deckhouse) Decks and Housetop
- Decks, a drawing of each deck and platform
- Innerbottom
- Midship and Cross Sections, indicating scantlings and details of construction and molded heights of decks above the baseline. The scale of the cross sections shall be 1 mm = 100 mm.
- Shell Expansion Drawing

The general principles in the preparation of the Booklets shall be as follows:

Detail arrangement of spaces is not desired except to show use or occupancy. The general arrangement of furniture and equipment in Staterooms, Offices, and similar spaces shall be shown where practicable, but in as little detail as practicable. Berths shall be marked single or double.

Type, location, and swing of all access shall be shown.

Trace in airports and windows on Deck Drawings and Outboard Profile.

Indicate the height of all masts, and any other items which may be higher than the masts.

The "Booklet of General Drawings" shall be prepared on an acceptable medium not over 760 mm wide. Space shall be allowed between the several deck drawings or profiles for cutting the prints into pages. The tracings shall not be cut up into pages but shall be retained in long sheets. Photographic reduction of larger scale working drawings will be considered. Prints of the Booklet shall be fully trimmed and assembled by the Contractor prior to distribution.

Each page on a sheet shall be of uniform width of not over 230 mm overall to the cutting line and of uniform length. For the inboard and outboard profiles on which masts are shown full height, the page may be 450 mm wide, or more, and arranged for folding in the Booklet. A margin of 6 mm shall be allowed outside the border of each page.

The cover of the Booklet shall have a title block and an alteration table to show the last date on which the tracing was corrected.

All drawings comprising the booklet shall be assigned the same drawing number followed by individual sheet numbers and the total number of sheets involved, e.g., sheet 1 of 3.

Copies of the Booklet shall be assembled so that each plate shall open out flat and so that the completed bound assembly of copies of the Booklet when closed shall be half as long as the individual plates.

(d) Vendors' Drawings and Vendors' Drawing Lists

"Vendors' Drawings" as used herein denote drawings, calculations, stress analyses, and other pertinent information, developed by other than the Contractor as necessary to show the suitability of the machinery, equipment, and appurtenances for use in the Contract work. Drawings shall indicate specific application and show Contractor's hull number and purchase order number.

The Contractor shall also provide a Vendors' Drawing List of vendors' drawings for manufactured equipment including, where appropriate, design calculations. The format shall include space for manufacturers' drawing numbers, drawing titles, and identification of equipment. The initial list shall be submitted 30 days after award. Thereafter, the Contractor begins to receive information from vendors as to the drawings the vendors propose to furnish and the scheduled dates for submittal of drawings for approval. These data shall be reissued every 3 months to show the current status reflecting additions, deletions, or alterations to drawings and schedule and actual dates. The Vendors' Drawing List shall also include material and equipment drawings to be produced by major subcontractors such as joiner, refrigeration, ventilation, and insulation subcontractors. Installation and/or arrangement drawings, prepared by a subcontractor, shall be included in the Working Drawing Schedule.

The Vendors' Drawings shall include the following:

(1) Outline drawings, with overall and mounting dimensions, weight, and performance curves and data.

(2) Drawing, elevation, and sectional assembly drawings to identify all parts with material lists which shall include original manufacturer's part number and material specifications. Weight and overall dimensions of major assemblies such as propulsion, turbine, and major auxiliary rotors shall be shown along with journal and thrust bearing sizes and clearances, critical clearances between rotating or sliding parts and similar data.

(3) List of spare parts.

(4) Speed, torque, power, and stress calculations for all items of weight handling equipment which shall be submitted simultaneously with, or in advance of, the submittal of outline and arrangement drawings and well in advance of release to manufacture dates. Sufficient design data shall be submitted as to ensure suitability of the equipment for the intended purpose.

Submittal and approval of Vendors' drawings may be waived for equipment which is identical to equipment which has been furnished on a previous contract for the same Owner and is in full compliance with the Specifications, subject to certification of its identical nature and the Owner's approval based on satisfactory service experience with the previous application.

28.4. REPORTS

(a) Steel Report

The Contractor shall submit to the Owner a Monthly Progress Report on the status of structural steel.

This Report shall be on a per ship basis, and shall state, in metric tons, the estimated total metric tons required, metric tons ordered to date, metric tons received to date, metric tons fabricated to date, metric tons sub-assembled to date, and metric tons erected to date.

(b) Change Order Status Report

The Contractor shall submit quarterly reports to the Owner on the status of all Change Orders and Inquiries for Change. The report shall include the Change Inquiry Number or Change Order Number, a brief description of the change, and preliminary and final costs, when determined.

28.5. INSTRUCTION BOOKS

Instruction books and drawings covering operating and maintenance instructions for all main, auxiliary, electrical, electronic and miscellaneous machinery and equipment, including pollution abatement systems and equipment, cargo oil system, galley and pantry equipment, navigational equipment, fire detection and extinguishing equipment, air conditioning, heating, and ventilation systems including pneumatic control systems, power operated and control valves, and all other pertinent systems, shall be furnished by the Contractor to the Owner for approval. The Contractor shall prepare a list of instruction books which are expected to be furnished by name of equipment and vendor's name. The list shall indicate anticipated dates of submittals for approval. It shall be kept up-to-date monthly and shall form the basis for final list of approved instruction books under the Contract.

Submittal and approval of instruction books and drawings may be waived for equipment which is identical to equipment which has been furnished on a previous contract for the same Owner and is in full compliance with the Specifications, subject to certification of its identical nature and the Owner's approval based on satisfactory service experience with the previous application.

All drawings, wiring diagrams, maintenance and repair instructions, equipment, descriptions, trouble shooting procedures, operating instructions, test procedures to evaluate the operation and safety features of the complete system, and all other pertinent data, developed by the Vendor for the Centralized Engine Room and Bridge Control shall be compiled together into one instruction book. After approval, the Contractor shall distribute final copies. Covers shall be of satisfactory quality, oil and water repellent with necessary identification information on front.

28.6. ENGINEER'S OPERATING MANUAL

The Contractor shall prepare an Engineer's Operating Manual based on the design and construction data. The Manual shall be prepared in preliminary form and be submitted to the Owner for approval sufficiently in advance of ship completion to permit completion and delivery of the finished Manuals to the ship not later than the delivery date of the ship.

Forty-five days shall be allowed for approval.

The Manual shall provide complete instructions for the operation of all engineering, piping, and electrical systems and related equipment, as well as for the cargo tank venting system and the inert gas system. The Manual shall be prepared in such a manner that it may be readily understood by operating personnel of limited experience and brief training, previously unfamiliar with the equipment and functions of the installation. It is intended that this Manual act as a supplement to the manufacturer's instruction books on the individual pieces of equipment, and duplications of the material contained therein are not desired. The Manual shall be bound in durable hard covers.

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

Index

List of pertinent references, including diagrammatics and manufacturer's instruction books.

General description of the system, and detailed descriptions and directions for operation, with reference to diagrams.

Special attention shall be paid to emergency and standby services. It shall include text describing arrangement and illustrative plates, which shall show arrangement of all equipment in the machinery spaces, and each piece of equipment shall be designated by name and number.

Warnings as to possible hazardous modes of operation, precautions required to minimize equipment damage and possible crew injury shall be included in the text, either by means of a different type face, underscore, or an alternate print color.

The Manual shall also include a simple straight line diagrammatic representation of each piping and ventilation system, with each component identified. The design functions and design limitations of each piping system shall be discussed and detail directions for operation of the system provided.

Diagrams shall not exceed 280 mm in height and 920 mm in length. Operating charts, where provided, shall be above or below the applicable diagram and folded over the diagram. A blank space, equal to the width of the text page, shall be provided on the left end of the diagram.

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

After approval, the Contractor shall distribute copies of the Engineer's Operating Manual as required by the Drawing and Correspondence Procedure.

28.7. ALLOWANCE LIST AND BUILDER'S RECEIPT

The Contractor shall prepare for the Owner's approval complete Allowance Lists of all portable and readily removable equipment, tools, and spares required to be on board at time of the ship's delivery. Mechanical and electrical installations for which spare parts, special tools, or accessories are required shall be listed with all essential characteristics. The Allowance List shall be prepared per these Specifications.

Allowance List entries involving material serving the same piece of equipment, driving or driven elements, or consolidated spare parts involving more than one group shall contain complete cross-referencing by group, page, and line number to each group.

The Contractor shall furnish the original and four sets of the completed Allowance List for representatives of the Owner. The Contractor shall perform and record a joint physical inventory at time of the ship's delivery. The inventory shall be recorded in one set which shall become the original inventory. The other four sets shall be conformed copies of the original. The original and all sets shall be signed by representatives of the Owner and Contractor. The Owner shall receive the original and two sets. The Contractor shall furnish one set to the ship. The Contractor shall retain a set.

28.8. MACHINERY AND EQUIPMENT IDENTIFICATION LIST

The Contractor shall supply for each vessel an identification list in booklet form giving nameplate data, including serial number and the Regulatory Body(ies) certification data where applicable, of each piece of machinery and equipment on the ship. This shall include vent fans and motors, deck machinery, galley equipment, ground tackle, shafting, propeller, electronics gear, and all other pertinent equipment. Two copies of the booklet shall be furnished each vessel, also three copies to the Owner.

28.9. FINAL DRAWINGS (TRACING)

(a) Tracings and Microfilm

All Contractor's Drawings shall be brought up to date and stamped "Final - As Built" with all alterations necessary to reflect the ship as finally constructed. Tracings shall be provided to the Owner per the schedules below as soon as practicable but not later than 75 days after delivery of the last ship of a contract.

(b) Owner's Requirements

(1) Drawings

Tracings (Mylar) (See Item 28.9.(b)(2))
Booklet of General Drawings
Midship and Type Section Drawings
Capacity Drawing
Complete lines Offsets, including offsets on frames
Arrangement of Machinery - drawings, elevations, and sections
Docking Drawing
Shell Expansion
Stability Booklet

(2) Tracings (Mylar)

Inboard Profile and General Arrangement
Arrangement of all decks, cargo tanks, and accommodations
Tank calibration and sounding tables for even keel with corrections for trim. Ullage tables also shall be provided for liquid cargo tanks provided based on sampling lines location or on tank top manhole if no sampling line.
Location of Safety Devices
Diagrammatic and Arrangement Drawings of all piping systems, ventilation ducts, and valves operating gear
Compartment Testing Drawing
Hydrostatic Curves
Outboard Profile
Body Drawing
Rigging Arrangement with Rope and Block List
Stern Frame and Stern Tube
Rudder and Stock
Stem

(3) Microfilm

One set of 105 mm film negatives of the drawings required under Item 28.9.(b)(1) shall be furnished to the Owner.

28.10. DRAWINGS AND CHARTS FOR MOUNTING

One graphic metal photo process, or equal, chart of each of the following drawings of the ship as constructed shall be provided and mounted in addition to those specified in SECTION 24 in suitable locations in the ship as directed by the Owner.

Ventilation, heating, and air condition arrangement and instructions (to be posted in Fan Room)
Gyro compass and gyro pilot arrangement, wiring diagram, and instructions
Instructions for cold ship starting (installed in Emergency Generator Room)
Electric power system, single line wiring diagram
Fire fighting and damage control systems (diagrammatic, including hose station markings, and hose sizes) and safety equipment list
Fire extinction and smoke detection systems (diagrammatic)
Bilge system (diagrammatic)
Ballast system (diagrammatic)
Cargo oil system (diagrammatic)
Fuel oil transfer system (diagrammatic)
Tank oil transfer system (diagrammatic)
Fire main system (diagrammatic)
Steering gear, arrangement, wiring diagram, and operating and lubrication instructions
Anchor windlass arrangement, operating and lubricating instructions
Constant tension mooring winches, operating instructions
Main and emergency switchboards, detail wiring diagrams
Instructions for operating Emergency Generator (to be mounted in Emergency Generator Room)
One-line diagrams of ship's electric power and lighting distribution system
Cargo hose crane operating and maintenance instructions
Cargo tank venting system
Inert gas system

Arrangement drawings showing for each deck the various fire retardant bulkheads together with particulars of the fire detecting, manual alarm, and fire extinguishing systems, fire doors, means of ingress to the different compartments and the ventilation systems including the positions of the dampers, the location of the remote means of stopping the fans with the identification of the fans serving each station.

Three prints of the Capacity Drawing (with deadweight scale) shall be furnished and mounted in passageways as directed by the Owner.

Piping system diagrammatics shall be stowed in a suitable rack located on or convenient to Main Engine Room Console.

28.11. DRAWINGS (PRINTS) FOR OWNER'S OFFICE USE AND FOR FILING ABOARD SHIP

(a) For Owner's Office Use

The Owner shall be provided with two complete sets of prints of all drawings, calculations, and design data for office use as listed in the final edition of the Contractor's Drawing Schedule to their latest approved alteration as occurring and, similarly two complete sets of drawings and calculations as listed in the Vendor's Drawing List. These sets of drawings shall be completed and furnished prior to delivery of the first vessel. Corrected drawings showing alterations applying only to succeeding vessels also shall be furnished as occurring to the extent necessary to correctly show each vessel delivered under contract. Corrected drawings shall also be provided showing any alterations made as a result of correction of guarantee deficiencies of a design nature. The Contractor shall also furnish three copies of Tank Capacity Tables and Stability Booklets, two copies of all Ship Test Reports and Trial Reports, five copies of the Capacity Drawing, and ten copies of the Drydocking Drawing.

(b) Drawings for Filing Aboard Ship

One print each of the following drawings, folded individually in accordion fashion to 230 mm x 360 mm size with the title block showing, shall be placed aboard each ship prior to delivery. All drawings shall be filed in the drawing file cabinets located in the Chief Engineer's and Chief Officer's offices. Adequate provisions shall be made for filing all instruction books and drawings in these spaces as directed by the Owner.

The set of drawings to be filed aboard ship shall be comprised of the following:

<u>Hull</u>

Selected set of principal hull structural and arrangement drawings as designated by the Owner from the Contractor's Drawing Schedule.

Set of approved drawings of manufactured articles (to be selected by Owner from Vendor's Drawing List).

Arrangement of rigging with operating instructions in booklet form in addition to posted instruction plates.

Two copies of Stability Booklet.

Two copies of the Docking Drawing.

Stability Test Report.

Six copies of Capacity Drawing.

Machinery

A complete set of all principal design, arrangement and construction drawings, and some detail drawings (to be selected by Owner from Contractor's Drawing Schedule).

One set approved drawings of manufactured articles (as selected by Owner from Vendor's Drawing List).

Two copies of Ship Test Reports, Hull, Machinery, and Electrical, and one copy of the Report of Sea Trials.

Two loose leaf bound copies of piping diagrams, including both hull and engineering systems.

List of machinery and equipment nameplate data including serial numbers for hull and engineering equipment.

Lubricating oil and grease schedule.

Electrical

A complete set of principal electrical installation drawings, as designated by the Owner from the Contractor's Drawing Schedule.

One set of approved drawings of manufactured articles including all switchboard drawings (to be selected by Owner from Vendor's Drawing List).

SECTION 29

DECK, ENGINE, AND STEWARD DEPARTMENT OUTFITTING EQUIPMENT AND PORTABLE TOOLS

29.1. GENERAL

The Owner will provide all outfitting equipment and portable tools for the following areas, which shall be installed by the Contractor prior to delivery:

A. Deck Department, Navigation and Bridge

1. Portable Tools
2. Portable Instruments
3. Miscellaneous Equipment
4. Consumables

B. Engine Department

1. Portable Tools
2. Portable Instruments
3. Miscellaneous Equipment
4. Consumables

C. Steward's Department

1. Linen and Bedding
2. Chinaware
3. Holloware and Miscellaneous Tableware
4. Flatware
5. Cooking Ware, Galley and Pantry
6. Miscellaneous Equipment
7. Consumables

D. Hospital and Medical Equipment

E. Office Equipment

MARITIME ADMINISTRATION
GUIDELINE SPECIFICATIONS FOR
MERCHANT SHIP CONSTRUCTION

PART II - MACHINERY

Office of Ship Construction

November 1995

TABLE OF CONTENTS

PART II - MACHINERY

SECTION 50

MAIN AND AUXILIARY MACHINERY - *SLOW SPEED DIESEL (ONLY)*

50.1. GENERAL

It is the intent of the following Specifications to describe the machinery plant, including all necessary auxiliaries, for the ship described in SECTION 1.

All equipment shall be designed to operate without the necessity for greasing or oiling for not less than 150 accumulative operating hours, except for the main engine cylinders, which require replenishment every 36 accumulative hours.

Major machinery and shafting alignment shall be performed at such times in the construction of the ship as agreed to by the Contractor and the engine vendor.

Machinery and electrical equipment requiring cover removal or bolted access shall be provided in such a manner as to have free access for tools and removable section clearance.

The main diesel engine shall be designed to withstand the external forces and deflections imposed upon its supporting structure by the deflections and stresses of the ship's hull. The engine shall be supported in such a manner as to allow for such deflections, without imposing external forces and misalignments on the components beyond their design tolerances, and without producing excessive vibrations or objectionable noise. The supporting structure foundation and the associated inner bottom strong backing shall be based on engine manufacturer's guidance drawing and shall be reviewed by the main diesel engine manufacturer prior to fabrication.

The engine shall be able to operate continuously at maximum continuous rating and be capable of starting, stopping and maneuvering while burning heavy fuel oil with the following composition:

Viscosity - up to 700 cSt @ 50°C
Vanadium - up to 600 ppm
Sodium - up to 200 ppm
Sulfur - up to 5% by wt
Carbon Residue - up to 15% by wt
Ash - up to 0.15% by wt

Shaft horsepower is the power determined by a torsion meter applied to a section of line shafting. The term ABS power used herein is the maximum continuous shaft horsepower rating permitted by ABS.

The guaranteed fuel and lubricating oil consumption of the main diesel engine shall be in accordance with the terms of the construction contract.

50.2. POWER PLANT PERFORMANCE

The Contractor shall prepare a detailed power plant energy analysis based on performance of components finally selected, at ABS power and the in-port condition.

50.3. NOISE

The noise level under all normal operating conditions at the Central Control Room console shall not exceed the values given in SECTION 1.

Additionally, machinery space ventilation fans shall not create a noise level on the open deck which will interfere with safe navigation on the bridge.

50.4. GENERAL DESCRIPTION

The main propulsion system shall consist of: a single acting, two stroke, crosshead, turbocharged, directly reversible slow speed marine diesel engine driving a propeller through a solid coupling and forged steel shafting. The engine shall be designed for normal operation with properly conditioned heavy fuel. Diesel fuel may be used for starting and low power operation, if desired.

Electric power shall be supplied by a minimum of two medium speed diesel driven generators. During normal cruising at sea operation one generator shall be operating with the other acting as standby. In addition, one emergency high speed diesel driven generator shall be provided. Other arrangements using a line shaft or main engine driven generator or a steam turbine generator using steam from an auxiliary boiler are acceptable alternatives.

Oil fired (packaged) boiler(s) and exhaust gas boiler shall be provided for steam services as required. A combination oil fired/waste heat boiler may also be provided as an alternative.

One distilling plant shall be provided for cooling system make-up and potable water requirements. If redundancy is of particular concern, additional capacity may be provided for.

Heavy fuel and diesel fuel bunkers, settling tanks, service tanks and complete fuel oil transferring, treatment and service systems shall be provided.

A minimum of two motor-driven air compressors shall be provided for charging the main air receivers which supply starting air for the main engines and ship service diesel generators.

Ship's service air shall be supplied.

A motor-driven air compressor and air receiver shall be provided for an adequate air supply to controls and instruments.

The associated ship's systems shall be as specified in the various sections of this Specification.

Mechanical ventilation shall be provided for the machinery spaces and shall be sized to provide adequate ventilation for the entire Engine Room plant, including the Control Room in case of an air conditioning failure.

The main propulsion machinery shall be capable of continuous operation at the ABS rated power corresponding to the specified rpm when burning heavy fuel (700 cSt @ 50°C).

A centralized Control Room shall be provided in or adjacent to the machinery space and shall be equipped with engine controls and all necessary monitoring and recording equipment. Controls, monitoring, and recording equipment shall meet requirements of Regulatory Body(ies) for unattended Engine Room operation. The Control Room shall be air-conditioned, with either two compressor systems, or compressor with crossover from compatible SS A/C system.

Bridge control of the main engines shall also be provided, capable of being overridden by local Control Room operation from the Engine Room.

Details of the Machinery Control Room and bridge control consoles are contained in SECTION 99.

All equipment controlled by the centralized control system shall be capable of immediate local operation in case of control system failure and all components of the control system shall be designed on the "fail safe" principle with respect to system function.

50.5. LIST OF MACHINERY

The following tabulation indicates the number, size, type and operating conditions of the machinery and equipment described in the specifications and indicated on the plans. The particulars listed shall be considered minimum values unless otherwise specifically indicated. They are for information and guidance only and are not necessarily all inclusive.

The List of Machinery in no way is intended to relieve the Contractor from responsibility of the proper selection of required equipment and for seeing that it will carry out the intent of the specifications. The Contractor shall submit calculations and data to the Owner, when required, to assure that individual components will satisfy such intent.

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
SECTION 51 -- MAIN ENGINES	
Main Propulsion Engine - 1	Direct reversing slow speed, turbocharged vertical, single acting, two stroke cycle, direct injection marine diesel engine of crosshead type. Engine to be fitted with an exhaust gas turbocharger arrangement. The main engine to be capable of operating on heavy fuel oil having a viscosity of up to 700 cSt @ 50°C with alternative connection for changing over to diesel fuel oil without delay, for starting and lower power operation or for system purging. kW/engine at ABS power . . _____ RPM at ABS power . . . . . _____ Engine shall be complete with the following accessories: marine type governor and load limiter feature.
SECTION 53 -- MAIN SHAFTING, BEARINGS, AND PROPELLER	
Line Shafts (number as required)	*Solid forged steel, ABS Grade 2, 3, 4, or 4C. Diameter, approx. mm . . . _____ Forward section length, approx. m . . . . _____ Aft section length, approx. m . . . . _____

*Use of higher strength steel permits reduction in shaft diameters and a more flexible shafting system, which is desirable from a vibration standpoint for main engine vibrations steels with a tensile strength 680 N/mm^2 for line shafting and up to 600 N/mm^2 for tailshafts are acceptable.

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Tail Shaft - 1	*Solid forged steel, ABS Grade 2. Diameter, approx. mm . . . ____ Length, approx. m . . . . ____
Line Shaft Bearings (number as required) (split roller bearings are also acceptable)	Steel or ductile iron, babbitt lined ring or disc oiled type. Max. bearing load, ring type, kPa . . . . ____ Max. bearing load, disc type, kPa . . . . ____ L/D ratio . . . . . 1.5 to 1.0
Stern Tube Bearings - 1 or 2 (including the outboard and inboard seals)	Steel or ductile iron, babbitt lined oil lubricated. Length Fwd. bearing, mm approx. . . . . ____ Length Aft bearing, mm approx. . . . . ____
Propeller - 1	Fixed pitch solid Nickel-Al Bronze ABS Type 4. Diameter, approx. m . . . ____ Number of blades . . . . . ____
Shaft Coupling (for fixed pitch propeller)	Integrally forged or muff type coupling fitted between aft line shaft and tailshaft. Oil injection (SKF) type couplings are also acceptable.

*Use of higher strength steel permits reduction in shaft diameters and a more flexible shafting system, which is desirable from a vibration standpoint for main engine vibrations steels with a tensile strength 680 N/mm^2 for line shafting and up to 600 N/mm^2 for tailshafts are acceptable.

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
SECTION 55 -- DISTILLING PLANT	
Fresh Water Distiller - 2 (or equivalent Reverse Osmosis Unit)	Package unit, flash type single stage, fitted with condenser evaporator, demister, salinity control, water pump and ejector pump. Capacity, m^3/h . . . . . . _____ Sea salt distillate max. ppm . . . . 4.3 Engine jacket pressure, kPa . . . . _____ Water supply temp, °C . . _____
SECTION 56 -- FUEL OIL SYSTEM	
Fuel Oil Centrifuge Purifier - 2 (each to be interchangeable)	Automatic self-cleaning single stage centrifugal type with motor, complete with separately mounted suction and discharge pumps, and separately mounted duplex strainer. Capacity, m^3/h . . . . . . _____
Fuel Oil Purifier Heater - 2	Horizontal, shell, and tube type or plate type, electrically heated. Capacity, kg/h . . . . . . _____ Oil inlet temp, °C . . . . _____ Oil outlet temp, °C . . . _____ Pressure drop, oil, kPa . _____ Design pressure, oil side, kPa . . . . _____ Power, kW . . . . _____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
F.O. Steam Heater - 2	Horizontal extended surface or tubular type, steam heated, controlled by viscometer. Capacity, kg/h . . . . . . ____ Oil inlet temp, °C . . . . ____ Oil outlet temp, °C . . . ____ Steam pressure, kPa . . . ____ Pressure drop, oil, kPa . ____ Design pressure, oil side, kPa . . . . ____ Cleanliness factor, % . . ____
F.O. Suction Strainer (course) - 1	Inserts accessible for cleaning. Heatable type. Duplex type. Mesh opening, mm . . . . . ____ Capacity, m^3/h . . . . . . ____ Max. pressure drop, kPa . . ____
F.O. Service Discharge Strainer (fine) (heatable if desired) - 1	Regenerative steam heated. Capacity, m^3/h . . . . . . ____ Steam pressure, kPa - micron particle separation 10
F.O. Service Discharge Filter - 1	Capacity, m^3/h . . . . . . ____ Steam pressure, kPa - micron particle separation 10
Deaerating Tank (heatable and insulated) or Return Pipe - 1	Total capacity, L . . . . 150 Fitted with electric heating coils, high/low level alarms, level indicators.
Heavy Oil Settling Tank, Heatable and Insulated - 2	Fitted with heating coils, high/low level alarms, level indicators. Steam pressure, kPa . . . ____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Heavy Oil Day Tank, Heatable and Insulated - 2	Fitted with heating coils, high/low level alarms, level indicators. Steam pressure, kPa . . . _____
Diesel Oil Purifier - 1	Self-cleaning type complete with suction and discharge pumps. Type - centrifugal. Capacity, m^3/h . . . . _____
Diesel Oil Storage Tank Suction Strainer - 1	Duplex type - mesh. Capacity, m^3/h . . . . _____
Diesel Oil Day Tank - 1	Fitted with high/low level alarms, level indicators, supply main engine and ship's generator engines.
Fuel Oil Flow Meter - 1 (with bypass arrangement)	Flanged, with horizontal direct reading dial and remote reading dial. Location of meter either upstream or downstream of the mixing tank is dependent on piping system arrangement. Capacity, m^3/h . . . . _____ Reading, m^3 . . . . _____
Heavy Oil Viscometer System - 1 (with manual bypass)	Flanged or buttweld, equipped with electric motor driven gear pump, capillary tube, thermometer, differential pressure transmitter, control station and recorder. Viscosity Range cSt . . . _____ Output Differential Pressure, mm . . . . _____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
SECTION 57 -- LUBRICATING OIL SYSTEM	
Lube Oil Purifiers - One for each generator engine and one for main engine.	Self-cleaning, automatic control. Complete with suction and discharge pumps. Type: Centrifugal. Capacity, m^3/h . . . . . . ____ Discharge pressure, kPa . ____ Lube Oil Viscosity, Centistokes (SSU) at 50°C . . . . ____ Oil Inlet Temp, °C . . . . ____
Main Engine Lube Oil Purifier Heater - 1	Electric type. Capacity, m^3/h . . . . . . ____ Oil inlet temp, °C . . . . ____ Oil outlet temp, °C . . . ____ Power, kW . . . . ____ Cleanliness factor . . . . 80% Material, shell . . . . . . Steel Material, steam heads . . . Steel Material, tube sheets . . Steel Material, tube . . . 90-10 Cu-Ni
Main Engine L.O. Suction Strainers (as required)	Simplex Type. Capacity, m^3/h . . . . . . ____ Screen openings, mesh . . ____
Main Engine L.O. Coolers - 2 (each sized for full capacity)	Horizontal shell and straight tube type, single pass water side. (Plate type heat exchangers are preferred.) Lube oil, m^3/h . . . . . . ____ Oil inlet temp, °C . . . . ____ Cleanliness Factor . . . . 85% Oil outlet temp, °C . . . ____ Tube dia. and thickness . 19 mm x #18 BWG Material, tube and tube sheet . . . . Aluminum Brass

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
	Material, sheet and baffle . . . . Steel Material, head . Neoprene Coated Steel Capacity (ea.) (Kcal/h) . _____
L.O. Temp. Control Valves - 2 (with bypasses)	Set at ___ °C Main Engine Automatic Lube Oil Temperature Control.
Main Engine L.O. Discharge Strainer - 1	Duplex ___ micron full flow type. Capacity, m^3 . . . . _____
Main Engine L.O. Sump Tank - 1	Welded steel, located under each main engine, fitted with level indicators, heated (if desired). Capacity, m^3 . . . . _____
Main Engine L.O. Storage Tank (number as required)	Welded steel, fitted with level indicator, overflow, vent, drain. Capacity, m^3 . . . . _____
Cylinder Lubricating System	Welded steel, fitted with level indicator, overflow, vent, drain. Capacity, m^3 . . . . _____
Main Engine L.O. Settling Tank - 1	Welded steel fitted with level indicator and heating coils. Capacity, m^3 . . . . _____
Daily Service Tank: Cylinder Lubricating System - 1 (Gravity Tank)	Fitted with sight glass, low level alarm, venting, drainage. Capacity, m^3 . . . . _____
Pressure Reduction Valve (for 2 pressure system, if installed) (Some installations use separate pump for cam shaft lube.)	Oil pressure reduction for the low pressure L.O. system. Set at kPa . . . . _____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Auxiliary Engines L.O. Storage Tank - 1 or more	Two compartment welded steel with level indicator. Capacity, m^3 . . . . _____
SECTION 58 -- SEA WATER SYSTEMS	
Sea Water Heater and Drain Cooler (if provided) - 1	Horizontal shell and tube type (or plate type). Steam pressure, kPa . . . . _____ Sea water quantity, m^3/h . _____ Sea water inlet temp, ^oC . _____ Drain temp ^oC max . . . . _____ Tube material . . . 90-10 Cu-Ni Min. tube dia. mm and thickness . . . . 19 mm x #18 BWG Cleanliness factor 85%
Forepeak Ballast Eductor (if provided) - 1	Capacity, m^3/h . . . . . . _____ Suction lift, m . . . . . . _____ Discharge head, m . . . . _____ Material . . . . Bronze Motivation pressure, kPa . _____
Cargo Tank S.W. Eductor (if provided - 1 <u>NOTE</u>: Cannot duct contaminated S.W. directly overboard.	Capacity, m^3/h . . . . . . _____ Suction lift, m . . . . . . _____ Discharge head, m . . . . _____ Motivation pressure, kPa . _____
Sea Water Suction Filters - 2	Simplex type, self-cleaning without interrupting the cooling sea water supply. Capacity, m^3/h . . . . . . _____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
SECTION 59 -- FRESH WATER SYSTEM	
Engine Jacket Fresh Water Cooling System - (Closed Type)	
Expansion Tank - 1	Maintains static pressure in the system, equipped with vent, drain and overflow connection, welded steel.
	Capacity, m^3 . . . . _____
Engine Jacket Fresh Water Heater - 1	Equipped with steam coil, relief valve, vent.
	Steam inlet temp, ^oC . . . _____ Steam outlet temp, ^oC . . _____
Engine Jacket Fresh Water Cooler - 1, or more if desired	Horizontal shell and tube type, fitted with automatic temperature control. (Plate type also acceptable.)
	Capacity, Kcal/h . . . . . . _____ F.W. qty, m^3/h . . . . _____ F.W. temp in/out ^oC . . . _____ Sea water qty, m^3/h . . . _____ Sea water temp in/out ^oC . _____ Tube dia and thickness . . 19 mm x #18 BWG
Air Separator - 1	Centrifugal type.
	Capacity, m^3/h . . . . _____ Pressure drop, kPa . . . . . _____
Automatic Temperature Control Valve, Jacket Water - 1	Controlling engine cooling water outlet temperature.
	Set at ____ ^oC

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Fresh Water Generator - 1 (minimum)	Jacket water, waste heat type, sized to meet needs of the ship. Capacity, L/h . . . . . . _____
Piston Fresh Water or Lube Oil Cooling System (if installed) (closed type)	
Fresh Water or Oil Drain Tank - 1	Fitting with low level alarm and heating coil with 0.25 m^2 heating surface area per m^3 of water in the tank. Capacity, m^3 . . . . _____
Central Fresh Water Cooler - 1 or more if desired	Horizontal shell and tube type, fitted with automatic temperature control. (Plate type also acceptable.) Capacity, Kcal/h . . . . . _____ F.W. qty, m^3/h . . . . . . _____ F.W. temp in/out °C . . . _____ Sea water qty, m^3/h . . . _____ Sea water temp in/out °C . _____ Tube dia and thickness . . 19 mm x #18 BWG
Automatic Temperature Control Valve - 1 (with bypass)	Regulating main engine inlet water temperature. Set at ____ °C
Water/Oil Separator - 1	Centrifugal type "Serep" or equivalent, electrically driven.
Fuel Valve Cooling System (if installed) (closed type).	

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Expansion Tank - 1	Fitted with vent, drain, low level alarm, sight glass, heating coil to preheat the coolant to a minimum of 70°C. Capacity, m^3 . . . . _____
Temperature Control Valve - 1 (with bypass)	To regulate the water temperature in the expansion tank at 80-85°C.
Fuel Valve (Injector) Cooler - 1 if required.	Horizontal shell and straight tube type. Coolant flow, m^3/h . . . . _____ Coolant inlet temp, °C . . _____ Coolant outlet temp, °C . _____ Tube dia. and thickness . . 19 mm x #18 BWG
Storage Type Hot Water Heater (Domestic Service) - 1 (Provisions for auxiliary heating with electric coil shall also be included.)	Submerged Type (Coil) Type. Storage capacity, m^3 . . . _____ Output capacity, m^3/h . . _____ Water inlet temp, °C . . . _____ Water outlet temp, °C . . _____ Steam pressure, kPa . . . _____ Design pressure, shell, kPa . . . . _____ Material, tank, shell, and head . . . . Steel, resin coated Material, heating coils . . . . Alum-bronze Material, tube sheet . . Bronze Material, steam inlet head . . . . Bronze
Fresh Water Hydropneumatic Tank - 1	F.W. pump to operate under pressure switch control. Compression tank of welded steel, galvanized construction. Capacity, m^3 . . . . _____ Design pressure, kPa . . . _____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
UV Purifiers - as required	
Chlorinators - as required	
SECTION 60 -- CONDENSATE SYSTEM	
Drain and Inspection Tank with Vent Condenser - 1	Fabricated steel fitted with sight glass, oily water indicator, and filter sections. Capacity, m^3 . . . . ____ Condenser Section: Two-pass straight tube horizontal unit vent to atmosphere. Condensing capacity, kg/h ____ Sea water temp, °C . . . . ____ Max. water velocity in tubes, m/s . . . . 1.5 Tube dia. and thickness . . 19 mm x #18 BWG Min. surfaces, m^2 . . . . . ____
Excess Steam Condenser - 1	
SECTION 61 -- STEAM GENERATING PLANT	
Waste Heat (Exhaust Gas) Boiler - 1 (if fitted)	Fire tube or water tube type; output controlled by water level or gas bypass to receive exhaust gases from the main engine. (Steam dump control also acceptable.) Output capacity at ___ kPa, kg/h . . . . ____ Boiler shall act as spark arrester and silencer on the engine.

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Auxiliary Oil Fired Boiler - 1 or more as required	Oil fired (package type) fully automatic complete with forced draft fan, feed pump, fuel oil pumps and controls, capable of burning diesel oil and heavy fuel oil.
	Total evaporation at ___ kPa, kg/h . . . . _____
	Unit shall start automatically when heat recovery (waste heat) boiler drops below ___ kPa; atomizing oil burner with automatic combustion controls and flame safeguard equipment providing for unattended operation.
SECTION 64 -- ENGINE ROOM VENTILATION	
Supply Fans - 2 or more as required	Type: Axial, two speed, motor driven.
	Capacity, m^3/h . . . . . . _____
	Static head, kPa . . . . . _____
	Motor output, kW . . . . . _____
	Motor speed, rpm . . . . . _____
Exhaust Fans - 2	Type: Axial, single speed, motor driven.
	Capacity, m^3/h . . . . . . _____
	Static head, kPa . . . . . _____
	Motor output, kW . . . . . _____
	Motor speed, rpm . . . . . _____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Exhaust Fan (Purifier Room) - 1	Type: Centrifugal, single speed, motor driven.
	Capacity, m^3/h . . . . . . ______ Static head, kPa . . . . . ______ Motor output, kW . . . . . ______ Motor speed, rpm . . . . . ______
Exhaust Fans (Paint Locker) - 2	Type: Axial flow, totally enclosed motor.
	Capacity, m^3/h . . . . . . ______ Static head, kPa . . . . . ______ Motor output, kW . . . . . ______ Motor speed, rpm . . . . . ______ Fan speed, rpm . . . . . . ______
SECTION 65 -- AIR CONDITIONING MACHINERY	
Air Conditioning Compressors - 2	Same type as Stores Compressors, SECTION 66, except as follows:
	Motor, kW, approx. min. . . ______ Capacity at $+2^{\circ}C$ suction temp., kW . . . . ______
Air Conditioning Condensers - 2	Same type as Stores Condensers, SECTION 66, except as follows:
	Capacity, kW . . . . ______ Condensing temp., $^{\circ}C$ . . . ______ Cooling water inlet temp., $^{\circ}C$ . . . . ______
Air Conditioning Receivers - 2	Same data as Stores Receivers, SECTION 66.

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
SECTION 66 -- SHIP'S SERVICE REFRIGERATION	
Refrigerated Stores Compressors - 2	Reciprocating, motor driven with capacity control and automatic unloading.
	Condensing temp., °C . . . _____
	Capacity at -29°C suction temp., kW, min. . . . . _____
	Motor output, kW . . . . . _____
	Motor speed, rpm . . . . . _____
Refrigerated Stores Condensers - 2	Shell and straight tube, finned.
	Condensing temp., °C . . . _____
	Sea water inlet temp., °C _____
	Tubes, min. dia. and thickness . . . . . 16 mm OD x #18 BWG
	Tube material . . . 90-10 Cu-Ni
Refrigerated Stores Receivers	Fabricated steel type.
	Capacity, pump-down, % . . _____
SECTION 67 -- CARGO REFRIGERATION	
Refrigerated Cargo Compressors	Screw or Reciprocating.
	Capacity at -26°C suction temp., J/h, min. . . . . _____
	Capacity at 2°C suction temp., J/h, approx. . . _____
	Motor kW min. . . . . . . _____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Refrigerated Cargo Condensers	Same type as Stores Condenser, SECTION 66, except as follows: Capacity at +2°C suction temp., equal to compressor capacity . . . . _____ Cooling water flow at 2°C Suction temp., max. . 1.27 m^3/J
Refrigerated Cargo Receivers	Fabricated steel type Capacity, pump down % . . _____
SECTION 68 -- LIQUID CARGO SYSTEMS	
Cargo Tank Cleaning Heater (Butterworth) - 1 (Plate type heater is also acceptable.)	Horizontal Shell and Tube type. Steam pressure, kPa . . . _____ Steam flow, approx. kg/h . _____ Sea water quantity, m^3/h . _____ Sea water inlet temp. °C . _____ Sea water outlet temp. °C _____ Tube material . . . 90-10 Cu-Ni Min. tube dia., mm and thickness . . . . 19 mm x #16 BWG Cleanliness factor, % . . . 75 Water velocity tubes, max., m/s . . . . 1.4 Design pressure, shell, kPa . . . . _____ Shell material . . . . _____ Tube sheet material 90-10 Cu-Ni Head material . . . 90-10 Cu-Ni Pressure drop, max., kPa 34.5

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Cargo Tank Cleaning Heater Drain Cooler - 1 (May also be integral part of Tank Cleaning Heater.)	Horizontal Shell and Tube type. Condensate inlet temp. °C . _____ Condensate outlet temp. °C . . . . _____ Sea water inlet temp. °C . _____ Sea water outlet temp. °C _____ Other data same as for Butterworth Heater. Drains from cooler regulated by liquid level controller.
Cargo Coil Hot Water Heater - 1 (if fitted)	Horizontal Shell and Tube type. Steam pressure, kPa . . . _____ Water quantity, m^3/h . . . _____ Water inlet temp. °C . . . _____ Water outlet temp. °C . . _____ Tube material . . . Alum. Brass Tube sheet material Naval Brass Water velocity, max., m/s. . . . . 1.37 Min. tube dia., and thickness . . . . . 16 mm OD x #18 BWG Design pressure, shell, kPa . . . . _____ Design pressure, tubes, kPa . . . . _____ Head material . . . . Cast Iron Pressure drop max., kPa . _____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
SECTION 70 - SEWAGE DISPOSAL SYSTEM	
Sewage Holding Tanks - 2	Welded steel construction, sand blasted and coal tar epoxy lined. Each tank fitted with water jets, high-level alarms, floatless control for sewage pumps, tank bottom sloped toward pump suction.
	Capacity, t . . . . _____
OR	OR
Sewage Treatment Plant and a Holding Tank - 1	Capacity m^3/day . . . . . _____
SECTION 71 -- TANK LEVEL INDICATORS	
Heavy Fuel Oil Storage, Settling, and Day Tanks Fresh Water Tanks Distilled Water Tank Lube Oil Sump Tank(s) Diesel Oil Service Tanks and Storage Tanks Liquid Cargo Tanks (if provided) Clean Ballast Tanks Sewage Holding Tanks	Number and type of Tank Level Indicators to be provided in accordance with Regulatory Body(ies) requirements and guidelines established in SECTION 71 for particular vessel design.
SECTION 72 -- COMPRESSED AIR SYSTEM	
(Diesel) Starting Air Compressors - 2	Two stage, motor driven (direct or "V" belt) fresh water or air cooled, equipped with oil/water separator.
	Free air, m^3/h . . . . _____ Discharge pressure, kPa . _____ Motor, kW . . . . _____ Motor, rpm . . . . _____ Start Limit, kPa . . . . . . _____ Stop Limit, kPa . . . . . . _____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Ship Service Compressor - 1	Similar to above.
	Compressors to operate under pressure switch control.
Control Air Compressor - 1	Motor drive, direct or "V" belt drive, centrifugal with water seal.
	Free air, m^3/h . . . . . . ____
	Discharge pressure, kPa . ____
	Motor, kW . . . . ____
	Motor, rpm . . . . ____
	Start Limit, kPa . . . . . ____
	Stop Limit, kPa . . . . . ____
	Compressor to operate under pressure switch control.
Diesel Engine Starting Air Receivers - 2 or more	Fabricated steel, galvanized, equipped with drain safety valve and pressure gage.
	Capacity, m^3 each . . . . ____
	Design pressure, kPa . . . ____
Ship's Service Air Receiver - 1	Fabricated steel, galvanized.
	Capacity, m^3 each . . . . ____
	Design pressure, kPa . . . ____
Control Air Receiver - 1	Fabricated steel, galvanized.
	Capacity, m^3 each . . . . ____
	Design pressure, kPa . . . ____
	NOTE: Approximate time for compressor operation to pump tank between pressure limits is 1 minute with normal use of air. Tank to be fitted with a low pressure alarm.

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Control Air Dehydrator - 1	Self-contained refrigeration unit, discharge air temperature +2°C.
	Capacity, sm^3/min. . . . . ____
S.S. Air Dehydrator - as required	Self-contained refrigeration unit, discharge air temperature +2°C.
	Capacity, sm^3/min. . . . . ____

SECTION 73 -- PUMPS - SEE TABLE 50-1 (pages 50-29 - 50-30)

SECTION 74 -- PIPING

Whistle - 1	Type . . . . Tyfon Air Diaphragm dia., mm . . . . ____ Operating press., max., min. . . . . ____

SECTION 76 -- AUXILIARY DIESEL ENGINES

Ship Generator Diesel Engines - 3	4-stroke cycle, medium speed, single-acting, non-reversing, solid injection, turbo-charged, intercooled and/or aftercooled type fitted with jacket water cooler, lube oil cooler, intake filter/silencer and exhaust silencer, all attached pumps, filters and controls, capable of burning either diesel or heavy fuel and remotely controlled from main console.
	Continuous rating, kW . . ____ Speed, rpm . . . . ____ Type starting . . . . Air

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Emergency Diesel Generator - 1	Radiator cooled, complete with pumps and coolers. Two or four cycle full diesel type.
	Continuous rating, kW . . _____ Speed, rpm . . . . _____ Type starting . . . . Electric
Emergency Diesel Fire Pump (if fitted)	
Main Cargo Pump Diesels (if provided)	Single-acting, non-reversing, solid injection, full diesel type complete with all attached pumps, coolers, filters, silencers, and controls. Drive cargo pumps through Engine Room bulkhead.
	Continuous, kW, approx. . _____ Speed, rpm . . . . _____ Type starting . . . . Air
SECTION 78 -- MISCELLANEOUS TANKS	
Clean Waste Locker - 1	Size (metric) . . . . ____/____
Oily Waste Can - 1	Size (metric) . . . . ____/____
Kerosene Tank - 1	Size (metric) . . . . ____/____
Heavy Fuel Sludge Tank - 1	Size (metric) . . . . ____/____
Main Engine Coolant Tank - 1	Size (metric) . . . . ____/____
Main Engine Coolant Drain Tank - 1	Size (metric) . . . . ____/____
Reserve Feed Tank - 1	Size (metric) . . . . ____/____
Tailshaft Bearing Drain Tank - 1	Size (metric) . . . . ____/____
Tailshaft Bearing Head Tank - 1	Size (metric) . . . . ____/____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Condensate Storage Tank - 1	Size (metric) . . . . ____/____

SECTION 80 -- ENGINEERS' AND ELECTRICIANS' WORKSHOPS, STORES, AND REPAIR EQUIPMENT

Specification Section, Item and Number Required	Description
Workbenches (as required)	Size (metric) . . . . ____ Engineers' workshop . . . ____ Electricians' workshop . . ____ Injector workbench . . . . ____ Purifier . . . . ____ Battery . . . . ____ Welding . . . . ____
Lathe (SEE PAGE 80-1)	Screw cutting geared head type. Swing (diameter) over bed, mm . . . . ____ Length between centers, mm . . . . ____ Motor, kW . . . . ____
Drill Press (SEE PAGE 80-2)	Vertical, back geared type. Size drill, mm . . . . ____ Traverse of table on column, mm . . . . ____ Spindle travel, mm . . . . . ____ Motor, kW . . . . ____
Pedestal Grinder (SEE PAGE 80-2)	Wet and dry type. Size wheel, mm . . . . ____ Motor, kW . . . . ____
Bench Grinder	
Power Hacksaw (SEE PAGE 80-3)	Motor driven, automatic shut-off type. Size, mm . . . . ____ Stroke, mm . . . . ____ Motor, kW . . . . ____

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Electric Pipe Threader - 1 (capable of metric and SAE)	Motor driven, variable chuck and die. Max Pipe Size, mm . . . . _____ Speed . . . . _____ Motor, kW . . . . _____
Electric Hoists (in addition to main engine overhaul crane)	Machinery space portable electric hoist. Capacity, t . . . . _____ Motor, kW . . . . _____
Storerooms and Storage Area (as required)	Provided as shown on Contract Plans.
Lifting Gear (as required) (SEE PAGE 80-4)	Provided with suitable gear for safe handling of machinery and equipment. Chain hoists. Capacity, t . . . . _____
Electric Welding Machine (if required) (SEE PAGE 80-5)	Electric manual shielded arc welding unit, stationary or portable, single or dual control, line resistor, DC generator, transformer or rectifier type. Machine to be capable of adapting ship's service power to a lower voltage suitable for welding. Unit to be provided with adequate safety features and accessories for the intended service. Capacity, ___ to ___ amperes at ___ to ___ volts.
AND	
Gas Welding Unit (SEE PAGE 80-5)	Approved apparatus provided with adequate accessories, controls, and safety features for the intended service.

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
SECTION 81 -- DECK MACHINERY	
Steering Gear - 1	See SECTION 81.
	Max. torque ahead, Nm . . ____
	Max. torque astern, Nm . . ____
	Motor, kW . . . . ____
Anchor Windlass (as required)	Anchor weight, kg . . . . ____
	Chain size, mm . . . . ____
	Anchor hoisting speed, m/s . . . . ____
	Warping head size . . . . ____
	Hawser size and material, mm . . . . ____
	Warping speed, m/s . . . . ____
	Line pull, N . . . . ____
	Motor, kW . . . . ____
Lifeboat Winch (as required)	Load, kg . . . . ____
	Hoisting speed, m/s . . . ____
	Motor, kW . . . . ____
Accommodation Ladder Winch (as required)	Load, kg . . . . ____
	Hoisting speed, m/s . . . ____
	Motor, kW . . . . ____

Number and capacities of cargo, stores handling, topping, mooring, and constant tension winches shall be developed to suit the vessel. Loads should be stated in kg, speeds in m/s, pulls in N, and motors in kW.

Specification Section, Item and Number Required	Description
SECTION 85 -- INSTRUMENTS AND MISCELLANEOUS GAGEBOARDS -- MECHANICAL	
Gageboards (as required)	Steel or aluminum construction, with all gages, instruments, and controls mounted as nearly flush as possible.
Mechanical Instruments	As specified in SECTION 85 and the various SECTIONS as required for proper operation.

LIST OF MACHINERY

Specification Section, Item and Number Required	Description
Telephone Hoods	Emergency Generator Room, diesel generator positions, Steering Gear Room.
Log Desks	Engine Room control stations, emergency Generator Room and evaporator and refrigeration stations.
SECTION 88 -- GENERATOR	
Ship's Service Generators - 3	A-C generator with integral brushless exciter direct connected to full diesel type engine mounted on common bedplate. Capacity, kW (cont. rated @ 0.8 pf) . . . . _____ Capacity, kVA . . . . _____ Volts . . . . _____ Three phase, 60 Hz . . . . _____
Emergency Diesel Generator - 1	Direct connected diesel driven A-C generator with integral brushless exciter mounted on common bedplate with characteristics as follows: Capacity, kW (cont. rated @ 0.8 pf) . . . . _____ Capacity, kVA . . . . _____ Volts . . . . _____ Three phase, 60 Hz . . . . _____
SECTION 89 -- SWITCHBOARDS	
Main Switchboard - 1	Dead front type.
Emergency Switchboard - 1	Dead front type.
Group Control Centers (as required)	Dead front type.

TABLE 50-1
PUMPS

NO. UNITS	SERVICE	TYPE	DRIVE	CAPACITY M^3/H (GPM)	HEAD kPa (PSIG)	rpm	DRIVER kW (HP)	FLUIDS PUMPED
2	Main S.W. Service	Vert. single stage centrifugal	Motor					
As req'd	Aux. S.W. Service	Vert. or Horiz. 1 stage centrifugal	Motor					
2	Exhaust Gas Boiler Feed	Vert. or Horiz.	Motor					
1	Bilge	Vert. or Horiz. 1 stage centrifugal	Motor					
1	General S.W. Service and Washdown	Vert. or Horiz. 1 stage centrifugal	Motor					
1	Emergency Fire (outside Engine Rm)	Vert. or Horiz. 1 stage centrifugal	Motor					
1	Bilge and Ballast	Vert. or Horiz. 1 stage centrifugal	Motor					
As req'd	Priming	Horiz. centrifugal w/water seal	Motor					
1	Fire: Engine Room	Vert. or Horiz. centrifugal	Motor					
2	Engine Fresh Water Cooling	Vert. single stage centrifugal	Motor					
2	Fuel Valve Cooling (if required)	Vert. or Horiz. single stage centrifugal	Motor					
2	Piston Water Cooling (if required)	Vert. single stage centrifugal	Motor					
2	Potable Water	Horiz. 1 stage centrifugal	Motor					
1 or 2	Hot Water Recirculating	Vert. or Horiz. single stage centrifugal	Motor					
As req'd	Distilling Plant Feed	Horiz. 1 stage centrifugal	Motor					
As req'd	Brine Overboard	Ejector	Motor					
As req'd	Desalination Condensate	Ejector	Motor					
As req'd	Air Cond. Chilled Water Circ.	Vert. 1 stage centrifugal	Motor					

NO. UNITS	SERVICE	TYPE	DRIVE	CAPACITY M^3/H (GPM)	HEAD kPa (PSIG)	rpm	DRIVER kW (HP)	FLUIDS PUMPED
As req'd	Air Cond. Chilled or Hot Water Circ.	Vert. 1 stage centrifugal	Motor					
As req'd	Sewage	Vert. 1 stage centrifugal	Motor					
As req'd	Liquid Cargo (if req'd)	Vert. or Horiz. (submersible)	Motor or Diesel					
2	L.O. Service	Horiz. or Vert. Rotary	Motor					
1	F.O. Transfer	Horiz. or Vert. Rotary	Motor					
1	D.O. Transfer	Horiz. or Vert. Rotary	Motor					
2	F.O. Service (Booster)	Horiz. or Vert. Rotary	Motor					
2	Crosshead L.O. Service	Horiz. or Vert. Rotary	Motor					
2	Stern Tube L.O.	Horiz. or Vert.	Motor					
1	F.W. Transfer	Vert. or Horiz. Centrifugal	Motor					

SECTION 51

MAIN PROPULSION ENGINE - *SLOW SPEED DIESEL (ONLY)*

51.1. GENERAL DESCRIPTION

The main propulsion engine shall be a single acting, two stroke, crosshead, turbocharged, directly reversible low speed marine diesel designed for normal operation with properly treated heavy fuel. The engines shall be of the long stroke, uniflow scavenged variety with a large exhaust valve. The engine shall be capable of being started and maneuvered on heavy fuel. Diesel fuel may be used for starting and low power operation if desired.

Engine shall be directly connected to line shafting via solid coupling.

The main diesel engine shall be designed to withstand the external forces and deflections imposed on its supporting structure by the deflections and stresses of the ship. The engine shall be supported in such a manner as to allow for such deflections without imposing external forces and misalignments on the components beyond their design tolerances and without producing excessive vibrations or objectionable noise.

The engine shall operate satisfactorily at the specified maximum continuous rating (MCR), and be capable of starting, stopping, and maneuvering while burning properly treated heavy fuel oil with the following composition:

Viscosity	Up to 700 cSt @ 50° C
Vanadium	Up to 600 ppm
Sodium	Up to 200 ppm
Sulphur	Up to 5% by wt
Carbon	Up to 15% by wt
Ash	Up to .15% by wt

The specific fuel consumption at MCR under the above conditions during ship trials shall not exceed the engine manufacturer's guaranteed value (g/BHP/Hr±3%), and with a net calorific value of 42,700 KJ/Kg. Fuel rate shall be adjusted for actual ambient conditions in accordance with ISO 3046, Part 1, "Reciprocating Internal Combustion Engines - Performance - Part 1: Standard Reference Conditions and Declarations of Power, Fuel Consumption and Lubricating Oil Consumption".

The engine shall be provided with all the necessary instruments and controls for stopping, starting, reversing and maneuvering from the Engine Room control console; and locally at the engine; and from the pilot house.

The engine shall be provided complete with all attached and unattached auxiliaries as described herein and in full compliance with the requirements of the Classification Society, including the requirement for operation with an unattended machinery space.

The engine shall be arranged clockwise seen from aft, i.e., the direction of rotation for "Ahead" is such that the top of the crankshaft turns to starboard.

51.2. BEDPLATE (CRANKCASE) AND ENGINE FRAME

The engine bedplate shall consist of fabricated longitudinal girders and rigid crossmembers with rigid center pieces of cast or forged steel which carry the main bearings and serve as anchors for the tie rods. The oil collection pan shall be integral with the bedplate and drain to the oil sump tanks in the ship's inner bottom.

The thrust bearing baseplate shall be an integral part of the engine bedplate.

An oil mist detector, of approved type, shall be provided in the engine. A local increase of oil mist generated by a "hot spot" in any crankchamber, camshaft gear drive train, or thrust bearing chamber shall cause a visual and audible warning.

Columns of the fabricated A-frame, welded/cast design frame boxes (monoblock), highly deformation-resistant, shall provide a rigid structure between the bedplate and the cylinder block. Large doors shall provide access to the crankcase. Explosion-relief valves shall be provided in the side wall in accordance with regulatory requirements.

The interior surfaces of the crankcase shall be coated with a corrosion-inhibiting oil or oil resistant paint as approved by the engine manufacturer.

51.3. CRANKSHAFT AND THRUSTSHAFT

Solid/semi-built-up type crankshaft shall be made of forged/cast steel throws and machined in accordance with Classification Society requirements. The crankshaft shall be a single piece crankshaft and shall be free of any lubrication bores in order to avoid additional stress concentration. For engines with more than 6 cylinders, the crankshaft may be made in two pieces.

An integral thrust collar or separate thrust shaft shall be of a single forging with thrust collar, flange for mounting the flywheel, which also acts as a turning wheel, and a coupling flange at the opposite end. A motor driven turning gear complete with safety interlocks shall be provided.

The main engine shafting shall incorporate appropriate attachments which effectively deal with abnormal second order and torsional vibrations.

51.4. BEARINGS

The main bearings shall consist of two interchangeable shell halves lined with white metal or of a lower shell type with a babbitt lined bearing cover. On some engines their vertical clearance is capable of adjustment by shims. Each bearing cover shall be held down by bolts which are tightened hydraulically against the columns.

The bottom end bearings of the connecting rods shall be of forged or cast steel, in two halves and white metal lined. The top half may have a bearing shell with the bottom babbitt lined. They shall be joined to the connecting rods by fitted bolts, which are hydraulically tightened.

Each crosshead assembly shall consist of one or two crosshead bearings, the crosshead pin, and crosshead slippers. Crosshead bearing(s) shall be in two halves. The crosshead pin shall be forged from homogeneous steel. The piston rod shall be fitted to the center and the slippers to each end of the pin. The cast steel slippers shall be white metal lined and self adjusting and run on guides machined in to the columns.

The thrust bearing shall transmit the thrust of the propeller to the vessel via the bedplate. The thrust bearing shall be double acting and provided with interchangeable white metal lined tilting pads. Two plain bearings fitted with interchangeable shells shall be provided to take the load of the flywheel and the thrust shaft.

51.5. PISTON AND PISTON RODS

The piston assembly shall consist of three parts:

- steel piston crown
- a cast iron skirt
- a forged steel piston rod

These parts shall be held together by necked-down tension bolts. The piston rings shall be located in chromium plated grooves. The piston rod shall be fitted to the crosshead pin and held in place by a hydraulically tightened nut, mechanically tightened nuts or bolts.

51.6. CYLINDER FRAME

Cylinder frame shall be of fine lamellar (close grained) cast iron. Individual cylinder frame units shall be bolted together to form a rigid cylinder block. The cylinder block, columns and/or box girders and bedplate shall be held in compression by tie rods, which shall transmit combustion and inertia forces to the underside of the bedplate.

The top of the cylinder frame shall be cooled by fresh water. At the bottom of the frame unit shall be a stuffing box between the underside of the cylinder and the crankcase in order to prevent contamination of the crankcase oil by combustion residues.

51.7. CYLINDER LINERS AND COVERS

Cylinder liners shall be in one piece of special fine alloyed cast iron. The top collar of the cylinder liners shall be held down onto the cylinder frame by the cylinder covers so that the liners are free to expand downwards. Liners shall be cooled as required.

Cylinder covers shall be forged in one piece and shall be bore or port cooled. Exhaust, fuel, starting, safety, and indicator valves shall be carried by the cylinder covers. Cylinder covers shall be bolted directly to the cylinder frame.

51.8. PISTON ROD STUFFING BOX

The piston rod stuffing box to separate the main cylinder from the crankcase shall be provided.

51.9. PISTON COOLING PIPE GLANDS

Piston cooling liquid shall be supplied to and drained away from the pistons through the piston rod.

51.10. CONNECTING RODS

Connecting rods shall be forged normalized steel. Bottom-end bearing shells shall be lined with white metal ready for installation, exchangeable without remachining. Shims shall be provided between the bottom end bearings and the connecting rods, or between the connecting rod and the crosshead bearing, to provide limited adjustment of the compression ratio during erection. The connecting rods shall be bored to supply lubricating oil to the lower end bearings from the lubricating oil system. All connecting rod bolts shall be arranged for hydraulic tightening.

51.11. CROSSHEAD

The forged steel crosshead pins may be symmetrical and reversible, if so designed. Piston rods shall be connected to crosshead pins by single hydraulically tightened nuts or by hydraulically tightened bolts. Cast iron and/or cast steel, white metal lined, crosshead bearing slippers shall run on cast iron double guided faces. Crosshead bearing shells shall be interchangeable.

51.12. CAMSHAFT

The forged steel camshaft shall be driven by the crankshaft either through a gear train or chain. Cams shall actuate fuel pumps, exhaust valves, and indicator drive. An oil operated rotary reversing servo motor or camshaft shifting caused by a pneumatic-hydraulic shifting unit shall change from ahead to astern cam timing.

51.13. FLYWHEEL AND JACKING GEAR

A flywheel incorporating a jacking worm wheel shall be provided with each main engine. Each jacking gear shall have a manually operated engaging and disengaging pinion, driven by a gearing system and a reversible electric motor or barring device. Hand operating gear and lever and/or crank shall be incorporated for turning the crankshaft through small angles. The flywheel or engine crankshaft flange shall be provided with an indexing scale to permit checking crank positions. A pneumatically operated interlock shall be incorporated in the turning gear to ensure that the main engine cannot be started when the pinion of the turning gear is in mesh.

51.14. SCAVENGING AND SUPERCHARGING

<u>The system described herein is one of several acceptable alternatives. Others will be considered.</u>

The engine shall be of the uniflow scavenged type with large exhaust valves. Turbocharger(s) shall supply charging air via fresh or seawater cooled air cooler(s) to the constant pressure supercharging system receiver.

Turbochargers shall have axial flow exhaust gas turbines and centrifugal blowers. Turbochargers shall be provided with individual motor driven or integral lubricating oil pumps or connected to the engine oil circuit. The exhaust gas inlets (if necessary) and turbine casings shall be water cooled. Provision shall be made for cleaning of turbochargers and air coolers.

During the compression stroke, scavenging air shall be supplied to the space beneath the piston by non-return valves. This air shall be compressed by the downward motion of the piston during the power stroke and forced into the cylinder when the scavenging ports are uncovered. After the pressure of the initial charge of air reaches the supercharging receiver pressure, non-return valves shall reopen and air from the receiver shall complete scavenging. At low engine loads, when the exhaust driven turbochargers are ineffective, an electric motor driven scavenging fan shall be provided in the load range below approximately 50 percent MCR. An electrically driven blower(s) cuts in and out automatically depending on the scavenge air pressure.

51.15. EXHAUST GAS SYSTEM

The system described in this paragraph is one of several acceptable alternatives. Others will be considered.

The exhaust gas system shall extend from the turbo supercharger outlet flange to atmosphere. The system shall consist of exhaust pipes, expansion bellows, a waste heat boiler, (acting as silencer) and a spark arrestor. If no waste heat boiler is fitted, a separate silencer or a silencer combined with the spark arrestor shall be fitted.

The exhaust pipes from the cylinder exhaust outlets shall be connected with the constant pressure exhaust manifold situated above the scavenge air receiver. Branch shall be arranged on the exhaust manifold to deliver exhaust gas to the turbo-blower entry. Turbocharger(s) shall be mounted below or above the exhaust manifold or on the engine front sides. Pyrometers shall be fitted to each cylinder exhaust. The exhaust outlet from the blower shall be connected by suitable exhaust pipes to exhaust gas silencer/boiler. Exhaust pipe lagging shall consist of high temperature resisting slabs embedded into high temperature resisting plastic composition and secured with wire binding or with insulation equivalent in effect and design. Asbestos in any form is prohibited. The lagging shall be supercoated with a layer of composition reinforced with 1/2 mesh galvanized wire netting and covered with galvanized steel sheets.

Expansion pieces shall be covered with cloth mattresses 50 mm thick with high temperature resisting composition. The exhaust gas from each auxiliary diesel engine shall be led separately to the atmosphere through a combined spark arrestor and silencer.

51.16. UPTAKES

The various uptakes shall lead from the silencer or waste heat boiler to the top of the stack. These uptakes shall have an 8 mm wall and shall be supported by the ship's structure independently of the waste heat boiler and silencers. The uptakes shall be led through expansion collars in the top of the stack.

51.17. FUEL SYSTEM

The engines shall be provided with motor driven booster pumps for supplying fuel oil to the fuel injection pumps.

The fuel oil supply unit shall be capable of automatically controlling selection and temperature of fuel oil being delivered to the fuel injection pumps. The engines shall be equipped with necessary pumps, and provided with filters, tanks, and other fuel conditioning equipment as deemed necessary to deliver fuel oil to the engine injectors in proper condition.

51.18. LUBRICATING SYSTEM

Each engine shall be provided with a forced feed pressure type lubricating oil system by means of a separate motor driven pressure pump.

The oil supply shall consist of two independent lubricating systems:

(a) Combined low pressure and high pressure oil system for bearings and control system, or a single system depending on the engine.

(b) Cylinder lubricating system.

All moving parts of the engines shall be lubricated from their respective central lubricating oil system.

The main bearings, crank pin bearings, crosshead bearings, thrust bearing, camshaft drive wheels, camshaft and fuel pumps shall be fed from the low pressure lube oil system.

The crosshead and bottom end connecting rod bearings shall be fed from the high pressure oil system or the crosshead bearing from the high pressure force-fed oiler actuated by connecting rod movement.

Each engine shall be equipped with an independent lubricating oil cooler.

51.19. COOLING WATER SYSTEM

Each engine shall be equipped with a fresh water cooling system for the various components as required. Each system shall be complete with motor driven pump, cooler, thermostatic valve and head tank as required.

Fresh water for cooling engine jacket water and oil coolers shall be circulated by means of a motor driven pump taking suction from main injection and discharging through its respective cooler. Provision shall be made for testing, treating and controlling the chemistry of the fresh water system to inhibit corrosion.

51.20. AIR SYSTEMS

The following air systems shall be provided:

Scavenging air (combustion)

Compressed air supply (for engine starting, pneumatic remote control and for general service).

Scavenging Air System

The scavenging air needed for combustion shall be delivered by the turbochargers mounted on the engine.

The turbochargers shall draw the fresh air directly from the Engine Room or via ducting from a screened room on deck. The blower air inlets shall be equipped with combined silencers and filters and/or an intake filter with shifting unit installed before it, to carry the intake air only over the auxiliary blower.

Compressed Air Supply System

The air supply system shall be a compressed air supply system with the pneumatic engine control consisting of the following:

Air compressors and air receivers shall each be provided with a water drain, safety valve and pressure gauge.

An automatic starting master valve shall serve to open and close the passage of main starting air to the engine.

The starting air distributor shall control the pilot air to actuate the starting valves during starting and engine braking.

51.21. STARTING AND REVERSING

The engine shall be started, stopped and reversed by compressed air at a maximum pressure of about 3000 kPa (= 30 bar).

The details of the starting and reversing systems shall be part of the engine manufacturer's specific design.

51.22. ENGINE CONTROL SYSTEM (This description of one system only. Others will be considered.)

The engine control system shall be a electro-pneumatic system for the following control modes:

Local Control From Engine Room: The engine control system shall be provided with local controls which shall be capable of starting, reversing, and controlling (speed setting) the engine and clutching mechanisms (if applicable), independent of the remote control system. Necessary direct reading instruments shall be provided locally to satisfactorily permit one person to control the engine speed and direction for extended periods.

Remote Control from Engine Control Room: The remote control system shall be capable of performing all engine control functions which can be performed from local controls, including emergency stopping of engine and control overrides. An engine monitoring system with all necessary alarms shall be provided for the remote control.

Remote Control from Bridge: As an integral part of the engine control system, a bridge control system shall be provided in accordance with SECTION 99.

51.23. MISCELLANEOUS REQUIREMENTS

An overspeed trip mechanism of the manual reset type, entirely independent of the regulating governor shall be provided.

The power plant performance characteristics data shall be prepared in accordance with the latest marine slow speed diesel power performance practices as published in Technical Bulletins by the Society of Naval Architects and Marine Engineers.

51.24. SPECIAL TOOLS

One set of tools for use solely for engine maintenance shall be provided and stowed aboard ship. All special tools including torque and impact wrenches of appropriate sizes, and all special tools as required by the design of the engine and as recommended by the engine manufacturer shall be provided.

SECTION 53

MAIN SHAFTING, BEARINGS, AND PROPELLER - *SLOW SPEED DIESEL (ONLY)*

53.1. SHAFTING

(a) General

The approved arrangement of shafting and bearings shall be free of all serious torsional, flexural, and longitudinal vibrations at all speeds within the operating range. The stern tube bearing and seals should preferably be provided by the same vendor. Marine Power Plant Practices SNAME T&R Bulletin 3-49, or other similar publications, should be consulted.

(b) Line Shafting

The line shafting shall be of solid forged steel, ABS Grade 2, 3, or 4. For shafting without the muff coupling arrangement, the aft section of line shafting shall be of adequate length to provide for inboard tail shaft removal with only this section of shafting dismantled. Hollow shafting and higher strength materials are subject to specific approval.

Shafting shall be machined to a surface roughness not exceeding 3175 RMS micromillimeters except for journals in way of bearings and stuffing boxes which shall be 6.35 mm in excess of the required shaft diameter and polished to a roughness not exceeding 810 RMS micromillimeters.

For trial purposes, one section of line shafting for one ship of a contract only, preferably the first, shall be machined for installation of a torsion meter. The shaft shall be calibrated as specified in SECTION 101. Ships provided with a horsepower meter may have one section of line shafting machined for its installation. This may be in addition to the machining for a torsion meter.

(c) Tailshaft

The tailshaft shall be of solid forged steel, ABS Grade 2 or as otherwise permitted by ABS; and where controllable pitch propeller control is specified, the tailshaft shall be bored for controllable pitch control and machined for the type coupling provided, such as the friction joint type sleeved coupling. The minimum diameter shall be not less than that required by ABS plus 6.35 mm. Shaft surface shall be machined smooth with surface roughness not to exceed 3175 RMS micromillimeters, except at taper and keyways where the surface roughness shall not exceed 1600 RMS micromillimeters. The shaft in way of the bearings shall be machined and polished to suit the requirements of the bearing manufacturer.

The after end of the tailshaft shall be accurately machined to a taper gage to fit the proper bore (usually 25.4 mm on diameter per 305 mm length). The end of the shaft shall be right hand threaded (right hand fixed pitch propeller) to suit a Pilgrim type nut with a locking device; or the normally threaded section of the tailshaft may be omitted, and a hydraulically operated securing collar installed.

Prior to finish machining, the propeller shaft shall be cold rolled for a length of one shaft diameter but not less than 455 mm forward of the start of the taper and for one third of the length of the shaft taper aft of the forward end of the taper. Subsequent to cold rolling, the removal of material in way of the cold rolled portion should be a minimum and shall not exceed 0.13 mm on the radius.

Suitable means shall be provided for the removal and relocation of the aft section of line shafting; withdrawal of the tailshaft inboard; and removal of the propeller.

53.2. ALIGNMENT

The Contractor shall prepare calculations to determine:

(a) Bending Moment, Shear and Deflection and the propulsion shafting system including propeller and bull gear rotor for the cold static, hot static and hot running conditions. Values shall be tabulated and plotted.

(b) Table of bearing reactions for the cold static, hot static and hot running conditions.

(c) Table of bearing influence numbers.

The results of these calculations shall be used to establish the proper number and location of bearings and bearing loads. Calculations shall also demonstrate the effects of bearing wear on bearing loads where critical.

Individual components of the shafting system shall be aligned by calculated gaps and sags at the interface flanges. Once aligned, the system alignment shall be checked by the Jacking Method. An alignment procedure including bearing jacking data test sheets shall be developed by the Contractor and approved by the Owner's representative prior to alignment of the shafting system.

53.3. COUPLINGS

All flanged couplings shall be fitted with steel bolts. Tapered bolts with 25.4 mm per 305 mm taper and with the large end of the taper on the after side are acceptable. Galvanized, painted steel guards shall be provided for all couplings.

The use of oil injection (SKF) type couplings is also acceptable.

53.4. STEADY BEARINGS

There shall be a suitable number of steady bearings of the ring or disc oiled type, with removable lower half shell fitted, for adequately supporting the shafting. If of the ring oiled type, there shall be two rings per bearing. The base and cap may be of ductile iron, cast steel or welded steel construction and the half shells of steel, ductile iron or bronze lined with an approved type of high tin babbitt metal and the caps with suitable bearing metal bands at ends. The babbitt shall be poured centrifugally or under a positive head. Ample oil reservoirs shall be provided with end baffles capable of preventing loss of oil at ends of bearings. Each bearing shall be equipped with a bayonet or other suitable type of oil level indicator other than a sight glass. Filling and drain connections and hand cleanout holes shall also be provided. All bearings shall be identical except that the aftermost bearing shall be fitted with bearing metal on both top and bottom.

For ring-oiled bearings the unit load shall not exceed 345 kPa on projected area and the bearing length shall not exceed 1.5 times the journal diameter. For disc-oiled bearings with a non-mechanical metallurgical bond in excess of 41,370 kPa the unit load may be as high as 520 kPa on projected area and the bearing length to journal diameter ratio shall be approximately 1/1 but in no case greater than 1.5/1.

Face plate on bearing foundations shall be 300 mm longer than the length of line shaft bearing base, to provide space for jacking up shaft when bottom half of bearing is removed.

A jacking plate on the main engine foundation at the aft end of the engine shall also be provided.

53.5. STERN TUBE AND STERN TUBE OIL LUBRICATED BEARINGS

The stern tube shall be designed to accommodate the bearing(s) as recommended by the bearing and seal vendor.

The stern tube bearing(s) shall be of the oil lubricated babbitt lined sleeve type. There shall usually be one bearing at the forward end of the stern tube and another bearing at the after end of the tube. The bearing(s) shall consist of a ductile iron or bronze backing material with centrifugally spun tin base babbitt. Bearing(s) to be precision type with a non-mechanical metallurgical bond. Evidence of superior bond (in excess of 41,370 kPa) by Chalmers method or equivalent must be furnished by supplier.

Two Resistance Temperature Detectors (RTD), one working and one spare, shall be provided in the aft stern tube bearing to remotely monitor bearing temperature.

The use of adjustable, horizontal split type bearings or self aligning tilting pad type bearings is also acceptable.

53.6. STERN TUBE SEALS

Service proven type inboard and outboard seals shall be fitted at forward and aft ends of stern tube to prevent ingress of sea water or loss of lubricating oil. The inboard seal shall be fitted with a package pump circulating and cooling system.

53.7. STERN TUBE OIL SYSTEM

An independent propeller shaft bearing lubricating oil system shall be provided for the stern tube bearing. The system shall be of a common open and closed reservoir system arranged to maintain static head on the stern tube. (A pressure balanced system will also be considered.)

A small pump shall be provided to take suction from the drain tank through a strainer isolated by valves for cleaning, and discharge to the head tank and to the line from the tank to the bearing. The pump shall be controllable at the pump and from the engine room console. A thermostatically controlled electric heater shall be installed in the drain tank. An oil cooler with by-pass and a local/remote temperature monitoring system shall be provided at each end of the stern tube.

Head tank(s) shall be provided for the lubricating oil system.

The head tank shall be located in suitable accessible space at an elevation recommended by the bearing and seal vendor. Tank shall have a funnel with cover for hand filling, gage glass with graduated scale, vent, supply and return connections and an overflow. The tank shall be installed away from any heat source underneath and shall have a suitable coaming with a drain connection.

Provision shall be made for actuating alarm on the engine room console for low level in the head tank.

A storage tank with a capacity of about 760 liters shall be installed in a suitable location and shall be fitted with fixed filling connection from the upper deck, vent, overflow, gage glass and valved piping connection to the circulating pump suction for transferring oil to the reservoir maintaining static head in the system.

All pipe and fittings shall be steel thoroughly pickled and cleaned by circulating oil through the system. The interior of the stern tube shall also be cleaned and thoroughly inspected to insure that no dirt or abrasive particles are present before final assembly and closing.

Connections shall be provided for filling the spaces between shaft and the stern tube readily with grease in an emergency.

53.8. BULKHEAD STUFFING BOX AND GLAND (if required)

Bulkhead stuffing boxes and glands shall be of cast steel with bronze bushings and shall be in halves to permit ready removal. Gland studs shall be bronze with bronze nuts. Grease lubrication shall be used and supplied through a split, composition lantern ring located centrally within the packing rings. Packing shall be secured from turning by grooving and bushing. The use of self-sealing bulkhead seals is also permitted.

53.9. MAIN THRUST BEARING

Included with main engine. See SECTION 51.

53.10. PROPELLER

(a) General

The propeller shall be right handed (for single screw ships) and shall be manufactured in accordance with the approved working plan. Unless otherwise specified in the contract, the Contractor will be responsible for developing the propeller design. The number of propeller blades shall be selected with Owner's approval so as to obtain the best possible combination of efficient propulsion and minimum vibration for both the main machinery and the ship's hull. The Contractor shall furnish an analysis of torsional, longitudinal and whirling vibration characteristics to verify the selection of the number of blades. The blade thickness and/or blade stress characteristics and number of blades shall be subject to approval of the Owner. All propellers and propeller shafts for multi-ship contracts shall be interchangeable.

(b) Model Test Requirements

The test shall be conducted and selected with the Owner's approval.

(c) Blade and Balancing Tolerances

Propeller blade tolerances shall be as follows:

Blade Width--.5R to tip	+ or - 13 mm or faired contour
*Blade Thickness--.2R to .5R	+ 4.75 mm -0
Blade Thickness--.6R to tip	+ 3 mm -0
Rake	+ or - 25.4 mm

Blade Spacing	+ or - 15 min.
**Pitch--average	+ or - 1% Var. from design pitch
Pitch--at any section	+ or - 1 1/2% Var. from design pitch
***Balance	1%
Propeller diameter	+ 0 - 13 mm

Note:

* Blade thickness tolerances are applicable to any point on the propeller blade.

** The average pitch over the whole propeller shall be within the specified tolerance. The average pitch over each blade shall be within specified tolerance.

*** The maximum residual unbalanced force developed at maximum rpm shall be within the specified tolerance which is expressed as a percentage of the weight of the propeller. To facilitate inspection, the unbalance shall be resolved in terms of a weight at the tip of one blade and noted on detail propeller plan.

ISO Standard R484, Class I, may also be used.

(d) Bore

The hub shall be taper bored with taper of 25.4 mm on diameter per 305 mm length and keyway cut to fit plug type template. Longitudinal tolerance on position of template when snug fit is plus 3 mm minus 0 mm. Tolerance on all other machined dimensions is 0.254 mm and on unmachined dimensions 6.4 mm. Unless otherwise specified each Contractor shall provide a set of plug type gages for the first ship of a contract to be constructed in the Contractor's yard.

Keyless propeller designs will also be acceptable for fixed pitch propellers.

(e) Water Sealing

The cavities at forward end, center, and aft end of hub shall be filled with an approved rust inhibitor compound. Filling and vent holes shall be drilled and pipe-tapped. Plugs shall be punched to prevent backing out.

(f) Guard

A heavy steel plate rope guard shall be provided between the stern frame boss and propeller hub.

A hydraulically secured device shall be provided for securing the propeller to the tailshaft. The propeller nut shall be complete with jacking tools and spare parts.

The following information shall be clearly stamped on the hub of solid propellers and on hub and individual blades of built-up propellers, in a location that will be visible when propeller is installed on ship:

Hull No.	Diameter
Plan No.	Pitch-0.7R
Contract No.	Weight
Manufacturer	ABS Approval
Material	Heat No.

53.11. FAIRWATER CAP

A cap with contour designed to suit the aperture space shall be bolted to the aft end of the hub to provide a watertight enclosure over the propeller nut. The cap shall be sealed to the hub face with an O-ring gasket. The groove for the O-ring gasket for fiber glass caps shall be cut in the propeller hub not in the cap.

The fairwater cap shall be filled at assembly with a rust inhibitor compound, and tested after assembly on hub with 103 kPa pressure.

53.12. SPECIAL TOOLS

Provide as recommended by cognizant vendors.

SECTION 55

DISTILLING PLANT - *SLOW SPEED DIESEL (ONLY)*

55.1. GENERAL

A distilling plant shall be provided to adequately meet all the fresh water needs of the vessel. The size of distilling units shall be as specified in the List of Machinery, SECTION 50. The following distilling plant is recommended for efficient utilization of engine waste heat. Other systems, such as reverse osmosis systems, may be utilized at Owner's discretion.

The distilling unit shall be a main engine jacket water circulated type, specifically designed for shipboard application and shall be capable of unattended, automatic operation after being put on the line locally. The unit shall be complete in all respects, with required heat exchangers, vapor separators, condenser, feed and ejector pumps, distillate pump, brine and vacuum ejectors, valves, instrumentation, and controls.

Means shall be provided to heat and circulate the jacket water when the main engine is shut down. Similarly, a suitably sized jacket water booster heat exchanger may be provided if the jacket water temperature will fall below the recommended level at sustained low engine loads.

The distilling unit shall meet all regulatory health organization requirements and meet the following performance requirements:

> Deliver its processed water at approx. 32°C or lower (35°C maximum) to the fresh water tanks via open funnel, fitted with splash cover.
>
> Rated clean tube or plate capacity for 24 hours continuous operation when supplied with sea water between -2°C and 29°C with 1/32 density shall be met after 90 days operation without shutdown for cleaning and without use of chemical feed treatment.

All components or unit surfaces in direct contact with the unprocessed, partially processed, and concentrated residual feed water shall be suitable for the intended service.

Fasteners (bolts, studs, nuts, and washers) in locations having contact with sea water shall be per manufacturer standards.

Contaminated water evaporators, where provided, shall be used in extreme emergency.

A standard salinity panel with alarms and meter shall be located at the distiller. This unit shall also provide a remote alarm for the salinity system at the Control Room.

All heat transfer sections with external connections shall have inlet and outlet thermometers.

Chemical cleaning connections shall be provided. Complete unit drainage and adequate venting shall be provided. Chemical dosage equipment shall be provided with the distilling plant for chemical cleaning.

The distillate pump shall have sufficient discharge head for supply of processed water to all required water tanks.

A water meter of the positive displacement type and an automatically operated three-way dump valve shall be incorporated in the processed water discharge line.

The dump valve shall be located downstream of its activating salinity cell and upstream of the water meter and shall incorporate facilities which automatically dump the processed water to the bilge when:

(a) Salinity at the point exceeds the specified 0.07 grains of salt per liter.

(b) Interruption of current to salinity indicator, solenoid or pump.

The dump valve shall be of the manual reset type.

Instrumentation shall be furnished to facilitate equipment, unit and plant control, including indication (local and remote) of operational status and salinity indication with visual and audible alarms.

The distilling plant deck area shall be surrounded by a coaming and possess a drain to bilge.

Distilling plant rupture disc (if required) outlet piping shall be routed to the coaming area.

SECTION 56

FUEL OIL SYSTEM - *SLOW SPEED DIESEL (ONLY)*

56.1. GENERAL

In accordance with the general requirements set forth herein, the ship shall be provided with a complete heavy fuel oil system and a diesel oil system covering bunkering, storage, transferring, treating, and discharge of the appropriate fuel.

The heavy fuel oil system shall be provided to supply heated fuel oil to the main propulsion units when the ship is operating at full power and to supply the oil fired auxiliary boiler, if desired.

The diesel oil system shall be provided to supply diesel oil for start-up of the main engines up to full power operation and shall also supply diesel-driven generators and oil fired boiler, if desired, under all operating conditions.

High level alarms shall be provided for the fuel oil settling tanks and the fuel oil standpipe.

All heavy fuel oil piping downstream of storage tanks shall be heat traced.

Sheet steel drip pans shall be provided for use under burners, heaters, pumps, strainers, and filling connections. The drip pans shall drain to the waste oil tank.

56.2. TANKS

Tanks shall be provided as required by the needs of the system and shall include the following:

(a) Heavy fuel storage tanks, heavy fuel oil settling tank, heavy fuel oil service tank, diesel oil storage tanks, and diesel oil service tanks shall be provided as shown on the Machinery Arrangement Plans. Each shall be provided with transfer connections, high-service connections, stripping connections, and level indicators. The heavy fuel settling tank, heavy fuel service tank, and diesel oil service tank shall have the capacity to supply its respective units for at least 30 hours at rated power. Diesel oil tank piping shall be fitted with check valves as necessary to prevent mixing with heavy fuel. Heavy fuel oil tanks shall be fitted with heating coils. All tanks shall be vented to deck with vent flame arresters provided.

Diesel oil tanks are not to have common surfaces with heated tanks.

(b) A mixing tank or other system suitable for the returning of excess fuel oil shall be provided as per the engine manufacturer's requirements.

(c) A sludge drain tank shall be provided to receive water and sludge from all sources, such as purifiers, service tanks, and other sludge producing sources.

(d) One diesel oil service tank of welded steel construction shall be provided for the emergency diesel generator. The capacity shall be as specified in the Machinery List and shall be sufficient for at least 12 hours operation of the emergency generator. The tank shall be located in or near the Emergency Generator Room. A level indicator shall be provided. If the tank is outside the Emergency Generator Room, a remote reading level indicator located in the Emergency Generator Room shall also be provided.

56.3. FUEL OIL FILLING CONTROL STATION

The monitoring of all the fuel oil tanks and the remote control of the fuel oil transfer pump during bunkering, transferring, and discharging of fuel oils shall occur from a central control station in the machinery space.

Remote control of all valves located outside of the machinery space (deck fill station valves shall be manual) is required with the exception of those valves located in the shaft alley adjacent to the Engine Room bulkhead.

The station shall be provided with:

(a) Bunkering Telephone System

(b) Local gage for detecting overflow level in the Standpipe.

(c) Control of F.O. Transfer Pumps

56.4. FUEL OIL FILLING

Port and starboard bunkering stations for both heavy and diesel oil shall be provided outside the Machinery Space. Each valved filling connection shall terminate with an approved quick release type safety flange coupling and a blank flange. Sampling connections shall be provided for the sampling of each fuel oil.

56.5. FUEL OIL TRANSFER

The fuel oil transfer piping, serviced via its designated pump, shall be capable of the following functions for both heavy fuel and diesel oil:

(a) The transfer of fuel oil from any tank used for storage to any other same fuel tank.

(b) The transfer of oil from the storage tanks to the settling tanks (where applicable) through the settling tank low suction with automatic shut down of the transfer pump upon settling tank high level alarm.

(c) The stripping of water from the settling tanks and service tanks through the low suctions.

(d) The discharge of fuel oil to the filling stations outside the Machinery Space.

One diesel oil transfer pump shall be provided to pump diesel oil to the generator diesel oil service tank and the emergency generator diesel oil service tank. The pump may be used as a manual standby for the heavy fuel oil transfer pump if elected by the Owner. Piping shall be arranged, and safeguards shall be provided, to prevent the inadvertent changeover/mixing of the two fuels.

Means to protect the fuel oil tanks from excessive pressure during filling and pumping operations shall be provided by use of a standpipe system or other approved method.

56.6. FUEL OIL PREPARATION SYSTEM

A complete heavy fuel oil conditioning system shall be provided. This system shall be served by two automatic self-cleaning type centrifuges with heaters, suitable for treating fuel oil with a specific gravity of 1.01. Heavy fuel oil shall be drawn from the fuel oil settlers via duplex strainer and discharged to the fuel oil service tanks via the purifier heater and purifier. Fuel oil sludge from the purifiers shall be pumped to the sludge tank.

One diesel oil purifier shall take suction from the diesel oil storage tanks via a duplex suction strainer and discharge to the diesel oil service tanks. Diesel oil sludge shall be pumped to the sludge tank.

The two centrifuges for heavy fuel oil shall be identical and shall be complete with attached suction and discharge pumps. If elected by the Owner, and with appropriate safeguards provided, one heavy fuel oil centrifuge may be used as a manual back-up for the diesel oil purifier.

A connection shall be provided to bypass the diesel oil purifier and lead diesel oil directly to the diesel oil service tanks.

Precautions shall be made so that heavy fuel oil and diesel oil cannot mix with each other by gravity flow.

The purifying systems shall be normally set to run continuously with an automatic timing device to trip the self-cleaning action at pre-determined intervals. A work bench with tool rack and vise shall be provided near the purifiers for cleaning and repairing. Sizing of the system, type of components, and general arrangement shall be as recommended by the engine manufacturer.

56.7. FUEL OIL SERVICE SYSTEM

The main engine fuel service system shall be provided as per the engine manufacturer's recommendations.

The main engine shall be supplied with heavy fuel oil or diesel oil by two fuel oil supply pumps and two fuel oil booster pumps, one each normally on standby.

Suctions from the heavy fuel oil service tank and diesel oil service tank shall join via a changeover valve designed to provide segregation between the two suctions. Thereafter, a common line shall lead the fuel through a full flow duplex filter, the M/E fuel supply pumps, the main fuel booster pumps, the main engine fuel oil heaters (either of two), a second full flow duplex filter and to the engine. The second full flow filter may be of the self-cleaning variety. A fuel oil meter shall be provided on the discharge side of the supply pumps. Between the heaters and the second filter an automatic viscosity control system shall be provided.

The excess fuel return system shall be provided as per the engine manufacturer's requirements. A means of maintaining fuel oil circulating pressures such as the use of an orifice and/or a back pressure valve shall be provided as required. If elected by the Owner, the return line may also be fitted with a meter and bypass.

The changeover valve electrically/pneumatically operated shall perform the following functions:

(a) Switch from heavy oil to diesel oil in event of heavy fuel oil system malfunction.

(b) The valve shall be controlled from the engineer's console to allow the engineer to change from one fuel system to another at all levels of operation.

(c) Local manual control shall be provided.

Separate supply lines from the diesel oil service tank to the auxiliary diesel engines and oil fired boiler (if applicable) shall be provided and fitted with strainer, service pumps (if applicable), valves, thermometers, pressure gages, and all necessary fittings.

56.8. FUEL OIL HEATERS

Two final or service fuel oil heaters, one operating and one standby, shall be provided with thermostatic controls capable of heating sufficient oil to provide maximum ABS horsepower and to maintain the proper viscosity and temperature of the heavy oil entering the fuel injection system. The capacity of the heater shall be as specified in SECTION 50.

Heaters shall be designed and located so that heating elements may be withdrawn without dismantling of piping or equipment. Valved connections shall be provided to permit chemical cleaning of heaters in place and without disconnecting fuel oil lines.

56.9. FUEL OIL AND DIESEL OIL STRAINERS AND FILTERS

All strainers or filters for fuel oil and diesel oil service shall be of all steel construction with flanged connections. Level of filtration shall be per the engine manufacturer's recommendations. Strainer baskets, when strainers are used, shall be of monel or stainless steel. The net clear area through all strainer baskets shall be at least six times the area of the inlet connections. The basket perforations shall be as detailed in SECTION 50 herein. Each strainer compartment shall be fitted with drain and vent valves.

Fuel oil filters shall be cartridge type as approved. Pipe inlet and outlet connections shall be flanged. A drain shall be provided on the filter sump. Self-cleaning filters may be utilized if recommended by the manufacturer. Piping shall be provided to route flushed material from self-cleaning filters to the sludge tank.

56.10. FUEL OIL METERS

Meters to indicate consumption shall be fitted in both the fuel oil and diesel oil systems.

The meters shall have steel or bronze body and cover, bronze gear train, direct reading horizontal dial with cover, slave dial indicators located on the operating console, feet for mounting, and flanged pipe connections. Accuracy shall be within 1 percent when passing 20 to 100 percent of its maximum capacity. A valved bypass shall be provided around each meter.

56.11. VISCOSITY CONTROL EQUIPMENT

A continuous viscosity measuring and automatic controlling device for fuel oil heating shall be provided. The unit shall be complete with all necessary appurtenances to regulate current to the final fuel oil heaters. Provisions shall be made for manual adjustment, high and low viscosity alarms, and indications of fuel oil viscosity at the central control console.

56.12. PUMP CONTROLS

The following pumps shall be equipped with means for shutting down from a position outside the machinery space, which will always be accessible in the event of fire in the machinery space:

Fuel Oil Transfer
Diesel Oil Transfer
F.O. and D.O. Purifiers
F.O. Supply Pumps
F.O. Booster Pumps
Sludge Transfer Pump
Main Engine Lube Oil Pumps
Main Engine Camshaft Lube Oil Pumps

56.13. DIESEL OIL SYSTEM FOR EMERGENCY GENERATOR

The diesel oil supply to the emergency generator engine shall be fed by gravity from a dedicated diesel oil tank in the Emergency Generator Room. The supply line shall be fitted with a valve at the tank.

Diesel oil return from the engine shall be taken to the top of the tank.

Diesel oil supply and return lines shall be fitted with flexible connections at the engine.

56.14. SLUDGE DRAIN AND STRIPPING SYSTEM

A valved stripping connection shall be provided in each fuel oil and diesel oil tank to allow gravity discharge of tank residues to a sludge drain tank in the Engine Room double bottom. The sludge drain tank shall be emptied by the sludge transfer pump for discharge ashore or to the incinerator if applicable.

56.15. SPECIAL TOOLS

The following special tools shall be provided:

Fuel Oil Heaters

Tube expander, if required (1)
Union and resurfacing tool, if required (1)

SECTION 57

LUBRICATING OIL SYSTEMS - *SLOW SPEED DIESEL (ONLY)*

57.1. GENERAL

Different oil quality lubricating oil systems shall have no connection with each other except as specified for purification of oil.

Under normal conditions lube oil shall be supplied to the main engine under pressure by one of the lubricating oil service pumps. A second pump shall act as a stand-by and shall automatically restart in the event of a drop in pressure below that required in the system.

All pipes connected to engines shall be of the flexible type. All motor-driven pumps serving lube oil systems shall be sized as recommended by the engine manufacturer and fitted with relief valves to suit system pressure. Drip pans, as necessary, shall be fitted.

Prior to filling with the initial operating charge, the complete main engine lubrication oil system, including all tanks, shall be thoroughly cleaned in accordance with the applicable portions of ASME 113, "ASTM-ASME Recommended Practices for the Flushing and Cleaning of Marine Propulsion Turbine Lubricating Systems" and in accordance with vendor's recommendations.

In addition to these requirements, the piping shall be vibrated with a portable machine, or other means upon approval, during the early stages of flushing.

The auxiliary oil systems shall be designed in accordance with applicable portions of ASME 115, "Recommended Practices for the Design, Operation and Maintenance of Marine Auxiliary Machinery Lubricating Systems" and the requirements herein, and the flushing and cleaning of such systems shall be in accordance with ASME 119, "Recommended Practices for the Flushing and Cleaning of Marine Auxiliary Machinery Lubricating Systems."

57.2. MAIN ENGINE LUBRICATING SYSTEMS

The lubrication system for the main engine shall be designed in accordance with the applicable portions of ASME 111, "Recommended Practices for the Design of Marine Propulsion Turbine Lubricating Systems", and to the engine manufacturer's requirements.

The main engine shall be fitted with lubricating oil and cylinder oil systems complete with all necessary pumps, coolers, filters, tanks, valves, piping, fittings, and instrumentation <u>as recommended by the engine manufacturer</u>.

The oil supply shall consist of at least two independent lubricating systems because of a minimum of two different oil qualities required. Each system shall serve independently its respective engine components.

(a) Combined low pressure and high pressure oil system or a single system, depending on the design of the main engine to service the following:

(1) main bearings, thrust bearing, camshaft drive wheels, camshaft (MAN-B&W would require two camshaft lube oil pumps plus a separate camshaft lube oil system) and fuel pump

(2) crosshead (Sulzer would require two crosshead lube oil pumps) and bottom end connecting rod bearings

(3) control system

The lubricating system shall be provided with two simplex suction strainers, two lube oil service pumps, one full flow lube oil duplex discharge filter, oil cooler, automatic temperature control valves, and two lubricating oil pumps, or as required by the engine manufacturer.

(b) The cylinder lubricating oil system.

The cylinder lubricating oil system shall be provided with the storage tank, a simplex suction fine mesh filter, electric transfer pump and the daily service tank, or as required by the engine manufacturer.

57.3. TANKS

(a) Tanks shall be provided of the type, capacity and general location as recommended by the equipment manufacturers. They shall include storage tanks, settling tanks, service tanks, head tanks, sump tanks, sludge tanks, and drain tanks as required. A tank shall be provided for the collection of used oils (may be a settling tank).

(b) All tanks in the system shall be provided with approved oil level indicators, sounding tubes, ventilation, manholes, cleanout holes, internal ladders as required and all necessary connections and fittings. Wherever possible, the bottom of the tanks shall be sloped to facilitate drainage. Where flat type tank level indicators are employed, the tank level indicator connection to the bottom of the tank shall be arranged to allow for deflection. Sump, settling, and used oil tanks shall be provided with heating coils.

57.4. LUBRICATING OIL COOLERS

(a) Main Engine Lubricating Oil Coolers

One or more main lube oil cooler of the horizontal or vertical type shall be provided for each engine serving its respective lubricating oil system. Cooling medium shall be fresh water.

Waterboxes of all coolers shall be designed so that it will not be necessary to dismantle any piping for access to the tubes. Material, approximate sizes and capacity of coolers shall be as specified in the Machinery List and recommended by the manufacturer. Internal fittings shall be arranged so that a minimum of interface with the water flow and a minimum turbulence will result.

The inside of the shells shall have all mill scale removed and shall be coated with rust preventative before assembly. The shells shall be equipped with a removable plate so that the internal condition may be inspected without removing the tube bundle. Each cooler shell shall have two 25 mm ips drain connections. Vent connections shall be a minimum of 20 mm ips.

Plate type heat exchangers are also acceptable.

(b) Auxiliary Equipment Lubricating Oil Coolers

In general, the auxiliary lubricating oil coolers shall be constructed as described above.

57.5. LUBRICATING OIL PURIFIERS AND HEATERS AND FILTERS

At least one motor-driven self-cleaning automatic centrifugal purifier shall be provided, complete with suction and discharge pump. The purifier shall serve the main engine sump and be arranged for continuous purification of the oil in the respective sump. Alternate purification systems, may be used as recommended by the equipment manufacturers.

The suction and discharge pumps shall be rotary units capable of handling oil at the rated capacity of the purifier and constructed in general accordance with SECTION 73. Each pump shall be fitted with a relief valve. The unit shall be fitted with all piping necessary for purification, and shall be arranged so that the pumps may be used in parallel bypassing the purifier bowl, for transfer service. The purifier bowl assemblies shall be stainless steel throughout, AISI, 302 or 304, or monel. Other component materials shall be suitable for the service intended, as per manufacturer's standards.

The purifier shall be capable of continuous operation at the specified capacity. With a water content of the incoming oil of 4 percent by volume, and solids content of 0.135 percent by volume, the purified oil shall not show more than 0.10 percent water by volume, and 0.02 percent solids by volume. Water separated from the oil shall not contain more than 0.50 percent oil by volume.

The purifier suction pump shall be arranged to draw a sample of oil from the sump tanks for testing. The purifier pump shall also be arranged to draw water or sludge from the bottom of the sump tank and discharge same to the sludge tank via funnel drain.

The purifier shall be equipped with a brake. The purifier shall be of the gastight type with flanged pipe connections and shall be arranged to permit quick access for cleaning. Means shall be provided for priming the bowls with fresh water. A sampling connection shall be provided on the discharge side of the purifier via system piping. The size of the sampling connections shall not be less than 15 mm.

The purifier waste water discharge shall be fitted with float actuated electric contact maker device that will shut down the purifier upon excess water discharge. A switch shall also be fitted to cut out the float actuated shutdown. A vibration switch shall be fitted to de-energize the purifiers upon excess vibration. Alternate methods for different types of purification systems will be permitted upon Owner's approval.

A workbench complete with bowl vise, tool rack, drip pan and drawers with thumb latches and drawer stops shall be provided near the lubricating oil purifiers for cleaning and servicing the purifier. Workbench top and drip pan shall be galvanized steel.

The lube oil purifier heater shall be of shell and tube type that will permit the tube bundle to be removed for cleaning. Plate type heat exchangers are also acceptable. Electric heater types are acceptable if desired by the Owner. Each heater shall be of capacity equal to that of the purifier.

57.6. STRAINERS

All lubricating oil strainers shall be fitted with differential pressure gages. The bodies and covers shall be of cast iron or steel. The baskets shall be one piece of suitably perforated monel and shall be lined with monel or stainless steel wire cloth where required for adequate particle separation. The total clear area through the perforations mesh when used shall be at least six times the area of the discharge piping. An effective arrangement of permanent magnets shall be provided in each basket for arresting ferrous particles.

The strainers shall have flanged connections and shall be suitable for the working pressure. Each strainer compartment shall have a flanged valved drain connection piped to the Lube Oil Sludge Tank. Each strainer compartment shall be provided with a 15 mm ips valve vent. The strainers shall be located so that baskets can be changed from the floor plates. Drip pans shall be provided beneath each strainer.

57.7. PIPING

(a) General

The layout of each lubricating oil system shall be designed to keep all oil piping as remote as possible from hot surfaces and electrical equipment to minimize fire hazards and in no case shall an oil pipe be located closer than 460 mm to a surface which exceeds 343°C. Joints installed close to a surface which exceeds 343°C where failure might result in a fire shall be 140 kg standard male and female flanges with metallic gaskets. Screwed type fittings shall not be permitted except in gage lines beyond the gage line root valve or cock.

Thermometers and gages shall be conveniently located for reading and replacement. Piping shall be cleaned by pickling or other approved methods.

The design and installation shall ensure that all parts of each system will be readily accessible for thorough cleaning in accordance with the specified procedure.

(b) Filling and Transfer

Separate connections shall be provided on deck, both port and starboard, for filling each lube oil system directly to the storage and settling tanks (if applicable) by gravity. The filling connection shall be arranged for locking, and shall be threaded to receive a plug, a screwed hose valve, or a screwed funnel. Fill lines may be of brass.

The transfer system shall allow the transfer of lube oil from the storage tanks to all applicable settling, service, head, and sump tanks. The system shall also allow the pumping of all sumps, drain tanks and used oil tank to the deck discharge connection, incinerator (if applicable) and the used oil tank. A 30 m length of hose shall be furnished at the deck connection for discharging oil into barrels.

The sludge transfer pump shall pump the sludge tank to the deck discharge connections and the incinerator (if applicable).

(c) Overflows and Vents

The used oil, settling, storage and head tanks shall be fitted with vents at least 65 mm in diameter each terminating in a screened gooseneck bellmouth fitting of sufficient height to insure that oil will not spill out under the most severe condition of roll of the ship and shall be at least 915 mm above the top of the tanks.

Sump tank vents shall be provided. Drains shall be provided to drain the precipitated oil and water to the sludge tank. The arrangement shall be such as to prevent the return of any of these drains to the lubricating oil tanks.

For other requirements, see SECTION 11 (Piping-Hull Systems).

(d) Service Piping

The system shall have sufficient capacity to supply the required amount of oil at the proper temperature to correctly lubricate the main engines, auxiliaries and diesel generators at all operating conditions.

Piping shall be arranged to permit overhaul of any duplicate unit without interfering with the operation of the other unit.

(e) Purifier Piping

Piping shall be arranged so that both continuous or batch purification may be performed for the main engine. The purifier piping shall allow both suction and discharge to all other tanks determined by the Owner.

When continuous purification is used, the oil shall be drawn from the main engine sump tank, run through its purifier and returned to the same sump. Suction and discharge tailpipes in the sump tank shall be adequately separated to prevent short-circuiting of purified oil.

When emergency batch purifying, the oil shall be drawn from sump tanks and discharged into a settling tank or used oil tank. After the oil has been heated and settled, the oil shall be discharged to the sumps by gravity flow. The water and sludge removed from the lubricating oil shall be discharged to the sludge tank.

The sump tank fill lines shall terminate below the working level to prevent the formation of foam.

57.8. DIESEL GENERATOR LUBE OIL SYSTEM

Each diesel generator set shall have a completely independent and self-contained lube oil system, including an engine driven circulating pump, a motor driven priming pump, jacket water cooled cooler, full flow filter and strainer. Oil temperature shall be controlled automatically.

57.9. TURBOCHARGER LUBE OIL SYSTEM

The main engine turbochargers shall be equipped with a lube oil system as per the manufacturer's recommendations. It may be integral with the main engine lube oil system or separate as required. 5

SECTION 58

SEA WATER SYSTEMS

58.1. GENERAL

The ship shall be provided with sea water systems for the following services:

- Jacket water heat exchanger, main and aux. engines (if S.W. cooled)
- Central fresh water cooling system heat exchangers (if applicable)
- Sea water service
- Fire main/tank cleaning system
- Clean ballast
- Bilge
- Distilling plant (or reverse osmosis)
- All condensers
- Boiler water test sample cooler
- Other services as required

These systems shall be complete with all necessary pumps, tanks, coolers, strainers, gages, thermometers, piping, valves, fittings, controls and other appurtenances necessary to meet the needs of a ship in compliance with the requirements of the regulatory bodies, the general requirements contained herein and applicable SECTIONS of these Specifications.

Expansion joints, where required in sea water piping systems, shall be of an approved reinforced flanged rubber design.

Provision shall be made to prevent progressive flooding between watertight compartments below the bulkhead deck via any open-ended pipe in the event the pipe is severed or otherwise damaged by collision or grounding.

Two sea chests (one each port and starboard) shall be provided for supplying water to all sea water service pumps.

See SECTION 70 for additional requirements.

58.2. MAIN SEA WATER COOLING SYSTEM

Each of two main sea water pumps shall take suction from a sea chest and discharge through a sea water main to the plant's main heat exchangers and discharge overboard.

If the main engine heat exchangers are salt water cooled, a 3-way temperature control valve shall be provided to maintain the minimum acceptable sea water inlet temperature to the engine cooling system as required by the engine manufacturer.

The main sea water service pumps may be cross-connected to serve the auxiliary sea water system.

An alternate system of a fresh water cooling system being serviced by a salt water heat exchanger may be installed if elected by the Owner.

58.3. AUXILIARY SEA WATER SERVICE SYSTEM

Sea water for miscellaneous services in the machinery spaces shall be supplied by one or more auxiliary sea water service pump(s).

58.4. FIRE MAIN SYSTEM

A complete fire main system shall be provided in accordance with requirements of the regulatory bodies. Each pump shall discharge through a separate riser to the fire main.

Fire main and risers shall be arranged and located so that damage due to collision shall not render the fire main system or portions thereof inoperative. All such piping shall be run in a protected location inboard of a line drawn one-fifth of the beam of the vessel where possible. Fire mains shall be provided with the necessary cut-out valves to maintain fire main service to any part of the vessel in the event of collision or damage to one of the fire mains and to facilitate maintenance. An expansion loop with a low point drain shall be located in each watertight compartment. Exterior fire stations shall have interior cut-out and drain valves.

Siamese hose inlet shore connections shall be fitted with 65 mm hose connections with ANSI fire hose coupling female threads. Contractor shall provide International Shore Connection (ship) as per SOLAS (1974) requirements.

Two 38 mm hose connections shall be provided on the Forecastle Deck forward for anchor washing. In addition, fixed nozzles supplied from the fire main shall be provided in the hawsepipes for washing down anchor chains. The nozzles shall be arranged so as not to interfere with the chains.

58.5. SEGREGATED BALLAST SYSTEM

A segregated ballast system shall be provided to ballast and deballast the designated segregated ballast tanks. Means shall be provided for both direct sea flooding and pump discharge to the ballast tanks. The system shall be served by the bilge and ballast pumps. A ballast control station shall be provided.

An approved level indicating system shall be provided for all ballast tanks.

All ballast piping led through any tank shall be extra strong pipe.

58.6. BILGE SYSTEM

A bilge system meeting Regulatory Body requirements shall be provided and served by conveniently located manifolds. Tail pipes shall lead from the manifolds to the points where suctions are required in the holds, in the machinery spaces, and the shaft alley including sludge tanks and cofferdams.

Where bilge suction tailpipes are located within one-fifth of the beam of the side of the vessel, or in a duct keel, a non-return valve shall be fitted to the end of the compartment which it serves. Manifolds and valves in the bilge pumping system shall be so arranged that in the event of flooding one of the bilge pumps can take suction from any compartment; and in addition, damage to a pump or its pipe connecting to the bilge main outboard of a line drawn at one-fifth of the vessel's beam shall not render the bilge system inoperative.

In addition to the bilge suctions, two of the machinery space drain wells, preferably at the aft end of the Engine Room, port and starboard, and one drain well in the shaft alley, if a shaft alley is provided, shall be fitted with level sensing switch operated, motor driven, vertical sump pump. The pump discharge line shall be fitted with a check valve and a stop valve at the pump and shall be led to the oily bilge collecting tank.

58.7. PRIMING SYSTEM

A priming system shall be provided for any sea water pumps that require priming.

The vacuum pumps shall be fitted with adjustable vacuum switches located on the vacuum tank that shall be set to automatically start one pump at 51 kPa absolute and the second at 61 kPa absolute, and to stop the pumps at 34 kPa absolute.

The priming suction from all the connected pumps shall be led through priming valves to the priming pump vacuum tank connection.

58.8. STRAINERS

All of the pumps mentioned in this SECTION shall be provided with suction strainers which shall be of the duplex basket type in continuously operating systems. The strainers shall be flanged and of galvanized steel body and cover. The basket shall be of monel. The perforations shall be 10 mm diameter. The free net area through the strainer shall be at least four times the area of the connected pipe.

Any equipment being served by a sea water system having passages of a smaller diameter than the mesh sizes of its associated sea chest strainer or pump suction strainer, shall be suitably protected by the individual simplex type strainers. However, where parallel units of equipment are served, duplex strainers shall be provided in a common line. One spare basket shall be furnished for each strainer.

Additional suction strainer box requirements can be found in ASTM F986, "Specification for Suction Strainer Boxes".

SECTION 59

FRESH WATER SYSTEM

59.1. GENERAL

Complete fresh water systems shall be provided for engine cooling, boiler feed system, domestic, and sanitary services consisting of tanks, pumps, heaters, coolers, gages, piping, valves, fittings, and other appurtenances necessary to meet the need of the ship in compliance with requirements of the Regulatory Body(ies) and applicable SECTIONS of the Specifications.

A sufficient number of branch connections and cutout valves shall be incorporated to facilitate full maintenance of equipment and sections of systems without interrupting service to remaining system or systems. Connections exposed to weather shall be fitted with cutout valves and valved drains.

59.2. STORAGE TANKS

Fresh water for all purposes shall be carried and/or stored in tanks designated for such on Contract Plans. These tanks shall be fabricated of steel with external stiffeners and their interiors coated with zinc dust or an acceptable substitute.

Each tank shall incorporate facilities for local and/or remote water level indicators. Remote indicators shall be located for ready observance from the central operating control station.

Potable processed water piping shall be arranged to supply any of the potable water tanks. The water shall first be disinfected by a chlorine, bromine or ultraviolet system as required by the regulatory health organization.

Piping from the distilling plant (or reverse osmosis plant) shall be arranged so that distilled water may be delivered to any fresh water storage tank by way of the Engine Room filling manifold.

A fresh water transfer pump shall be provided to transfer feed water to services as required.

Additional storage tank requirements can be found in ISO 5620, "Filling Connection for Drinking Water Tanks on Ships".

59.3. COLD FRESH WATER SYSTEM

Cold fresh water shall be supplied for all potable, domestic, and sanitary purposes, including any system or unit of equipment requiring usage of fresh water for make-up, cooling, cleaning (washdown) or priming. The cold water supply to showers and lavatories shall not exceed 35°C.

Make-up for fresh water cooling systems should preferably come from the distilled water system rather than from chlorinated fresh water.

The system shall be serviced by two parallel fresh water service pumps (motor-driven, centrifugal) with each pump pressure actuated and arranged so that both pumps can operate simultaneously or be set so that one pump starts at a 34-69 kPa higher pressure setting than the other.

The hydropneumatic tank, incorporated in the common supply main, shall be cylindrical with dished heads of steel construction, galvanized or equivalently coated, and shall comply with Regulatory Body requirements.

59.4 HOT FRESH WATER SYSTEM

Hot fresh water shall be supplied to all domestic fixtures, systems or units of equipment requiring usage thereof.

Fresh water, via a branch connection from the cold fresh water supply main, shall supply the storage type fresh water heater through a stop-check valve. The discharge or riser from the heater shall be run directly to the highest deck level requiring service and return as the return main to the heater via a hot water circulating pump. Services to the various domestic fixtures, systems or units of equipment shall be supplied through branches off loop circuits at various levels. Each circuit shall loop from the riser to the return main and shall be fitted with a manual control valve for balancing the system. Branches from the loop circuits shall be as short as possible to minimize wastage of water due to dead-end connections.

The hot water circulating pump, taking suction from the return main and discharging to the heater via a stop-check valve, shall have a bypass, incorporating a cutout valve and a non-return type valve, to permit water circulation by the thermosiphon principle.

(a) Storage Type Water Heater

The storage type hot water heater shall be of the submerged tube coil type meeting Regulatory Body requirements. The heater shall be fitted with a secondary electric heating element with thermostatic control.

The water temperature leaving the heater shall be 66°C, thermostatically controlled by a regulating valve in the steam supply line. The outlet from the heating coils shall be fitted with a mechanical trap.

Steel, resin coated, shall be used for the tank shell and head with bronze for the tube sheets and inlet head. Heating coils shall be of aluminum-bronze.

(b) Sink Heaters

Sinks used for sterilizing cooking utensils and dishes shall be provided in accordance with the regulatory health organization requirements.

(c) Instantaneous Heater

In lieu of the storage type heater, a fast recovery type water heater may be provided. The flow controlled fast recovery type water heater shall be an integrally piped heater-control package capable of supplying hot water instantaneously at the set temperature within 2°C over full capacity range without the use of a thermostatic control device. Package shall consist of cast steel shell, copper coil heat exchanger, flow operated blending valve, and strainer.

59.5 FRESH WATER COOLING SYSTEM

In lieu of the main sea water cooling, a central fresh water cooling system shall be provided consisting of two 100 percent capacity fresh water pumps, and the necessary heat exchangers, tanks, temperature control valves, fittings, make-up feed connections, chemical feed connections, air separators, drain connections, and instrumentation. The system shall be designed to maintain appropriate temperatures, pressures, and flow rates at all equipment served.

SECTION 60

FEED AND CONDENSATE SYSTEMS - *SLOW SPEED DIESEL (ONLY)* (IF FITTED)

60.1. GENERAL

A feed and condensate system shall be provided.

The system as described herein is based on one vertical exhaust gas boiler and one oil fired boiler packaged unit. Consideration will be given to other system configurations.

60.2. STEAM DRAIN COLLECTING SYSTEM

A steam drain collecting system shall be provided to collect drains from steam heating coils and machinery and return them to the steam drain collecting tank. This includes drains from lube oil and fuel oil tank heating systems and other contaminated services.

A steam drain cooler condenser shall be provided to condense all drains prior to entering the inspection tank. Excess boiler steam shall also be dumped to this condenser.

Boiler gage glasses, escape piping, soot blowing piping and other similar intermittent services which would be impractical to lead to the drain collecting system may be led directly to the bilge. Drains shall not impinge directly on piping, tank top, or equipment or discharge in way of equipment.

60.3. FEED SYSTEM

There shall be two motor driven feed pumps, one working and one standby, each with sufficient capacity to handle the boiler loads under all conditions of operation. The pumps shall take suction from the inspection tank. A feed water valve and control system shall be provided to maintain the correct boiler water level. Make-up feed shall be provided to the tank from the distilled water tank.

Two motor driven circulating pumps, one working and one standby, dedicated to the exhaust gas boiler shall be provided. These pumps shall take suction from, and return to, the oil fired boiler steam drum via the exhaust gas boiler. Water level shall be controlled in the exhaust gas boiler via a control valve and steam pressure sensor.

A simplex type strainer shall be provided in the suction of each main feed pump.

60.4. BOILER COMPOUND FEED SYSTEM

A boiler compound feed system shall be provided and shall be as specified herein. The system shall consist of a chemical compound feed tank and all necessary piping, valves and fittings and shall be designed and arranged to discharge chemical compounds from the compound feed tank to each of the boilers using feed pump discharge pressure. The feed water line to the compound tank shall be connected to the feed discharge lines so that feed water will be available at all times. The chemical compound shall be discharged directly into the boiler steam drums via a stop valve and a check valve.

The compound feed tank shall be of welded steel construction and shall have a capacity of approximately three gallons. The tank shall be designed for full boiler pressure and shall have all necessary connections including vent, drain to bilge and a funnel for filling. The tank shall not be insulated but shall be suitably screened to protect personnel.

60.5. TANKS

(a) Steam Drain Inspection Tank

One welded steel steam drain collecting tank suitably stiffened and galvanized after fabrication shall be provided and shall have appropriate fittings and instrumentation.

(b) Reserve Feed Water Tanks

A reserve feed water tank shall be provided and fitted with all necessary connections including a filling connection from the desalination plant and from shore.

60.6. SALINITY INDICATOR SYSTEM

Salinity indicators of the distant reading electrical type shall be provided to indicate the salinity of the feed system with cells provided at the following locations with an indicator and alarm panel located at the central control console:

Drain inspection tank outlet line
Make-up feed line from reserve feed tank

SECTION 61

STEAM GENERATING PLANT - *SLOW SPEED DIESEL (ONLY)* (IF FITTED)

61.1. GENERAL

One oil fired, (auxiliary), fully automatic boiler shall be provided as shown on the Machinery Arrangement Contract Plans. This boiler shall be capable of burning heavy fuel oil 700 Cst @ 50°C, or diesel oil.

One vertical tube exhaust gas (waste heat) boiler shall be provided as shown on the Machinery Arrangement Contract Plans.

Each boiler shall be designed for continuous operation and shall be complete, factory assembled (where practical), units of the manufacturer's standard design in current production. The design of the units shall have been proven satisfactory for the service intended.

This equipment shall be supplied complete with fuel pump, forced draft fan, boiler feed pumps, and waste heat boiler circulating pumps; all instrumentation, controls, and alarms; all mountings and integral piping with fittings; motors, motor controllers, and integral wiring with fittings; insulation bed plates and mounting brackets, special tools, and equipment as required.

(Consideration will be given to other boiler types and system configurations to provide the required steam, such as electric resistance heating.)

The normal mode of operation shall be as follows:

> The boiler feed pumps shall maintain a normal water level in the oil fired boiler, at the maximum operating condition.
>
> The boiler circulating pumps shall take suction from the oil fired boiler and circulate the water through the exhaust gas boiler where it will be heated by the engine exhaust gases. The resulting steam and water mixture will return to the oil fired boiler.
>
> All steam for the ship's services shall be drawn from the oil fired boiler so that it shall act as a steam drum of the waste heat boiler.
>
> On an increase in steam demand and/or a decrease in production from the waste heat boiler, resulting in reduced pressure to the system, the oil fired boiler shall fire automatically to maintain the steam pressure without interruption of services.
>
> At times when the waste heat boiler is not producing sufficient steam or is not in service, the oil fired boiler shall function

automatically to supply the ship's requirements.

Other modes of operation shall be considered.

61.2. OIL FIRED AUXILIARY (<u>PACKAGE</u>) BOILER

The oil fired fully automatic, self-contained boiler of the <u>packaged</u> type, shall be complete with:

- Safety Valves
- Burners and Boiler Front Assembly
- Solid State Burner Management System
- Pneumatic Single Element Combustion Control
- Pneumatic Feed Water Control
- Boiler Control Console
- Duplex Fuel Oil Pump Heating Set
- Light Oil Pumping and Straining Unit
- Forced Draft Fan and Motor
- Soot Blower(s)
- Water Level Gages
- Miscellaneous Boiler Trim valves
- Visual Photo-electric Smoke Indicator

The boiler shall be provided as shown by the Machinery Arrangement Contract Plans.

The boiler fuel oil service pump(s) shall take suction from the heavy fuel oil day tanks or diesel fuel tanks and discharge to the boiler.

The oil fired boiler shall automatically start and assume load when the waste heat boiler drops below certain levels as indicated in SECTION 50. This shall include automatic start up of forced draft blowers, fuel oil pumps, feed water pumps, and timed purge cycles. This start-up sequence shall be triggered by a single switch activated by the steam pressure in the waste heat boiler.

61.3. EXHAUST GAS (WASTE HEAT) BOILER

The exhaust gas boiler shall form a section of the main engine uptake; it shall be a vertical tube boiler with the exhaust gases inside the tubes (NOTE: Watertube exhaust gas boilers are also acceptable.) partially submerged in the water contained in the boiler shell. The water level shall be maintained by a level control valve which senses the steam pressure in the shell and regulates the flow of feed water. Provision shall be made for low steam demand operation at all engine powers. The boiler shall be capable of operating as a silencer in the dry state.

61.4. FEED PUMPS

Two boiler feed pumps shall be provided, each having the capacity to maintain the normal water level on the boiler at the maximum operating condition shown on the Machinery List. The pump shall be designed to take suction from the fresh water drain tank.

61.5. EXHAUST GAS BOILER CIRCULATING SYSTEM AND PUMPS

The oil fired boiler shall serve as a steam drum for the waste heat boiler. Circulating pumps for the waste heat boiler shall be provided in duplicate, driven independently of other accessories. Waste heat boiler supply and circulating connections with suction nozzle and return distribution pipe, shall be provided by the manufacturer of the oil fired boiler. The system shall be designed to enable the two boilers to operate together, sharing the load, with neither impeding the operation of the other.

One circulating pump shall run continuously when the waste heat boiler is in service.

61.6. INSTRUMENTATION AND CONTROL SYSTEMS

Pressure gages shall be provided at each pump discharge ahead of the discharge stop valve, at the waste heat boiler outlet header and on the oil fired boiler shell (or drum). A differential pressure gage shall be provided across the fuel oil strainer. Shut-off cocks shall be provided for each gage.

Two tubular gage glasses with shut-off cocks, drain valves, and protective cage shall be provided for the oil fired boiler.

The combustion control system and the feedwater regulator shall function as described above to maintain steam pressure and water level within operating limits.

Safety features shall be provided in accordance with regulatory body requirements for unattended Engine Room operation and shall be designed to provide the following responses:

Condition	Action
Low Water Level	Shut down and alarm
Low Steam Pressure	Alarm
Flame Failure	Shut down and alarm
Low Fuel Pressure	Shut down and alarm
Low Forced Draft Air Pressure	Shut down and alarm
Low Circulating Pump Pressure	Start standby pump and alarm
Low Feed Pump Discharge Pressure . .	Start standby pump and alarm
High Water Level	Alarm

Combustion associated alarms shall be integrated with the combustion control system to restrict their functioning to periods when the combustion system is called into operation.

Visual alarms shall operate independently but shall trigger a common audible alarm. The common audible alarm shall be provided with connections for remote repetition.

A push button shall be provided to trigger the shut-down system manually. Additional connections for remote push buttons shall be provided.

Alarm and control system components shall be assembled from standard equipment as far as possible and shall comply with the requirements for marine service.

61.7. BOILER BLOWDOWN

The bottom blowdown from the water drum of the boiler and the surface blow from the steam drum of the water tube boiler shall be led overboard through an independent discharge sea chest. The bottom blow shall be fitted with stop valves equipped with hose valves for draining the boiler.

61.8. BOILER WATER TESTING OUTFIT

A boiler water test station, complete with boiler water test outfit in a metal cabinet, stainless steel sink, chemicals, glassware, sample coolers, gages, thermometers, and other necessary components, shall be provided. The sink shall be conveniently located adjacent to the testing station work bench and shall be provided with fresh water from the ship's fresh water system and a drain to the bilge. A water test kit, suitable for testing for oxygen, alkalinity, phosphate, chlorides, hardness in the feedwater, shall be provided.

The feedwater sample cooler with capacities as specified in the Machinery List shall be provided, consisting of a primary cooler and a secondary cooler connected in series. The primary cooler shall be supplied with cooling water from the sea water service system and the secondary cooler shall be provided with cooling water from the machinery space drinking water cooler.

61.9. SPECIAL TOOLS

Special tools shall be provided as recommended by the boiler and component vendors.

SECTION 62

AIR INTAKE, EXHAUST UPTAKE, AND FORCED DRAFT SYSTEMS - *SLOW SPEED DIESEL (ONLY)*

62.1. GENERAL

The ship shall be provided with efficient air supply and exhaust systems for the main diesel engine, ship's service diesel generators, emergency generator, and steam generating equipment. Systems design shall be in accordance with applicable portions of ISO 8861, "Shipbuilding - Engine-Room Ventilation in Diesel-Engined Ships - Design Requirements and Basis of Calculations", and all Annexes.

Exhaust spark arresters and silencers, expansion joints, air intake filters or Air Intake Filter Room and flexible connectors shall be provided as required.

Insulation and lagging shall be in accordance with SECTION 75. Air supply for the Generator Room (if provided) for ventilation and combustion shall be trunked from the Engine Room ventilation system.

For combustion and cooling of the emergency diesel generator, air shall be drawn through louvered openings in the Emergency Generator Room. The blower fan mounted on the engine shall discharge through the radiator then to the outside through a discharge trunk.

Combustion air for the main engine shall be filtered separately in a smaller filter house and led to the engine via ducts and silencers; or alternately, all Engine Room air shall be filtered eliminating separate ducting.

The air duct (if provided) shall be adequately stiffened and supported so that negligible stress shall be taken by the turbo-chargers.

See SECTION 64 for interface considerations with the Engine Room ventilation.

62.2. MAIN ENGINE EXHAUST SYSTEM

The exhaust gases from the engine's turbo-chargers shall be led through a waste heater boiler, and silencer spark arrestor to the atmosphere. See SECTION 70 concerning stack emission. The exhaust ducts shall be routed so as to allow adequate clearance for dismantling the main engine. Each turbo-charger exhaust outlet shall be provided with an expansion joint, depending on the type of supercharger.

Other expansion bellows shall be provided as necessary in the system and the entire system shall be adequately supported and insulated.

Provision shall be made for drainage of the system.

62.3. SHIP'S SERVICE AND EMERGENCY DIESEL GENERATOR EXHAUSTS

The exhaust gases from each diesel generator shall be led through a silencer and spark arrester to the stack, if practical, or to the weather.

Necessary expansion bellows shall be provided in the system and the entire system shall be adequately supported and insulated.

Provision shall be made for drainage of the system.

62.4. OIL FIRED BOILER UPTAKE

The oil fired boiler uptake shall be led as directly as possible to the stack.

Necessary expansion bellows shall be provided in the system and the entire system shall be adequately supported and insulated.

The uptakes shall be constructed of welded steel, adequately stiffened.

Provision shall be made for drainage of the system.

A smoke indicator shall be provided in the Engine Control Room.

62.5 S.S.D.G. EXHAUST

The exhaust shall exit through spark arresting silencers to the stack.

62.6. FORCED DRAFT BLOWER

Forced draft blower(s) shall be provided in accordance with the Machinery List.

The motor and blower shall be arranged on a common baseplate and suitable welded steel seat shall be provided.

The blower shall draw air from inside the machinery space. The suction opening of the blower shall be protected by 12 mm mesh wire screen.

Sufficient work space shall be provided for maintenance of the blower and for dismantling or removal of various blower parts.

(a) Forced Draft Air Ducts

A transition piece shall be fitted at the blower outlet and shall be constructed of steel plate suitably stiffened to prevent vibration.

An airtight expansion bellows shall be fitted between the transition piece and the boiler windbox.

Inspection cleanout openings shall be provided where necessary.

62.7. SPECIAL TOOLS 5

Special tools shall be provided as recommended by the equipment vendors.

SECTION 63

STEAM SYSTEMS - *SLOW SPEED DIESEL (ONLY)*

63.1. GENERAL

Reference Document: ASTM F1139, "Standard Specification for Steam Traps and Drains"

Auxiliary steam and exhaust piping shall be installed as required. The systems shall be complete with all valves, traps, fittings, reducing stations, gages, thermometers, and any other equipment necessary for safe and efficient operation of the plant.

All strainer baskets shall be stainless steel.

Root valves shall be installed in all lines to equipment to facilitate testing, as per Regulatory Body requirements, and repair without interrupting the remainder of the system.

63.2. AUXILIARY STEAM SYSTEM

The auxiliary steam piping system shall be supplied from the auxiliary boiler or waste heat boiler outlet connection at boiler pressure. The system shall be designed to deliver steam at specified pressures and temperatures to the following:

1. Soot Blowers
2. Distilling Plant
3. Shore Steam
4. Fresh Water Heater
5. Main Engine Cooling Water Heating
6. H.F.O. Heaters
7. H.F.O. Purifier Heaters
8. H.F.O. Day Tank
9. H.F.O. Bunkering Tank Heating Coils
10. Galley
11. Lube Oil Purifier Heaters
12. Lube Oil Purifier Sludge Tank Heating Coils
13. Ship's Heating
14. Steaming Out for Sea Chest and Sewage Tank
15. Cargo and Deep Fuel Oil Storage Tank Cleaning System (if provided)
16. Air Conditioning Converter
17. Slop Tank Heating Coils
18. Elsewhere as Required

While underway, the ship's heating systems shall be supplied with steam from the exhaust gas boiler. This main shall be cross connected with the heating system reducing station branching off the main from the oil fired boiler.

The auxiliary steam system shall consist of the necessary reducing stations sized for maximum steam flow plus 25 percent.

The number of reducing stations shall be kept to a minimum, with all reduction taking place in one step, where practicable.

63.3. SAFETY AND RELIEF VALVE ESCAPE PIPING SYSTEM

The boiler safety valve escape pipe shall be led to the atmosphere near the top of the stack so discharge shall be clear of operational areas. Each boiler drum outlet safety valve shall be fitted with an approved type slip joint connection at the valve outlets to prevent any undue strain or reaction on the safety valves.

The discharge from miscellaneous steam relief valves, 690 kPa and above, shall be combined into a single line and led to the atmosphere through a separate escape pipe, arranged in a manner similar to the boiler safety valve escape.

The discharge from miscellaneous steam relief valves, below 690 kPa shall be piped directly to the bilges in such a manner as not to endanger personnel, motors, or other equipment.

63.4. FUEL OIL TANK HEATING COILS

Each heavy fuel oil settling, service, and storage tank shall be fitted with heating grids distributed over the tank bottom with the steam inlet adjacent to the tank suctions. Valves controlling the steam supply to and condensate return from each tank shall be conveniently grouped in the machinery space. The amount of heating surface to be provided shall be as follows:

> Service and settling tanks .07 m^2 for each metric ton of fuel in the tank (assume tank to be 95 percent full) plus .09 m^2 of coil surface for each 6 m^2 of tank exposed to the sea and air and abutting ballast tank (if any).
>
> Storage tank .03 m^2 for each metric ton of fuel in the tank (assume tank to be 95 percent full) plus .09 m^2 of coil surface for each 6 m^2 of tank exposed to the sea and air and abutting ballast tank (if any).

In addition to the heating surface noted above, a helical heating coil, containing approximately 2 m^2 of heating surface shall be installed around suction tail pipe in the storage tank only.

Grids of the coil type shall be made continuous with heavy welded sleeves, without the use of fittings. Flanged joints will not be permitted inside of tanks. The grids shall be provided approximately 102 mm above the tank bottom and shall be securely fastened to the ship's structure with substantial bolted and/or welded clips.

Steam for the fuel oil tank heating coils shall be supplied from the auxiliary steam system. Individual tank drains shall be combined in drain manifolds and led via a stop check valve to the drain main which shall drain to the drain-inspection tank. All necessary traps, strainers, by-passes, etc., shall be provided.

Thermostatic valves shall be installed in the steam line to the heating coils in each fuel oil tank and steam heating lines. The thermostatic valves shall be provided with cut out valves and a valved by-pass. The valve in the by-pass line shall be of the needle or plug type.

SECTION 64

MACHINERY SPACE VENTILATION

64.1. GENERAL

A mechanical ventilation system shall be provided for the machinery space. The system shall consist of motor driven two speed supply and single speed exhaust fans with suitable Weather Deck inlets and outlets and all necessary duct work to supply the ventilation needs of the machinery space plus combustion air for the main engines, diesel generators, and auxiliary boiler. Air velocity in main trunks or ducts shall not exceed 18 meters per second unless specifically approved.

Alternately, air for combustion may be filtered separately in a filter room and led to the engine via ducts and silencers without filtering all engine room ventilation air.

The requirements of SECTION 12 apply to this SECTION 64. The mechanical ventilation system design shall be in accordance with the applicable portions of ISO 8861, "Shipbuilding - Engine-room Ventilation in Diesel-engined Ships - Design Requirements and Basis of Calculations", with all Annexes.

64.2. FANS

The supply and exhaust fans shall be of quantity and size as described in the Machinery List. Where the fans take the air directly from the plenum, the weather, or the machinery space, they shall be fitted with bellmouths.

64.3. AIR SUPPLY

Fresh air supply to the fans for the machinery space shall be taken from separate intakes designed for minimum entrance loss, located so as to avoid short circuiting of exhaust air or stack gas. Non-return dampers shall be fitted downstream of each supply fan operating in parallel.

Air shall be supplied and distributed to the machinery space in accordance with ISO 8861, "Shipbuilding - Engine-room Ventilation in Diesel-engined Ships - Design Requirements and Basis of Calculations", and all Annexes.

Air shall not discharge directly on steam piping, machinery or electrical equipment, nor shall it be required that air be directed at any equipment in order for it to function properly.

The air shall be delivered at the operating stations through adjustable diffusers. Directional terminals shall supply not less than 0.7 cubic meters per second at not less than 10 meters per second. Adjustable shutoff dampers shall be provided for each terminal. Remote damper operators shall be provided when dampers are not accessible from floor or gratings. Shutoff operators to be provided for all machinery. Space dampers, remote location to be outside of machinery space for use in the event of fire and subsequent discharge of CO_2.

The central operating station shall be air conditioned in accordance with SECTION 12. A ventilation duct shall supply air to the central control station in event of air-conditioning failure. When the duct penetrates the machinery space boundaries, the duct shall be fitted with an automatic fire damper. The duct shall be fitted with an (electric) heater.

64.4. AIR EXHAUST

Air shall be exhausted from the machinery space in accordance with ISO 8861, "Shipbuilding - Engine-room Ventilation in Diesel-engined Ships - Design Requirements and Basis of Calculations", with all Annexes.

The exhaust fans shall draw air from the top of the machinery space and discharge it direct to the atmosphere through non-restrictive louvered openings directed aft and protected from the weather. Automatic, non-return dampers shall be mounted in the discharge ducting of each exhaust fan operating in parallel.

SECTION 65

AIR CONDITIONING REFRIGERATION EQUIPMENT

65.1. GENERAL

Cooling shall be supplied by means of circulating chilled water to air cooling coils installed in the ventilation systems supplying conditioned air to the spaces defined in SECTION 12.

The machinery providing the chilled water shall use a refrigerant of a non-ozone depleting substance. The use of R-22 is acceptable as an interim measure until other systems are developed. The machinery shall consist essentially of two motor driven reciprocating type compressor condenser units together with necessary associated equipment. Screw type compressors are also acceptable. The above equipment shall be supplied as one or two packed units. The equipment shall receive fresh water from the air conditioning circulating system, cool the water and return it to the circulating system for distribution.

The air conditioning refrigeration compressors, condensers and accessory appurtenances shall be in accordance with the descriptions and requirements given for the same type of item in SECTION 66. Insofar as practicable, compressors shall be the same as those used for ship's service and cargo refrigeration, except as to the number of cylinders or speed.

ANSI/ASHRAE Standard 26-78, "Mechanical Refrigeration Installations on Shipboard", should be consulted.

Direct expansion systems are also acceptable.

65.2. REFRIGERATING MACHINERY

(a) Compressor Performance

The compressor, motor, and condenser shall have capacity and performance characteristics for continuous operation at conditions equivalent to plus $2^{o}C$ saturated vapor suction temperatures and $41^{o}C$ condensing temperature.

(b) Refrigerant Circuits and Loads

The refrigerant system, as far as practical, shall be designed for automatic operation and shall be capable of maintaining design cooling water temperatures to within $\pm 5^{o}C$.

There shall be two separate identical, refrigerant circuits so arranged and valved that the chilled water of either circuit, or both circuits (as needed), may be utilized to serve the load. Both circuits will be needed to serve the maximum load.

Means shall be provided for manual operation and adjustment at the machines by the operator. The compressor controls shall be arranged so that the machines can be started and stopped from the console, but only if the local control is in the automatic position.

(c) Air Conditioning Water Circulating System

Two circulating pumps shall be arranged to circulate chilled water from the chilled water cooler, or hot water from the hot water converter, to the air cooling or heating coils in conformance with the requirements of SECTION 12. The pumps shall be located in the vicinity of the compressors. The converters and chillers shall discharge into a manifold to completely mix the water from the two coolers before distribution to the system. The return lines shall be similarly arranged. The chilled or hot water system shall consist of a main from the discharge manifold to the coils and returns to the suction manifold.

The compressor controls shall be interlocked with their associated chilled water pump controls so that the compressor cannot be started if the pumps are not running.

(d) Fresh Water Chillers

The chillers shall be of the two circuit straight tube type, with refrigerant in the tubes and water in the shell. The design shall be based on an outlet temperature of 5°C, an inlet temperature of 12°C, a suction temperature of 2°C and a maximum water velocity in the tubes of 1.8 m/sec. Tubes shall be of copper with a minimum diameter and thickness of 16 mm x #18 BWG. Steel shall be used for the tube sheets and shell with cast iron for the heads.

The coolers shall be provided with inlet and outlet thermometers for the water and a connection for inserting a thermostatic device into the chiller so that the compressor will automatically stop to prevent freezing.

65.3. MISCELLANEOUS TOOLS AND EQUIPMENT

The same as in SECTION 66, but duplication of tools and equipment is not intended.

SECTION 66

SHIP'S SERVICE REFRIGERATION

66.1. GENERAL

(The following Specifications shall be complied with when the ship's stores refrigeration spaces are of the permanently installed type with the machinery located in the Engine Room. Consideration will be given to other arrangements such as portable refrigerated boxes with self-contained, air-cooled condensing units.

A ship's service refrigerating system designed for the direct expansion of refrigerant of a non-ozone depleting substance, shall be provided for the compartments indicated on the arrangement plans. The use of R-22 is acceptable as an interim measure until other systems are developed.

Ship's service refrigeration design shall be in accordance with the applicable portions of ISO 9099, "Air-conditioning and Ventilation of Dry Provision Rooms on Board Ships - Design Conditions and Basis of Calculations".

All equipment except the condenser circulating pumps shall be designed for completely automatic operation and shall preferably be of the package type. All "high-side" equipment shall be supplied by the manufacturer as one (preferably) or two packaged units, complete with refrigerant piping and a holding charge of refrigerant.

66.2. REFRIGERATED COMPARTMENTS

The refrigerated compartments shall be located and sized as per the Contract Arrangement Plans. The temperature and methods of cooling shall be as follows:

Compartment	Temp °C	Loading Temp °C	Methods of Cooling
Vegetables & Fruit	2	2	Air Cooler
Dairy	2	2	Air Cooler
Meat, Fish & Frozen Food	-18	-9	Air Cooler
Thaw (vestibule type) Approx.	4		Infiltration from Freeze Room

When the bulkheads are adjacent to other ship's stores refrigerated spaces, the temperature shall be that of the refrigerated space, however, no credit shall be taken for a negative heat gain.

66.3. REFRIGERATING MACHINERY

(a) Compressors

Two air cooled multi-cylinder, single acting, marine type, compressors shall be provided. (Screw type compressors are also acceptable.) Each compressor shall have ample capacity to "pulldown" the refrigerated compartments to design temperatures within 72 hours after loading. The refrigeration capacity of the compressors shall be based on 41°C condensing and 2°C saturated vapor suction temperatures. Refrigerant suction returns shall enter the cylinder directly without passing through the crank case. The compressors shall have automatic unloading, starting and capacity adjustment. Each compressor shall have its own gage board, mounted off the compressor, with all the gages, pressure switches and alarms as required herein. The machinery shall be provided with forced-feed lubricating oil system.

The controls and motor size shall be selected so that the motor cannot be overloaded when in service.

(b) Condensers

Two horizontal shell and straight integral finned tube marine type condensers shall be provided. They shall be designed with a maximum water velocity of 2 meters per second and a maximum pressure drop of 34.5 kPa.

Tubes shall be rolled at both ends in drilled, reamed and grooved tube holes and shall be readily removable for repair. Intermediate support plates shall be fitted. Tubes shall be of 90-10 Cu-Ni with a minimum diameter and thickness of 15 mm x #18 BWG. Steel shall be used for the shell with bronze or 90-10 Cu-Ni for the heads and tube sheets. Condenser heads shall be arranged so as to avoid disturbing pipe when the heads are removed. The condenser shall be protected by the use of replaceable zincs and fitted with suitable baffles on the hot gas inlet connection to prevent impingement and erosion of the tubes in way of the connection. If a condenser of the two-pass type is used, the divider plate on the condenser head shall be arranged to clear all tubes and not interfere with water flow.

Condensers shall be sized for circulating water temperature per paragraph A6, Annex A, of ISO 7547, "Air-conditioning and Ventilation of Accommodation Spaces on Board Ships - Design Conditions and Basis of Calculations" with a condensing temperature of 41°C.

(c) Liquid Receiver

Two liquid refrigerant receivers designed for marine service shall be provided. Each receiver shall have ample capacity to provide an adequate liquid seal and to store 120 percent of the total ship's stores system refrigerant charge. The receiver shall be complete with all necessary connections, liquid sump or double drains, baffles, and two bulls eyes or a magnetic type liquid level indicator.

(d) Liquid Strainers

One angle type refrigerant liquid strainer with removable strainer basket, with a three valve bypass, shall be fitted in the liquid line to each refrigerated space ahead of the solenoid valve and in the discharge from the receivers.

(e) Liquid Dryers

An angle type refrigerant dryer with renewable type cartridge, cut-out valves, and bypass for permanent installation shall be fitted in the liquid line from each receiver. The use of a combination dryer-strainer is permitted in this location.

(f) Liquid-Suction Heat Interchangers

If the suction superheat is not too high, heat exchangers of welded steel construction shall be placed in the suction line close to the compressor. Each heat interchanger shall be fitted with a bypass.

66.4. REFRIGERATED COMPARTMENT EQUIPMENT

(a) Air Coolers

The air coolers shall be of the self-contained type. If fans are belt-driven, the V-belt drive shall be protected by a guard and the motor mounting shall be adjustable.

The cooling coils shall be of seamless copper tubing (minimum of 15 mm O.D. x .0875 mm wall thickness) with copper or aluminum fins 25 mm x 0.25 mm thickness, spaced not more than two per mm. Copper coils and fins shall be electro-tin plated after fabrication or be of enameled aluminum.

Defrosting of compartments below 2°C shall be automatically accomplished by electric heating, with manual over-ride, built into the cooler coils and drip pans. The defrosting cycle shall be controlled by a clock mechanism with a thermostat initiating the close of the defrost cycle. Controls shall be installed to limit the increase of the box temperature by acting as safety devices to deactivate the electric heater. Pilot lights with identification label plates shall indicate when the defrosting heaters are in operation and shall be located in the passageway outside the refrigerated compartment.

Casing shall be galvanized or bonderized sheet (0.9375 mm minimum) finished with baked enamel. Drip pans shall be designed with sufficient depth and baffles suitable for marine service to drain under conditions of roll or pitch of the ship without overflowing the pan. The drip pan shall be fitted with drain and overflow connections which shall be piped to floor drains. The drip pan shall have electric heaters and the drains shall be wound with electric heating cords which shall operate in conjunction with the electric defrosting heaters to keep the drains clear of ice. Drain pipe heating shut-off shall be delayed 10 minutes beyond other heating shut-off.

66.5. CONTROLS

The following automatic control equipment shall be provided:

(a) Two dual pressurestats, or separate high and low pressure switches, which are adjustable.

(b) Necessary controls for unloading and reduced capacity operation.

(c) One oil pressure failure switch with automatic shut-down and alarm for each compressor.

(d) One automatic water regulating valve for each condenser.

(e) One liquid line king solenoid valve for each compressor energized through the compressor controller so as to close when the compressor stops for any reason other than the opening of the low pressure cut out switch.

(f) One liquid line solenoid valve and contact maker with thermostatic element for each refrigerated compartment circuit.

(g) One externally adjustable thermal expansion valve for each coil circuit in the refrigerated compartments.

(h) One suction pressure regulating valve complete with pressure gage and valve in the suction line from each refrigerated compartment. For ship's service, only those compartments above $-1^{o}C$ require suction pressure regulating valves.

(i) Condenser water failure switch for shut-down of each compressor.

Expansion valves and suction pressure regulating valves shall be provided with three valve bypass to permit continued manual operation if they are cut out of the system.

If a refrigeration control board is fitted, per SECTION 67, the ship's stores refrigeration alarms, defrosting pilot lights and motor controls shall be installed upon it.

66.6. REFRIGERANT PIPING SYSTEM

Piping shall be bent wherever practical to keep number of fittings to a minimum. Compressor stop valves shall be of the back seated type. Piping system shall be non-ferrous.

The discharge line from each compressor shall be fitted with a relief valve and a stop valve specially designed for a refrigerant service. The relief valve may be built into the compressor.

The refrigerant piping system shall be carefully installed and every precaution taken to keep the system absolutely clean internally during erection. Before operating the compressors, the system shall be cleaned by means of a special surge drum containing a filter screen, and large quantity of desiccant, connected into the suction side of the system. Prior to cleaning and pressure tightness tests, the system shall be dehydrated by means of special vacuum pumps capable of developing a vacuum of at least 100 kPa or 2°C on a wet bulb vacuum indicator.

A charging line shall be provided from the spare refrigerant bottle storage area to the ship's service, air conditioning and cargo refrigeration compressor units. The line shall be fitted with flexible connections at each end, or be a suitable length of flexible hose, fitted with bleed-off valves.

66.7. THERMOMETERS AND GAGES

Thermometers shall be fitted for the condenser water lines to indicate the sea water supply temperature and the temperature of the water discharged from each condenser. Thermometers shall also be fitted on the compressor suction and discharge lines, and in the refrigerant line downstream for the receivers.

Refrigerant pressure gages, 89 mm diameter, shall be provided for each compressor, one for indicating the suction pressure, one for indicating the discharge pressure and one for indicating the oil pressure. The gages shall be mounted on a board with the pressure switches for the compressor, and the board shall be hung on the ship's structure, not the compressor.

A pressure gage shall be fitted for each suction pressure regulating valve.

One thermometer of the dial type with necessary tubing shall be provided for each refrigerated stores compartment.

Thermometers and gages for all other equipment shall be provided as required for the efficient operation of the system.

66.8. ICE CUBE MAKER

An automatic, self harvesting ice cube maker suitable for marine use, with stainless steel outer top and front, interior casing and up-lid, stainless steel locking bars with padlocks for front access panel and storage bin shall be provided. Standard commercial units may be used provided they are modified as necessary to meet the requirements of the Regulatory Body(ies).

An air cooled condenser will be acceptable for use on the ice cube maker provided there is adequate ventilation to insure proper operation.

66.9. MISCELLANEOUS TOOLS AND EQUIPMENT

The following miscellaneous materials and equipment shall be provided:

(a) One complete charge of refrigerant for the system.

(b) One complete charge of special lubricating oil for the compressor, including necessary make-up oil for the system.

(c) One set of any special tools required for proper examination of apparatus.

(d) One special halide leak detector, complete with fuel container and tubing for locating leaks in the refrigerant system.

(e) One flexible refrigerant and oil charging connection.

(f) One hand oil pump if filling must be done under pressure.

(g) One motor operated vacuum pump shall be provided, suitable to dehydrate the system as required in SECTION 66, Art. 6 herein. This pump shall not be in addition to any supplied in accordance with the requirements of SECTION 67.

SECTION 67

CARGO REFRIGERATION - DIRECT EXPANSION SYSTEM

67.1. GENERAL

The plant shall be so designed and installed that the cargo refrigeration system will be controlled from the Engine Room at the Refrigeration Control Board and, except for emergencies, there will no need for personnel to enter the cargo refrigeration compartments or Fan Rooms while at sea. The Control Board shall be equipped in accordance with the requirements of SECTION 95. While loading, the expansion valves and thermostats will be adjusted manually for the correct carrying temperature. Fine adjustment of the compartment thermostats shall be made from the Refrigeration Control Board.

The plant shall be complete in every respect, to comply with the latest methods for carrying refrigerated cargo at any temperature from -23°C to +10°C.

All equipment, except the condenser circulating pumps, shall be designed for completely automatic operation and shall be capable of maintaining compartment temperatures to within ± 5°C.

Cargo compartments shall be cooled by a recirculated air system comprised of finned coils, motor driven fans, and suitable air ducts. Provisions shall be made for ventilating all compartments as specified in SECTION 12.

The cargo refrigeration compressors, condensers, and accessory appurtenances shall be in accordance with the descriptions and requirements given for the same type of item, SECTION 66, except where specified otherwise. Insofar as practicable, ship's service cargo and air conditioning compressors shall be identical except as to the number of cylinders or speed.

67.2. REFRIGERATION LOADS

(a) The duty of the plant is to maintain the required temperature in the refrigerated compartments under any of the cargo loading conditions stated below and with refrigeration loads calculated on the same basis as required for ship's stores by SECTION 66. The volumes given in the capacity tables are based upon dimensions taken face to face of the inside of the insulation. Product volumes shall be calculated with due consideration given to stowage factors, required air circulating space, access ways and any space occupied by air cooling and circulating equipment.

The outside air shall be taken as 35°C and 70 percent relative humidity. Pulldown of the entire cargo space shall be accomplished within 72 hours with all compressors operating.

(b) Condition #1 - Room Temperature -23°C

Products - Meat or quickly frozen fruits or vegetables in a completely frozen condition loaded at -7°C. No fresh air to be supplied.

Condition #2 - Room Temperature 2°C

Products - Fresh fruit or vegetables loaded at 29°C. Fresh air to be supplied after pulldown at a rate of two gross volume changes per hour.

Condition #3 - Room Temperature 10°C

Products - Fresh fruit or vegetables loaded at 29°C. Fresh air to be supplied after pulldown at two gross volume changes per hour.

Condition #4 - Any combination of the above conditions

(c) Capacity Tables

Hold	Condition	Capacity

67.3. REFRIGERATING MACHINERY

Cross connections with the units described in SECTIONS 65 and 66 shall be provided where practical and advantageous. Each compressor shall have a minimum capacity of refrigeration tonnage as stated in the Machinery List when operating at a suction temperature of -32°C and condensing at 41°C. The motors for each compressor shall be selected on the basis of the horsepower required at 2°C suction temperature with condensing water supplied at a rate not exceeding 19.0 liters/minute per ton of refrigeration.

67.4. REFRIGERATED COMPARTMENT EQUIPMENT

Each refrigerated compartment shall be provided with a cold air diffuser unit of the vertical built-up surface type. Diffuser cooling coils shall be constructed in accordance with the requirements of SECTION 12, except that they shall be electrotin-plated after fabrication.

The coil free velocity shall not exceed 3 m/s at maximum fan speed.

The diffuser units shall be enclosed in a sheet metal casing and shall include cooling coil, built-in drain pans, fan section and dogged access plates for inspection and cleaning. Construction of casing and drain pan shall be at least of 12 gage steel, hot dipped galvanized after construction or have an epoxy coating. The pan drain shall be provided with splash baffles and with non-clog screens of non-corrosive wire mesh on the drain connection(s). The drain piping shall be trace heated to permit defrosting under all conditions.

The fan shaft end bearings shall be of the ball or roller type while the intermediate bearings shall be of the split roller type to allow bearing replacement without withdrawing the fan shaft.

The design and quality of fabrication of the fans shall be equal to the fan requirements in SECTION 12.

The fan capacity of each diffuser shall be sufficient to change the air once a minute with the compartment empty and when operating against the total pressure of the system. The fans shall be provided with two speed motors, full and half speed reduction.

Heating coils shall be provided in sufficient capacity to hold a compartment temperature of 10°C with an outside temperature of -18°C and with fresh air added at the rate of 2 changes per hour. Heaters shall be located in, or on, the cooling units and the coils shall be finned copper, electro tin-plated after fabrication and equal to the construction specified in SECTION 12. Heating coils shall be controlled by means of self-contained steam regulating valves of the modulating type, sensing discharge air temperature. Access shall be provided for inspecting and cleaning heating coil elements.

Air ducts shall be constructed of not less than #18 USSG galvanized steel, with approved type adjustable slots. Provision shall be made for distribution of supply air throughout the compartments such that 80 percent is discharged over the cargo below the deckhead and 20 percent discharged vertically down along the shell insulation and between the vertical battens where the air may pass under the gratings and between the grating sleepers.

67.5. DEFROSTING

Defrosting of the air cooler units shall be accomplished by electric heating elements built into the units and controlled from the Refrigeration Control Board. Pilot lights with identification labels shall be installed in the passageway adjacent to the entrance to the box and on the Control Board to indicate when the heaters are in operation.

Differential pressure gages, remotely read from the Refrigeration Control Board, shall be installed across each diffuser cooling coil to determine when defrosting is necessary.

67.6. AUTOMATIC CONTROLS

Automatic control equipment shall be provided in accordance with the requirements of SECTION 66 and as otherwise specified in this SECTION.

67.7. MANUAL CONTROLS

Hand valves shall be provided as follows:

(a) Refrigerant hand valves 28.6 mm O.D. and smaller shall be diaphragm packless type with forged brass bodies with integral seats, phosphor bronze and stainless steel diaphragms, stainless steel springs, disc of micarta, nylon or teflon and screwed bonnets. Provision shall be made to insure prompt and positive opening of the valve whether the pressure is above or below the seat.

(b) Hand expansion valves shall be of the same construction except that they shall be of the needle type and shall have replaceable seats. Seats shall be of stainless steel; discs of nickel copper alloy.

(c) Refrigerant hand valves of 35 mm O.D. and larger shall have bronze solder type bodies with integral seats, bolted bonnets, replaceable discs of brass with lead antimony alloy insert, suitable stem packing and gasketed steam seal caps.

(d) Refrigerant purge, drain and charging hand valves 15 mm O.D. and smaller shall be of the same construction and style as refrigerant hand valves 30 mm O.D. and smaller except for screwed outlet connection with seal cap.

(e) The dial thermometers specified herein shall be located adjacent to the controls.

67.8. REFRIGERATION PIPING

The system shall be flexibly arranged so that each compressor may operate on separate systems during pulldown or normal operation and may serve any combination of compartments. On direct expansion systems, only one compressor unit shall be permitted to operate on a piping system at any one time.

The piping shall be provided in accordance with the requirements of SECTION 66.

67.9. THERMOMETERS AND GAGES

Each refrigerated compartment shall be provided with a 115 mm 30 dial type remote reading thermometer having a temperature range from -40°C to plus 43°C located in or adjacent to the compartment in the vicinity of the local controls.

Thermometers and refrigerant pressure gages shall be provided as per SECTION 66.

67.10. MISCELLANEOUS TOOLS AND EQUIPMENT

The same as in SECTION 66, but duplication of tools and equipment is not intended.

SECTION 68

LIQUID CARGO SYSTEM (IF INSTALLED AND APPLICABLE)

68.1. GENERAL - PETROLEUM TANKER

The liquid cargo handling system shall be installed to carry liquids (described in the Table of Liquid Cargos) in the tanks as indicated in the Capacity Tables. Liquid cargo systems designed for the carriage of petroleum products shall be suitable for loading and discharging petroleum products according to MARPOL 73/78. See SECTION 70 for pollution abatement requirements. The liquid cargo handling system shall be fitted with a vapor recovery system which meets 46 CFR Part 39.

68.2. LIQUID CARGO HANDLING SYSTEM - PETROLEUM TANKER

Each tank shall be fitted with a stripping well, a sounding and sampling tube located directly over the stripping well, tank cleaning connections, a vent, remote reading thermometers (located on the cargo control console) and a stripping pump connection to the stripping well.

The entire system shall be designed so as to facilitate cleaning and the inspection by liquid cargo surveyors to the maximum degree with minimum effort and shall be self-draining to the maximum practical extent. Ready means shall be provided for the local drainage, cleaning and inspection of any unavoidable pockets, such as in valves and pumps. The design of inspection openings shall be such as to minimize the effort required in their use. Quick acting couplings and securing fittings shall be employed as necessary to obtain this objective. The weight of demountable inspection components shall be limited so that one person can handle them, or special fittings shall be provided for the use of lifting gear.

All piping, fittings, blank flanges, hoses and tank surfaces that come in contact with the liquid cargo must be of material suitable for the liquid cargos to be handled.

Expansion of pipes shall be provided by horizontal loops, suitable offsets, slip type or bellow type expansion joints.

Pipe anchoring and hangers shall be designed to provide adequate support and to allow for the pipe line movement with thermal changes and working of the ship without causing undue stresses.

A steel drip pan, sized in accordance with Regulatory Body(ies) requirements shall be fitted under each port and starboard manifold. A stainless steel plug shall be fitted to drain any collected fluid to a bucket.

Valves in the liquid cargo system shall be either remotely controlled-power operated; locally controlled-power operated; or locally manually operated. All power operated valves shall utilize hydraulic actuators.

Piping materials shall be in accordance with SECTION 74 of these Specifications.

Provisions shall be made to remove all possible liquid from the cargo pump column (submersible pumps), cargo pump discharge lines and deck cargo lines to shore, by pressurizing the pump column/discharge piping and deck lines with compressed inert gas applied via portable hose to quick connect couplings at the liquid cargo pump discharge head and liquid cargo mains.

For additional compressed inert gas system requirements see Item 68.9.f. below.

All hose connections shall be of the quick connect-disconnect safety type flange coupling with blank flanges.

68.3. TABLE OF LIQUID CARGOS - PETROLEUM TANKER

Cargo	Specific Gravity at ^{o}C	Viscosity at ^{o}C (SSU)	Melting Temp ^{o}C (Approx)	Flash Point ^{o}C	Holding Temp ^{o}C	Pumping Temp ^{o}C

(Insert values to suit cargos carried)

68.4. CARGO TANK CLEANING SYSTEM - PETROLEUM TANKER

A sea water cargo tank cleaning system, complete with heater, drain cooler, chemical tank and all necessary piping and fittings shall be provided. The fire pump in the machinery space shall provide sea water to the heater and pump from and to the chemical mixing and storage tank. A common tank cleaning main, completely independent of the liquid cargo and ballast system piping, shall be provided. Recirculation of the chemically treated water from the tanks shall be accomplished by the liquid cargo pumps.

The cargo pumps will be utilized to draw the wash water/oil from the cargo tanks and discharge it to (a) the slop tank, (b) the sea through an approved oily water monitor (see SECTION 70), and (c) the deck manifold discharge connection.

The tank cleaning system shall be equipped with either (a) two portable tank cleaning machines, complete with mounting adapters; or (b) fixed tank cleaning machines suitable for cargo oil and water washing shall be mounted in all cargo tanks and the slop tanks, arranged to clean all tank surfaces in accordance with Regulatory Body(ies) requirements.

The fixed tank cleaning system shall be arranged to allow cargo oil washing with the liquid cargo pump in each segregation supplying the cleaning machines in that segregation via a swing elbow.

Provisions shall be made for flushing and rinsing the tanks with fresh water through the tank cleaning machine connections to remove all traces of tank cleaning chemicals and sea water.

The heater and drain cooler shall be of the horizontal shell and tube type with sea water in the tubes and steam in the shell or plate type heater. The heads, tubes and tube sheets shall be of 90-10 copper nickel. The minimum tube diameter shall be 19 mm with #16 BWG thickness. The design of these units shall be based on a cleanliness factor of 75 percent maximum water velocity in tubes of 1.4 m/min and a maximum pressure drop of 3.4 kPa.

68.5. TANK HEATING SYSTEM - PETROLEUM TANKER

The liquid cargo tanks shall be heated by steam coils passing through fresh water filled hotwells located beneath the tanks. The steam inlet to the tanks shall be controlled by an adjustable thermostatic valve sensing the liquid cargo's temperature.

If required by the liquid cargos to be carried (see Table of Liquid Cargos above), additional means of tank heating may be necessary. In such a case, the tanks shall also be heated by circulating hot fresh water through portable coils provided in the tank. The water shall be heated by steam in a shell and tube type heat exchanger with aluminum brass tubes of 16 mm minimum diameter and #18 BWG thickness. Tube sheets shall be of naval brass and heads of cast iron. The design of this heat exchanger shall be based on a maximum water velocity of 1.4 m/min and a maximum pressure drop of 34 kPa.

The temperature of the liquid cargo shall be monitored at three levels, and the hotwell at one location, in each tank by temperature recording instruments on the cargo control console.

68.6. TANK GAUGING SYSTEMS - PETROLEUM TANKER

Each liquid cargo tank shall be fitted with a radar type gauging system with remote readout at the liquid cargo control console. The tank gauging system shall provide signal points for level alarms. In addition, each tank shall be fitted with an independent overfill alarm arranged to display at the liquid cargo control console. Exterior audible and visual overfill alarm annunciators shall also be fitted in accordance with Regulatory Body(ies) vapor control requirements.

68.7. LIQUID CARGO CONTROL SYSTEM - PETROLEUM TANKER

A centralized liquid cargo control system shall be provided to allow monitoring and control of the cargo and related systems from the Control

Room including the following:

1) Control of hydraulic motor driven cargo, slop, ballast, and fire/tank cleaning pumps.

2) Remote control of cargo, ballast, and miscellaneous valves.

3) Liquid cargo tank pressure monitoring system.

4) Remote tank level indicators for liquid cargo and ballast tanks.

5) Inert gas system remote control and monitoring.

6) Emergency shut down system as required by Regulatory Body(ies).

All electrical equipment to be located within the liquid cargo block hazardous area shall be suitable for installation in hazardous atmosphere as defined by Regulatory Body(ies).

68.8. TANK VENTING SYSTEM - PETROLEUM TANKER

All liquid cargo tanks including slop tanks shall have a venting system. Each tank shall be fitted with a high velocity pressure/vacuum vent valve with flame arrestors and local positive means of opening, provided on individual stand pipes located approximately 2.4 m above the Main Deck.

Pressure/vacuum valves shall be set at 0.172 bar pressure and 0.035 bar vacuum. The tank venting system shall be adequately sized to allow loading a homogeneous cargo in 12 hours.

In lieu of each tank having a pressure/vacuum valve, a header system which meets Regulatory Body(ies) requirements and approval may be used.

68.9. INERT GAS AND VAPOR RECOVERY SYSTEM - PETROLEUM TANKER

a. General

The vessel shall be fitted with an inert gas system as described herein. The distribution of the inert gas shall suit the cargoes being carried and shall be in accordance with Regulatory Body(ies) requirements. The vessel shall be fitted with a complete vapor recovery system, in accordance with Regulatory Body(ies) requirements, designed to return vapor from high vapor pressure cargoes to shore during cargo loading.

b. Inert Gas System

(1) General

Each vessel shall be fitted with an inert gas system supplied by an inert gas generator. The system shall be capable of delivering the following quality and quantity of inert gas with 85°F sea water when burning marine diesel oil with a maximum of 1.8 percent sulfur content.

(a) Inert gas generator quality inert gas at 1.25 times the maximum rated discharge capacity of the vessel in m^3/min.

(b) Fresh air for purging at the quantity in (1).

(2) Distribution System

The system is intended to be used to supply inert gas to maintain an oxygen deficient atmosphere in cargo tanks and slop tanks as required by regulations, and to supply air for gas freeing cargo and slop tanks. The system shall also provide fresh air for ventilation of segregated ballast double hull tanks (through portable connections).

The system shall have an independent inert gas main fitted with a deck water seal.

The inert gas distribution system shall be based on the dilution principle with inlets and deck mounted standpipe outlets according to the manufacturer's standard. Inlets shall be fitted with check valves, isolation valves, and nozzles as required to ensure the gas will penetrate to the bottom of the tank. Standpipes shall be fitted with flame screens.

c. Inert Gas Generator

(1) General

An inert gas generator plant shall be furnished for providing inert gas and fresh air to the cargo tanks as described above. The plant shall cool and wash the products of combustion from burning diesel fuel in order to achieve an inert gas condition and composition to prevent ignition of hydrocarbon vapors, remove particulates, and reduce the content of sulfur oxides (SO_x) for the minimization of corrosion. The plant shall be capable of supplying the quantity of inert gas specified above the one blower with 100 percent capacity. The plant shall consist of fuel oil pump, main and pilot burners, scrubber/cooler-water eliminator, deck water seal, valves, O_2 analyzer with calibration gas and equipment, controls, etc., and all necessary monitoring and instrumentation devices.

The generator shall be capable of a turndown of (2 to 1) with no degradation in gas quality.

(2) Scrubber/Demister

The unit is to cool, clean, and reduce the sulfur content of the inert gas to the conditions stated above.

A scrubber pump will be furnished. The scrubber is to be suitably lined or fabricated from a material to suit the quality of inert gas being provided, subject to Owner's approval.

A high level and low level float switch shall be provided in the scrubber to sound the appropriate alarm and also prevent scrubber flooding.

A flow switch shall be provided in the salt water supply line which on low salt water flow will prevent a blower from being started and will stop a blower that is already operating. This switch will also energize audible and visual alarms.

The scrubber/demister unit shall be provided with manholes, sight glasses, and covers as required for proper maintenance and also a fresh water capped hose valve for flushing out the unit. In addition, ladders and platforms shall be furnished as necessary to safely permit performing routine maintenance on this unit.

(3) Blower

A 100 percent capacity, horizontal, constant speed, continuous service centrifugal blower shall be provided for the plant. The blower shall take suction directly on outside air through a suitable designed plenum and filter/silencer which reduces noise level to a maximum of 100 db at one meter from the blower, and deliver the air to the burner chamber.

The blower/motor combination shall be non-overloading with the motor rating being not less than the power absorbed when the system resistance is at a minimum with $0^{o}F$ outside air; that is, if the inert gas is allowed to exhaust freely to atmosphere from the aftermost tank hatches.

(4) Deck Water Seal

A deck water seal shall be provided to prevent the return of hydrocarbon gases from the inert gas main up to a pressure of 104" W.G. in the inert gas main. This seal unit shall be furnished with a foundation for mounting to the ship's structure.

A thermal oil heating coil shall be provided in the water seal to prevent freezing.

(5) Pressure/Vacuum Breaker

A pressure/vacuum breaker utilizing a column of antifreeze shall be installed on a branch off the inert gas main down stream of the deck seal and non-return valve.

d. Inert Gas System Controls

The Main inert gas system (I.G.S.) control panel shall be located local to the equipment. This panel shall allow start up and operation of the system in a vent-to-atmosphere mode only. Transfer of control from the main I.G.S. control panel to the cargo control room panel shall be at the discretion of the main I.G.S. control panel operator and shall occur in the vent-to-atmosphere mode only.

A manufacturer's standard inert gas monitoring and control panel shall be fitted int he control console to control release, quantity, quality, and pressure of gas to the distribution system. Transfer of control back to the main I.G.S. control panel shall be possible only in the vent-to-atmosphere mode from the cargo control room panel at the discretion of the operator.

e. Vapor Recovery System

A complete vapor recovery system shall be provided, independent of the inert gas system. The system is to be complete with all necessary alarms and instrumentation as required by vapor recovery regulations.

f. Compressed Inert Gas System

A complete compressed inert gas system shall be provided to supply inert gas at a suitable pressure for blowing out and purging the cargo pumps and piping. The system shall be complete with gas compressor, receiver, and all associated piping and fittings.

The inert gas compressor shall be of the two stage, motor driven, reciprocating air cooled type. It shall be arranged to draw gas from the inert gas main and discharge to the inert gas receiver. The compressor shall be furnished complete with all accessories, similar to the starting air compressors.

The inert gas receiver shall be of galvanized fabricated steel construction outfitted similar to other air receivers as described in SECTION 72.

A compressed inert gas main shall be fitted in the Main Deck pipe rack. A number of hose connection fittings will be provided in way of the cargo pumps to allow for attaching a hose to supply compressed inert gas to the cargo pump purging connection for stripping of the pump and discharge piping. Branches shall be led from the main line to the cargo manifolds port and starboard, where appropriate fittings will be provided to purge the manifold piping and cargo hoses.

68.10. GENERAL - DRY CARGO SHIP

The liquid cargo handling system shall be installed to carry liquids (described in the Table of Liquid Cargos) in the tanks as indicated in the Capacity Tables. See SECTION 70 for pollution abatement requirements.

68.11. LIQUID CARGO HANDLING SYSTEM - DRY CARGO SHIP

Each tank shall be fitted with a stripping well, a sounding and sampling tube located directly over the stripping well, tank cleaning connections, a vent, remote reading thermometers (located on the cargo control console) and a liquid cargo pump connection to the stripping well.

The entire system shall be designed so as to facilitate cleaning and the inspection by liquid cargo surveyors to the maximum degree with minimum effort and shall be self-draining to the maximum practical extent. Ready means shall be provided for the local drainage, cleaning and inspection of any unavoidable pockets, such as in valves and pumps. The design of inspection openings shall be such as to minimize the effort required in their use. Quick acting couplings and securing fittings shall be employed as necessary to obtain this objective. The weight of demountable inspection components shall be limited so that one person can handle them, or special fittings shall be provided for the use of lifting gear.

All piping, fittings, blank flanges, hoses and tank surfaces that come in contact with the liquid cargo must be of material suitable for the liquid cargos to be handled.

Expansion of pipes shall be provided by horizontal loops, suitable offsets, slip type or bellow type expansion joints.

Pipe anchoring and hangers shall be designed to provide adequate support and to allow for the pipe line movement with thermal changes and working of the ship without causing undue stresses.

A steel drip pan, sized in accordance with Regulatory Body(ies) requirements shall be fitted under each port and starboard manifold. A stainless steel plug shall be fitted to drain any collected fluid to a bucket.

Valves in the liquid cargo system shall be either remotely controlled-power operated; locally controlled-power operated; or locally manually operated. All power operated valves shall utilize hydraulic actuators.

Piping materials shall be in accordance with SECTION 74 of these Specifications.

The sampling tube shall be led as directly as possible from the top of the liquid cargo tank to the weather deck. The sampling tube shall serve as the filling connection and the sampling and ullage connection; and shall be large enough to permit an air motor driven liquid cargo pump to be lowered into the tank, operate, and be removed without jamming or binding. While in the tank, the pump's air supply, air exhaust, and liquid cargo discharge hoses shall be led through the sampling tube.

In addition to the air motor driven liquid cargo pumps, portable electric motor driven pumps shall be used to empty the tanks through a connection in the stripping well. The tank connections and access trunks in way of the tanks shall be arranged to accommodate the portable pumps. The pumps shall take suction via a length of hose connected to the tank and discharge to the weather deck via a hose led through the access trunks.

Where the liquid cargo system is outfitted with submersible pumps, provisions shall be made to remove all possible liquid from the cargo pump column, cargo pump discharge lines and deck cargo lines to shore, by pressurizing the pump column and deck lines with compressed air applied via portable hose to quick connect couplings at the liquid cargo pump discharge head and liquid cargo mains.

Adequate lengths (suitable for handling) of flexible marine type hose, stowed in convenient locations, shall be provided for loading and unloading the liquid cargo.

All hose connections shall be of the quick connect-disconnect safety type flange coupling with blank flanges.

68.12. TABLE OF LIQUID CARGOS - DRY CARGO SHIP

Cargo	Specific Gravity at °C	Viscosity at °C (SSU)	Melting Temp °C (Approx)	Flash Point °C	Holding Temp °C	Pumping Temp °C

(Insert values to suit cargos carried)

68.13. CARGO TANK CLEANING SYSTEM - DRY CARGO SHIP

A sea water cargo tank cleaning system, complete with heater, drain cooler, chemical tank and all necessary piping and fittings shall be provided. The fire pump in the machinery space shall provide sea water to the heater and pump from and to the chemical mixing and storage tank. A common tank cleaning main, completely independent of the liquid cargo and ballast system piping, shall be provided. Recirculation of the chemically treated water from the tanks shall be accomplished by the liquid cargo pumps.

The cargo pumps will be utilized to draw the wash water/oil from the cargo tanks and discharge it to (a) the slop tank, (b) the sea through an approved oily water monitor (see SECTION 70), and (c) the deck manifold discharge connection.

The tank cleaning system shall be equipped with either (a) two portable tank cleaning machines, complete with mounting adapters; or (b) fixed tank cleaning machines suitable for cargo oil and water washing shall be mounted in all cargo tanks and the slop tanks, arranged to clean all tank surfaces in accordance with Regulatory Body(ies) requirements.

The fixed tank cleaning system shall be arranged to allow cargo oil washing with the liquid cargo pump in each segregation supplying the cleaning machines in that segregation via a swing elbow.

Provisions shall be made for flushing and rinsing the tanks with fresh water through the tank cleaning machine connections to remove all traces of tank cleaning chemicals and sea water.

The heater and drain cooler shall be of the horizontal shell and tube type with sea water in the tubes and steam in the shell. The heads, tubes and tube sheets shall be of 90-10 copper nickel. The minimum tube diameter shall be 19 mm with #16 BWG thickness. The design of these units shall be based on a cleanliness factor of 75 percent maximum water velocity in tubes of 1.4 m/min and a maximum pressure drop of 3.4 kPa.

68.14. TANK HEATING SYSTEM - DRY CARGO SHIP

The liquid cargo tanks shall be heated by steam coils passing through fresh water filled hotwells located beneath the tanks. The steam inlet to the tanks shall be controlled by an adjustable thermostatic valve sensing the liquid cargo's temperature.

If required by the liquid cargos to be carried (see Table of Liquid Cargos above), tank heating may be necessary. In such a case, the tanks shall also be heated by circulating hot fresh water through portable coils provided in the tank. The water shall be heated by steam in a shell and tube type heat exchanger with aluminum brass tubes of 16 mm minimum diameter and #18 BWG thickness. Tube sheets shall be of naval brass and heads of cast iron. The design of this heat exchanger shall be based on a maximum water velocity of 1.4 m/min and a maximum pressure drop of 34 kPa.

The temperature of the liquid cargo shall be monitored at three levels, and the hotwell at one location, in each tank by temperature recording instruments on the cargo control console.

68.15. TANK GAUGING SYSTEMS - DRY CARGO SHIP

Each liquid cargo tank shall be fitted with a radar type gauging system with remote readout at the liquid cargo control console. The tank gauging system shall provide signal points for level alarms. In addition, each tank shall be fitted with an independent overfill alarm arranged to display at the liquid cargo control console. Exterior audible and visual overfill alarm annunciators shall also be fitted in accordance with Regulatory Body(ies) vapor control requirements.

68.16. LIQUID CARGO CONTROL SYSTEM - DRY CARGO SHIP

A centralized liquid cargo control system shall be provided to allow monitoring and control of the cargo and related systems including the following:

1) Control of hydraulic motor driven cargo, slop, ballast, and fire/tank cleaning pumps.

2) Remote control of cargo, ballast, and miscellaneous valves.

3) Liquid cargo tank pressure monitoring system.

4) Remote tank level indicators for liquid cargo and ballast tanks.

5) Emergency shut down system as required by Regulatory Body(ies).

68.17. TANK VENTING SYSTEM - DRY CARGO SHIP

All liquid cargo tanks including slop tanks shall have a venting system. Each tank shall be fitted with a high velocity pressure/vacuum vent valve with flame arrestors and local positive means of opening, provided on individual stand pipes located approximately 2.4 m above the Main Deck.

Pressure/vacuum valves shall be set at 0.172 bar pressure and 0.035 bar vacuum. The tank venting system shall be adequately sized to allow loading a homogeneous cargo in 12 hours.

SECTION 69

CARGO HOLD DEHUMIDIFICATION SYSTEM

69.1. GENERAL

If cargo hold dehumidification is specified the following shall apply:

A complete automatically operated dehumidification system(s) shall be provided for preventing moisture damage to, or condensation of moisture on, cargo and internal structures of the dry cargo holds. Units using granular solid desiccant such as silica-gel, shall be furnished with replenishment desiccant equal to 15 percent of the unit's capacity and shall have satisfactory means of compensating for settling of the desiccant to prevent process air bypassing the desiccant.

The dewpoint temperature in any cargo hold shall be maintained at a minimum design depression -12°C dewpoint below the surface temperature of the cargo or ship's structure. During rapidly changing outside conditions, a short time drop to a -15°C dewpoint will be permitted. The cargo hold dewpoint temperature shall be measured in the exhaust trunk and shall reflect the average of the different hold levels.

The capacity of the dehumidifying unit shall be certified by the vendor as adequate for the requirements of the dehumidified cargo hold or holds served as described above.

Mechanical supply and natural exhaust systems shall be fitted in each hold, as well as means for recirculating the air in each hold. Recirculation dampers or valves with oilite bushings, pneumatically or electrically actuated from the wheelhouse and manually at the damper or valve location, shall be provided to control supply, exhaust, recirculated and dry air independently to each hold. Four-way pneumatic control diverting switches or electric selector switches shall be used for this purpose.

The dehumidification system(s), except for the distributing duct work and hold air circulation fans, shall be furnished complete in all respects by one vendor and shall include all operational devices necessary for satisfactory performance of the plant. The design shall be such as to facilitate access to all working parts and shall be suitable for continuous duty.

The maximum temperature of the dry air leaving the dehumidifier shall not exceed 74°C.

Adjustable louver damper and diverting air valve operator motors (pneumatic or electro-torque) shall be sized for a torque 100 percent in excess of actual requirements as established by catalog ratings.

All steel parts shall be hot-dipped galvanized after fabrication or protected with a coat of inorganic zinc silicate.

The requirements in SECTION 12 for the cargo hold air circulation system(s), fans (except that the performance and witness test requirements shall not apply to the wet and dry air fans), duct work, terminals, louvers, dampers, and related items, shall apply to this SECTION.

The dehumidification unit shall have a certified rating.

It shall be guaranteed that the dehumidifier will not entrain or carry over amounts of desiccant into the dry air or wet air discharge streams which could be harmful in any respect.

69.2. DEHUMIDIFICATION UNITS

(a) Individual Hold System

The dehumidifier shall be of non-cycling absorption type having a single rotary desiccant bed capable of continuous operation, fully automatic, complete with reactivation heaters, roughing filters, motors, fans, desiccant drive unit, access panels, desiccant bed and all auxiliary components.

Regeneration energy shall be automatically modulated in response to changing loads for economy of operation. The maximum power consumption per dehumidifier unit (one per hold) shall not exceed 0.32 kWh per kg of moisture removed if steam regeneration is used.

The rotary desiccant carrier shall be so arranged that internal bypassing of air between absorption and reactivation air circuits is prevented. Gauges to indicate air flow rates of reactivation and process air streams shall be provided.

The dehumidifier casing shall be a welded, airtight structure with access panels on both sides for inspection and service. An inspection window shall be provided for visual inspection of the desiccant wheel. The unit may be constructed of hot-dipped galvanized steel or aluminum.

(b) Central System

The regeneration steam consumption of the dehumidifying unit shall not exceed 0.32 kWh per kg of moisture removed.

If two separate units are provided, they shall be interconnected to permit either to function for all spaces independent of the other in case of breakdown of one unit.

Air supply to the dehumidifier shall be taken direct from the space in which the unit is installed. Adequate air supply to this space shall be provided from the weather. Wet air discharge from the dehumidifier shall be direct to the weather.

The cooling coils for the liquid desiccant type unit shall be constructed of hot-dipped galvanized steel sheets and fins of 70-30 or 90-10 copper nickel tubes with inlet water manifolds equipped with clean-out plugs for chemically cleaning each individual tube. The steam coils for the liquid desiccant type shall be constructed of 70-30 copper-nickel with copper-nickel tube sheets. Density control shall be provided. All piping and fittings, spray nozzles, pumps and gages shall be suitably protected against any corrosive effect of the desiccant.

Four-way pneumatic control diverting switches or electric selector switch control shall be mounted on the instrument control console or panel in the wheelhouse or chart rooms to provide the following operations:

Ventilation without dry air
Ventilation with dry air
Recirculation without dry air
Recirculation with dry air

Means shall be provided for exhausting air direct to the weather from the cargo holds served.

The hold damper house plenum assemblies if used, shall be furnished as a complete assembly, pre-tested and ready for operation upon connection to the fan units.

Pneumatic controls and systems shall be in accordance with the requirements in SECTION 12.

69.3. INSTRUMENTATION (INDIVIDUAL HOLD AND CENTRAL TYPE SYSTEMS)

The atmospheric and cargo conditions in the cargo compartments shall be recorded by means of multi-point strip chart electronic recorders. The recorders shall be of a type that will satisfy the requirements for sensing temperatures in °C and dewpoint temperatures in °C. The record for protection against "Ship-Sweat" shall be confined to a single recorder on which each of the cargo hold dewpoints will be tracked in a printing sequence relative to the respective cargo holds; the same chart will also record the weather temperature, weather dewpoint and the sea temperature. The record for protection against "Cargo-Sweat" shall be confined to a separate recorder (similar to the "Ship-Sweat" recorder) on which the cargo temperature will be tracked in a printing sequence relative to the respective cargo holds. In addition, this recorder shall track the average dewpoints of each cargo hold.

The chart records shall employ color-coded numerals and/or symbols to facilitate visual detection of conditions in the cargo compartments, including cargo hold dewpoints, cargo temperatures, weather dewpoint, weather temperature, sea water temperature and (for the central system only) dry air dewpoint. Converging color tracks will facilitate visual detection of approaching critical conditions in the cargo compartments.

The above recorders shall be furnished as a complete prewired console mounted assembly. The remote control switches for operating the multi-louver dampers or diverting valves shall be mounted on the front panel of the console. Each circuit shall be identified by a fixed nameplate and each wire and pneumatic line shall be color-coded. The console shall be drip proof and shall have a parts drawer with flush type drawer pull and key lock.

The weather station with aspiration fan for measured samples of weather conditions, cargo hold dewpoint and cargo temperature sensing elements including all necessary dewcel draft shields, temperature probe boxes, receptacles and plugs shall be furnished. The entire package shall be a complete instrumentation system to satisfy the requirements to prevent damage to the cargo. A sufficient number of sensors shall be provided in each hold to insure this.

69.4. APPARATUS PANEL BOARD (IF REQUIRED)

An Apparatus Panel Board complete with mounting brackets and name plates, shall be provided at the dehumidifier unit for mounting gages, relays and other central components associated with the dehumidifying unit.

SECTION 70

POLLUTION ABATEMENT SYSTEMS AND EQUIPMENT

70.1. GENERAL

(a) It is the general intent of this SECTION to specify appropriate pollution control measures to be taken in the design and operation of all merchant ships in order to protect and enhance the quality of the marine environment from ship-generated pollutants, such as oil, sewage, garbage and smoke. Pollution abatement systems shall be constructed in compliance with the 1973 MARPOL Convention as modified by the 1978 Protocol relating thereto, (MARPOL 73/78), as follows:

Annex I of MARPOL 73/78, Regulation for the Prevention of Pollution by Oil.

Annex II - Control of Pollution by Noxious Substances.

Annex IV - Regulations for the Prevention of Pollution by Sewage from Ships.

Annex V - Regulations for the Prevention of Pollution by Garbage from Ships.

(b) All vessels shall be so equipped as to prevent the discharge of oil or hazardous waste into or upon navigable waters (12 nautical miles from the nearest shore), adjoining shorelines and waters of the Contiguous Zone in such quantities as to cause a film or sheen upon or discoloration of the surface of the water or upon adjoining shorelines.

(c) All vessels equipped with toilets and urinals shall be provided with marine sanitation devices designed to prevent the discharge of untreated or inadequately treated sewage into or upon navigable waters.

(d) All vessels shall be equipped with low emitting engines designed in accordance to meet draft, IMO Annex VII, Prevention of Air Pollution From Ships Including Fuel Oil Quality, Subcommittee on Bulk Chemicals - 24 Session Agenda Item 7, 21 March 1994.

(e) All vessels shall be equipped with an IMO Annex VIII approved shipboard marine incinerator in accordance with ASTM F1322, "Standard Guide for Selection of Shipboard Incinerators", ASTM F1323, "Standard Specification for Shipboard Incinerators", and ISO DIS 13617, "Shipbuilding - Shipboard Incinerators - Requirements".

70.2. BILGE, BALLAST AND CARGO/BALLAST SYSTEMS

(a) General

(1) All bilge and ballast systems shall be so arranged as to assure that all oily bilge or ballast water will be discharged either overboard, through an approved Regulatory Body oily water separator, or directly into a designated slop tank which can later be decanted to 15 ppm or to a shore ballast reception and treatment facility.

(2) Cargo/ballast systems on tank vessels shall be so arranged to insure that oily ballast water or tank washing are: (1) decanted or discharged overboard via a certified oil content meter; (2) retained on board for "load-on-top"; or, (3) discharged ashore to a reception and treatment facility.

(3) Vessels shall be fitted with slop tanks having a capacity to retain on board all oily wastes and oily bilge slops that may accumulate while operating in navigable waters.

(b) Oily Water Separators

Approved separators in accordance with Regulatory Body(ies) requirements shall be provided in the bilge and ballast system and shall be capable of producing an effluent containing not more than 15 ppm.

(c) Oil Content Meters

An oil content meter meeting Regulatory Body(ies) requirements shall be provided in each bilge, oily ballast, and tank washing overboard discharge line. The oil content meter shall be fitted with an alarm device set at a preset value to shut-down the pump or operate an appropriate valve in the discharge line to recirculate the flow automatically when the oil content in the overboard discharge exceeds 15 ppm. The meter will be considered as meeting this standard of 15 ppm if the standard can be met in certified laboratory tests. (See 70.1.(b)).

(d) Shore Connection

Discharge stations shall be fitted for the bilge and ballast system on the Main Deck, port and starboard, to enable oily bilge and ballast water to be piped to shore facilities. Remote control of the bilge and ballast pumps shall be provided at the discharge stations on the Main Deck.

To enable flexible piping at shore reception facilities to be connected with the ship discharge pipe lines for residues from machinery bilges, both lines shall be fitted with a standard discharge connection in accordance with the following table:

Standard Dimensions of Flanges for Discharge Connections for Oil

Description	Dimension
Outside Diameter	215 mm
Inner Diameter	According to pipe outside diameter.
Bolt Circle Diameter	183 mm
Slots in Flange	6 holes 22 mm in diameter equidistantly placed on a bolt circle of the above diameter, slotted to the flange periphery. The slot width to be 22 mm.
Flange Thickness	20 mm
Bolts and Nuts: Quantity and Diameter	6, each of 20 mm in diameter and of suitable length.
The flange is designed to accept pipes up to a maximum internal diameter of 125 mm and shall be of steel or other equivalent material having a flat face. The flange, together with a gasket of oil proof material, shall be suitable for a service pressure of 6 kg/cm^2.	

The steel materials used shall meet the material specifications of ANSI B16.5, "Pipe Flanges and Flanged Fittings".

(e) Overboard Discharge Piping

Overboard discharge piping from oil/water separators and "load-on-top" operation shall be fitted with at least two shut-off valves as close to the shell as possible.

(f) General Cargo Vessel

A 100 percent segregated ballast system shall be provided for ballasting and deballasting of the designated segregated ballast tanks in order to maintain the vessel's stability characteristic in accordance with the damaged stability requirements presented in SECTION 1 without the use of oily ballast in the fuel or liquid cargo tanks. Means shall be provided for both direct sea flooding and pump discharge to the segregated ballast tanks. The system shall be served by a clean ballast pump with standby service from a bilge and ballast pump or a general service or bilge pump.

At no time shall ballast water be placed in fuel tanks or cargo oil tanks.

Remote liquid level indicators shall be provided at the ballast control station for all segregated ballast tanks.

(g) Tank Vessels

Tank vessels shall be designed to meet one of the two design alternatives described below:

(1) All tank vessels shall be designed to allow for deballasting and tank cleaning operations by means of the "load-on-top" method. The method shall allow the oily ballast and tank washings to be pumped to a designated slop tank or tanks. All decanted ballast water discharged overboard shall not contain oil in excess of the maximum limits prescribed for the receiving waters.

(2) All tank vessels not equipped to handle deballasting and tank cleaning operations by the "load-on-top" method shall be designed for segregated ballast operation. In such cases sufficient tankage for all weather operations in ballast condition shall be assigned exclusively for segregated ballast.

70.3. FUEL OIL SYSTEMS

All overflow piping in the fuel oil system discharging overboard shall be fitted with an alarm with indicators at the filling station and control console.

70.4. SEWAGE TREATMENT AND LIQUID WASTE DISPOSAL SYSTEMS

(a) General

Any vessel equipped with toilets, showers, lavatories, laundries or a galley shall be provided with suitably sized holding tanks to retain the sewage and liquid waste while in port or in restricted waters. In lieu of holding tanks for human wastes, an approved sewage treatment plant which will meet the requirements of the Regulatory Body(ies) shall be provided to handle human wastes.

(b) Sewage Treatment Plant

Where sewage treatment plants are used to handle human body wastes only, holding tanks shall also be provided to handle other wastes (grey water).

The marine sanitation device shall be capable of discharging to dockside facilities. Provisions shall be made to facilitate internal cleaning.

(c) Holding Tanks

When provided, holding tanks shall be of sufficient capacity to retain all accumulated drains from urinals, toilets, showers, lavatories, laundries, and galleys and shall be capable of holding a 5-day capacity based on the total ship complement. When using recirculation or vacuum flush systems, holding capacity for these low flow systems will be based on individual system requirements. Holding tanks for "grey" water where no sewage solids are discharged into the tank, shall only be fitted with manholes, air vents to the Weather Deck, an overflow to the sea above the deep water line, and all necessary piping connections.

Each tank shall be fitted with means to discharge to dockside facilities. Provision shall be made to prevent the accumulation of noxious and explosive gases in the holding tanks and vents.

The tanks shall be equipped with manholes, air vents to the Weather Deck, an overflow to the sea above the deep load water line, and all necessary piping connections. All air vents that terminate above the Weather Deck shall be located where odors will not be objectionable.

Sufficient air shall be supplied to the sewage holding tank in order to prevent the contents from becoming anaerobic and to keep the solids in suspension. A pressure regulator and shut-off valve shall be provided to control the air flow into the tank.

Each holding tank shall be fitted with a floatless type level indicator and a separate high level alarm. The remote level indicators and alarm annunciators shall be placed on the Engine Room control console. The level control electrodes should not be in direct contact with sewage and the unit should be arranged for easy access and maintenance.

On vessels where the Engine Room is aft, or where it is impractical to have the sewage system distributed throughout the ship, a holding tank or a small independent sewage treatment system shall be provided for the Engine Room toilets and lavatory drains.

Provisions shall be made for the use of water and steam for tank cleaning purposes.

(d) Piping

Sewage drains shall be led to the treatment plant or holding tank independent of other drains. Shore connections shall be located on the Main Deck, port and starboard, to enable sewage and liquid waste to be pumped to shore facilities with the following discharge connections:

Standard Dimensions of Flanges for Discharge Connections for Sewage

Description	Dimension
Outside Diameter	210 mm
Inner Diameter	According to pipe outside diameter.
Bolt Circle Diameter	170 mm
Slots in Flange	4 holes 18 mm in diameter equidistantly placed on a bolt circle of the above diameter, slotted to the flange periphery. The slot width to be 18 mm.
Flange Thickness	16 mm
Bolts and Nuts: Quantity and Diameter	4, each of 16 mm in diameter and of suitable length.
The flange is designed to accept pipes up to a maximum internal diameter of 100 mm and shall be of steel or other equivalent material having a flat face. The flange, together with a suitable gasket, shall be suitable for a service pressure of 6 kg/cm^2	

For ships having a molded depth of 5 m and less, the inner diameter of the discharge connection may be 38 mm.

(e) Pumps

Each sewage system shall be equipped with two sewage pumps connected in parallel. The pumps shall take suction from the holding tanks or sewage treatment plant and shall be capable of discharging overboard independently of other drain lines and to the shore connection. The sewage pumps shall be of the non-clog marine type, suitable for handling raw sewage and either sea or fresh water as required.

70.5. STACK EMISSION

(a) General

All stack emissions shall meet air purity standards established by the ports of call of the vessel. Relative to reciprocating internal combustion engines, exhaust emission measurements and evaluation are covered in Main Engine Exhaust, ISO/DIS 8178-2, 8278-4, and 11042-1.

(b) Smoke Indicator

Each boiler shall be equipped with a combination visual-photoelectric smoke indicator which shall clearly indicate the absence or presence of smoke. The indicator shall be provided with an alarm which actuates when the smoke intensity exceeds the value established by 70.5.(a) above. The indicator shall be provided with an auto or semi-auto pressurized lens cleaning system to insure cleanliness of the lens. The indicator shall be visible in the vicinity of the Central Control Console. A recorder shall be coordinated with the smoke intensity alarm to record the duration of pollution above the standards established by 70.5.(a) above.

70.6. INERT GAS SYSTEMS

All tankers over 101,600 t and having tank sizes greater than 10,000 m^3 shall be equipped with an approved inert gas system to prevent tanker casualties from fire and explosion.

70.7 VAPOR RECOVERY SYSTEMS

Vapor recovery systems are required for all U.S. Flag and foreign flag vessels which trade in the U.S. waters as cited in 46 CFR Part 39.

70.8. COLLISION AVOIDANCE RADAR

All tankers must be equipped with a collision avoidance radar system which complies with the requirements of SECTION 94.4 of this Specification.

70.9. CARGO OIL TANKS ON TANK VESSELS

The size and arrangement of cargo tanks shall be such as to limit the oil outflow from tanks assumed to be breached by collision or grounding to a value of 30,000 m^3 <u>or</u> 400 times the cube root of the deadweight, whichever is larger, but in no case exceeding 40,000 m^3. The oil outflow shall be calculated in accordance with Regulatory Body(ies) requirements. The hypothetical outflow of oil shall not exceed Regulation 23, "Hypothetical Outflow of Oil" in International Maritime Organization, MARPOL 73/78 Consolidated Edition, 1991.

70.10. CARGO PIPING SYSTEMS ON TANK VESSELS

(a) Remote shut-down of all main cargo pumps shall be provided at the loading and discharge manifold on the deck, port and starboard, and at the centralized cargo control station.

(b) Quick closing valves with means of local control shall be fitted at the loading and discharge manifold.

(c) To reduce the calculated oil outflow due to grounding, an emergency cargo transfer system shall be provided having a high suction in each cargo tank, and capable of transferring cargo oil from a breached tank to any other segregated ballast tanks or other available cargo tanks. The pipes for the emergency suction shall be provided at a point 3 m below the load waterline, but not less than 6 m from the bottom of the tank. Manual control of these valves shall be provided on the deck as well as remote control from the centralized control station. The requirements of this paragraph are not mandatory, except when this cargo transfer system is used to reduce the calculation for oil outflow. (By the use of this system larger tanks may be used.)

(d) Means shall be provided to contain any oil spillage around each oil loading and discharge manifold and oil transfer connection area. Oil abatement booms and other equipment spaces shall be designed to properly outfit the vessel.

70.11. TANK WASHING PROCEDURES FOR NON-SOLIDIFYING SUBSTANCES

1. Tanks should be washed by means of a rotary water jet, operated at sufficiently high water pressure.

2. During washing, the amount of water in the tank should be minimized by continuously pumping out slops and promoting flow to the suction point (positive list and trim). If this condition cannot be met, the washing procedure should be repeated three times, with thorough stripping of the tank between washings.

3. Those substances which have a viscosity equal to or greater than 25 mPa.s at 20°C should be washed with hot water (temperature at least 60°C).

4. The number of cycles of the washing machine used should not be less than specified in the following table. A washing machine cycle is defined as the period between two consecutive identical orientations of the washing machine (rotation through 360°).

5. After washing, the washing machine(s) should be kept operating long enough to flush the pipeline, pump, and filter.

Prewash procedures for solidifying substances.

1. Tanks should be washed as soon as possible after unloading. If possible, tanks should be heated prior to washing.

2. Residues in hatches and manholes should preferably be removed prior to the prewash.

3. Tanks should be washed by means of a rotary water jet operated at

sufficiently high water pressure and in locations to ensure that all tank surfaces are washed.

4. During washing the amount of water in the tank should be minimized by pumping out slops continuously and promoting flow to the suction point. If this condition cannot be met, the washing procedure should be repeated three times with thorough stripping of the tank between washings.

5. Tanks should be washed with hot water (temperature at least 60°C).

6. The number of cycles of the washing machine used should not be less than specified in the following table. A washing machine cycle is defined as the period between two consecutive identical orientations of the washing machine (rotation through 360°).

7. After washing, the washing machine(s) should be kept operating long enough to flush the pipeline, pump, and filter.

Number of Washing Machine Cycles to be Used in Each Location

Category of Substance	Number of Washing Machine Cycles	
	Non-Solidifying Substances	Solidifying Substances
Category A (residual concentration 0.1% or 0.05%)	1	2
Category A (residual concentration 0.01% or 0.005%)	2	3
Category B	1/2	1
Category C	1/2	1

SECTION 71

TANK LEVEL INDICATORS

71.1. GENERAL

Tank level indicators of a type designed for marine service shall be provided to serve the following tanks:

- All Fuel Oil Tanks
- All Fresh Water Tanks
- All Lube Oil Sump Tanks
- All Diesel Oil Service Tanks (including Emergency Generator Diesel(s))
- All Liquid Cargo Tanks (where provided)
- All Clean Ballast Tanks
- All Sewage Holding Tanks

Tank level indicating systems may be of the electric, electronic, pneumatic, mechanical or combination types. Local and/or remote reading tank level indicators may be provided to serve the tanks listed above. All tank level indicating systems shall be intrinsically safe types designed for marine service. Additionally, the systems and components shall be suitable for the particular application (i.e., compatible with fluids in the respective tanks and the environmental conditions which they shall be subjected to in actual operation). Components and systems provided in cargo oil (where provided), fuel oil, lube oil, and other tanks containing potentially hazardous fluids shall meet all applicable Regulatory Body requirements. The requirements of this SECTION are not intended to exclude necessary provisions for supplementary manual means of tank level sounding.

Testing of each tank level indicating system shall be in accordance with the system it serves. All tank level indicators subject to over-pressure shall be fitted with a device designed to prevent such over-pressure from being applied to the indicator. Such devices shall be so designed to assure that when overpressure is removed the indicators will respond accordingly to measure the tank levels with the same degree of accuracy and reliability present before the occurrence of excessive pressure in the tanks.

The instruments used for tank level indication may be powered electrically, pneumatically, mechanically, or combinations of any approved energy source. The energy source shall be easily replaceable and/or rechargeable with a minimum amount of special equipment or handling required. All devices shall be capable of operation in ambient temperature conditions above those encountered in normal operation and the environmental conditions associated with a corrosive marine atmosphere. Means shall also be provided for the testing of the power source and the entire liquid level instrument. Safety of the device shall be an absolute requirement. The instruments shall also be designed so as to be easy to clean and maintain.

The sensor, or that portion of the system located inside the tank, shall be capable of withstanding operational temperatures above the normal fluid temperature. Sensors shall be designed to function properly without becoming fouled or clogged by repeated immersions in the fluid being measured. The size of the sensor shall be such that it will not interfere with normal tank cleaning, inspection, or maintenance operations.

Tank level indicating systems shall be designed so that all components may be installed or replaced, calibrated, and maintained while the associated tanks are full and in service with the ship under way at sea. The system must also be designed so that the heading up of tanks which is normal with the system specified does not affect the accuracy and repeatability of the level indicating system.

When dial type indicators are used they shall have: a minimum effective scale length of 343 mm plus or minus 6 mm; a graduated scale length which subtends an angle of 240° for any tank indication; and shall be so designed to suitably withstand 1480 kPa overpressures without affecting calibration or repeatability of the instrument. Vertical or digital indicators shall be designed to provide the same readability and the same inherent degree of repeatability and accuracy under the same conditions listed above for dial indicators. The primary criteria for any reading instrument shall be based on human factors considerations, i.e., safety of operation; legibility and clarity of the readout with minimum chance of error in interpretation (within reasonable practical limits) shall be the benchmarks for approval of alternate indicating instruments not specifically delineated in these Specifications.

71.2. ELECTRICALLY OPERATED INDICATING SYSTEMS

Electrical and/or electronic type tank level indicating systems shall be designed to utilize the standard shipboard AC power source, DC battery bus, self-generated power, or other approved sources provided that such power sources are intrinsically safe where required in accordance with USCG requirements. Where applicable, the requirements stated in SECTIONS 70, 85, 87, 89, 90, 95, 96, and 99 of these Specifications shall be used in the design, manufacture, and installation of the systems and their components. The above requirements also apply to combination systems such as pneumatic-electric/electronic and mechanical-electric/electronic.

Electrical and/or electronic systems may be of the float (magnetic or mechanical), differential pressure, hydrostatic head, transducer or alternate types suitable for marine service. Electrical or electronic instruments for use in hazardous locations, such as fuel oil tank level and cargo oil tank level sensors, shall be explosion-proof or intrinsically safe as required by the Regulatory Body(ies).

In general, the electrical/electronic tank level indicator shall consist of a sensing element, some form of transmitting device, associated relay devices and cable, and an indicating instrument (vertical, dial, digital readout) which perform the functions of: sensing the tank level, effectively compensating for variations in fluid characteristics so as to provide the maximum practicable accuracy, transmitting the signal to the required number of local and/or remote reading instrument(s), and displaying the tank level in a form useful to operating personnel. All components installed in the tanks shall not be affected by any liquid normally carried in ship's service or cargo tanks.

The system design shall be such that heading up of the tanks will not affect the repeatability and accuracy of the level indicating system.

The indicating instruments or meters shall have easily read markings appropriate to the application and shall be semi-flush panel mounted (where practicable) in a quantity per display panel as required for the particular application.

Independent audible and visual level alarms may be provided in conjunction with the level indicating systems where appropriate. Level alarms (if provided) shall meet all requirements of the Regulatory Bodies and applicable SECTIONS of these Specifications. Additionally, level alarm points shall be adjustable and shall be provided in adequate numbers as required for safe operation and control.

71.3. PNEUMATICALLY OPERATED SYSTEMS

Generally, this type of level indicator shall operate on the hydrostatic principle whereby a head of liquid in the tank is balanced against an indicating medium. Pneumatic indicators shall be air operated by air supplied from the ship's control air system except that the level indicator for the potable water tank(s) may be fitted with a hand pump in lieu of the compressed air supply. Sufficient air stations shall be provided between the indicators and the control air system to provide reduced air pressure for operation of the indicators.

Standpipes in pneumatic tank level indicating systems shall terminate in an air bell so proportioned that liquid will not enter the smallest gage sensing lines and so as to minimize gage error when the tank is filled rapidly. Pipe installed inside any tanks bearing corrosive products other than fresh water shall be Schedule 80 or equivalent corrosion resistant material. Pipes of ferrous material shall have steel sleeves at the tank penetrations. Downpipes in fuel oil tanks shall be at least 25 mm nominal ips. The sizing and configuration of pipe runs from the tanks to the indicating instruments shall be compatible with the manufacturer's requirements. If possible, the copper tube lines for tanks shall run one full deck above their respective tank tops.

Each individual tank gage system shall consist of a manometer type level gage, air bubbler sight glasses, a cleanable orifice (if required), a standpipe, connecting tubing, and such other equipment that is essential to efficient design and satisfactory operation. The gages shall be constructed so that the indicating fluid cannot be blown out. Necessary traps, filters, needle valves, cleanable type orifices, and facilities for system purging shall be provided as required.

The testing of pneumatic tank level indicating systems shall be in accordance with the system which it serves (see Article 1 of this SECTION).

The system design must be such that heading up of tanks which is normal with the system specified does not affect the repeatability and accuracy of the level-indicating system.

71.4. MECHANICALLY OPERATED SYSTEMS

Local and/or remote reading mechanical tank level indicating systems may be provided to serve the tanks listed in Article 1 of this SECTION. The arrangement, location, and size of mechanical tank level indicators (if provided) shall be appropriate for the particular application. The same criteria (in terms of repeatability, accuracy, safety, readability, and environmental considerations) stated for the types of systems previously specified shall apply to mechanical tank level indicating systems.

Generally, mechanical tank level indicating systems shall measure tank levels by transmitting the position of float devices (sensors), which are installed within pipes or protective shields, mechanically by means of reels and gears (or linkages) or alternate suitable arrangements to the indicating instruments. Indicating instruments shall have easily read markings appropriate to the application. See SECTION 85 for detailed requirements for reading instruments associated with mechanical systems. See SECTION 95 for detailed requirements for electric remote readouts from mechanical tank level indicators.

71.5. ALTERNATE SYSTEMS

Even though the preceding articles concern three particular types of tank level indicating systems, consideration will also be given to alternate system designs and/or configurations or combinations of the systems previously described provided that the alternate systems meet the same requirements and exhibit the same degree of accuracy and reliability as the systems described in the other Articles of this SECTION. In any case the system configuration and principle of operation shall be consistent with the service or application. Tank level indication of sufficient accuracy for proper operation may be achieved by a simple graduated gage glass, mechanical float or marked petcocks in some non-critical applications, whereas sophisticated remote level indicating systems with multiple readouts and alarms are required for other applications such as cargo and ballast tank systems (where provided). The design and testing of alternate or combination tank level indicating systems shall be in accordance with the system which it serves.

71.6. TANK LEVEL INDICATOR PANELS

All fuel oil indicators shall be mounted on as few panels as practicable and should be visible from the fuel oil filling control station. In unattended machinery spaces and machinery spaces where the layout makes the above impractical, remote tank level indicators shall be mounted on the engine room console or in the engine control room in close proximity to the console. Critical water tank level indicators should be visible from the engine room control console. The lube oil sump tank level indicators should also be visible from the engine room control console.

Tank level indicator panels shall be of sturdy construction capable of withstanding stress and vibration encountered in marine operation. The panels shall be fabricated from steel, aluminum, or other approved material. The materials shall be corrosion resistant, galvanized or equivalently treated to prevent corrosion. The panels shall be adequately stiffened and/or supported.

Gages shall be provided for each tank served, shall be of an approved type designed for marine service and be of sufficient size to be clearly visible from their respective stations (see Article 1 of this SECTION).

Scales shall be graduated as follows:

Service	Scale Graduations
Fuel Oil	m, mm - cubic meters
Cargo Oil	m, mm - cubic meters
Water	m, mm - tonnes
Lubricating Oil	m, mm - cubic meters

Gages for liquid cargo tanks (where provided) shall be designed to accommodate the resultant head on the tank when filled with the liquid cargo of the highest density to be carried. These gages shall be provided with special multiple scales, or alternate means of compensation, appropriate for the entire range of specific gravities required in SECTION 68.

Suitable operating instruction plates and identification name plates shall be fixed to each panel.

SECTION 72

COMPRESSED AIR SYSTEMS

72.1. GENERAL

Three complete compressed air systems shall be provided: diesel engine starting, ship service, and control air service.

72.2. COMPRESSORS

Motor driven compressors shall be provided: two for diesel engine starting, one for ship service systems, and one for control air. The compressors shall be of the two-stage, single-acting air or water cooled with an air or water cooled intercooler (if required). Air intake filter and silencer, automatic unloader, automatic start-stop pressure switch, self-contained lubricating system, belt guard and accessories shall be provided. Controls for constant speed, continuous operation, consisting of unloaders set to maintain the pressure within the determined range, shall also be provided.

If belt driven, provision shall be made for belt adjustment by sliding motor rails or other suitable means.

72.3. CONTROL AIR COMPRESSOR

The control air system must be supplied with air containing 5 ppm or less oil carryover, and have a dewpoint of 2°C at line pressure. The control air compressor shall be of the centrifugal displacement type with water seal.

The pressure controls and unloading features shall be similar to those specified for the ship service compressor.

72.4. AIR RECEIVERS

There shall be a minimum of four receivers, two or more receivers for diesel engine starting, one for ship service air, and one for the control air system. Each receiver shall have a cubic capacity as shown in Machinery List and shall be of welded steel construction with dished heads. Each receiver shall be fitted with a pressure gage, safety valve, necessary connections, and hand holes for cleaning and inspection.

72.5. DIESEL ENGINE AIR START PIPING

Each starting air compressor shall be arranged to discharge directly to the main air start receivers.

The main air start receivers shall supply starting air directly to the main engines. A separate line from the air start receivers shall lead to a two valve station. This station shall supply starting air to the diesel generators.

72.6. SHIP SERVICE AIR PIPING

The ship service air compressor shall discharge through a check valve and moisture separators to the receiver.

The ship service air system shall be supplied from the ship service air receiver and shall distribute air to the following locations as needed:

- Machinery space for general service, in addition to those listed below
- Each deck in machinery casing for general service
- On Main Deck at forward and aft ends of main deckhouse
- Winch Motor Generator Rooms, after deckhouse if fitted, and each winch house
- Ship Service Generators
- Hydropneumatic pressure tanks
- Fuel injector testing unit
- Lubricating oil purifier workbench
- Steering Gear Room
- Shaft Alley
- Engineer's Workshop
- Electrician's Shop
- Emergency Generator Room
- Refrigerating machinery
- Diffuser Rooms, if fitted
- Fan Room
- Elsewhere as required

One hose connection shall be provided at each boiler front for use of air operated boiler cleaning tools. The air supply to these connections shall be not less than 32 mm ips.

Each ship service air outlet shall be fitted with a moisture separator and a hose valve. Where air is for cleaning purposes, such as in the workshops, an additional hose valve shall be provided with an orifice upstream to reduce the pressure to about 270 kPa.

72.7. CONTROL AIR PIPING

The reduction of the moisture content of the control air shall be accomplished by passing the air through a self-contained, refrigerated air cooler via a check valve with a discharge air temperature of 2°C. The air shall be piped uninsulated to its receiver via a moisture separator. The moisture separator shall be connected to a suitable drain to carry off the residual moisture. The self-contained refrigerated air cooler shall also be fitted with a trap connected to a drain.

The control air system shall be supplied from the control air receiver and shall distribute air of the previously specified quality, at the required pressure, for all pneumatically operated control valves and devices.

72.8. HOSE

Eight 20 m lengths of approved type air hose shall be supplied. Each hose shall be fitted with detachable, quick disconnect, couplings. Hose shall be stowed in galvanized hose racks in convenient locations in the spaces to be served.

72.9. WHISTLE

See SECTION 94, Item 8. for air whistle requirements.

SECTION 73

PUMPS

73.1. GENERAL

All pumps shall be of a high commercial marine standard.

The pumps shall be as specified in the Machinery List, SECTION 50, but in all cases the pumping equipment shall be suitable and adequate for the service intended.

Where two or more pumps of the same size and type are specified for a particular service, 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.

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 insure proper alignment.

All vertical pumps, including reciprocating, shall be entirely supported either by a horizontal foundation or from a vertical ship structure, but not both. Vertical pumps 0.74 kW and above shall be provided with substantial brackets to support the drivers and with bases for the units mounted on the tank top or with supporting lugs if mounted on the bulkhead.

Bases for pumps handling oil shall be provided with oil troughs and drains. Drains should terminate in contaminated oil tank if feasible.

Each pump shall have a pressure gage connected on the discharge side and a compound pressure gage on the suction side, provided before the stop valves. Suitable provision shall be made for using a portable tachometer to determine the speed of motor driven and turbine driven pumps.

All pump connections 38 mm and over shall be flanged in accordance with American National Standards. 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. Pump components with large mating surfaces, shall be properly doweled and provided with jacking bolts for breaking joints. A vent shall be located at the top of the casing and a drain at the bottom.

Heavy pump components shall have proper arrangements for the attachment of lifting gear.

Mechanical seals shall be provided for pumps where specified except for rotary types and those for vacuum service. For sea water pumps, to preclude problems with grit, sand and mud, filtration of sea water flushing should be provided.

Where possible, pumps shall be balanced hydraulically. All pumps shall be equipped with suitable thrust bearings to absorb any primary or residual thrust which may occur during operation or when the pump loses suction. Vertical motor driven units shall be designed so that the thrust load and the entire weight of all moving parts will be carried by a thrust bearing located in the driver or by a separate thrust bearing mounted on the upper bearings contained in housings and removable as a unit with the pump shaft. Sleeve type bearings may be used with oil, grease or clean water lubrication only. Where water jacketing is supplied, jackets shall be formed by cored casting with no joints offering possibilities of jacket water leakage into the bearings. Bearing water shields or slingers shall be provided.

Special consideration must be given the bottom bearing of vertical pumps mounted on inner bottom to prevent bilge water from splashing into the bearing. Generally bearings shall be grease or oil lubricated, as sea water will not be allowed as a lubricating medium. Grease fittings for bearings located below the floor plate level shall be provided with extensions so as to be clearly visible and readily serviced from the floor plates. Bearing lubrication shall be such to preclude the necessity of lubrication at short intervals.

The following shall be furnished: a bill of materials with ASTM or other commercial reference for all materials, characteristic curves showing the expected performance throughout each pump's operating range and the required NPSH where critical (i.e., for condensate pumps, auxiliary feed pumps and other pumps handling hot fluids near their flash points).

73.2. CENTRIFUGAL

(a) General

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 power shall at least equal the maximum power requirement of the pump at rated speed without allowance for a service factor.

(b) Construction

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

Close coupled pumps, i.e., those having both the motor rotor and impeller mounted on the same shaft, shall be of the heavy duty type and shall be suitable for horizontal or vertical mounting with thrust bearings provided. Glands, where used, shall be of two piece construction and gland studs shall be not less than 9.5 mm in diameter. Suction piping connected to this type of pump must be arranged so the impeller can be removed without disturbing the suction and discharge valves.

Any salt water pump which has a suction lift or is located near the light draft water line shall be arranged for connection to the priming system or shall be of the self priming type. These pumps must be designed to operate dry during the priming period without damage. If a priming system is fitted, the emergency bilge pump shall be connected to it.

Where dry running is a pump operating mode, it shall be so specified as in the pump requirements.

Vents on salt water pumps shall be fitted with a connection to the bilge to permit continuous venting.

Multi-stage pumps shall be fitted with case bushings. All casings shall be fitted with case wearing rings and, where applicable, stuffing box throat bushings.

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

(c) Materials

The materials for the component parts of the centrifugal pumps shall be as follows. Equivalent or superior materials may be substituted.

Components	Materials	Service
Casings	Comp. "G" or Ni-Al-Brz	Sea Water Pumps
	Comp. "G", "M", Ni-Al-Brz, Ductile Iron, Close Grained Cast Iron, or FRP	Pumps handling fresh water
Impellers	Comp. "G", Ductile Iron, Ni-Al-Brz, or FRP	Fresh water pumps
	Ni-Al-Brz	Pumps handling sea water with discharge pressures 780 kPa and over
	Comp. "G", Ni-Al-Brz, or FRP	Pumps handling sea water with discharge pressures less than 780 kPa
Shafts	As approved or Monel with sleeve	Sea Water Pumps
	Steel with Sleeve, Stainless Steel	Pumps handling fresh water other than condensate
Shaft Sleeves	"K" Monel, Stainless Steel, Bronze	Pumps with steel shafts
Impeller Wearing Rings	Same material as impeller (if fitted)	All Services
Case Wearing Rings	Comp. "M" or Ni-Al-Brz (if fitted)	All Services
Gland Water Seal Rings	Monel or Comp. "G" or Ni-Al-Brz (if fitted)	All Services
Stuffing Box Bushings	Comp. "M" or Ni-Al-Brz (if fitted)	All Services
Gland Studs and Nuts	Comp. "M" or Ni-Al-Brz	All Services

Components	Materials	Service
Packing	Semi-Metallic or Mechanical Seal	All Services
Couplings	Steel or as approved	All Services
Supporting Brackets and bases	Cast or welded steel, Ductile Iron, or as approved	All Services
Bolting Material	Bronze, K-Monel, steel	S.W. Services All others

The materials used for pumps shall be supplied to meet the requirements of the classification and regulatory bodies, where applicable, and to meet the following commercial standards:

Material	Commercial Specification
Nickel-Aluminum-Bronze	ASTM B148-71, CA No. 955
Composition "G" Bronze	ASTM B584-73, CA No. 905
Composition "M" Bronze	ASTM B584-73, CA No. 922
S-Monel	QQ-N-288 Composition D
K-Monel 500	QQ-N-286
Stainless Steel	
"18-8"	ASTM A296
Shaft & Sleeve 416	ASTM A582
12 percent chrome	ASTM A296
Diffusers & Diaphragms	ASTM A296
Ductile Iron	ASTM A395
	ASTM A445
	ASTM A536, Grade 60-40-18
	MIL-I-24137, Class A
Cast Iron	ASTM A48, Class 30
	ASTM A278, Class 30

73.3. ROTARY PUMPS

(a) General

Rotary pumps shall be of the helical-screw, herring-bone-gear, vane or cam type. Preferably pumps shall be direct coupled to drivers but where necessary may be provided with reduction gears.

Where the pump is internally lubricated by the fluid pumped, wearing parts shall be of such design and materials that the pump may be operated safely for short periods when pumping liquids of non-lubricating character.

(b) Construction

Bearings shall be ball or roller bearing type, except that pumps with internal bearings may have bearings of the sleeve type. Anti-friction bearings shall be of the sealed type, except when lubricated by the fluid pumped, and shall be designed and sized to have a minimum service life of 20,000 hours. If the pump is to be used for pumping non-lubricating fluids or fuel oils, bearings and timing gears, if fitted, shall not be located in the fluid being pumped.

Mechanical seals shall be used.

Replaceable bearings shall be fitted on helical-screw type pumps.

The materials for the component parts of rotary pumps shall be as follows. Equivalent or superior materials may be substituted.

Casings	Steel or Ductile Iron
Timing Gears (if required)	Steel or Ductile Iron
*Rotors	Steel, Ductile Iron, or Cast Iron
*Shafts	Steel
Gland and Gland Studs	Steel
Gland Nuts	Brass
Stuffing Box and Gland Bushings (where used)	Composition "M" or Ni-Al-Brz

*Note: Material shall be capable of withstanding the fluids to be pumped.

73.4. FUEL OIL SERVICE PUMPS (FOR MEDIUM SPEED DIESEL)

The fuel oil service pumps shall be of the positive displacement type designed to pump diesel oil and heavy fuel oil with a viscosity up to 700 cSt. The rated capacity shall be as specified for heavy fuel oil at 25.2 cSt while the power shall be calculated at 700 cSt. Although the fuel oil system shall be designed so that there is a positive head at the inlet of the pump, the fuel oil pump shall be capable of 33.76 kPa lift with diesel fuel and 50.7 kPa lift with heavy fuel at 700 cSt.

73.5. FUEL OIL BOOSTER PUMPS (FOR SLOW SPEED DIESEL)

The fuel oil booster pumps shall be of the positive displacement type designed to pump diesel oil and heavy fuel oil with a viscosity up to 700 cSt. The rated capacity shall be as specified for heavy fuel oil at 25.2 cSt while the power shall be calculated at 700 cSt. Although the fuel oil system shall be designed so that there is a positive head at the inlet of the pump, the fuel oil pump shall be capable of 33.76 kPa lift with diesel fuel and 50.7 kPa lift with heavy fuel at 700 cSt.

73.6. FUEL OIL TRANSFER PUMP

The fuel oil transfer pump shall be of the positive displacement type and shall develop rated capacity at specified head with an oil viscosity of 98.8 cSt when operating at full speed with horsepower requirement calculated at 700 cSt. The design suction lift shall not be less than 5.7 kPa at full-speed.

73.7. LUBE OIL SERVICE PUMPS

Lube Oil Service Pumps shall develop rated capacity while pumping oil with a viscosity of 27.5 to 110.0 cSt at specified head. The lube oil pumps shall be of the rotary or submerged centrifugal type.

73.8. MAIN SEAWATER PUMPS

The pumps shall be of the centrifugal or positive displacement type; vertical or horizontal; single stage; motor driven; fluid pumped: seawater.

73.9. ENGINE FRESH WATER COOLING PUMPS (JACKET WATER COOLING AND CENTRAL COOLING)

The pumps shall be of the centrifugal or positive displacement type; vertical or horizontal; single stage; motor driven; fluid pumped: fresh water.

73.10. PISTON COOLING PUMPS (if provided)

The pumps shall be of the centrifugal or positive displacement type; vertical or horizontal; single stage; motor driven; fluid pumped: fresh water or lube oil.

73.11. INJECTOR FUEL VALVE COOLING PUMPS (if provided)

The pumps shall be of the centrifugal or positive displacement type; vertical or horizontal; single stage; motor driven; fluid pumped: fresh water or lube oil.

73.12. DISTILLING PLANT PUMPS

The distilling distillate pumps and the brine overboard discharge pumps shall be fitted with vent connections, except where pumps are self priming.

73.13. PRIMING PUMP

If required, an automatic central priming system of the vacuum control type shall be provided. The priming pump shall be of the centrifugal displacement type and shall have a sealing water tank and a vacuum tank which shall be welded steel construction, galvanized after fabrication.

SECTION 74

GENERAL REQUIREMENTS FOR MACHINERY PRESSURE PIPING SYSTEMS

74.1. GENERAL

This SECTION contains the general requirements for all machinery pressure piping systems which shall be used in conjunction with the requirements of the Regulatory Body(ies). For detailed and/or specific requirements of a particular system, refer to the applicable SECTION which describes the system.

74.2. SYSTEM DESIGN

System piping and associated components shall be designed to provide adequate flow to auxiliary equipment. The use of automatic-type regulators and/or restrictive devices, such as orifices, in lines servicing auxiliary components, such as heat exchangers, shall be permissible for obtaining and maintaining operational conditions, providing such appurtenances do not impose undue restrictions, such as large pressure drops (necessitating increase in pumping power) and destructive erosion conditions.

Orifices, where required, shall be incorporated at flanged joints. The design of orifices shall be such that a portion of each protrudes beyond the incorporating flanged joint thereby indicating its presence and size, which shall be stamped thereon.

All automatic type control valves shall be designed and installed to meet full operational requirements and permit local adjustment, inspection and maintenance without removal from line. They shall also be designed to "fail-safe" with respect to the system's function. (Valve shall be designed to assume a fail position which will satisfy the requirements of system safety while affording continued operation).

A self-cleaning "Y" or basket type strainer shall be incorporated upstream of each automatic type control valve. Strainers, except those for oil services, in Machinery Spaces shall have accessible valved blow-off lines to bilge.

Cutout, isolation and/or stop type valves shall be incorporated in sufficient quantity for individual and/or sectional control of the various units of equipment, branch lines, and mains (headers) for meeting operational conditions, and to facilitate full maintenance operations.

Check type valves shall be incorporated wherever flow reversals would be detrimental to operation requirements. Stop-check type valves shall be incorporated wherever flow reversals could flood a space. Wafer type check valves may be used on systems approved by the Owner.

Manually operated valves shall be readily operable by one man, directly or through mechanical advantage type operators.

Trap selection and sizing shall be on the basis of intended service, service conditions, and a continuous flow capacity rate of not less than twice the maximum anticipated rate of condensation (at condensate temperature equal to steam temperature). Connecting pipe sizes shall not constitute a basis for sizing traps. Constant flow drain orifices may be used where approved by the Owner.

The maximum allowable velocities for the various systems' media, in conjunction with the line sizing, shall be based on pressure drop determined by pressure and flow requirements of incorporated equipment and appurtenances within a system without imposing an unwarranted (economically) increase in the system's pumping facilities.

Velocity of water, except sea water and/or brine, in constantly running systems shall not exceed 4.57 m/s free-stream velocity. Sea water and/or brine velocity shall not exceed the product K*D, where D is the actual inside diameter of the pipe in millimeters, the velocity is in m/s, and the value of K is 0.3024. However, in no case shall this velocity exceed 3.66 m/s. The velocity of sea water and/or brine at inlet nozzles of and within tubular heat exchanger units shall not exceed 1.83 m/s.

Diesel oil system velocity shall be limited generally to a maximum of 4.57 m/s for shipboard operations (suction, discharge, and transfer). However, for "Taking On" and "Unloading" operations the maximum allowable velocity shall be 7.62 m/s.

Lube oil "suction" velocity shall be limited to a maximum of 1.22 m/s.

74.3. INSTALLATION

Piping installation shall permit: free passage along walkways and ladderways; free access to perform shipboard operational and routine maintenance; free access for, and to perform, cargo handling; and free access to all doors, hatches and openings covered by portable plates. Where impracticable for piping to be clear of removable plates, piping shall be made portable for easy access.

To facilitate inspection and maintenance (including tube or tube bundle withdrawals) on components having removable heads, the piping connecting thereto shall be arranged to permit removal of heads without breaking more than the connecting flanges.

Unavoidable low points and/or pockets shall be fitted with either flanged or bossed drainage facilities suitable for the particular system involved. Drainage points requiring drainage only during start-up or during infrequent or intermittent operation in service such as soot-blower and those requiring relatively frequent manual drainage in service such as salt water defrosting systems and liquid cargo lines, shall be provided with valved drains only. Other points requiring drainage only infrequently, in conjunction with maintenance, may be provided with screwed plugs.

Where screwed plugs are incorporated they shall not be insulated and shall, in general, be brass for either ferrous and nonferrous materials. However, plugs exposed to sea water and/or brine shall be monel, while plugs exposed to temperatures over 208°C shall be stainless steel Type 316.

Pressure control stations (reducing or regulating), unless specifically approved otherwise, shall consist, in the following order, of an isolation valve, self-cleaning strainer with valved blow-off, automatic control type valve, isolation valve, pressure gage, and relief valve (where necessary). A single valved bypass line shall be incorporated, connecting upstream of the upstream isolation valve and downstream between the downstream isolation valve and pressure gage.

74.4. RESTRICTIONS

No piping shall pass through refrigerated, medical, and/or predominantly electrically equipped spaces, unless directly associated with and/or servicing such spaces. Such piping shall be of one length throughout unless installation dictates otherwise. Necessary joints shall be either welded or brazed sleeved joints or otherwise shielded as approved.

Piping conveying flammable media shall be routed to avoid being located over hot surfaces, unless adequately shielded, and shall be located at least 457 mm from high temperature steam lines.

Piping penetrations through non-watertight flats shall have a watertight coaming, not less than 76 mm high, to prevent drainage to the space below or piping to be welded directly to the flat, depending upon service conditions.

Piping penetrating integral hull tank tops, flats, and decks shall be fitted with Schedule 80 pipe sleeves at all locations where such pipes are subject to damage from corrosion due to standing water or from physical abuse. Pipes shall pass through sleeves which are continuously welded on both sides of the plating. Sleeves shall extend 152 mm above and 25 mm below the plating. Pipes shall be continuously welded to the sleeve top and bottom.

Non-socket pipe weldments (buttwelds) for services such as feed pump discharge, fuel oil service discharge, lube oil service supply, and steam generator discharge shall be fitted with the consumable insert type backing ring.

Butterfly type valves shall be suitable for use with all types of flanges and in locations requiring "shut-off" for joint "breakdown" for maintenance without interruption of service to the rest of the system(s). Butterfly valves shall either be of the drilled and tapped lug type, with fastenings to each mating flange or be equipped with an adjacent flanged spool piece connecting the equipment or flanged joint.

Gate valves shall not be used for throttling services, nor shall resilient-seated butterfly type valves be used where close controllable throttling is mandatory.

All globe type valves shall be of the regrindable type, and shall be incorporated with the system's pressure under the disc.

Swing-check type valves shall be incorporated, where practical, in a fore and aft direction.

Except where otherwise specified, the designation of valve trim includes the following: stem, disc, disc nut, seat, back seating bushing, and guides.

Use of mitered joints or fittings shall not be permitted except where other types of fittings are not practical.

The use of cocks in place of valves is not permitted.

Drains from piping and equipment shall not be less than 15 mm ips.

Cap screws shall not be used for valve bonnets.

74.5. CORROSION PRECAUTIONS

Piping conveying sea water, brine, and/or other corrosive media shall be protected from the effects of corrosion and/or corrosion erosion by the adoption of the following:

(1) Valves and fittings (except resilient-seated butterfly type valves and other approved lined or liner type valves and fittings) in nonferrous piping runs shall either be bronze or material comparable to the applicable piping material.

The seats, discs, stems, and other internal trim of all valves, including reducing valves, exposed to sea water shall be bronze except that the discs of fire station hose valves shall be of approved molded composition. All valve stems shall be rolled bronze.

(2) Where joints of ferrous and nonferrous materials cannot be avoided, a short "waster piece" at least 305 mm of extra-heavy steel pipe

shall be provided between the dissimilar metal lines. However, no "waster piece" is required where a nonferrous line connects to a ferrous line having a diameter two or more times larger. Waster pieces shall be designed for easy replacement and incorporated in readily accessible locations.

(3) Turbulence of flow(s) shall be minimized to curb corrosion/erosion by restricting the velocities with the specified limits; by elimination of abrupt changes of pipe diameters in piping runs and connections through the incorporation of gradual transitions in diametral changes, and by the use of long-radius bends and fittings, sweep tees, and "Y" and lateral type fittings. To assure smooth flow within the pipe, the following should be avoided: misaligned flanges, pipes not finishing flush with the flange face, protruding jointing material, weld or braze bead on the inside of the pipe, and in general, sharp changes of direction and pipe sections.

Body passages in throttling devices shall be designed to provide gradual changes in flow direction. In addition, the downstream cavity shall be as large as practical to permit dissipation of the issuing jet before making wall contact.

At points where direct impingement at close range does occur, and cannot be avoided, section thickness shall be increased to provide adequate material to withstand the additional erosive effect. All piping downstream of throttling devices shall have a straight run at least 10 times the pipe inside diameter.

74.6. WHISTLE

A whistle, air operated, shall be provided, located on the stack, and incorporated as per the requirements of the Regulatory Body(ies) and the following:

(1) The whistle and its appurtenances, designed for shipboard installation, shall be of a size comparable to the vessel's tonnage, having an audible range not less than 6.43 km in all directions on a calm clear day and/or a decibel rating at 30.5 m of not less than 118.

The whistle shall be capable of instantaneous sounding at each actuation regardless of elapsed time since previous sounding and after several hours of exposure to sub-zero and/or snowy weather.

(2) The whistle shall generally be of the low-toned, loose multi-leaf, diaphragm type and shall be of bronze construction, with phosphor-bronze diaphragm(s) and stainless steel internals.

(3) Controls, both manual and automatic, shall be provided as described

in SECTION 94.

Should the vessel require a second whistle, consideration will be given to an electric whistle located forward, preferably on the foremast.

74.7. CLEANING

All piping, piping appurtenances, and applicable equipment shall be thoroughly cleaned after fabrication and prior to installation shipboard. After complete shipboard installation each system shall be thoroughly cleaned and flushed of all foreign matter with the applicable system's medium, or an approved substitute.

System flushing shall be conducted at the applicable system's maximum operating pressure and temperature, and above normal line velocity. Line vibrators, of the temporary in-line and/or portable hand types, shall be employed in all applicable systems, particularly the lube oil servicing systems. However, prior to flushing operations, such units as auxiliaries, turbines, heat exchangers, and control valves, having in-line mechanisms capable of trapping, or affected by the carry-over, of foreign matter, shall either be removed or blanked-off and bypassed.

74.8. IDENTIFICATION

Systems, associated components and/or equipment piping and appurtenances shall be readily identifiable as to their identity, and as applicable: operational characteristic, service, and direction of flowing medium. Valve name plates shall be securely attached to all valves.

Identification methods shall comply with the requirements of the Regulatory Body(ies), consisting of one, or a combination of the following:

Label Plates: brass and/or metal photo process

Stenciling and/or Color Coding

SECTION 75

INSULATION - LAGGING FOR PIPING AND MACHINERY

75.1. GENERAL

Where surface temperatures are normally between 52°C and 66°C and the omission of insulation will not adversely affect operational efficiency, non-metallic lagging only may be applied, where necessary, to protect personnel from contact with hot metal surfaces.

Insulated and fabric-lagged surface temperature shall not exceed 66°C; metal or metallic type lagging surface temperature should not exceed 52°C when in areas susceptible to personnel contact.

Piping and units of equipment with design internal temperature of 150°C and over or 10°C and under shall be insulated from their supports or the supports insulated from the structures to which they are attached where the heat transmitted may be objectionable on the other side of the structure.

On piping and tubing sized less than 10 mm ips, attaining 52°C to 400°C suitable thermal insulating tape, shall be applied where applicable for personnel protection.

Insulation in way of supporting hangers shall be adequately protected against crushing.

For painting of surfaces before application of insulation and after application of lagging, see SECTION 14.

75.2. MATERIALS

NOTE: Insulating or lagging materials which contain asbestos shall not be used.

(a) Insulating Materials

Insulating materials, defined as materials applied to offer resistance to heat flow shall be of the below type or equivalent. To determine specific insulation material construction requirements utilize the standard document ASTM F683, "Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery".

<u>Low Temperature (-34°C to 52°C)</u>

Cellular Glass, Fibrous Glass, Foamed Plastics (Including Flexible, Rigid and Mineral Fiber)

*NOTE: Foamed plastics having a freon base blowing agent shall not be applied to any freon piping.

<u>Medium Temperature (53°C to 315°C)</u>

Calcium Silicate, Felt Fiber, Fibrous Glass, Mineral Fiber, Cellular Glass

<u>High Temperature (316°C to 537°C)</u>

Calcium Silicate, Felt Fiber, Fibrous Glass, Mineral Fiber

<u>High Temperature (538°C to 649°C)</u>

Calcium Silicate, Felt Fiber, Fibrous Glass

(b) Lagging Materials

Lagging, defined as the protective and confining covering or jacket placed over the insulating materials, shall be of the below type or equivalent. To determine specific lagging material construction requirements utilize the standard document ASTM F683, "Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery".

Brattice Cloth (-29°C to 260°C), Fibrous Glass (Cloth, tape and thread), Aluminum (Nominal thickness, mm 0.4), Sheet Steel (Hot-dipped galvanized -Nominal thickness, mm 0.35), PVC (To be used in area where USCG restrictions regarding incombustibility are not in effect)

(c) Adhesives, Coatings & Sealing Compounds

To determine specific adhesive, coating and sealing compound requirements, utilize the applicable documents referenced in the standard document ASTM F683, "Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery".

75.3. APPLICATION

(a) Piping Insulation

In general, single layer type insulation shall be applied on piping having internal temperatures up to 260°C. For piping over 260°C either single or double-layer insulation may be applied. Suitable expansion joints to permit thermal movement of piping, without opening of insulation joints shall be provided.

In double-layer construction, the second layer shall be applied over the first layer so that all joints are staggered.

Straight runs of piping or tubing shall generally be insulated with molded or pre-formed type materials. Butt-end and longitudinal joints surfaces shall be buttered with an approved joint compound, not more than 1.5 mm thick.

On bends, elbows, etc., pre-formed or fabricated segments of the same insulation on adjacent straight runs shall be applied. All joints shall be tightly fitted and cemented together with an approved joint sealing-adhesive compound. Where required for rigidity, usage of galvanized iron wire mesh or netting shall be incorporated. Insulating or insulating-finishing cements shall be applied to fill crevices and/or smooth all surfaces, as required.

Typical 0.9 meters lengths of insulation shall be secured with No. 18 gage galvanized iron wire at three points on piping up to and including 152 mm diameter and not less than four points on larger pipes--6 meters lengths and less shall be secured at two points.

Application of a vapor barrier is not required on flexible (elastomeric) foamed plastic insulation, nor is lagging required except where such insulation would be subject to damage.

Suitable anti-sweat type insulation shall be applied, where required, and secured with heavy twine. Where piping or tubing passes through the galley and other humid spaces, the insulation shall be double layer, waterproofed outside of each layer.

Anti-sweat insulation, other than flexible (elastomeric) foamed plastic type, shall be covered with either cloth or tape lagging secured with an adhesive to form a moisture-proof finish.

All insulation surfaces, including the outer surface(s), shall be coated with a vapor sealer at time of application, where applicable.

THICKNESS TABLES

Thickness

The minimum insulation thickness for -34°C to 13°C surfaces, listed in TABLE "A" and TABLE "D", are based on usage of cellular glass material which does not preclude usage of other acceptable materials.

LOW TEMPERATURE PIPING INSULATION (-34°C to 52°C)
TABLE A
THICKNESS IN MILLIMETERS OF INSULATION FOR PIPING

	Design Internal Operating Temperature °C		
Pipe sizes mm	Column 1 -34°C to -29°C	Column 2 -30°C to 2°C	Column 3 3°C to 52°C
100 and below	76	64	38
125 thru 200	76	64	51
250 and above	89	76	51

NOTE: Refrigerant supply piping ahead of expansion valve need not be insulated where ambient temperature is less than 49°C, except where dripping may cause damage or discomfort.

Piping leading to and from refrigerated spaces shall be suitably insulated for reasonable distance from the spaces to prevent heat transfer.

MEDIUM TEMPERATURE PIPING INSULATION (52°C to 315°C)
TABLE B
THICKNESS OF PIPING INSULATION

	Design Internal Temperature Range				
Nom. Size mm	52°C to 93°C	93°C to 148°C	149°C to 204°C	205°C to 259°C	260°C to 315°C
	Nominal Thickness of Insulation, mm*				
38 + under	25	25	25	38	38
51	25	25	38	38	51
64 to 76	25	25	38	51	51
89	25	38	38	51	51
102	25	38	38	51	64
127	25	38	51	51	64
152	25	38	51	51	64
203	38	38	51	64	76
254	38	51	64	64	76
305	38	51	64	76	76
356 + over	38	51	64	76	89

*NOTE: Actual thickness to conform to the National Manufacturers Association Table of Simplified Thickness.

HIGH TEMPERATURE PIPING INSULATION (316°C to 537°C)
TABLE C
THICKNESS FOR AN INNER LAYER OF HIGH TEMPERATURE INSULATION AND AN OUTER LAYER OF MEDIUM TEMPERATURE INSULATION, MILLIMETERS

Design Int. Temp	316°C to 371°C			372°C to 426°C			427°C to 482°C			483°C to 537°C		
Nom. Pipe Size mm	A	B	C	A	B	C	A	B	C	A	B	C
38 or less	51	none	51	51	none	51	64	none	64	64	none	64
51	25	38	64	25	38	64	25	38	64	38	25	64
64	25	38	64	25	38	64	38	38	76	38	38	76
76	25	38	64	25	51	76	38	38	76	38	38	76
89	25	38	64	25	51	76	38	38	76	51	38	89
102	25	51	64	25	51	76	38	38	76	51	38	89
127	25	51	76	25	51	76	38	51	89	51	38	89
152	25	51	76	38	51	89	38	51	89	51	51	102
203	38	51	89	38	51	89	51	51	102	51	51	102
254	38	51	89	38	64	102	51	51	102	64	51	114
305	38	51	89	38	64	102	64	51	114	64	51	114
356	38	51	89	38	64	102	64	51	114	64	51	114

KEY: A - High Temperature Inner B - Medium Temperature Outer C - Total

NOTE: The thickness of the two materials may be varied somewhat but the total thickness shall be at least equal to the sum of the two thickness shown with the thickness of the high temperature insulation at least as shown in the above Table.

(b) Machinery and Equipment Insulation and Lagging

Machinery and equipment shall be insulated with molded, curved or shaped segmented block within limitation of commercial standards in lieu of blanket of felted type materials.

When metal surface temperatures are less than -18°C, a double layer construction shall be used. Insulation shall be installed with all joints staggered for both single and double layer. All inside surfaces and joints shall be thoroughly coated with a thin layer of vapor sealer. Outer surfaces shall be coated at time of installation. An angle iron support for the base source of block type material on vertical equipment shall be provided. The horizontal leg of the angle iron shall be approximately 12.7 mm less in length than the insulation thickness. All insulation shall be tightly wired to prevent settling. All joints in medium and high temperature applications shall be pointed up with insulation cement.

Insulation on auxiliary boiler drums and similar surfaces shall be lagged as follows:

> Apply a 12.7 mm coat of a mixture of 4 parts of insulating cement and one part of Portland cement, reinforced with hardware cloth. After drying 24 hours, apply two coats of hard finish insulating cement, allowing one hour for each to dry. The whole shall then be covered with fibrous glass cloth to which has been applied adhesive lagging cement.
>
> Evaporators, tanks, auxiliary boiler uptakes, and similar surfaces shall have the insulation lagged with a 12.7 mm thick hard finish insulating cement reinforced with hardware cloth.

TABLE D

THICKNESS IN MILLIMETERS OF CELLULAR GLASS
INSULATION FOR COOLERS, TANKS, ETC.

	Design Internal Operating Temperature, °C		
Unit Size Dia. mm	Column 1 Below -29	Column 2 -29 to 2	Column 3 2 & over
Below 635	89	76	51
635 to 940	102	89	51
940 thru 1219	114	102	51

THICKNESS IN MILLIMETERS FOR INSULATION OF LARGE SURFACES

Design Internal Temperature	High Temp Insulation	Med Temp Insulation	Insul. Cement	Total
52°C to 93°C	-	25	12.7	38
93°C to 148°C	-	38	12.7	51
148°C to 204°C	-	51	12.7	64
204°C to 260°C	-	64	12.7	76
260°C to 315°C	-	76	12.7	89
315°C to 371°C	25	51	12.7	89
371°C to 426°C	38	51	12.7	102
426°C to 482°C	64	38	12.7	114
482°C to 537°C	76	25	12.7	114

(c) Lagging

Piping and/or equipment insulation not exposed to weather shall be covered with either a cloth, tape, or rewettable type lagging, when not of the pre-lagged type insulation.

Lagging in tape form shall be applied spirally wound with not less than 9.5 mm overlap and with ends fastened to the insulation and/or lagging by either adhesives, stitching or stapling.

Insulation on piping and/or equipment exposed to weather or excessive moisture shall be protected by the application of a 6.4 mm thick weather-resistant type coating thereon and secured in place, prior to application of its lagging.

In locations where the completed insulation and lagging is liable to abuse protective galvanized sheet metal lagging of No. 20 USSG shall be installed.

All insulation and lagging alongside of hatches subject to mechanical injury shall be protected by a 6.4 mm checkered and heavy angles.

(d) Removable-Reusable Covers or Pads

All piping components and applicable machinery, susceptible to takedown for inspection and maintenance, shall make use of readily removable-reusable type covers or pads.

Covers and/or pads shall generally be made of applicable felted material completely lagged. To ensure non-interference with servicing or takedown joints and installation of flexible covers, the permanent insulation shall stop short of takedown joint and a short removable-reusable section of insulation installed between the permanent insulation and the takedown joint.

When installing the subject covers or pads, all spaces or voids beneath the inner surfaces shall be filled with pieces of applicable felted material. Pieces shall be packed loosely enough to preserve air cell structure, but tightly enough to prevent air circulation.

75.4. ALTERNATIVE INSULATION REQUIREMENTS

For alternative practices in insulating piping and machinery, the contractor may adhere to the materials, thicknesses and installation requirements provided in the standard document ASTM F683, "Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery".

SECTION 76

DIESEL ENGINES DRIVING GENERATORS

76.1. SHIP SERVICE GENERATOR ENGINE(S)

At least three medium speed diesel engines or a combination of two medium speed diesel engines and one power take-off (PTO) from the main diesel engine or shafting shall be provided for driving the ship's service generators. Capacity and characteristics of the generators shall be as specified in the "List of Machinery" of SECTION 50 and in SECTION 88. The engines shall be capable of driving their generators continuously at the generator's specified rating. The engines shall be capable of burning heavy fuel oil or diesel oil.

Each diesel engine driving the ship's service generators shall be capable of automatically assuming the ship's service electrical load within 30 seconds after running generator failure in a single step.

Each diesel engine with its generator shall be mounted on a common bed plate. It shall have a normal continuous capacity at its marine rating sufficient to meet the rating of its generator. It shall be a non-reversing, single acting, two or four cycle, inline or V-type, engine designed to operate on fuel oil as specified herein.

Each engine generator set shall be complete with all attached and unattached accessories including turbo-charger (if provided), air intake filters and silencers, air starting system, fresh and raw water pumps, lube oil, and fuel oil pumps, injectors and filters, governing and regulating systems, tachometer, generator, exhaust muffler, fresh water and lube oil coolers, lube oil filters, instrument boards, starting air tanks, integral piping valves, and related items. The sets shall be complete with local and remote monitoring and contact systems including safety devices required by Regulatory Body(ies).

The fuel supply for each diesel generator shall be from diesel oil service/day tanks in the engine room.

The engines shall be capable of local, remote and automatic starting, stopping, and being ready to take load within 30 seconds after running generator failure. Re-energizing of the starting motor while the engine is running shall be prevented by a suitable interlock.

The capacity of the starting system shall permit not less than six cranking cycles. Each cranking cycle shall consist of the necessary number of revolutions at the required engine rpm to permit the diesel engine to meet the starting requirements specified.

The ship service diesel generators shall be of the self-contained fresh water, closed circulation type complete with salt water to fresh water heat exchanger, attached fresh water and salt water pumps, thermostatically controlled valve for heat exchanger, surge tank with gage glass and float make-up valve, vent line, and other related items. The heat exchanger shall be sized to cool the fresh water to the proper operating temperature when supplied with sea water at 32°C. The fresh water system shall furnish cooling water to the lube oil cooler. Designs using a separately mounted motor driven sea water cooling pump will be considered.

Central fresh water cooling systems are also acceptable.

The exhaust gas from each auxiliary diesel generator shall be led separately to the atmosphere through a combined spark arrestor and silencer.

The entire mass elastic system of the engine and connecting masses rotating with the engine shall have no dangerous peaks or torsional vibration within the operating range. The operating range shall be considered to be up to the overspeed governor.

76.2. EMERGENCY GENERATOR ENGINE

The high speed diesel engine driving the emergency diesel generator shall be of the single acting, mechanical injection, two or four stroke cycle, inline or V type, direct-connected to the generator and mounted on a common cast or fabricated steel sub-base isolated from the ship's structure by suitable vibration isolators. The unit shall be complete with all attached accessories including: air intake filter, dry spark-arresting type muffler, lubricating oil pump, strainer filter and cooler, fuel oil pump, strainer and filter, fresh water cooling system, regulating and overspeed governors, drip-proof starting panel, starting motor, gage board on resilient mounts with lubricating oil pressure and temperature and water temperature gages and safety devices required by Regulatory Body(ies).

The engine shall be capable of driving the generator continuously at its specified rating. For characteristics of the generator, see SECTION 88.

The speed regulating governor in conjunction with the voltage regulator shall be capable of regulating the speed of the engine such that the emergency generator will meet the voltage regulation requirements of IEEE No. 45.

Cast iron may be used in the construction of the engine except that it shall not be used for the flywheel, for brackets supporting engine accessories, or for feet or mounts connecting the engine to the sub-base unless such parts of cast iron have been tested with an engine which has passed the high intensity shock tests.

The lubricating oil system shall be of the forced feed type cooled by the fresh water cooling system.

Fuel supply shall be by gravity from the diesel oil service tank through flexible connections at the engine. The fuel system shall include a positive displacement rotary type booster pump, bypass relief valve, and filter.

Exhaust from the engine shall be led to the stack or other suitable locations on a weather deck.

The engine shall be arranged for automatic and non-automatic positive electric starting without the use of starting aids. The emergency engine shall be capable of carrying its full rated load within 20 seconds, with the intake air, cooling water, room ambient temperature and battery at 0°C. Re-energizing of the starting motor while the engine is running shall be prevented by a suitable interlock. Capacity of the electric starting system shall not be less than six starts. Each cycle shall include at least one-half minute of battery rest. At the end of the sixth cranking cycle the battery, while cranking the engine, shall be at least 50 percent of nominal battery power. See SECTION 96 concerning starting batteries. Note that SOLAS requires a "secondary" means of starting this unit.

The cooling system shall be of the self-contained, fresh water, closed circulation type complete with radiator, fan, and attached fresh water pump. It shall be of adequate capacity to permit continuous operation of the engine at rated power with cooling air temperatures up to 38°C.

The radiator fan shall be designed to pull an air stream over the engine and exhaust through the radiator into a discharge trunk to the weather with a total pressure of at least 125 Pa on the discharge side of the radiator. Provision shall be made to supply the quantity of air specified by the engine manufacturer into the emergency generator room through louvers adequately protected against the weather or by ventilation duct. See SECTION 12.

Sufficient permanent anti-freeze with a suitable rust inhibitor shall be provided to prevent freezing at -23°C.

Shop and installation tests shall be run using fuel meeting the minimum requirements of Grade DF-2 Regular fuel oil.

76.3. SPECIAL TOOLS

Special tools shall be provided as recommended by the engine vendor.

SECTION 78

TANKS - MISCELLANEOUS

1. GENERAL

Miscellaneous containers and tanks not listed elsewhere in the Specifications and required for general servicing of machinery shall be provided.

All tanks shall be labeled with black letters, painted on, at least 25 mm high, giving contents and total capacity.

Refrigerator compressor oil, emergency diesel generator engine lubricating oil, steering gear oil, anchor windlass hydraulic oil, and other special oils shall be stored in sealed as-shipped containers. Steel racks shall be provided for the stowage of these containers in convenient locations.

2. LIST OF TANKS

The following are miscellaneous tanks to be provided in approved locations:

1 - kerosene tank approximately 285 L
2 - clean waste lockers 0.5 m^3
2 - oily waste cans 0.5 m^3
1 - engineer oil tank approximately 40 L

3. TANK FILLING AND DETAILS

The kerosene tank shall be provided with a brass lever-lock type service faucet located about 50 mm above the bottom of the tank, gage glass, and a capped or plugged filling line from an approved location.

All tanks and storage containers shall be provided with a suitable means of dispensing oil.

The engineers' hand oil service tanks shall have a screwed handhold in top, and a brass lever-lock type service faucet.

A 75 mm deep sheet metal tray, having a removable perforated sheet metal plate on which to set measures and hand oil cans, shall be provided under the service faucet of all tanks and containers.

SECTION 79

LADDERS, GRATINGS, FLOOR PLATES, PLATFORMS, AND WALKWAYS IN MACHINERY SPACES

79.1. GENERAL

Ladders, walkways, floors, and platforms shall be provided, as necessary, for convenient access to and operation of all machinery, apparatus, and controls and for entrance to and escape from the machinery spaces. Ladders, walkways, floors, platforms, and handrails shall be of portable construction and easily removable to the extent required for access to and removal of piping, machinery, and other components with the remaining sections self-supporting. Where grating and floor plate supports are fastened to insulated surfaces, the bolted connection shall be outside the insulation line. The walking or working surface shall be composed of fixed or portable solid floor plating or portable open gratings as appropriate and as further specified herein. Raised or depressed portions of operating platforms, floor plates, gratings, and walkways shall be avoided to the maximum extent practicable but if they are necessary they shall be provided with steps and be adequately protected with guard rails.

Ladders, walkways, and elevated platforms shall be provided with adequate stanchions, handrails, toe plates and fastenings. Stanchions and guard rails shall be provided around all openings in the main operating platforms or floors at all levels and around machinery and elsewhere as required for safety in operation. Elevated platforms and walkways shall be provided with toe plates approximately 50 mm high. Suitable coamings shall be provided around machinery subject to oil or water leakage, and around permanent openings.

Walkways, floors, and platforms shall be designed to support static loads of 976 kg/m^2 and shall be locally reinforced where greater loadings are contemplated in the removal or disassembly of machinery for overhaul. Ladder treads shall be designed to support a load of 136 kg.

79.2. LADDERS

Ladders in frequent use shall lean fore and aft and shall be inclined sufficiently for each use. Maximum ladder inclination shall be 55°. Treads shall be of a non-slip type spaced about 230 mm apart and substantially designed and constructed to avoid being bent by moving equipment. Treads shall be at least 600 mm long wherever possible and in no case less than 460 mm long. All ladders shall be of steel construction.

Sheet metal dust shields shall be fitted below inclined ladders where debris falling from the ladders might be objectionable.

Vertical ladders shall be used only where conditions do not permit use of inclined ladders, and shall have treads formed by two 15 mm square bars on horizontal 38 mm centers, or equivalent non-slip treads. When at a bulkhead or other surfaces the tread shall be 130 mm clear of the structure. Ladders in trunks providing access to machinery spaces shall be permanently installed in such a manner that their removal is not necessary when moving equipment and supplies through the trunk. Where feasible, ladders shall be offset at intervals of not more than two deck heights, there being a landing platform with handrails at each offset. Grab rods of 15 mm diameter steel bar shall be welded to bulkheads above top of vertical ladders.

79.3. GRATINGS

Portable open gratings shall be used for machinery space walkways, platforms, and floors only where specifically required for ventilation and continuous visibility purposes.

In selecting open grating areas for ventilation purposes, due regard shall be paid to the probable path of the return mass air flow and its effect on the ambient conditions surrounding important items of machinery. In addition, such grating areas shall be located away from main traffic paths and operating stations insofar as practicable.

Open gratings shall be made with 15 mm square bars on 57 mm centers, riveted or welded into flat 57 mm by 10 mm flat bars. The standard grating panel shall be 610 mm x 1830 mm but panels of other sizes may be used, where necessary, within equivalent limits of easily portable size and weight. Where special shapes or cutouts are necessary, the edges shall be finished with a bonding bar for rigidity and to eliminate protruding members. Open spaces between the grating members shall not exceed 100 mm in length and 40 mm width, with the longer dimension transverse to the general direction of walking traffic. Supports for abutting sections shall not extend above the grating surface. Suitable fastenings shall be provided for firmly holding the gratings to the supporting structure.

79.4. FLOOR PLATES

Solid floor plating, whether fixed or portable, in way of traffic, operating and maintenance working areas, shall be 4.5 mm raised pattern non-skid plate. Fixed floor plating directly in the way of deck mounted machinery may be plain steel plate of equivalent thickness. Plain floor plates shall also be fitted in the way of safety rubber-matted areas in front of switchboards and electrical group controls.

Portable floor plates shall be no longer in size than can be conveniently handled by one person. They shall be supported on frames of not less than 75 x 50 mm by 8 mm steel angles and secured thereto with easily operated fastenings. Supports shall not extend above the surface of abutting plates. Sufficient floor space for the placement of machinery parts such as pumps and heat exchangers shall be provided.

Main access walkways and ladders shall be as wide as possible, including but not limited to those leading to engineers' Workshops and Storerooms.

Non-skid treads shall be fitted in the way of doors and passages where the decking is of bare steel and the use of raised diamond plate is found impractical.

Hinged portable plates shall be provided in the way of areas under the floor plate level requiring periodic observation or frequent inspection, and for access to valves, strainers, manifolds and other equipment located below the floor plate level. Flush type hand grabs shall be provided for lifting the hinged plates and hinges shall not extend above the plating surface.

Where pipes pass through non-watertight flats, the openings shall be surrounded by a watertight coaming about 75 mm high to prevent drainage of spilled liquids flowing into the space below. Other openings in and free edges of such flats shall be similarly protected. Drains for removal of casual drainage and spilled liquids shall be provided, as necessary.

79.5. HANDRAILS AND STANCHIONS

Except in way of electrical equipment, such as switchboards, where non-conducting material must be used, handrails shall be 25 mm steel pipe and shall be galvanized in locations where subject to corrosion. Handrails supported from bulkheads or other surfaces shall have a clear hand space of at least 63 mm.

Handrails for inclined ladders shall extend at least 300 mm beyond the nosing of the last tread. Such rails shall have a smooth finish.

Stanchions shall be 30 mm steel pipe with suitable handrail fittings. They shall be installed with spacing not to exceed 1520 mm.

SECTION 80

ENGINEERS' AND ELECTRICIANS' WORKSHOPS, STORES, AND REPAIR EQUIPMENT

80.1. GENERAL

All special tools and wrenches necessary for proper maintenance and operation of machinery and equipment shall be provided and stowed in an approved manner and location.

Lockers, bins, drawers, dividers and shelves shall be constructed of steel of not less than 1.5 mm. Shelves shall have 75 mm high lips at front, back and sides. Drawers shall have positive pull-out stops.

80.2. ENGINEERS' WORKSHOP

The engineers' workshop shall be fitted with one steel workbench at least 3.1 meters long with a minimum of three drawers 200 mm deep distributed underneath, steel bins, racks, and tool boards. The workbench shall have mounted thereon one swivel base machinist vise with 150 mm jaws and 230 mm opening and one hinged jaw pipe vise with 3 mm to 230 mm pipe capacity. The toolboard(s) shall be provided with tool holding fixtures and shall be sized to suit the shop's arrangement and the stowage of the frequently used tools. Alternate equipment will be considered for approval when required for proper maintenance and repair (see 80.1).

The Engineers' Workshop shall be outfitted with the following independent electric motor-driven tools:

<u>Lathe</u>

A precision-toolroom type floor lathe with a minimum swing (diameter) of 380 mm and a minimum length between centers of 1500 mm shall be provided. The back-geared or geared head drive mechanism shall connect to the motor (at least 1.5 kw) through either a pulley (3 step) or chain drive, all totally enclosed but easily accessible. Lathes using vee belt or cog belt drive for higher speeds with suitable gearing for other speeds are also acceptable.

The preceding lathe dimensions shall be fully met without the use of filler pieces.

The lathe shall be fully equipped, as per manufacturer's standard commercial practice.

In addition, the following additional accessories, if not standard, shall be furnished:

Compound rest
Follower rest
Steady rest
Headstock & Tailstock centers
Jacob type spindle nose
Collets, complete set--2 mm to 25 mm in millimeters
150 mm Four-jaw independent chuck with reversible jaws
152 mm Three-jaw universal chuck with two sets of jaws, one external--one internal
Set of 6 lathe dogs, increasing capacities
Set of 12 unground cutter, high-speed, bits

The lathe accessories shall be packaged in a steel case suitable for the storage thereof within the Engineers' Workshop.

Drill Press

One upright, 530 mm, motor driven, back-geared stationary head type, complete with manual wheel and lever feed, power feed, automatic stop, adjustable table and ball bearing spindle bearings. Spindle nose shall have a No. 4 standard Morse taper hole. Motor shall be mounted on the frame or base and rated at not less than 746 watt at about 1750 rpm.

The following equipment shall be furnished and properly fitted to the drill press:

Three-jaw drill chuck 0 to 13 mm diameter with taper shank to fit spindle

Set of Morse standard taper reducing sockets consisting of one No. 1 to No. 4, one No. 2 to No. 4 and one No. 3 to No. 4

Drill press vise with renewable jaws 125 mm wide or over 50 mm deep, to open 150 mm or more

One complete set of wrenches

Complete guarding of machine

Grinder (Pedestal) (Wet and Dry)

One motor-driven, 305 mm x 51 mm wheel size, floor pedestal mounted, double wheel, combined wet and dry type grinder shall be provided. The wet grinding side shall have a splash bowl, adjustable tool rest, water tank of .01 m^3 capacity with setting chamber and pump, water piping, adjustable nozzle and valve, and metal hood of the hinged door type adjustable for wheel wear. The dry grinding side shall have an adjustable tool rest, eye shield of heavy glass, and a detachable drill grinding attachment for grinding twist drills up to 38 mm size. One wheel shall be aluminum oxide, medium grit, and one wheel carbide of silicon, coarse grit.

The enclosed dust-tight motor shall not be less than 1.5 kw at about 1750 RPM, one hour full load rating.

Power Hacksaw

A 140 mm size power hacksaw shall be provided. The maximum capacity shall be 142 mm x 142 mm stroke, with 305 mm long blade. The unit shall have an automatic shut-off feature. The motor shall be rated at not less than 375 watts at about 1750 RPM for 1 hour.

Pipe Threader

As required.

80.3. ELECTRICIANS' WORKSHOP

The Electricians' Workshop shall be fitted with one workbench, steel bins, lockers, racks and tool boards as shown on the Contract Drawings. Test panels may also be installed providing such panels are designed and constructed in accordance with good marine practice (see SECTION 98, 98.2.).

The workbench shall be of steel with wood top, two drawers and cleaning tank under, and mounted with one swivel base vise with 115 mm jaws.

The following motor-driven tool shall be provided:

Grinder (Bench)

One 150 mm motor-driven bench type, double wheel, dry type, fitted with one medium grit aluminum oxide wheel, one wire buffing wheel and adjustable tool rests and heavy shatterproof glass eye shield for each wheel.

The motor shall be of the enclosed, dust-tight type and rated at not less than 250 watt at about 3600 RPM, one hour full load rating.

80.4. ENGINEERS' STOREROOMS AND/OR STORAGE AREAS

The Engineers' Storerooms and/or Storage areas shall be provided with bins, lockers and storage racks as shown on the Contract Drawings. This also includes suitable racks for refrigerant and burning equipment cylinders.

80.5. LIFTING GEAR

Suitable lifting gear for convenient and ready handling of machinery equipment shall be provided in the machinery space and shaft alley. The gear shall include but not be limited to all necessary tracks, chain hoists, jacks, and slings of the proper size for safe handling of all the equipment.

Adequate eye plates shall be provided for lifting heavy machinery, major valves and other equipment requiring removal for repair, and in way of ladderways where heavy parts may be shipped and unshipped.

All removable lifting gear equipment shall be stowed on bulkheads near machinery to be served unless stowage is provided at lifting point.

Suitable lifting gear and accessories as detailed in the above Paragraphs may also be provided for spaces such as but not limited to auxiliary Machinery Rooms, and Engineer's Workshops where it is considered necessary for convenient and ready handling of machinery equipment in such spaces in order to accomplish proper maintenance and repair of the equipment.

80.6. WELDING EQUIPMENT

A manual shielded metal arc welding unit of sufficient capacity to perform necessary repairs to machinery and equipment may be provided and stored in a clean, dry well-ventilated space in an approved manner.

The welder may be of the fixed or portable type, suitably grounded and provided with the necessary electrical components, safety features and accessories in accordance with requirements of the Regulatory Bodies, IEEE No. 45, and the applicable electrical sections of these Specifications.

Even though this description primarily concerns a transformer stepless rectifier welding machine, consideration will also be given to other welding units such as: a line resistor welding unit, a direct current generator unit with variable voltage, an alternating current transformer unit with variable voltage characteristics, shielded inert gas metal arc units, etc. In addition, gas welding apparatus which would serve the same intended purpose will be considered.

The 460 volt, 3 phase input to the electric welding machine should be derived from the 480 volt bus of the ship's service switchboard. Welding machines may be of the single or dual control type, with provisions for proper grounding and insulated, lock type connections of the power supply cable (if portable type) and a welding cable. Welding cable should be flexible, durable, well insulated and adequately sized to carry the required welding current. Only cable designed especially for welding should be used. Fixed welding machines should be provided with sufficient lengths of cable to reach any area of the machinery space where welding repairs may be required. The welding cable should be neatly stowed on reels in a safe manner.

Gas welding hose should meet similar requirements as applicable.

All electric welding units provided should be equipped with the necessary eye shields with filter lenses, flameproof gauntlets, whips with insulated electric holders, controls, gages, and special tools necessary for the proper operation and maintenance of the welding equipment. Gas welding apparatus should be equipped with the necessary eye shields with suitable filter lenses, flameproof gauntlets, torches, tips, tip cleaners, regulators, gages and special tools and wrenches necessary for the proper operation and maintenance of the apparatus. Pressure gages for gas welding apparatus shall be designed in accordance with requirements of the Regulatory Body(ies) and SECTION 85 of these Specifications.

80.7. WORKBENCHES

As required.

SECTION 81

HULL MACHINERY

81.1. GENERAL

In general, all hull machinery assemblies located in the weather shall be provided with watertight housings, and where located below deck, with drip-proof protected housings, unless otherwise specified. Deck machinery may be powered by electric motors, dedicated hydraulic systems, or a central hydraulic system.

(a) Mechanical Features

(1) General

Driving equipment, including gears, motors, pumps, and tanks, shall generally be mounted on a common bedplate. The bedplates for the steering gear pump group tanks and other hydraulically driven equipment or the deck upon which they are mounted shall be fitted with oil retaining rims.

(2) Bearings

Slow moving shafts subject to impact loading shall have bronze bearings. Bronze bearings shall be grooved to retain lubricant, and each shall be lubricated by a separate grease fitting.

Ball or roller bearings shall be used in the steering gear follow-up differential control box, on worm and worm wheel shafts, on driving motor shafts, and in other locations where positive alignment, minimum lost motion and freedom from wear are essential for proper operation.

(3) Reduction Gears

Reduction gear drives shall be totally enclosed and provided with oil bath lubrication. Enclosures for reduction gears and brakes shall be provided with inspection covers and shall be such as to permit inspection and removal of internal parts. Removable covers with jacking bolts and inspection plates shall be suitably gasketed. The inside surface of all gear casings shall be sand blasted and steam cleaned prior to assembly. Gear cases shall be coated with a glyptol or other lacquer to insure a clean, grit free surface.

Worm and wheel reduction units shall be designed to be overhauling. Overhung worms shall not be used.

Spur, helical, and herringbone reduction gears shall be of steel, with machine cut teeth.

Gears shall be designed and manufactured to meet the American Gear Manufacturers Association, AGMA, standards. A value of 1.0 shall be used for K_o in calculating the allowable horsepower for strength, P_{at}. The following values shall be used for C_o in calculating the allowable horsepower for durability, P_{ac}.

Capstan & Windlass	0.5	Winches, power-operated, Other	0.5-1.0
Steering gear drive	1.0	Worms, gears (all power applications)	0.7
Winches, Cargo	1.0		
Winches, constant tension	1.0		
Lateral thruster	1.0		

(4) Couplings

Where flexible couplings are required, they shall be of the all steel type.

(5) Materials

The rope contact surface on gypsy windlass heads shall be finished to 125 RMS.

Worm wheels shall be made of gear bronze. Worms shall be integral with their shafts and shall be of steel case-hardened or heat treated.

All fasteners exposed to the weather up to and including 13 mm diameter shall be of nonferrous material or of stainless steel. Larger fasteners may be galvanized steel. Breathers and drain check valves shall be of nonferrous material. Dowels and taper pins shall be of stainless steel or monel. Roll pins for any use will not be permitted. Aluminum fasteners shall not be used for watertight enclosures. Shafts and rollers for limit, master and transfer switches exposed to the weather shall be of nonferrous material. Set screws shall not be used for securing keys.

(6) Stresses

Normal duty stresses in shafting and gearing shall not exceed 40 percent of the yield point of the material, and maximum stresses shall not exceed 75 percent of the yield point.

(7) Lubrication

Pressure gun grease lubrication to bearings shall be furnished where automatic or oil bath lubrication is not supplied. All oils, hydraulic or lubricating, shall be designated by SAE. Grease fittings shall be of stainless steel or monel.

(8) Oil Piping

All oil piping and components shall be thoroughly cleaned before installation. In addition, all systems shall be cleaned after assembly.

Means shall be provided for filling, draining and venting and for measuring hydraulic and lubricating oil levels. Hydraulic systems shall be provided with gage connections fitted with shut off valves. Gages shall be permanently installed on steering gear systems and centralized hatch cover systems. Magnets shall be provided in hydraulic oil sumps. Strainers shall be installed in all suction piping. Where a heater is provided for an oil reservoir or sump, it shall be thermostatically controlled. Access covers shall be provided for cleaning sump and for servicing suction strainers.

Supplementary means for bleeding air from the hydraulic system shall be furnished at points where air is likely to be trapped. An oil strainer shall be provided in the suction from each sump tank.

(b) Electrical Features

(1) Brakes

Electric brakes shall be of the spring set, solenoid released wheel and shoe or disc type except where specified otherwise. Brakes shall be fitted with incombustible linings not adversely affected by moisture. Watertight brakes shall be equipped with external hand release.

(2) Controls

Controller enclosures exposed to the weather shall be corrosion resistant. If panels are force ventilated, filters shall be provided in the air intake.

When an hydraulic system utilizes a separately driven replenishing pump, control shall be such that the replenishing pump starts before the main pump starts.

(3) Master Switches

Unless otherwise specified, all hull machinery controllers shall have reversible, watertight, cam type master switches with vertical handles with integral knobs. Plastic material may not be used for the enclosures of watertight push button switches. They shall be permanently marked to indicate operating directions.

(4) Motors

Motors shall have removable type ball or roller bearings and shall be grease lubricated. Each watertight motor shall be equipped with an automatic drainage fitting.

(c) Special Tools

Provide one set of special tools as required for proper maintenance or servicing of mechanical and electrical equipment.

81.2. STEERING GEAR

(a) General

The steering gear shall be of the two or four cylinder, electro-hydraulic type, the ram driving the crosshead through a Rapson slide. The crosshead hub shall be of split construction and keyed to the rudder stock with dual torque keys.

Consideration of direct drive electric steering gears will be given.

Consideration shall be given to the installation of a rotary vane type of steering gear and also to the installation of a gear that is activated by four double acting clevis-mounted cylinders which will drive the tiller directly through spherical bearings mounted in independent clevises provided that the quality and performance will satisfy the criteria given below for a Rapson slide type. The actuator may be attached to the rudder stock with a tapered key, keyway and retaining nut, or the actuator may be adepted for a keyless mounting on the rudderstock using a hydraulic nut.

There shall be two independent power sources, each of which shall be capable of handling the rudder.

(b) Duty

At the estimated maximum ahead rudder torque, the electric motor in use shall not be overloaded more than 25 percent of its rating; nor shall the motor be overloaded more than 50 percent in astern steering.

(c) Mechanical Equipment

(1) Cylinders and Rams

The cylinders and rams shall be of steel. The ram stops shall serve as ultimate stops if the rudder takes charge. Their bearing areas, the cylinders and their foundations, the crosshead, and the rudder stock keys, shall be made in excess of the strength of the rudder stock of this account.

The rams shall be of the outside packed type and shall be guided by bronze bushings fitted in the cylinders. Rams may be solid, hollow bored, or built up weldment. Copper ram stops shall be provided to take effect at right and left angles of 36^{o} and steel ram stops at 37^{o}.

(2) Hydraulic Pumps

Each pump shall be driven by an electric motor through a flexible coupling.

Each pump shall have its separate and independent system of replenishment.

If used, the hydraulic variable stroke pumps shall be of the radial or parallel piston type, fully equipped with ball or roller bearings. Means shall be provided to insure adequate recirculation of oil from parallel piston pumps to sump. The servo and/or replenishing pumps may be driven directly or by separate electric motors as required.

Two separate oil storage and drainage tanks shall be furnished and shall each have a capacity of not less than 110 percent of hydraulic system. The steering gear fill and drain system shall be provided with a reversible non-overhauling hand pump together with suitable relief, replenishing, and cylinder stop valves which will permit this system to be used for rudder positioning and hydraulic braking in the event of main hydraulic plant failure. The hand pumping system shall be adequate for developing the ram cylinder pressure which will produce one-fourth of the maximum calculated ahead rudder torque. The pump shall be arranged for operation by two cranks with two persons on each crank.

(3) Follow-up Control

Each pump system shall have its independent electric follow-up control.

(4) Shift-Over Valves

The shift-over valves shall be of either the six-way or the dual four-way type manually operated locally by a single lever and automatically operated from the Bridge. They shall be designed so as to insure that the idle pump can be started in advance of the shift-over. Shift-over by servo control blocking valves may be used if desired. The design of valves shall also be such as to prevent the high pressure system from discharging into the low pressure system, and suitable leak-off connections shall be provided. Leak-off piping shall be arranged so that leakage oil will return only to the active pump.

The shift-over arrangement shall be designed for three distinct positions: the first to permit operation of the port pump with the starboard pump bypassed; the second to permit operation of the starboard pump with the port pump bypassed; and the third to hydraulically lock the rams with both pumps bypassed. The valves shall be balanced so that shift-over may be accomplished readily with the system under pressure. Stop valves shall be provided at each ram cylinder to prevent rudder movement in case of damage to piping.

(5) Piping

The relief valves shall be adjustable within a range of 25 percent above normal working pressure and shall reseat at a pressure sufficiently above normal working pressure to insure proper functioning of the gear.

(d) Steering Control

Steering gear control is described in SECTION 94.

(e) Electrical Equipment

Main steering gear motors shall be rated for continuous duty at 15 percent rated load followed by full load for 1 hour. If separate replenishing and servo pump motors are used, they shall be rated for continuous duty, and each motor shall be interlocked with its respective main pump motor so that the main pump cannot be started without first starting the auxiliary pump.

81.3. WINDLASS

(a) General

There shall be provided one or more anchor windlass(es) for bower anchor handling and warping duty.

(b) Duty

(1) Anchor Handling

The windlass shall be capable of hoisting both anchors simultaneously with their attached chains from a depth of 55 m of water at an average speed of not less than 10 m/min, or one anchor and 180 m of chain when suspended clear of the bottom, at no specific speed. The motor may be over-loaded no more than 25 percent of its rating at the start of hoist.

(2) Warping

The windlass warping heads shall be capable of withstanding all heaving loads on lines leading to one or both heads, up to the maximum amount permitted by the hydraulic transmission relief valve settings, on one head or distributed between both heads.

(c) Mechanical Equipment

(1) General

Design of anchor windlass shall be such as to provide adequate space and accessibility to enable the proper securing of covers at tops of the chain pipes.

Bushings shall be constructed so that they may be replaced without dismantling other parts of the windlass.

(2) Wildcats

The wildcats shall have snug cable lifters. Renewable chain strippers attached to the windlass bedplate shall be fitted for each wildcat.

(3) Warping Heads

The warping heads shall be of steel of the smooth barrel type, and shall be located at the proper height so that the lowest working portion of the barrel will insure suitable lead of lines from the bulwark chocks. Mountings shall be capable of withstanding safely all service loads, including stresses set up by the breaking of the specified hawser applied tangentially at mid-length normal to the axis.

(4) Hand Brakes

Each wildcat shall be fitted with a hand operated, lined hand brake, actuated through linkage. The mechanical advantage shall be such that no more than five turns of the handwheel are required from full "off" to full "on" within the range of first contact between band and drum, and full set tension in the band.

Each brake shall be capable of stopping and holding the associated anchor and chain within a 9 m drift, when suspended freely and dropped under control of the brake 27 m from 82 m to 110 m depth. The effort to actuate the brake shall not exceed 450 N on the rim of the handwheel.

The brake mechanism shall also be capable of withstanding a torque input at the handwheel of not less than 450 Nm, and the brake band shall withstand a load equivalent to a chain pull at the wildcat of at least 60 percent of the chain-proof strength, without exceeding 75 percent of the band material yield strength.

(5) Materials

Worm wheels, locking rings, and other parts in sliding contact with steel shall be bronze. Handwheels shall be bronze. All other strength parts shall be of steel.

(6) Stresses

The wildcats, main shaft, main shaft bearings, pedestals, locking heads, and bedplate shall be designed to withstand the breaking strength of the chain "outside the hawse pipe", as well as the snapping of a hawser with load applied tangentially, but not simultaneously. The rest of the windlass shall be designed to withstand stresses produced by the torque equivalent to the full relief valve setting in the hydraulic transmission.

(d) Electrical Equipment

(1) Motor

The pump motor shall be rated 1/2 hour full load windlass or warping duty following 1/2 hour idle pump operation and shall meet the anchor handling requirements without exceeding 125 percent of its rated load. The replenishing pump motor, if required, shall be rated for continuous duty.

81.4. BOAT WINCHES

(a) Duty

The capacity of each winch shall be such as to insure that the specified size of boat, with equipment and a nine person crew, can be safely hoisted without exceeding the full load rating of the motor.

(b) Mechanical Arrangement and Details

Means shall be provided for equalization of the falls and for overhauling the falls.

External brake bands shall be of corrosion resisting material.

(c) Electrical Equipment

The motors shall be rated for 15 minute short time, full load duty.

The trackway limit switches shall be in the control circuit.

81.5. CAPSTAN

(a) Mechanical Arrangement

Each capstan shall consist of a vertical head of the smooth barrel type mounted on the Weather Deck, driven by a vertical shaft connected to a power unit which shall be located on the deck below.

The main reduction gear unit shall consist of a worm and wheel reduction and a spur, helical or herringbone gear reduction unit.

(b) Stresses

The capstan shall be considered to be normally stressed when it is producing the specified line pull. The capstan head, main shaft, main shaft bearings, and the capstan base shall be designed to withstand the breaking of the specified hawser when applied tangentially at mid-height without exceeding 75 percent of the yield point of the materials.

(c) Electrical Equipment

The control shall provide satisfactory control of overhauling loads. Step-back protection from high to low speed upon excessive line pull shall also be included, as shall return to high speed upon reduction in line pull.

81.6. DUMB WAITER

The motor and gear case shall be mounted at the top of the trunk. An access door for the machine space and a clean out door shall be provided. Particular care shall be given to restraining electrical cable so that they will not be damaged when the ship rolls or pitches in a seaway.

The motor shall be reversible, rated for 30 minute short time, full load duty.

A "Door-Open" buzzer or bell on the car shall be connected to the regular call push button, to sound when car is called, if it is prevented from responding by a car or trunk door having been left open. "In-Use" and "Car-Here" signals, push buttons, interlocks, and limit switches, suitable for marine type dumb-waiter shall be provided with the complete installation.

81.7. ACCOMMODATION LADDER WINCHES

The motor shall be reversible and rated for 15 minute short time, full load duty. It shall be equipped with an electric brake which may be of the disc type. The motor shall be capable of hoisting the ladder without overload. Master switches shall be of the spring return type.

Pneumatically operated accommodation ladder winches are also acceptable.

81.8. CARGO HATCH COVERS (HINGED)

(a) General

If fitted, the hydraulic system for the hatch cover actuation shall have a design working pressure not exceeding 20500 kPa and shall be designed so as to eliminate hydraulic shock, vibration and pulsation.

All cylinders or torque actuators shall be located so that they will not extend below the cover structure in either the closed or open position.

(1) Self Contained and Adjacent Power Units

All hatch covers except the oiltight covers shall be opened and closed by power units contained within the covers served. The power units shall be independent for each pair or each set of end folding covers and shall be capable of opening or closing covers in not more than 2 minutes. The operating mechanism within covers including the power units shall be installed, factory tested and sealed and shipped intact with the covers by the hatch cover manufacturer. Power units for oiltight covers shall be separate from the hatch covers and shall be complete units, factory sealed and tested.

Access to the self contained units shall be by a watertight cover flush with the hatch cover.

(2) Centralized Power Unit (Alternate)

Two power stations shall be provided for operation of hatch covers and shall be located in Deckhouses at fore and aft locations on the Main Deck. A cross connection between stations shall be provided for emergency use.

Each power station shall be able to open or close the covers for any one hatch in not more than 2 minutes.

Single and clear instructions shall be mounted in a conspicuous location adjacent to the power stations.

(b) Control Stations and Piping

Operator control stations shall be in such a position that the operator can observe the movement of the hatch covers from the control stations. It shall be necessary for the operator to hold the selector valve handle or push button in operating position during entire cover movement.

Control stations mounted on the Weather Deck shall be housed in watertight boxes. 'Tween Deck electrical controls shall be watertight or explosion proof. All Weather Deck control consoles shall be constructed with heavy-duty corrosion resisting hinges, dogs, padlock hasp and staple. The control boxes shall be constructed so as to provide access to all valves and piping connections from the operating side of the box. An emergency bypass shall be provided at the control station to allow the hydraulic fluid to circulate while operating the associated cover with the ship's cargo gear. All hydraulic tubing and fittings exposed to the weather shall be of stainless steel.

Flow control and sequence control valves in the cover circuits shall be so located as to be readily accessible for adjustment from the adjacent deck.

Flexible hydraulic hoses of approved size and type shall be installed in compliance with the hose manufacturer's recommendations as to bending radii and other fatigue factors. All hoses which may be subject to chafing shall be protected with stainless steel chafing guards.

Hydraulic tubing shall be mounted within the hatch cover structure on cadmium plated cushioned supports located no more than 900 mm apart. The tubing shall be routed so that it will be protected by the ship's structure against damage during cargo handling or from stacked cargo in the hold below.

Operating instructions at deck stations shall be clear and concise and aimed at stevedore operation.

(c) Electrical

The motors shall be drip-proof protected for centralized hydraulic systems. Motors shall be TENV or explosion proof when mounted in the covers. They shall be rated for continuous duty on centralized power units, and 15 minute short time, full load duty on other.

The control panels shall be mounted in the Deckhouse.

81.9. CARGO HATCH COVERS (SLIDING OR PONTOON)

81.10. TOPPING, VANG AND SCHOONER GUY WINCHES, WHERE FITTED

The topping winches shall be capable of topping the fully loaded boom from the lowest working position to the highest working position in not more than 2 minutes; and shall be capable of lowering the unloaded boom to the deck for servicing and of topping the boom to the stowed position if stowage is vertical. The winches shall also be capable of withstanding safely all test loads and holding maximum load imposed on the topping lift and vangs during cargo handling without the aid of drum ratchet and pawls or other securing devices.

Handling maximum load shall be considered "normal" for stress calculation purposes.

The motor shall be reversible and rated for 1/2 hour short time, full load duty.

Master switches shall be of the spring return type.

81.11. CARGO WINCHES, IF FITTED

(a) General

The cargo winches shall be provided with additional auxiliary drums and gypsy heads as indicated on the plans and described herein.

(b) Mechanical

The winches shall be of the electric or hydraulic motor driven type. Winches fitted with gypsy heads or driving auxiliary drums shall be fitted with drum clutch and latching foot brake.

Where auxiliary drums are fitted, an additional spur gear reduction shall be provided to obtain the required line pull. In addition, each auxiliary drum shall be fitted with a full capacity screw compressor band brake. Two drum clutches shall be provided and inter-locked so that both cannot be clutched in at the same time and so that a drum may not be declutched unless its brake is set. An indicator for clutching positions shall be provided as required by the design of the clutch.

The rope drums shall be fitted with removable rope guards, properly located to clear hoisting rope lead.

The winches shall be designed to withstand safely a static torque corresponding to 300 percent of the full load motor torque.

81.12. WARPING WINCHES

Each warping winch shall have two horizontal heads driven by a horizontal shaft connected to a reduction gear, electric or hydraulic motor and brake unit, all mounted on the Weather Deck.

The warping heads shall be of the smooth barrel type and shall be located at the proper height so as to insure a suitable lead for lines from the mooring chocks.

The warping winch shall be considered normally stressed when it is producing a line pull as specified in the machinery list. The warping head, main shaft, main shaft bearings, warping winch base and pedestal bearings shall be designed to withstand the breaking of the hawser when applied tangentially at mid-length of the head without exceeding 75 percent of the yield point of the materials.

The motor and control shall be such as to produce adequate torque for warping, and satisfactory control of overhauling loads during snubbing operations. Step-back protection from high to low speed upon excessive line pull shall also be included and shall return to high speed upon reduction in line pull.

81.13. CONSTANT TENSION MOORING WINCHES (IF FITTED)

(a) General

The motor driven constant tension mooring winches shall automatically maintain a constant line pull (within acceptable tolerance) in accordance with the preset value selected at the winch tension selector.

(b) Mechanical

Components of the tension sensing system exposed to the weather shall be of corrosion resistant material. The tension switch shall have a minimum of six tension settings for automatic control.

A totally enclosed clutch band shall limit the strain that can be put on the line and shall be designed to hold the rated static line pull. Sudden and high shocks imposed on the winch shall also be limited by the clutch band. It shall be provided with an arrangement to be fully released by hand so that free spooling of the drum may be accomplished.

The diameter of the drum shall be approximately 20 times that of the mooring line.

Where gypsy or warping heads are provided, independent operation of the head shall be possible with the drum dogged.

The head shall be considered normally stressed when it is subjected to a line pull as specified in the machinery list. The warping head, shaft, and bearings, shall be designed to withstand the breaking of the hawser when tangentially applied at mid-length without exceeding 75 percent of the yield point of the materials.

(c) Electrical

Any of the following arrangements will be considered:

(1) AC Motor Generator Set (AC motor driving DC generator)

(2) Electro Hydraulic

(3) Thyristor Control and AC Motor

81.14. ENGINEER'S PLATFORM HOIST

The engineer's platform hoist and the installation thereof shall comply with the requirements of ANSI A17.1, "Safety Code for Elevators and Escalators" and its Annexes, except that code limits on maximum load and platform area and requirements for car top do not apply. An access door for the machine space and a clean out door shall be provided.

The motor shall be reversible and rated for 30 minute short time, full load duty. It shall be equipped with an electric brake with a rating of not less than 150 percent of full load motor torque.

Control circuit shall permit hoist to operate through the deck hatch opening (if such an opening is provided) and shall automatically prevent the hoist from traveling to this hatch when the hatch cover is closed.

A "door-open" buzzer or bell on car shall be connected to the regular call push button to sound when car is called if it is prevented from responding by a trunk door having been left open.

"In-use" and "Car-here" signals, push buttons, interlocks, electric brake, and limit switches, suitable for a marine type hoist shall be provided with the complete installation.

81.15. BOW THRUSTER

(a) General

Each lateral thruster shall be of the controllable pitch type driven by a constant speed non-reversing motor through a spiral bevel gear right angle drive. (Hydraulic, fixed pitch types will also be considered.) The propeller shall have four blades and be statically balanced. The propeller shall be located near the centerline of the ship with its axis athwartship in a circular tunnel. Propeller, tunnel, and tunnel end bell design shall be coordinated to provide maximum thrust effect from power available, and with a minimum increase in hull resistance. Propeller tip clearance shall be not more than 6 mm. Ends of tunnel shall be belled out at shell and fitted with protection bars. Several bars on each side shall be removable to provide access to tunnel.

Fixed pitch, variable speed hydraulic type is a viable option.

Fixed pitch, three speed electric, or AC/AC-SCR DC motors are also viable options.

All bolts, studs, nuts and other fastenings exposed to sea water shall be of monel.

The tunnel and guide vanes shall be made of mild steel. Propeller blades shall be of stainless steel or nickel-aluminum bronze, struts of cast steel and hub of bronze.

The tunnel and other carbon steel parts exposed to sea water shall be treated as called for in SECTION 14 for underwater hull.

(b) Mechanical

The right angle gear drive, propeller and associated shafting shall be rigidly supported in oil lubricated heavy duty, anti-friction bearings. The bearings shall be contained within a pod or pods, supported by struts. The gear drive, shafting, propeller hub and controls shall be removable without removing the prime mover. Cooling water and/or lubricating pumps shall be separately powered.

A hydraulic power and control unit shall be located in the same space as the thruster drive motor. Unit shall have a motor-driven pump mounted on a sump tank, complete with necessary piping including suction filter, pressure gage, dual relief valves, and pressure switches. The tank shall have the capacity in liters at least equal to 2 1/2 times the capacity of the pump in liters per minute and shall be fitted with direct reading level gages, drain connection and stress cover.

Lubrication of all moving parts shall be of the fully flooded type.

A hydraulic head tank shall be provided of capacity and at a height as recommended by the bow thruster manufacturer to maintain required head on seals.

(c) Control

A master control stand shall be provided in the Wheelhouse. The control stand shall contain a single level to control the hydraulic blade positioning system such as to provide stepless variable pitch control from zero to maximum either to port or starboard.

A control and indicating panel shall also be provided in the Wheelhouse. The panel shall contain push buttons for starting and stopping main drive, hydraulic system, and other required controls. Indicating lights and alarms for critical pressures and temperatures, including thruster motor temperature, propeller pitch indication, main motor ammeter, and a power available light shall be provided.

The control system shall be so arranged that the hydraulic pitch positioning system, lube oil system, and Thruster Room vent fan must be in operation, and the propeller pitch at zero, before the main motor can be started. A positive pitch follow-up system shall be provided for the pitch actuating mechanism.

(d) Electrical

All motors shall be rated for continuous duty.

81.16. CRANES

Crane design shall conform to Classification Society(ies) requirements and be so approved and tested.

Self-contained container (and/or lighter) handling cranes of ___ t capacity and ___ mm outreach beyond the ship's beam shall be provided.

Other cranes shall be provided as shown on the Contract Drawings.

Details and attributes shall be per Owner's requirements.

SECTION 82

HEAT EXCHANGERS

82.1. GENERAL

Heat exchangers shall be designed and outfitted on the basis of the following general specifications:

Tube cleanliness factor:
- S.W. heat exchangers - 80%
- Oil heat exchangers - 70%
- F.W. heat exchangers - 85%

S.W. velocity through tubes of shell and tube heat exchangers shall not exceed 2 meters per second, and generally velocities shall not exceed values recommended for long life. Oil side pressure shall be higher than water side pressure.

Local temperature indication shall be provided for both fluids in and out, over each heat exchange. For fresh water evaporator distillate coolers, the surface of the heat exchangers should be calculated for cooling down the distillate to a maximum of 5°C above the seawater temperature.

For all heat exchangers, a stop valve shall be provided at each inlet and outlet of fluid connections (except at aid side of air coolers).

Sea water cooled heat exchangers shall be designed for 32°C S.W. supply and 50°C maximum outlet temp.

The tube or plate bundle and/or tube or plate withdrawal space required for maintenance of heat exchanger equipment shall be shown on machinery, ventilation, and piping arrangement plans and shall be maintained free of all interferences.

82.2 PLATE TYPE HEAT EXCHANGERS

Generally, all liquid-to-liquid exchangers shall be of the plate type except where otherwise specified and in cases of very minor exchangers. Plate material shall be titanium for sea water services and 316 stainless steel for other applications.

All plate type exchangers shall be designed strictly in accordance with the highest industry standards for intended service and to include provisions for future extension of the exchanger's surface area when the vessel is in service. Inlet nozzles, if required, for plate type heat exchangers shall be of the same material as the heat exchanger plates.

82.3 SHELL TUBE TYPE HEAT EXCHANGERS

All shell tube type heat exchangers shall be of the finned or bare tube type. Where tubes are secured on tube sheets by rolling, they shall be rolled by an electronically controlled method. A number of spare tube expanders shall be provided on the ship for all heat exchangers utilizing the same size and type of tube.

The inlet connection for auxiliary salt water heat exchangers shall be such that it provides tangential flow to the tube sheet preventing direct impingement and minimizing the possibility of erosion of the tube sheet.

Zinc or other suitable sacrificial anodes shall be fitted in the inlet heads (other than heads of copper-nickel alloy) of all heat exchangers which are sea water cooled. Magnesium or soft iron will be acceptable as an alternate to zinc.

Tubes and tube sheets of tubular heat exchangers in salt water service shall be of 90-10 copper-nickel alloy. Fabricated covers of 90-10 copper-nickel alloy plating are acceptable.

SECTION 85

INSTRUMENTS AND MISCELLANEOUS GAGE BOARDS - MECHANICAL

85.1. GENERAL

The necessary miscellaneous instruments, gages, indicators, gage boards, thermometers, instrument panels, mountings, and test equipment, shall be furnished for all machinery, equipment, apparatus, and piping systems as specified in the various sections as required for proper operation. All instruments, components, mountings, and fittings specified herein shall be in accordance with the applicable Regulatory Body(ies) requirements.

In general, the mechanical instruments and devices described in this SECTION shall be designed for marine service and tailored to their particular applications. Mechanical instruments and their components shall be of rugged construction, suitable for marine service and not adversely affected by the vibration, temperature, moisture, shock damage, and dust, normally encountered in operation. Instruments provided in exposed locations, machinery spaces, working passageways or spaces, Cargo Control Rooms, Pump Rooms, Fan Rooms, and similar exposed areas shall be waterproof or suitably shielded or protected so as to prevent moisture and other corrosive elements from damaging the instruments.

Generally accepted principles of human engineering should be used when determining the design characteristics of the various devices specified in this SECTION.

The design, construction, arrangement, and installation of mechanical instruments should be as simple as is functionally and practically possible. The primary objective of all instrument design and installation shall be to provide an uncomplicated arrangement which:

(a) is functional, safe, and reliable

(b) is easy to interpret and maintain

(c) is constructed so as to reduce logistic, personnel, and training problems to a practical minimum.

The proper location and angle for viewing shall be considered when determining the location of individual instruments and panels, boards or grouped displays of instruments. Display faces (readouts) should be perpendicular to the operator's line of sight wherever possible. Elevated positions are also acceptable provided that the distance and angle from the normal viewing position are chosen so as to provide easy identification of the value to be read. Care should be taken to prevent placing readouts in positions that are not reasonably accessible and/or logical. When instruments are located on a panel board or grouped display, special consideration shall be given to the logical or "expected" position of individual instruments, particularly instruments which relate vital or critical data. The instrument readouts shall also be properly labelled for rapid and easy identification.

The compatibility of instrument pointers, and cursors, shall in so far as practicable, be in accordance with the measured value or parameter. Scale values and pointers should have a logical sequence of operation (i.e., increase from left to right, clockwise or from bottom to top and decrease from right to left, counter-clockwise or from top to bottom). Instruments shall be plainly labelled and provided with distinguishing marks which denote normal, maximum load conditions, or ranges as applicable.

The size of the instrument readout shall be designed for the maximum distance from which it is to be observed in order to achieve optimum visual acuity. In most cases, the data shall be readable from 3000 mm. Scale sizes, scale division, pointers, cursors, labels, figure, and character sizes, shall be adequate to be readily perceived from the distances listed above.

All instruments and displays should be located and arranged to properly utilize available lighting to the best possible advantage. Illumination should be sufficient to permit rapid, accurate instrument reading from the normal working or monitoring positions. Refer to SECTION 92 for detailed requirements regarding illumination. Colors chosen for indicator faces, characters, figures, pointers, and backgrounds, should be colors that best utilize the available lighting in each location so as to maximize visual perception.

Mechanical instruments should be provided so as to provide the maximum possible mechanical protection. Vertically mounted instruments shall be rigidly secured in place by means of suitable fasteners. Wherever possible, the instruments shall be placed inboard of the vessel's sides at locations where any anticipated structural vibration would be expected to be at a minimum.

Any attachments made to machinery, apparatus, or equipment for the operation of mechanical instruments shall be such that the removal of such attachments will not interfere with the operation of the machinery, apparatus, or equipment. The attachments shall also be designed and arranged so as to be readily detached.

Molded materials used in the construction of instruments and/or displays shall be flame retardant. All small parts including screws, bolts, and fasteners, should be corrosion resistant or steel suitably protected against corrosion. Steel springs shall be treated to resist corrosion using a method that does not impair their spring elasticity or quality.

Instruments and their components requiring maintenance shall also be arranged for easy access, clear of or shielded from high voltage, high temperature, or other dangerous working areas.

The instruments described herein are those which are not included as part of the central control console. Instrumentation for the control console is covered in SECTION 99.

Instruments which monitor vital parameters shall have both local and remote indications where deemed necessary for the safe and proper operation of machinery, apparatus or equipment.

85.2. PRESSURE, VACUUM, AND COMPOUND

(a) Indicator Cases

Cases for gages shall be made of brass, aluminum, molded phenolic or other corrosion resistant material suitable for marine service. Where phenolic material is used, it shall be hot molded with cellulose fiber of the shredded fiber type. The construction of cases shall be such that they will be designed to exclude dust and moisture under usual variations of temperature. Indicator cases shall also be designed to resist vibration and shock damage.

(b) Indicator Dials

Dials shall be made of steel, adequately protected against corrosion. Alternate materials will be considered for use in the fabrication of dials, provided that the materials possess equal strength and quality for service in marine applications. Dials should generally be of a standard, commercial type, with black markings on dulled aluminum, silver or white background. Color combinations for backgrounds and markings other than the described above will be considered, provided that such combinations provide equivalent visual perception for the particular locations and/or applications for which they are to be designed.

Indicator dials should be 115 mm, 152 mm, or 216 mm diameter with the exception of indicator dials for refrigerant gages mounted on local gage boards which may be 89 mm in diameter, as specified in SECTION 66. Vertical scale pressure and vacuum instruments (where provided) should be sized to provide similar scale lengths as the indicator dials described above. Graduations of dial indicators shall cover an arc of not less than 270^{o}.

A name plate showing the purpose for which the gage is intended shall be placed at a point directly below the indicator spindle.

Dial ranges should be selected so that the pointers will be between the vertical and two thirds range positions when at the operating pressures.

Unless otherwise listed or specified, the graduation of the dials should be in accordance with the requirements as listed in the table below. Other dial graduations may also be considered as per the Owner's discretion. The use of "BAR" or "kg/cm^2" for pressure is also acceptable.

Gage Service	Scale: Vacuum kPa	Scale: Vacuum mm Hg	Scale: Pressure kPa	Smallest Scale Divisions: Vacuum kPa	Smallest Scale Divisions: Vacuum mm Hg	Smallest Scale Divisions: Pressure kPa
Vacuum	0	760	-	2.0	12.5	-
Compound	0	760	300	4	25	10
Compound	0	760	800	20	100	10
Compound	0	760	1150	20	100	10
Compound	0	760	2200	20	100	25
Pressure	-	-	520	-	-	10
Pressure	-	-	800	-	-	10
Pressure	-	-	1500	-	-	15
Pressure	-	-	2200	-	-	25
Pressure	-	-	2900	-	-	25
Pressure	-	-	4250	-	-	50
Pressure	-	-	5620	-	-	50
Pressure	-	-	7000	-	-	50
Pressure	-	-	10445	-	-	140
Pressure	-	-	13890	-	-	140
Pressure	-	-	17340	-	-	140
Pressure	-	-	20790	-	-	140

(c) Pointers

Pointers should be sized so as to be exactly as wide as the smallest division of the scale of the instruments for optimum reading accuracy with minimum error probability. It is also good practice to arrange normal pointer operating (reading) position in similar attitudes (i.e., two-thirds of scale range, for example) wherever possible to facilitate rapid scanning and detection of off-normal conditions.

Red stationary pointers or markings should be provided which can be secured in place to indicate the working pressure.

(d) Operating Mechanism

All parts of the operating mechanism shall be of corrosion resisting materials or protected by suitable treatment or coating of the surfaces. All wearing surfaces shall be of suitable alloy steel, heat treated or surface hardened to minimize wear.

All gages shall have single seamless Bourdon tubes. For steam services up to and including 690 kPa working pressure, and other services up to and including 6895 kPa working pressure, tubes shall be bronze with silver brazed joints. For steam services over 690 kPa working pressure and other services above 6895 kPa, tubes shall be of corrosion resisting alloy steel. Bourdon tubes shall be welded or silver brazed into the supporting frame.

(e) Accuracy

Each gage shall indicate the correct pressure or vacuum within one smallest scale division when tested for accuracy at a number of points equally distributed over the entire range of the dial.

(f) Fittings

All gages subject to pulsating pressures shall be fitted with an approved type damper or snubber. All steam gages shall be furnished with siphons.

Connections for remote mounted pressure gages should be fitted with a plugged tee just beyond the gage cut-off valve to allow installation of a test gage.

85.3. DRAFT GAGES

(a) General

Where auxiliary boilers of sufficient size to require draft gages are provided, draft gages of the two (or more) pointer vertical scale type may be provided. Scales should be of white translucent material with black numbers and graduations, illuminated from the interior of the casing. One gage shall be furnished for each auxiliary boiler with the following connections: forced draft fan discharge, burner windbox, and furnace. Additional connections and draft gages with more points (scales) may be provided where necessary for proper auxiliary boiler monitoring.

(b) Accuracy

The gages shall maintain an accuracy of $\pm$ 1 percent middle 75 percent of the scale, and subject to the roll and pitch of the ship.

85.4. THERMOMETERS - REMOTE READING, INDICATING DIAL

(a) Separable Sockets

All thermometers shall be of the separable socket type with 20 mm American Standard pipe threads and shall be of corrosion resisting steel for temperatures of 232°C and above and of brass for temperature below 232°C except that all thermometers used with oils shall have steel sockets, and all thermometers used in salt water shall have monel sockets or equivalent corrosion resisting material which is compatible with the associated piping or equipment.

(b) Indicator Cases

Indicator cases shall be the same as those specified for pressure gages.

(c) Indicator Dials

Indicator dials shall be the same as those specified for pressure gages except as follows:

Temperature Range - °C	Graduations - °C	Maximum Figure Interval - °C
121 or less	1	10
121 to 260	2	25
Over 260	5	50

Dial ranges should be selected so that pointers will not be indicating more than 75 percent of the scale range at the operating temperatures.

(d) Pointers

Indicating pointers should be yellow or red.

(e) Bulbs

All thermometer bulbs shall be suitable for service intended.

(f) Capillary Tubing

The capillary tubing shall be covered throughout its entire length with a spirally wound, flexible, zinc-coated steel casing (so constructed that the flexibility of the tubing will not be affected).

The length of the capillary tubing to be used for a particular application should be determined to suit the location (with the minimum excess length possible). Excess capillary tubing shall be neatly coiled and properly secured. All capillary tubing shall be properly supported and secured throughout its entire run.

(g) Operating Mechanism

The operating mechanism as specified for pressure gages shall apply except that thermometers shall be supplied with tubular springs.

(h) Accuracy

Each thermometer completely assembled with tubing and socket shall indicate the correct temperature to within one smallest scale division when tested for accuracy at a number of points equally distributed over the entire range of the dial.

85.5. THERMOMETERS - DIRECT READING - DIAL TYPE

Direct reading thermometers of the dial type shall be industrial type and shall be fitted with separate sockets and direct connected bulbs. Design and materials otherwise shall be similar to those specified for remote reading, indicating dial thermometers.

All lines and figures should be black on white dials. The figures shall be of a large size, readable at distances from 3000 mm. Alternate configurations and reading ranges will be considered provided that they are suitable for their intended applications for service requirements.

Scale ranges shall be selected so that the operating temperature reading will be at approximately 75 percent of the scale range.

85.6. THERMOMETERS - BI-METALLIC DIAL TYPE

Except as indicated herein, features of the bi-metallic dial type thermometers shall be as specified for these in common with the remote reading type dial thermometer.

(a) Indicator Dials

Bi-metallic dial thermometers shall have a linear scale length not less than that of a 178 mm mercury in glass type thermometer. All lines and figures on the scales and all pointers shall be black. Alternate colors will be considered where equivalent visual perception is achieved.

(b) Operating Mechanism

The actuating elements shall be a specially processed bi-metallic helix, so designed to have a minimum hysteresis effect and shall not stick. It shall be constructed to dampen the oscillations of the pointer due to normal vibration, and shall not be affected by abnormal working temperature or overheating.

85.7. THERMOMETERS - INDICATING FLUID GLASS TYPE

Cases shall be of the V-shape design and shall be made of aluminum or brass. Scales should be at least 178 mm in length. Scale ranges shall be selected so that the temperature reading will be at approximately 75 percent of the scale range for the operating temperature.

The use of mercury in the thermometer is prohibited.

Glass tubes of thermometers shall be of magnifying lens tubing.

Each thermometer completely assembled with socket shall indicate the correct temperature to within one smallest scale division when tested for accuracy at a number of points equally distributed over the entire range of the scale.

85.8. MISCELLANEOUS GAGE BOARDS

Miscellaneous gage boards shall be provided, as required, to consolidate instrumentation throughout the Machinery Space.

Gage boards shall be constructed of steel, aluminum, or equivalent material and be coated or painted entirely (where necessary) with a suitable coating to protect the material. The coating should be of a suitable color such as flat black or gray to provide a good background (without glare) for the instruments and labels mounted thereon.

The design of gage boards or mounts should be mechanically simple and arranged so as to avoid the need for special tools in dismantling. Nut and bolt connections should be suitably locked. Threads should not be tapped directly into molded or synthetic resin board or similar material. All cable and pipe penetrations in gage or display boards (or mountings) shall be adequately sealed, protecting the instruments from dust and moisture. Instruments and components requiring maintenance should be arranged to be clear of or shielded from high voltage, high temperature, corrosive elements or other hazardous conditions.

Gage piping connections shall, in general, be provided with two shut-off locks or valves; a valve fitted at the pipe line or pressure connection; and a cock or valve at the gage. Alternate arrangements which result in the same degree of safety will be considered, provided they are in accordance with the applicable Regulatory Body(ies) requirements.

All gages, instruments, and other devices mounted on miscellaneous gage boards and displays, shall be as nearly flush mounted as possible. The mountings should be designed so as to minimize shock and vibration.

85.9. LOG DESKS

Fixed log desks should be provided as necessary for proper operation in such locations as the vicinity of the Engine Room centralized control console, Emergency Generator Room and evaporator station. The location and size of the log desks should be commensurate with the particular application. Log desks should be fabricated from steel, aluminum or equivalent materials and secured in a safe manner to the vessel's structure by an approved method.

85.10. DIGITAL INSTRUMENTS

Digital reading indicators may be provided for mechanical instruments such as mechanical tank level indicators. Digital indicators shall maintain the same level of accuracy required for the other mechanical instruments listed in this SECTION under the same environmental conditions (roll, pitch, and corrosion-resisting).

Digital instruments shall be properly shielded to prevent interference which may be caused by the use of walkie-talkie radios in their proximity.

The digital indication shall be a numeric or alpha-numeric display.

All numbers and figures should be black on a white background and should be sized such that they may be readable at approximately 3000 mm by operating personnel. Indicator configurations display and background colors, and maximum reading distances may be adjusted provided that they are suitable for their intended applications and/or service requirements.

85.11. OTHER MECHANICAL INSTRUMENTS

Other mechanical instruments such as tachometers, flow meters, and flow rate indicators, may be provided as necessary in accordance with Article 1 of this SECTION. The design and construction of such instruments shall be in accordance with Regulatory Body(ies) requirements and the preceding articles of this SECTION, where applicable.

Generally, such instruments should be designed for (and constructed of quality materials suitable for) service in a marine environment. Also, such instruments should be relatively easy to read, use, maintain, and should provide accuracies consistent with their specific applications.

SECTION 86

SPARES - ENGINEERING

86.1. SPARE PARTS - GENERAL

The Contractor shall provide aboard ship spare parts in accordance with the minimum requirements of the Regulatory Body(ies) involved, and which have such requirements. Spare parts in addition to those required by the Regulatory Bodies shall be selected by the Owner and furnished by the Contractor in accordance with provisions and the monetary amount set forth in the applicable Contract. At the discretion of the Owner, these latter spares shall be stored either on board or delivered ashore to a location designated by the Owner.

86.2. SPARE PARTS - STOWAGE ABOARD SHIP

All spare parts shall be clearly marked or tagged with suitable identification data.

Bulky or heavy parts, such as armature or pump rotors, shall be mounted on skids with suitable wood framing and shall be securely stowed on suitable supports.

Spares subject to damage from moisture shall not be stored in the shaft alley or other damp places.

Spare tubes for coolers and other heat exchange equipment shall be protected for storage and shall be mounted on cribs providing full length support of the tubes.

Spare parts subject to corrosion shall be slushed with an approved rust preventive coating. Small machined parts subject to rusting or corrosion may be dipped in an approved plastic protective compound which can be peeled off readily when the parts are used.

Particular care shall be exercised in the support of all spare electrical coils so that their original shape shall be retained, and all spare parts having insulation are to be protected against moisture, rodents and varying temperatures. Cable ends shall be effectively sealed against air and moisture.

86.3. SPARE PARTS BOXING

All spare parts applying to a particular unit of equipment shall be assembled in a spare parts box or boxes of such a size so that the weight of any one box with its contents shall not exceed approximately 90 kg. Boxes shall be of sheet steel not less than 1.5 mm if the volume is 0.06 m^3 or over.

Maximum center-to-center distance between adjacent spot-welds and/or rivets shall not exceed 8 mm. The sides of the cover shall be turned down approximately 25.4 mm and shall have a continuous weld at the corners.

The cover of each spare parts box shall be furnished with steel hinges and shall be provided with a hasp to accommodate a padlock, which shall be furnished by the Contractor. The ends of each box shall be provided with suitable steel handles.

All metal boxes shall be painted on the inside and outside with two coats of commercial gray paint. Both the outside of the cover and the front of all boxes shall be stenciled in black paint giving the name of the equipment which the spares serve, as for example: "Spares for Fire Pump". A typewritten itemized list of the contents, giving drawing numbers where possible, and installed location, shall be secured to the underside of the cover of each box. This list shall be in durable form to prevent deterioration or damage.

SECTION 87

ELECTRICAL SYSTEMS, GENERAL

87.1. GENERAL

It is the intent to describe a complete electrical generation and distribution system using the latest Regulatory Body(ies) and industry standard approved methods of design and workmanship as defined by the Owner, for the ship described in SECTION 1. (Typically, these industry standards will include IEEE 45, "IEEE Recommended Practice for Electric Installations on Shipboard" and/or IEC 92, "Electrical Installations in Ships" which deal with electrical installation in ships.)

The system presented herein is based on low voltage (low voltage is defined as 500 or 600 volt for IEC and IEEE respectively). For those applications where medium voltage is desired, then it will be incumbent upon the Contractor to properly select the equipment and design the system using the information contained in SECTIONS 87, 88, 89, 90, and 91 as a functional guide.

Equipment (other than major units) shall be accessible for removal, servicing and adjustment without dismounting or removal of other equipment.

The design of the electric plant including generators, motors, and controllers shall be coordinated to insure that the voltage dip, when starting the motor with the highest starting current, shall not exceed 20 percent of rated voltage. Contractor shall perform calculations to determine minimum voltage dips at the main and emergency switchboards.

The Contractor shall remain cognizant of all changes in load conditions resulting from design developments during the construction period of the vessel in order to check adequacy of the generating plant.

The Contractor shall provide a short circuit analysis of the electrical system, and the adequacy and selectivity of the protective devices shall be as specified in SECTION 90.

All bolts, screws, nuts, and washers unless otherwise specified shall be corrosion resistant.

87.2. EQUIPMENT AND MATERIAL

All equipment shall be designed for satisfactory operation under the conditions of moisture and vibration prevailing in shipboard service and shall be treated to provide protection against corrosion, moisture, salt, mold or other destructive agents to which the vessel may be exposed under adverse climatic conditions during normal operation in either warm or cold areas.

All power consuming equipment shall be operated satisfactorily with a voltage variation in accordance with IEC or IEEE guidelines. AC equipment operating with a frequency variation of more than ±3 percent shall be supplied via special regulating equipment. Temporary voltage dips of 20 percent max during motor starting or speed changing shall not cause damage or interruption of service to equipment.

Equipment mounted in or on cranes or similar deck machinery shall be weathertight unless located in weathertight cabs. Dripproof protection shall be provided for other equipment whether individually enclosed, or assembled on open panel structures, except that installations concealed in joiner work in dry spaces such as Staterooms, Mess Rooms, and similar living spaces need not be dripproof.

Explosion proof or intrinsically safe equipment shall be used where required by Regulatory Body(ies) requirements.

Ferrous components of equipment subject to corrosion, except motor enclosures, switchboard panels, distribution and control cabinets, and similar enclosures shall, unless otherwise specified, have a corrosion resistant finish such as zinc or cadmium plate, applied before any painting, but after fabrication work is completed. In general, painting is accepted as a corrosion-resistant finish for switchboard panels, distribution cabinets, motor and control enclosures and similar enclosures.

Attention shall be directed to the design of electrical and electronic circuits, particularly those containing transistors, diodes and other solid state devices, with regard to protection from transient voltage spikes of the type normally encountered in shipboard power distribution systems. Devices, such as solid state transient voltage suppressors, shall be provided in such equipment as required.

In general, electrical equipment requiring external wiring shall be provided with suitable terminal boards or blocks equipped with solderless lugs to which the Contractor may make all necessary connections. Exceptions are as follows:

(a) Terminal boards may be omitted in motor terminal boxes and the leads equipped with lugs for direct connection to lugs on ship cables.

(b) Circuit breaker and motor control main power terminals may be equipped with lugs for direct connection of ship cables except where otherwise required.

(c) Approved, twist-on, pressure-type non-plastic connectors may be used in lieu of terminal blocks and lugs for making connections in lighting outlets and connection boxes as allowed by Regulatory Body(ies).

87.3. EQUIPMENT IDENTIFICATION

All electrical equipment shall be supplied with nameplates on the equipment.

Any special precaution, maintenance or operation instructions shall be indicated on a separate plate attached elsewhere on the equipment.

Size of name plates shall, in general, be selected to conform to the relative size, type and prominence of the equipment for which they are used, and shall have a width to length ratio in the proportion of 1:3 wherever possible.

Nominal size of cabinet nameplates shall be 40 mm x 120 mm.

Color coding of power supply conductors shall be consistent, with black, white and red colors reserved for phases "A", "B" and "C", respectively; using colored synthetic tubing at conductor ends where insulation colors are not compatible.

Terminal strips, except for lighting and power branch circuits, shall be marked with circuit terminal designations.

Cables shall be identified at central control consoles, and junction boxes.

Designations on markers and nameplates shall agree with designations on plans.

87.4. SPECIAL TOOLS

Any special tools, not furnished under other sections of these specifications but required for inspection, maintenance or shipboard repair of electrical equipment shall be provided in the spare parts box for the equipment.

SECTION 88

GENERATORS

88.1. SHIP SERVICE GENERATORS

(a) General

Three diesel driven ship service generators shall be provided to meet specifications for the distribution system outlined in SECTION 90. The rating of the ship service power plant shall be sufficient to ensure the operation of auxiliary services, indispensable for the propulsion and the safety of the ship, passengers and crew and preservation of the cargo, even when one generating set is out of service; in accordance with IEC or IEEE requirements. The generators shall be rated for continuous operation in an ambient temperature of 50°C. Generators shall be marine type and arranged for parallel operation with each other in any combination over the complete load range from zero to 100 percent. Stator and rotor insulation and allowable temperature rise shall be Class B or Class F.

For ships intended for unmanned Machinery Room operation, special consideration shall be given to additional automatic operation features such as load shedding, start up and paralleling of stand-by generator in accordance with IEEE and IEC recommendations.

Generator and exciter system shall be capable of providing short circuit current of sufficient magnitude and duration in accordance with IEC or IEEE standards to properly actuate associated distribution system protective electrical devices.

(b) Construction

The generators shall be totally enclosed with access openings, for proper servicing, provided with suitable covers. The diesel generators may utilize drip-proof self-ventilated construction if feasible for unit size when operating in an ambient temperature of 50°C, otherwise each generator shall be provided with an air cooler of the totally-enclosed double tube type, using sea water or fresh water for cooling.

Air coolers when used shall be provided with means for indicating tube leakage.

The recirculating air system when used shall be provided with a thermometer for measuring temperature of air leaving the cooler and a thermostatic switch for energizing a visual and audible alarm.

The terminals shall be housed in a drip-proof protected enclosure mounted on the generator and arranged for entry of cables. The enclosure shall have access covers as required.

Space heaters shall be provided within generator enclosure in order to prevent condensation when generator is idle. The generators shall be equipped with resistance temperature detectors (RTDs) in the stator winding and equipment at the switchboard to indicate stator temperature.

The bearings shall be removable for replacement without removing rotor or driving coupling. These bearings shall be insulated from their support pedestals or brackets.

88.2. EMERGENCY GENERATOR

(a) General

The diesel engine driven generator shall be selected to meet specifications for the distribution system outlined in SECTION 90, for continuous operation in an ambient temperature of 50°C. Stator and rotor insulation shall be Class B or Class F.

(b) Connected Loads

The generator shall provide sufficient power to the emergency switchboard for the satisfactory operation of the following connected loads, but not limited to:

CATEGORY	LOAD
General	Fire pump motor.
	Fire pump foam proportioner.
	Steering gear pump motor.
	Lube oil pump motor as required for gears and steam turbines.
	Bilge pump motor.
	Sprinkler pump motors.
	Air compressor motor, if required for emergency generator starting and automation control.
	Window wiper motors.

Hydraulic pump motor, if required for emergency generator starting and automation control.

Fire screen door.

Watertight door motor.

Engine Room console power supply.

Bridge throttle console power supply.

Direct current bus with battery charger for supplying all alarm systems.

Emergency Space Lighting - Exit lights; and sufficient lighting to allow passage of the crew through passageways, stairways, escape trunks; machinery spaces, operating areas such as Emergency Generating Room main switchboard and Engine Room console, and public spaces such as Mess Room, Lounge, Galley, Pantry, Chart Room, Wheelhouse, Hospital Room or any berthing arrangement having over 20 personnel; and Main Deck to the Forecastle.

Navigation Lighting - Running lights; signal lights; search lights and disembarkation floodlighting such as lifeboat areas and gangway areas.

Emergency Generator Equipment - Electric lube oil pump motor; starting mechanisms of either a battery with battery charge, a hydraulic unit or any other electrical accessories.

Navigation Aids - Both radars; collision avoidance system; LORAN; either GPS or SATNAV; gyrocompass and its recorder and repeaters; radio direction finder, echo depth sounder; rudder angle indicator; whistle control unit; steering gear control unit; electrical fog bell and gong signal; and general alarm.

Radio Equipment Console - All communication and distress equipment in accordance with Global Maritime Distress and Safety System (GMDSS) and other SOLAS requirements.

Interior Communication Systems -	Bell log; data log; dial telephone, salinity indicating system; smoke detection indicator; clock system anemometer and wind direction indicator.
Public Address Systems -	Intercom system; dock, crane or barge loudspeaker system or watch call system.

(c) Construction

The generator shall be dripproof protected and self-ventilated.

The terminals shall be housed in a dripproof protected enclosure with access cover. Generator terminals shall be silver surfaced.

(d) Emergency Generator Starting

Starting of the emergency diesel generator shall be by means of the electric system specified in SECTION 76.

The units shall be provided with "fail-safe" means for automatic starting upon failure of the normal AC power supply to the emergency switchboard and shall be stopped manually after restoration of the normal supply.

88.3. EXCITATION AND VOLTAGE REGULATION FOR AC GENERATORS

Excitation shall be of the rotating, brushless type without the use of commutator or slip rings, and integral with the generator, or of the static type.

Voltage shall automatically build up without the necessity of flashing from a source external to the generator set or action by the operator.

It shall not be necessary to switch off the regulator when the set is turning below rated speed in order to prevent damage to the generator, the exciter or the regulator.

88.4. SPARE PARTS AND SPECIAL TOOLS

Spare parts and special tools for each generator shall be provided and separately boxed. Spare parts for generators and ancillary equipment shall be provided in accordance with the requirements of SECTION 86.

SECTION 89

SWITCHBOARDS

89.1. GENERAL

Descriptions in the following paragraphs indicate the general features and arrangement required but the design shall be developed by the Contractor as may be required to suit the final approved electric plant development of the ship in accordance with Regulatory Body and industry standard requirements.

(a) Structure

Switchboards shall be freestanding dead front type units. Sheet metal or fiber glass barriers shall be provided to form separate individual compartments for power circuit breakers.

In the arrangement of equipment and the general design of switchboards, particular attention shall be given to their overall dimensions to assure installation with adequate clearances in the limited headroom and deck space available.

Bolts, nuts, and washers used in the construction of the unit shall be steel suitably treated to resist corrosion. Lock washers or self-locking nuts shall be used throughout to prevent loosening of bolts.

(b) Enclosures

Enclosures, bolted to the switchboards and made of reinforced expanded metal or wire mesh, shall be provided extending from the ends of the switchboards to the ship's structure with doors arranged for locking. Alternatively, louvered, hinged door panels may be provided to completely enclose the rear of the switchboards.

Distribution switchboards and emergency generator and distribution switchboards may be constructed without rear access when designed and built to provide complete access from the front for inspection, maintenance, and repair.

Suitable drip shields shall be provided where required over switchboards.

Switchboard lighting shall consist of a row of fluorescent lamps mounted in canopy type fixtures integral with the drip shield and extended the length of the board. The fixtures shall have prismatic lenses and shall provide adequate illumination without excessive glare.

In general, switchboards shall be arranged for top entry of cables.

(c) Switchboard Instruments

Instruments shall preferably have white dials with black markings. Red marks shall be placed on instrument scales to indicate rated voltage, current, and kilowatts of the circuit into which the instruments are connected.

Potential transformers shall be used for instruments, meters, and relays connected to AC circuits over 230 volts. Transformers for voltage regulators shall not be used for other purposes.

Switchboard indicating instruments shall typically be accurate to within 1 percent of full scale deflection.

(d) Air Circuit Breakers

Air circuit breakers when used shall meet the applicable requirements of the latest IEEE or IEC recommended Standards.

The protective features and interrupting ratings of circuit breakers shall be coordinated to provide protection for the electric plant without exposing the protected equipment to excessive thermal or mechanical stress.

Open type air circuit breakers when used shall be of the drawout type and shall be equipped for manual closing and tripping.

Spaces for spare feeder breakers shall be provided on switchboards as required to provide for future use. All spaces for circuit breakers shall be equipped with the necessary connectors fully insulated and braced to accept the required breaker without the need for additional parts.

(e) Bus Bars and Connections

All bus bars shall be made of hard drawn commercial copper. Cable shall not be used for this purpose unless specifically approved.

All bus bar joints and contact areas shall be silver surfaced.

Busses to individual feeder circuit breakers shall be designed on the frame rating of the breakers except for connections to breakers in frame sizes over 255 amperes, in which case the connections may be based on the breaker rating or 400 amperes, whichever is the larger.

Cable supports shall be provided where necessary to avoid undue strain on circuit breaker studs.

(f) Control Switches

Switches provided for instrument transfer or control functions shall be of the rotary type. They shall be equipped with clearly marked escutcheon plates to indicate their positions and shall be provided with a positioning device to securely hold the switch in the selected position.

(g) Relays and Contactors

Relays which have sensitive characteristics and precision mechanism and/or adjustments shall be housed in moisture and dustproof cases. Contactors, auxiliary relays, alarm relays and similar devices which do not have such precision properties shall be provided with a suitable cover.

(h) Indicator Lights

Indicator lights shall be flush mounted, and shall be provided with a colored lens to convey the desired indication. The color shall be integral with the lens and not externally applied.

Lamps shall be of a standard size, with approved bayonet type base. Colors shall be assigned to indicate operating conditions on the basis of the following:

Red: Alarm: Not Normal, Circuit Breaker Closed

Green: Normal: Automatic Circuits Complete, Circuit Breaker Open

Amber: Special Purpose

Blue: Special Purpose

White: Power Available

Clear: Ground Indicator: Synchronizing

(i) Insulation Material

Insulating materials shall be of laminated phenolic, glass-polyester laminates, or equal. Porcelain or wood products shall not be used.

(j) Voltage Regulators

This equipment shall be furnished with the regulated machine but installed as a part of the switchboard or as specified in 89.2. below.

89.2. ENGINE ROOM CONTROL CONSOLE

The ship service generator and distribution switchboard should preferably be located in the immediate vicinity of the Engine Room control console with the switchboard instrumentation completely readable from the operating position.

Where such arrangement is not feasible, and the switchboard must be located remotely from the Engine Room control console, generator instrumentation and control appurtenances as required for manual paralleling and for monitoring the generator and distribution system should then form a section of the Engine Room control console with the generator circuit breaker and distribution panels remotely located.

89.3. SHIP SERVICE GENERATOR AND DISTRIBUTION SWITCHBOARD

(a) General

The ship service generator and distribution switchboard shall be arranged for operation of generator circuit breakers and for distribution of power. The switchboard shall include facilities for ground detection and paralleling of the generators.

(b) Equipment

The following equipment shall be included:

(1) Generator Panels (Each)

Electrically operated, open frame or insulated case type circuit breaker with a current rating compatible with generators being provided. The breakers shall also be furnished with low voltage trip, shunt trip, auxiliary switch, trip button and mechanical position indicator. Breakers shall be electrically interlocked with synchronizing switch to prevent closing without synchronizing.

Generator breaker indicating lights

Control transformer, connected to the generator side of the generator circuit breaker, for the operation of the prime mover governor motor and the tripping of the generator circuit breaker.

Three phase circuit breaker for bus tie to emergency switchboard.

(2) Distribution Panels

Primary Distribution Feeders (As Required)
Secondary Distribution Feeders (As Required)

89.4. EMERGENCY GENERATOR AND DISTRIBUTION SWITCHBOARD

(a) General

This switchboard located in the Emergency Generator Room shall be arranged for the control of the emergency generator and shall provide automatic transfer equipment and distribution and battery charging facilities as required for proper operation of the emergency electric plant.

The switchboard shall consist of dead front panels and shall include a three phase generator bus, a primary distribution, three phase bus, a secondary three phase distribution bus, and a DC battery bus. In lieu of the secondary distribution bus, a distribution type panelboard may be flush mounted on the end of the switchboard.

(b) Equipment

The following shall be included:

(1) Emergency Generator and Bus Transfer Panel

Control switch with indicator light for generator space heaters connected through the generator circuit breaker auxiliary switch to a circuit breaker on the secondary distribution panel.

Indicator light to show when all manually operable control devices pertaining to the transfer equipment and to the starting of the Emergency Generator Prime Mover are set up for automatic operation.

Automatic bus transfer equipment designed to initiate the prime mover automatic starting cycle approximately 3 seconds after voltage from the main switchboard drops 20 percent or more and to automatically transfer the emergency switchboard supply to the emergency generator upon development of sufficient voltage from the source. The bus transfer switch shall consist of two 3 pole, open frame or insulated case type circuit breakers of appropriate frame size with suitable overcurrent trips on the generator breaker. Under normal operation overcurrent on the emergency switchboard bus will be cleared by the bus tie breaker of the main switchboard by means of the series overcurrent trips. Under feedback operation, if implemented, overcurrents on the main switchboard shall be cleared by the bus tie breaker by means of an overcurrent relay in the emergency generator leads, operative only during feedback. The two breakers of the transfer switch shall be interlocked to prevent simultaneous closing, and shall be provided with means for manual operation.

A keyed lock type release shall be provided for the interlock to permit closing of both breakers for feedback purposes. Electrical interlocks shall prevent inadvertent paralleling of the main and emergency generators after the transfer switch interlock is released. A momentary contact interlock bypass shall permit closed transition between emergency and ship service switchboards only when the ship service generator is de-energized.

A control switch to simulate loss of normal supply voltage for testing automatic bus transfer and prime mover starting equipment shall be provided.

Manual retransfer switch for use with automatic bus transfer equipment.

Control switch for testing automatic starting cycle of the prime mover and for its direct starting (may be combined with test switch described above).

Control switch for shutting down the prime mover.

Ground detector lights with spring return type control switch for testing for grounds.

(2) Distribution

Primary Emergency Distribution Feeder Breakers (As Required)

(3) Battery Charging Panel

This panel shall provide for the charging and discharging of the I.C. batteries. The equipment shall be complete with transformers and other components as required to accomplish high rate charging and trickle charging of the batteries. Overcurrent and surge protection shall be provided.

Charging rates shall be manually selected and shall be readily adjustable over both the high charging and trickle charging ranges.

The respective chargers shall be capable of fully charging either of the duplicate I.C. batteries in not more than 8 hours.

The following equipment shall be included:

Equipment	I.C. Battery
Ammeter, high rate	1
Ammeter, low rate	1
Voltmeter	1

Ammeter, Output	1
Control Switches	As required

Four pole, double throw, rotary type switch with no "OFF" position for selecting which I.C. battery shall be on charge while the other is supplying the DC bus.

When required, a battery charger for emergency diesel generator starting, together with associated components, shall be provided.

SECTION 90

ELECTRICAL DISTRIBUTION

90.1. GENERAL

Typically the primary AC distribution system shall be a 3 phase (3 or 4 wire) insulated system capable of continuously monitoring the insulation level to ground (earth).

In general, in spaces such as but not limited to, Engine Room auxiliaries, shop equipment, ventilation, deck machinery, and Commissary equipment, shall be energized from separate power panelboards or group control boards supplied by individual feeders from the ship service generator and distribution switchboard. Similarly, electronic equipment and I.C. equipment shall be energized from separate power panelboards supplied by individual feeders from the emergency generator and distribution switchboard. The normal and emergency lighting distribution shall be supplied through suitable transformers energized from ship service and emergency switchboards, respectively.

Fixed electrical appliances, except for certain small commissary type equipment such as domestic size refrigerators and toasters, shall have means provided to make permanent connections to ship cables.

90.2. DISTRIBUTION VOLTAGES

The nominal voltage for the primary AC distribution system shall be 460 volts and 60 Hz or 380 volts and 50 Hz depending upon future deployment of the ship. Secondary distribution voltage for items such as but not limited to, lighting and receptacles, shall be 115 or 220 volts.

Power equipment in general, including the principal galley equipment, shall operate on, nominal supply (460 or 380 volts), 3 phase.

Small appliances and motors of .37 kw or less for commissary equipment such as but not limited to egg boilers, domestic size toasters, domestic refrigerators, and mixers, shall operate on 115 or 220 volts AC obtained from power distribution panelboards.

The transformers energized through the emergency switchboard shall also supply the interior communication, battery charging, electronic and navigation equipment.

The general alarm system and power failure alarm panel shall operate on DC obtained from either of the two I.C. storage batteries. Battery voltage shall be determined by system voltage drop restrictions.

Equipment not compatible with the foregoing power characteristics may be supplied through other transformation or conversion equipment.

90.3. RECEPTACLES

Power receptacles for portable equipment, such as but not limited to, cargo container units shall be 3 phase, 4 pole, NEMA-3R (raintight) interlocked type.

The portable cords, used for power receptacles, shall be heavy duty type 4 conductor cord with the fourth conductor furnishing ground connection to the equipment. Suitable cord stowage facilities shall be provided convenient to refrigerated cargo container receptacles.

General purpose receptacles for portable equipment shall be provided in all spaces, including elevator shafts and open deck areas, but excluding cargo holds or hazardous zones in any way of cargo tanks. Each space and each work bench, except in hazardous areas, shall have at least one unassigned receptacle. Mess, Recreation, Steering Gear and Emergency Generator Rooms and work spaces, such as Galley, Radio Room, Wheelhouse and Chart Room, shall have at least two. Large spaces shall have receptacles in numbers and locations adequate to provide complete coverage of the space by portable appliances, tools or lights equipped with cords of not more than 8 m in length, except that cords may be 16 m in length for open deck coverage. In general, receptacles shall be the duplex type except that watertight or explosion proof receptacles may be single unit type. Receptacles in spaces where they may be exposed to mechanical injury shall be watertight. All receptacles shall be of the grounded type.

90.4. ELECTRIC CABLES

Cables shall be selected and provided in accordance with Regulatory Body(ies) requirements.

The minimum size of conductors for portable cords shall be in accordance with IEC or IEEE respectively.

All electric cables shall be of the flame retardant type complying with IEC 92 Standard or IEEE Standard 45.

90.5. CABLE CALCULATIONS

(a) Power

Generator and tie feed, power and lighting feeder, and branch cable computations shall be based on demand load factors as specified by the Regulatory Body(ies). Allowable voltage drop for power circuits should not exceed 5 percent.

(b) Lighting

Voltage drop for lighting circuits should not exceed 5 percent. Wattage for fluorescent fixtures shall include associated ballast wattage.

(c) Interior Communication

Cable sizes for these circuits shall be selected with due consideration to a possible expansion of the system. A minimum of 20 percent spares, based on the actual number of conductors used, shall be provided in all such cables except for up to 3 conductor I.C. cables and the single pair telephone cables.

Voltage drop for interior communication circuits shall be calculated on the basis of the "in-phase" component of current, except that where voltage is critical the recommendations of the equipment manufacturer shall be followed. The allowable voltage drop should not exceed 5 percent.

90.6. CABLE INSTALLATION

(a) General

Cables shall be run as directly as practicable, consistent with adequate ventilation of the cable wireways and with due care in the avoidance of hazardous or otherwise undesirable locations.

Cables shall not be installed adjacent to piping or other apparatus which may cause leaks or condensation drips. When such proximity is unavoidable, suitable shielding shall be provided.

Cables for weather deck mounted fixtures shall be installed on the inside surface of house structures supporting such fixtures.

Cables shall not be installed on gratings or walkways in Engine Room, in bilges, or in spaces exposed to oil damage.

Where necessary to run cables under gratings or walkways they shall be installed on the underside of dripproof galvanized metal pans.

Electrical and electronics circuits shall be segregated to ensure electromagnetic compatibility as recommended by IEEE or IEC standards.

(b) Wireways and Supports

All cable hanger material shall be of steel not less than 2.4 mm thick with corrosion resistant finish. Painting will be acceptable as a corrosion resistant finish for all interior hanger material except in refrigerated spaces and galleys. Bolts, nuts and washers for use with painted hanger material shall be sherardized or cadmium plated. Hanger material for refrigerated spaces and galleys shall be galvanized steel with brass or bronze nuts, bolts and washers. Exterior hanger material and studs shall be of stainless steel with stainless steel, brass or bronze nuts, bolts and washers. Each weld area at hanger or stud shall be wire brushed or sandblasted, where required, and coated immediately after welding and before the installation of any cables.

(c) Penetrations

Openings in decks or platforms for the purpose of cable penetrations which do not require stuffing tubes or kickpipe protection shall have a lining continuously welded all around the edge of the opening. The lining shall consist of a steel collar extending not less than 76 mm above platform. This requirement particularly applies where watertight integrity is not otherwise required.

Cable penetrations through bulkheads and decks, both watertight and non-watertight shall comply with Regulatory Body(ies) requirements. Multicable penetrator devices may be used in place of watertight stuffing tubes for all penetrations except through open decks. Extra heavy low alloy kickpipes with stuffing tubes or equivalents shall be welded into all open decks. All kickpipes shall be 230 mm high to top of stuffing tube. Built-up watertight boxes may be used in lieu of kickpipes.

The metal bars for wireway guards shall be of 50 mm by 6.3 mm steel and sling guards made of flat bars or expanded metal shall be provided where necessary.

Sheet steel enclosures, where used, shall be sectionalized in lengths convenient for removal by hand.

Wireways in cargo spaces where installed below deck beams shall, as far as practicable, be limited to a single tier so as to leave the maximum headroom below the wireways for the cargo.

All electrical cable to deck mounted winch motors and controls exposed on deck shall be adequately guarded the full run from deck to terminal box, with pipe or other substantial protection. When a kickpipe is extended the full run from the deck to terminal box, the kickpipe shall be arranged to permit movement of the deck relative to the terminal box.

Cable in Passengers', Officers' and Crews' private and public accommodations, including bathrooms, shall be concealed wherever practicable. Where bulkhead construction makes concealment difficult or impractical, the wiring shall be neatly formed, and installed on the surface in a workmanlike manner, giving particular attention to appearances.

90.7. PANELBOARDS

Panelboards shall be dead front, circuit breaker type, meeting Regulatory Body(ies) requirements.

Lighting panelboards shall be provided with at least one spare switching unit complete, installed but not used, for every ten active units or fraction thereof installed. Power panelboards shall be provided with at least one switching unit complete, installed but not used, for every five active units or fraction thereof installed.

90.8. PROTECTIVE ELECTRICAL DEVICES

Protective devices shall be so selected and arranged as to isolate any fault in the system vital to operation of the ship with the least possible portion of the system's service being interrupted. The system shall be so designed that the generator breakers will be the last to open. Each protective device shall have sufficient interrupting capacity to safely interrupt the maximum fault current obtainable at its point of application.

Circuit breakers used in panelboards shall be of the commercial marine molded case type, quick-made, quick-break, with inverse time tripping characteristics on overloads and air instantaneous trip device for short circuits.

90.9. TRANSFORMERS

One or more banks of three 460/120 or 380/220 volt, single phase, dry type, air cooled transformers shall be provided for ship service lighting and secondary power requirements. One bank shall be provided at the main switchboard.

One bank of three 460/120 or 380/220 volt, single phase, dry type, air cooled transformers shall be provided at the emergency switchboard for emergency lighting, interior communication and power requirements.

Ratings of foregoing transformers shall be not less than the connected loads plus spare circuit allowance.

Other transformers of adequate capacities and required voltages shall be furnished as required to supply special equipment including but not limited to refrigerated container units.

90.10. SHORE CONNECTION

A 3 phase shore connection feeder shall be provided from the main switchboard to a single shore connection box of adequate capacity located so as to be readily accessible to shore cables from either side of the ship with minimum interference with deck activities.

90.11. ELECTRIC HEATERS

Electric heaters for equipment warm-up shall be of the immersion type; for equipment condensate prevention shall be of the convection type; and for space heating shall be of the strip convector type.

Window heaters shall be of the conductive panel type with controls integral with panel.

Heaters, except those for condensate prevention, shall be provided with automatic temperature control and safety shut off.

90.12. CATHODIC PROTECTION SYSTEM

Provide an impressed current cathodic protection system to protect the submerged hull and appendages against corrosion. Control and power supply components shall be solid-state, static type of sufficient capacity to provide not less than 86 milliamperes per square meter of wetted area. The number and dissolution rate of the anodes shall be such that this output can be maintained for at least 10 years without replacement of anodes. The number of anodes shall be as recommended by the manufacturer, but shall be not less than six.

The system shall be arranged for both manual and automatic operation. In automatic operation, the controller(s) shall continuously monitor the degree of protection and provide at all times the proper anode current to maintain the optimum level of protection as preset by the operator and as indicated by the voltage between the required silver-silver chloride or pure zinc reference electrode(s) and the hull. The equipment shall automatically maintain the hull potential at the millivolt value selected with an error not to exceed plus or minus 20 millivolts.

External underwater components, including anodes and reference cells shall be designed for minimum drag and shall not protrude more than 76 mm from the hull at any point.

Provide main propulsion shaft grounding.

The system shall maintain all appendages such as but not limited to propellers, rudders, and stabilizer fins, at the proper potential. Propeller shafts shall be well grounded through slip rings and brushes.

The system shall be energized from ship service power.

The system shall be intrinsically safe as required by Regulatory Body(ies).

SECTION 91

AUXILIARY MOTORS AND CONTROLS

91.1. GENERAL

All motors and controllers shall be provided to suit the requirements of each application.

Heaters shall be provided within all motor and control enclosures subject to accumulation of condensation and wide variation of temperature such as refrigerated space air cooler fan motors and controls and fire pump motor and controls.

All motors and motor controllers shall be designed for operation in the ambient temperature dictated by the space in which they will be located as required by Regulatory Body(ies), e.g., motors for the machinery space exhaust fans shall be designed for operating in an ambient temperature of 65°C ambient, with Class B, F, or H insulation. Controllers located in the same area shall also be suitable for operation in 65°C ambient.

For miscellaneous electrical power drive shop tools with built-in motors and controls, such equipment will be acceptable if it conforms with Regulatory Body(ies) requirements.

91.2. MOTORS

All motors shall be of the same manufacturer, in so far as practicable and shall be of commercial marine quality.

All motors rated over .186 kW shall be AC squirrel cage induction type designed for 460 or 380 volt, 3 phase, 60 or 50 Hz, continuous duty, with Class B or F insulation, unless otherwise specified. Motors of .186 kW rating and less may be designed for operation on 115 or 220 volt, single phase.

Particular care shall be exercised in the selection of AC motors to insure that each motor is not too large for the intended service, and thus avoid the low power factor inherent in underloaded induction motors.

In general all motors shall be at least dripproof protected except as noted.

Each waterproof motor shall be provided with an automatic drain and breather fitting.

Open type motors for commissary and laundry equipment may be used where the equipment housing provides motor protection comparable to a dripproof protected machine.

All motors .186 kW and over shall be equipped with anti-friction bearings of suitable design to meet the imposed thrust and radial loads and to provide an adjusted fatigue life of 50,000 hours except fan motors which should have a life of 100,000 hours. Where motors are used with solid couplings, a bearing to take thrust shall be fixed to the shaft end housing, and the shaft end play limited to the clearance in the bearing. Use of tandem ball bearings for axial thrust loads is not acceptable.

All motors equipped with anti-friction bearings using pressure grease fittings shall have positive means, either by relief plugs or fittings or a clearance differential relief system, to prevent grease from being forced out upon the motor windings.

Axial flow fan motors shall have bearing housings which are adequately sealed to prevent either loss or contamination of the lubricant and that the size of the lubricant chamber shall be adequate enough to preclude the need for in service greasing.

Round frame motors shall be provided for axial flow and propeller fans.

All motors driving close coupled pumps, i.e., those having both the motor rotor and pump impeller mounted on the same shaft, shall have the combined motor-pump shaft materials as required by SECTION 73; motor shaft sleeves shall also be provided with the pump as required by SECTION 73.

Motor overload protection shall normally be provided by the controller overload relay, but alternative built-in motor thermal protection also may be used if considered needed for the intended service, e.g., fuel and lube oil purifiers.

91.3. CONTROLLERS

All controllers shall be of the same manufacture, in so far as practicable and shall be of commercial marine quality.

Generally, all integral motor power controllers shall be across-the-line magnetic type, with master switches mounted at the controller door and with provision for control by protective thermal sensors where provided on the motor.

Controllers for multi-speed motors rated 75 kW and above shall be provided with timed decelerating relays. Each pushbutton station for multi-speed motors shall include speed indicating lights properly labelled.

A complete wiring diagram of each controller shall be attached, with heat resistant, transparent protective covering, to the inside surface of the control cabinet door.

Each controller shall be provided with the necessary circuits and auxiliary contacts for energizing indicating lights, alarms and illuminated pushbuttons as required in SECTIONS 95 and 99.

Motor control circuits extended to the Engine Room centralized console or to any control console may be supplied from a common low voltage AC or DC power supply provided at such console for monitoring and control functions.

Motor control circuits shall be so arranged that normal or "at-will" stoppage of a motor connected to an alarm circuit will not activate the stopped alarm on the Engine Room control console, but any stoppage resulting from loss of voltage, overload or operation of safety protective devices, or interlocks associated with Engine Room control, shall actuate the stopped alarm.

Where practical, controls for motors of related service category, such as those used respectively for Engine Room auxiliaries and deck machinery, shall be provided in group control centers.

Group control centers shall be dead front type of rigid dripproof construction. The vertical sections shall be provided with removable lifting angle iron to facilitate installation of the control center. At least 15 percent of the control cubicle area of each group control center shall be reserved as spare space suitable for mounting future unit controllers. Such space shall be complete with bus and blank filler doors. Circuit breakers for unit controllers shall provide instantaneous magnetic trip protection only except that thermal and instantaneous magnetic trip protection with current limiting fuses may be provided where required to provide adequate interrupting capacities.

Connections to the main bus shall be made by means of "stab" type fittings or equivalent.

Where the controller is not located adjacent to the motor, a start-stop pushbutton with means to prevent operation of the unit from other locations, shall be provided at the motor.

In accordance with Regulatory Body(ies) requirements for unmanned Machinery Rooms, the motor controllers for essential pumps such as but not limited to lubricating oil service pumps, fuel oil service pumps, sea water and jacket water cooling pumps and steering gear pumps, shall be configured to allow "lead" or "stand-by" operation. Typically, this means that a set drop in discharge pressure will automatically start the stand-by pump.

Automatic controls shall have provision for manual over-ride control.

All items such as but not limited to compressors, potable water pumps, and priming pumps, shall be interlocked as described under the driven auxiliaries.

Steering gear motor controllers in Steering Gear Room shall provide for local "Start-Stop" control and for transfer of control to Wheelhouse. In local "Start" and "Stop" positions the selector switch shall disconnect all wires except for motor running indication to the Wheelhouse control. Wheelhouse position of this selector switch shall permit automatic starting and stopping of pump motors by action of the steering pump selector switch in the Wheelhouse. Provide "Motor Running" indications in Wheelhouse and Engine Room control consoles. The "Stop" control in the Steering Gear Room shall stop the motors regardless of the position of the selector switches.

All motor-operated valve control shall provide pushbutton stations which shall include position indicating lights, open, and closed, with both lights on when valve is in any position between fully open or fully closed.

Galley exhaust-fan master switch shall be mounted in the Galley at a readily accessible location near an exit.

91.4. EMERGENCY "STOP" STATIONS

Emergency "Stop" Stations as required by Regulatory Body(ies) shall be provided.

91.5. LIST OF MOTOR DRIVEN AUXILIARIES

Motor and control characteristics such as but not limited to rating, speed, insulation class, enclosure, and special functions, shall be listed in a table similar to the sample table shown on the following pages. This list should include major auxiliaries only and not Commissary, Laundry, portable motor-driven, office or miscellaneous shop equipment.

APPLICATION					
Item Number	6	7	8	9	10
Name	Sewage Plant Discharge Pumps	Sewage Holding Tank Discharge Pumps	Fire Pump	Standby Fire Pump	Jacket Water Circulating Pump
Quantity per ship	2	2	1	1	2
MOTOR					
kW (Horsepower)	0.75 (1)	2.2 (3)	93.7 (125)	93.7 (125)	3.7 (5)
Speed in RPM	1200	1200	1800	1800	1800
Volts/phases	460/3	460/3	460/3	460/3	460/3
NEMA Cs/Amb. Temp.	B/40°C	B/50°C	B/50°C	B/50°C	B/50°C
Duty	Continuous	Continuous	Continuous	Continuous	Continuous
Mounting	Vertical	Vertical	Vertical	Vertical	Horizontal
Enclosure	D. P. Prot.	D. P. Prot.	D. P. Prot.	D. P. Prot.	D. P. Prot.
Remarks				Note 3,4	
CONTROL: Starter					
Location	Local	Local	Group A	Local - Emerg. Bus	Group A & B
Function	ATL Start	ATL Start	ATL Start	ATL Start	ATL Start
Operation	Semi-Automatic	Semi-Automatic	Semi-Automatic	Semi-Automatic	Semi-Automatic
Enclosure	Drip-proof	Drip-proof	Drip-proof	Drip-proof	Drip-proof
Undervoltage	LVP	LVP	LVP	LVP	LVP
CONTROL: Switch					
Location			Local	Local	Local
Enclosure			Drip-proof	Drip-proof	Drip-proof
Function			St. - St.	St. - St.	St. - St.
CONTROL: Control					
Location			Remote	Remote	Remote
Enclosure			Watertight	Watertight	Watertight
Function			St. - St.	St. - St.	St. - St.

APPLICATION					
Item Number	6	7	8	9	10
Name	Sewage Plant Discharge Pumps	Sewage Holding Tank Discharge Pumps	Fire Pump	Standby Fire Pump	Jacket Water Circulating Pump
Quantity per ship	2	2	1	1	2
CONTROL: Misc. Dev.					
Type	Float Switch	Float Switch			
Enclosure	Watertight	Watertight			
CONTROL: Remarks					
			Remote control from engine.	Remote control from engine.	

SECTION 92

LIGHTING

92.1. GENERAL

The ship shall be lighted throughout with incandescent and fluorescent fixtures in accordance with applicable standards and recommendations, e.g., Illuminating Engineering Society publication entitled "Recommended Practice for Marine Lighting RP-12", or IEC standard publication 92-306 "Equipment Luminaries and Accessories".

Fluorescent lighting of the rapid start type, where applicable, shall be used in all living and working spaces except as otherwise specified. Fixtures arranged for less than 20 watts shall be provided with low power factor ballasts and radio interference suppression in accordance with ANSI C82 or equivalent. The use of high power factor ballasts for fluorescent lights shall be considered.

Fixtures for service areas, open decks, and spaces of similar nature and uses, where illumination of a high level is not an essential requirement, shall be incandescent type. Fixtures for floodlights may be of the incandescent and/or electric discharge type.

All Wheelhouse instrumentation shall have red dial illumination, either by back illumination with red filter or by dial illuminator and red lamps, with the light of longer wave length than 5900 Angstrom Units and not greater in intensity than .34 candela/m^2 controlled by dimmer rheostat. The dial illuminator shall be designed of polarized material, sufficiently transparent to project light for cross dial illumination and sufficiently rigid for satisfactory results.

Wheelhouse log desk and chart table lights shall be fitted with red filters.

Wheelhouse and Bridge wing indicator lights shall be controlled individually by means of series rheostats for varying the intensity of the light. The rheostats shall be housed in the same cases with the lamps.

Exterior lighting fixtures and receptacles shall not be connected to branch circuits energizing interior lighting fixtures and/or receptacles.

Fresh lamps shall be provided in each space immediately prior to the illumination survey and all burned out, damaged or missing lamps shall be replaced at time of delivery of the ship. In lieu of the replacement, 100 percent of lamps of each type and size may be placed on board immediately prior to ships delivery.

92.2. EMERGENCY LIGHTING

Emergency lighting, as specified in SECTION 88 shall be energized from the emergency lighting and power system.

92.3. ILLUMINATION LEVELS

Lighting fixtures shall be provided in numbers, sizes and arrangement in order to maintain in service at least the average lumens/m^2 recommended by applicable standards.

Areas not listed in applicable standards shall be illuminated in a manner corresponding to a similar space listed.

Supplementary illumination shall be provided for all desks, berths, mirrors, bulletin boards, and transoms, and be adequate for reading without discomfort. In work spaces, illumination shall be provided for such items as gages and instruments, gage boards, control consoles, switchboards, and bulletin boards, so as to permit accurate readings from the usual operating positions. Galley and pantry sinks, work benches, power driven tools, and desks, in work spaces shall be provided with supplementary lighting on the work surfaces.

Illumination for the Engine Room Control Console shall be greater than the minimum level necessary to maintain a visual gradient with the alarm, signal and indicating lights, to readily recognize the information cues from the normal operating positions.

Lumens/m^2 (lux) readings shall be recorded during a photometric survey of the completed spaces for the first ship of a group wherever built.

Lumens/m^2 (lux) readings shall be such that when multiplied by a light loss factor of 0.7, to allow for deterioration of lamps, fixtures and painted surfaces, their value will not be less than those specified.

92.4. LIGHTING IN WORK SPACES

The space below Engine Room gratings shall be adequately lighted and access means shall be provided for maintenance of the lighting installation.

Lockers shall be lighted by guarded watertight deck fixtures controlled by watertight switches located at entrances to these spaces.

Lighting fixtures in galley shall be flush mounted and all wiring shall be concealed.

Passageway lights, and lights in machinery spaces shall be controlled at local panelboards.

Lighting for spaces accessed from the Weather Deck shall be controlled by watertight switches located adjacent to entrances to the respective spaces.

Switches for control of lights to be located within refrigerated spaces with pilot light units located outside the compartment entrances. Fixtures in refrigerated areas shall be suitable for use in minus 18°C boxes.

Two wire, 3 pole grounded Weather Deck receptacles for portable lights shall be provided in accordance with Regulatory Body(ies) requirements.

92.5. LIGHTING IN ACCOMMODATIONS

Flush mounted lighted fixtures shall be provided and all wiring shall be concealed where lined ceilings, acoustical or marine veneer ceilings and/or bulkheads are installed.

In accommodation areas and offices with single accesses, local single pole switches shall be provided. In those areas with multiple accesses, three or four-way switching shall be provided at each entrance.

All plates for switches and receptacles shall be made of brass, stainless steel or aluminum.

A fluorescent mirror light of at least 20 watts with switch and convenience outlet shall be provided over each toilet cabinet and mirror mounted over lavatories in toilets, showers, and Staterooms.

A berth light of at least 14 watts (fluorescent) with switch shall be provided for each berth. Table lamps and desk lights with switches shall be provided in spaces such as but not limited to Staterooms and Lounges.

Utility receptacles for personal use in Bathrooms, Staterooms and for general use such as but not limited to desk fixtures, decorative table lamps, and portable devices, shall be provided. Grounding pole or isolation transformers shall be provided in accordance with Regulatory Body(ies) requirements.

92.6. EXTERIOR LIGHTS

(a) General

Lights on the Bridge Deck and in other areas which cause interferences to navigation shall be controlled by switches located in the Wheelhouse. Exterior lights, required at sea and visible from ahead, shall be shielded.

Exterior lights required to be extinguished prior to sailing shall be controlled from not more than three central locations.

(b) Gangway and Lifeboat Lighting

Two hundred-watt, portable, projected type fixtures with local control shall be provided port and starboard to illuminate the gangway and accommodation ladder. Lights shall be mounted on brackets so constructed that they may be swung outboard for overside lighting and rigidly locked in position. If portable, stowage shall be provided for these lights when not in use.

One 500 watt projector type floodlight, mounted on a bracket so constructed that it may be swung inboard for deck lighting or outboard for overside lighting and rigidly locked in either position, shall be provided for each lifeboat or life raft.

(c) Weather Deck Lighting

Floodlights, mounted on house structures and masts or king posts, shall be provided to adequately illuminate the Weather Decks for operation of cranes, stowage and lashing of deck cargo.

Weather Deck floodlights shall be equipped with cords and watertight non-plastic plugs and shall be plugged into watertight receptacles.

Exterior lights shall be provided around each hatch coaming, to provide illumination for safe deck access and inspection of cargo and container lashings. Exterior lights shall also be installed on the forecastle.

For tank vessels consult applicable Regulatory Body(ies) requirements, e.g., IEC publication 92-502, "Special Features for Tankers".

92.7. NAVIGATING AND SIGNAL LIGHTS

A running and anchor light system in compliance with applicable International and Inland Rules of the Road and Regulatory Body(ies) requirements shall be provided so as to permit compliance with the Rules.

A cargo loading light shall be provided if required by the applicable Regulatory Body(ies).

A navigating and signal light panel shall be provided in the Wheelhouse. This panel will combine a semi-automatic telltale navigating, light section for audible and visual control (alarm) of the masthead, port, starboard, range and stern lights and a signal light section for control of the anchor, not-under-command and towing lights. Additional mast mounted signal light arrays with appropriate Wheelhouse switch panel shall be provided as required to comply with trade route requirements.

Two fixed masthead towing lights and one yellow aft towing light, single filament, and two (w) portable not-under-command (N-U-C) lights together with halyards and fittings for rigging the two assemblies into position shall be provided. These lights shall be energized from watertight receptacles, suitably located, connected to the navigating light panel located in the Wheelhouse.

All lights shall be of brass, bronze, aluminum or stainless steel construction. The navigating lights shall be of the two compartment type and the signal lights shall be of the single compartment type.

One marine type, signaling searchlight shall be provided. The signaling light shall be either a fixed unit mounted on top of the Wheelhouse, or a semi-fixed unit with arrangements for quick mounting at either Bridge wing of the Navigating Bridge.

A switch and receptacle in conformance with Suez Canal Authority "Rules of Navigation" shall be provided for vessels navigating the Suez Canal. A Suez Canal searchlight shall not be provided.

For vessels navigating the Panama Canal a Panama Canal Steering Light shall be provided in accordance with Regulatory Body(ies) requirements.

92.8. MISCELLANEOUS

Bracket fans in working spaces that are not air conditioned shall be 40 cm oscillating, quiet blade, marine type suitable for direct connection to the ship's wiring system without the use of portable cords and outlets. Control switch shall be mounted in the base and shall be readily accessible.

Window wipers shall be provided in the Wheelhouse. Wiper motors shall be 115 or 220 volt AC and each shall be controlled by a separate rheostat and cut-off switch at wiper.

SECTION 93

COMMUNICATIONS

93.1. GENERAL REQUIREMENTS

All communications and related electronics systems installed by the Contractor shall comply with the requirements for installation, performance and testing set out by IMO and its Safety of Life at Sea (SOLAS) Conventions.

The plan development and the installation of all equipment, including antennas, shall be accomplished under the guidance of authorized representatives of the respective equipment manufacturers. All final checks and adjustments shall be made by authorized representatives of the manufacturer of the particular equipment involved, and where possible, prior to the official ship's trials.

Antenna layout plans shall be submitted for approval to the approving authority, well in advance of the installation. Both radio manufacturers and radar manufacturers shall review the antenna arrangement plans for concurrence of location and size of all antennas, potential radio frequency interference and compatibility, and they shall make appropriate notations indicating their acceptance on the drawings.

The radio manufacturers shall provide radio frequency noise suppression for out of band noise and shall provide adequate isolation and filtering to eliminate extraneous radio frequency emissions. These shall protect the frequencies between 150 KHz and 27.5 MHz to prevent extraneous noise on radio receivers.

The electronics equipment shall be energized from ship's AC power through isolation transformers to achieve the appropriate voltages. The systems shall use a nominal 120 or 230 volts AC at 60 Hz. The systems shall be capable of independent powering from the emergency distribution switchboard.

93.2. COMMUNICATIONS EQUIPMENT (U.S. FLAG ONLY)

The following suite of communications systems shall be provided in accordance with Regulatory Body(ies) requirements.

(a) Communications Suite Including Global Maritime Distress and Safety System (GMDSS):

- * Very High Frequency (VHF) Two-way transceiver with:
  - o Digital Selective Calling (DSC) on Channel 70 (156.525 MHz).

- o Radio Telephone on Channel 6 (156.300 MHz), Channel 13 (156.650 MHz), and Channel 16 (156.800 MHz).

- o General Radiotelephony (156.000 to 157.000 MHZ).

* VHF Dedicated Watch Receiver with DSC on Channel 70 (156.525 MHz).

* NAVTEX International Receiver for Maritime Safety Information.

* SafetyNET INMARSAT (Enhanced Group Call Type) Dedicated Standard C with distress call feature initiated from the helm.

* Medium Frequency (MF) and High Frequency (HF) Single Side Band (SSB) 400 watt Transceiver (1.605 to 27.5 MHz).

  - o DSC dedicated watch keeping on 2187.5 kHz.

  - o DSC watch keeping capability on 4207.5 kHz, 6312.0 kHz, 12577.0 kHz, and 16804.5 kHz. All must be available; however, watch-keeping can select one of these at a time in addition to the 2187.5 kHz watchkeeping.

  - o DSC on 2187.5 kHz.

  - o Transmission and reception of general radio communications including voice and direct printing telegraphy.

  - o Means of initiation of an alert from the helm.

* INMARSAT voice and data two way communications system over satellites.

(b) Survival Craft GMDSS Requirements:

In addition to the basic GMDSS communications suite, there are requirements for emergency location and communications devices which can be removed to survival craft. These include:

* Three VHF Portable Transceivers including DSC on Channel 70 (156.525 MHz) for survival craft use.

* Two Search and Rescue Transponders (SART) operating in the 9 GHz radar band with one on each side of the vessel and capable of removal to the survival craft.

* One (or more) 406 MHz Satellite Emergency Position Indicating Radio Beacon (EPIRB) with 121.5 MHz homing beacon and flashing light. The EPIRB device must be capable of automatic release from its holder and automatic activation in the event of a sinking; it

must be capable of being released manually and carried to a survival craft; and it must be capable of being manually activated.

(c) Installation

The radio console assembly shall include the items designated above, together with the necessary auxiliary items required for complete operation and supervision of the radio equipment. The transmitters and receivers shall be designed and electrically interconnected to provide a complete self-contained unit with the various controls on the front of the panels within convenient reach of the operator.

The very high frequency (VHF) radiotelephone equipment, located in the Radio Room, shall be fitted with remote station to operate from the Wheelhouse. The Bridge-to-Bridge radiotelephone shall be provided in the Wheelhouse.

The satellite communications and the MF/HF SSB shall be in the Radio Room with remote station facilities in the Wheelhouse.

For ships without a separate Radio Room, the communications suite should be located in a compact unified console and mounted on the aft bulkhead of the Wheelhouse.

93.3. FACSIMILE

A facsimile recorder capable of reproducing weather charts and other documents received by radio on standard 483 mm sheets, shall be provided in the Radio Room. The system shall consist of a radio receiver, antenna, a discriminator, and a printer. The printer shall be of the continuous roll type with automatic start and stop feature, and operate at 60, 90, and 120 r/min. The radio console high frequency receiver shall be connected as a backup to the facsimile receiver.

93.4. ANTENNAS

A radio antenna system including the main, reserve, medium, and high frequency SSB/CW transmitting, medium, and high frequency receiving, DGPS, Loran, Omega (if applicable), direction finder sense, facsimile, VHF radiotelephone, television and broadcast antennas complete with lead-ins and all necessary hardware shall be provided.

The main transmitting and receiving antenna shall consist of either a top loaded vertical antenna or an inverted L-type. Where the inverted L-type is provided, it shall be supported by masts over or nearly over the centerline of the vessel.

The reserve transmitting and receiving antenna shall consist of either a top loaded vertical antenna or an inverted L-type and shall also serve as the auxiliary receiving antenna. Where the inverted L-type is provided, it shall be supported independent of the main antenna.

The lead-in trunks shall be self-draining fiberglass reinforced plastic trunk and shall be designed and installed so that water will not ground any part of the radio installation, accumulate in the trunk, or leak into the Radio Room.

Standing rigging in the vicinity of the antennas, including the direction finder loop, shall be sectionalized by insulators.

Antenna switching for the receivers and transmitters shall form an integral part of the console.

An effective signalling interlock system shall be provided as part of the radio and direction finder installation. This system shall be designed so that the direction finder cannot be operated before the radio operator has acknowledged a signal which will indicate that all antenna are connected as they were at the time of calibration of the direction finder.

A whip antenna system complete with tuner shall be provided for operation over the frequency range 1.6-27.5 MHz.

The direction finder "sense" and Loran shall share the same antenna which may be either a vertical whip or wire type with provision for switching in the Chart Room.

The VHF radiotelephone antenna shall be a fixed omnidirectional type having minimum gain of 3 dB suitable for shipboard installation and designed for transmission/reception in the marine VHF radiotelephone band.

The television antenna shall be a fixed omnidirectional type suitable for shipboard installation to cover VHF channels 2 to 13 and UHF channels 14 to 83. Television outlets shall include impedance matching transformers.

An antenna/amplifier distribution system with combination antenna, ground and single power outlets to provide for convenient operation of AM, FM, and TV receivers in all Staterooms, Lounges, Recreation Rooms, and Mess Rooms, shall be provided. This system shall cover the TV, 500 to 1600 kHz, 4 to 27.5 MHz and 88 to 108 MHz broadcast radio bands. A 5-way receptacle arranged with color coded terminals, including connector cables and plugs for the radio antenna, and power supply terminals including a ground terminal which will not permit the insertion of a standard appliance plug, shall be provided in each space. Cover plates shall be marked to indicate application of each receptacle.

93.5. TOOLS

Tools shall be supplied in accordance with Regulatory Body(ies) requirements, and any additional tools recommended by the manufacturer.

SECTION 94

NAVIGATION

94.1. GENERAL REQUIREMENTS

All navigation systems and related electronics installed by the Contractor shall comply with the requirements for installation, performance, and testing set out by IMO and its Safety of Life at Sea (SOLAS) Conventions.

The installation of all electronics navigation equipment shall be made by the Contractor under the guidance of authorized representatives of the respective equipment manufacturers. Such traditional navigation related systems such as whistle control, rudder angle indicator, propulsion shaft revolution indicator and electronic fog bell and gong shall be installed using good marine practice. All final checks and adjustments to the electronics navigation equipment shall be made by the authorized representative of the manufacturer of the particular equipment involved, and it shall be tested and shown to operate properly prior to the official ship's trials. The exception is that the radio direction finder may, in addition, be calibrated during the trial trip.

Instruments that are weather-exposed or may be subject to salt spray, dirt, or moisture under any operating condition shall comply with requirements in SECTION 95.

All signal and control relays, other than for power applications, shall comply with requirements in SECTION 95.

AC operated electronic equipment shall be energized through a shielded-type isolation transformer as described in SECTION 93.

All navigational equipment and instruments in the Wheelhouse and on the bridge wings shall be provided with night vision intensity options or red filtered dial illumination as specified in SECTION 92.

All electronic equipment including antennas shall comply with requirements in SECTION 93.

94.2. ECHO DEPTH SOUNDER

The echo depth sounder equipment shall provide direct readings at a visual indicator and at a recorder.

The indicator shall be located in the navigation control section of the bridge control console. It shall have a range from 1.8 meters to 1,100 meters. A shallow water alarm feature shall also be provided.

The recorder shall be located in the Chart Room. It shall have a maximum range of 1,430 meters.

The optimum transducer location consistent with accessibility, as recommended by the manufacturer, shall be provided. The location of the transducer shall be clearly noted on a tag attached inside the indicator. Two transducers shall be provided, where required, on large ships.

A zero depth adjustment and means by which the recorder chart can be marked, shall be provided.

The system shall be energized from the 115 volt AC interior communications panelboard in the Wheelhouse.

94.3. ELECTRONIC POSITION FIXING

(a) Loran C shall be provided complete with the appropriate antenna for the receiver, taking due care to avoid electromagnetic interferences with the Loran C signals from other electronics. The Loran C antenna shall not be used for any transmissions of radio signals.

(b) Differential Global Positioning System (DGPS), satellite navigation shall be provided along with associated marine navigation computers or processors with the capabilities to provide at least 99 waypoints in memory; a highly visible day or night display of position, bearing and distances to waypoints on command, and GPS satellite status on command. The differential signals to the GPS shall utilize the DGPS radio beacon signal data protocol (RTCM SC-104). Other sources of differential signals, in that same format, are allowed; however, they will be only an addition to the capability to access the basic DGPS signal service.

The antenna for the GPS receiver shall be located at an elevation at least 300 mm higher than the top of the radar antenna and within one meter on either side of the fore and aft center line of the vessel. It must be located in a position such that there is no more than one 5^{o} wide vertical shadowing structure in the entire 360^{o} horizontal plane. The antenna must be provided a clear view of the sky above elevation angles of 5^{o} above the horizon.

The equipment shall be energized from the 115 volt 60 Hz AC interior communications panelboard in the Wheelhouse.

94.4. RADAR/COLLISION AVOIDANCE SYSTEM

A radar system including a collision avoidance display Automatic Radar Plotting Aids (ARPA) and alarm systems shall be provided. All such systems shall comply with SOLAS IMO Standards.

(a) Radar Systems

Two systems, one main S-band (10 cm) and one auxiliary X-band (3 cm), both designed for surface navigation operation, shall be provided. Monitors can be switched between the two radar systems.

The antennas shall be mounted on pedestals provided on a suitable mast high enough so that full presentation through 360° will be obtained without appreciable attenuation of signal in any sector. Disabling switches shall be provided to stop rotation of antennas and de-energize the radar transmitter prior to servicing.

In addition, warning signs shall be provided, prominently visible from access paths to the antenna, warning personnel to operate the disabling switches prior to entering the radar platforms.

The following features although not necessarily all inclusive are applicable to both the main and auxiliary radar installations and shall be provided:

(1) Main Radar - Raster Scan Display at least 400 mm by 400 mm with relative bearing and gyro stabilized display. True motion (optional) with maximum scale at least 29 km high persistence cathode ray tube having long integration time, so that small targets can be distinguished from sea return and trails on moving targets are visible.

(2) Auxiliary Radar - Raster Scan Display at least 250 mm by 250 mm with optional relative bearing or gyro stabilized display.

(3) Reflection plotter and viewing hood.

(4) Minimum 7 range scales for ranges greater than 5 n.m.

(5) Maximum scale at least 48 n.m.

(6) Minimum range - 35 meters or less.

(7) Electronic range marker rings, calibrated movable range ring and two azimuth scales (one fixed) on periphery of relative motion plan position indicator.

(8) Range resolution, at least 35 meters.

(9) Bearing accuracy, at least $\pm 1^{\circ}$.

(10) Main Radar - Bearing resolution 2.5° when provided with a 3700 mm antenna.

(11) Auxiliary Radar - Bearing resolution at least 1.6° when provided with a 1800 mm antenna and 0.6° with a 3700 mm antenna.

(12) Head-up stabilized relative motion and North-up stabilized presentations.

(13) Dial illumination shall be by means of variable indirect red light, and be sufficient to easily read azimuth scales and obtain cursor bearings during day or night operating conditions.

(14) Antennas shall be designed for continuous operation in 185 km/h relative wind, and must withstand without damage winds up to 278 km/h.

The radar transmitter receivers shall be energized from the 115 volt AC interior communication panelboard in the Wheelhouse. Power to the main antenna motors shall be 440 volt, 3 phase, 60 Hz and to the auxiliary radar antenna motor may either be 440 volt, 3 phase, 60 Hz (preferred), or 115 volt, 1 phase or 3 phase, 60 Hz, energized from the emergency switchboard.

(b) Collision Avoidance System

A collision avoidance system designed as a supplement to both surface search navigational radars, via interswitching shall be provided. The system shall provide unattended monitoring of all radar echoes and automatic audio and visual alarm signals that will alert the watch officer of a possible threat. The display shall be contained within a console capable of being installed adjacent to the radar displays in the Wheelhouse and may form a part of the bridge console. The features may incorporate ARPA or Electronic Chart Displays.

Provision for signal input from the ship's radars, gyro compass, DGPS, and speed log, without modification to these equipments shall be made. The collision avoidance system, whether operating normally or having failed, must not introduce any spurious signals or otherwise degrade the performance of the radars, the gyro compass, DGPS, or the speed log.

Computer generated ARPA display data for each acquired target shall be in the form of a line or vector indicating true or relative target course, speed, and both present and extrapolated future positions. Data shall be automatically displayed on a cathode ray tube or other suitable display contrivance sufficiently bright and unobstructed to permit viewing by more than one person at a time.

In addition to displaying the collision potential of the most threatening fixed and moving targets, the system shall be capable of simultaneously showing land masses.

The system display shall include a heading indication and bearing ring. The system shall also have the capability of allowing the operator to select "head-up" and to cancel the vector or line presentation of any of the targets. The presentation shall be non-smearing when changing modes or display scales in order to permit rapid evaluation of the displayed data.

Target acquisition, for display data purposes, may be manual, automatic or both, as specified by Owner.

For any manual acquisition system the alarms shall be initiated by a preset minimum range; and likewise for any automatic acquisition system the alarms shall be initiated by a preset minimum acceptable passing distance (CPA - Closest point of approach) and a preset advance warning time (TCPA - Time to closest point of approach). Means shall be provided to silence the audio alarm for a given threat but the alarm shall resound upon a subsequent threat. The visual alarm shall continue to operate until all threats have been eliminated. If the collision avoidance system fails to perform as indicated above, after the system is set for unattended monitoring, the system shall produce both audio and visual warning alarms.

The system shall be capable of simulating a trial maneuver.

In addition to the target display, an alpha-numeric readout shall be provided which can present range, bearing, course, speed, CPA, and TCPA for any selected target, either on the target display or by other display means.

The collision avoidance system shall be energized from the interior communications panel board in the Wheelhouse.

The collision avoidance function may be incorporated in an integrated conning system or Electronic Chart Display System, provided that failure of any other integrated system component will not degrade the collision avoidance function.

(c) Test Requirements - Radar/Collision Avoidance System

Manufacturers shall be required to certify in writing that:

(1) Each radar and collision avoidance equipment has been tested in accordance with the Production Testing Requirements of the Radio Technical Commission for Marine Services (RTCM) Paper 265-77/EC-240/SC65-259, Equipment Reliability Specification for Design and

Production of Radar, Collision Avoidance, and Marine Interrogator Transponder Equipment, and

(2) Production samples of the radar and collision avoidance equipment have undergone qualification testing in accordance with the requirements of RTCM Paper 265/77/EC-240/SC65-259, and RTCM Paper 104-74/EC-140/SC-42, Performance Specification for a General Purpose Navigational Radar Set for Oceangoing Ships of 1,600 Tons Gross Tonnage and Upwards. Appendix A.

94.5. RADIO DIRECTION FINDER

A radio direction finder shall be provided. The connection between the loop and the receiver-indicator shall be entirely electrical, by means of ship's cable, and the design shall permit at least 30 meters separation between the two units. Alternative phase comparison radio direction finders may be incorporated in place of the loop system.

The apparatus shall be designed to function on shipboard in the presence of heavy static and interference. Its own operation shall not affect or interfere with the operation of other navigational aids. A signalling interlock system, as described in SECTION 93, shall be provided as part of the installation.

The receiver-indicator shall be adaptable to table, bulkhead, or overhead mounting. True bearings shall be indicated on an illuminated dial with provisions for controlling intensity of the dial illumination. The receiver-indicator shall include a gyro-compass repeater to provide own ship's course inputs. A built-in loud-speaker and a portable telephone headset shall be furnished with circuit arranged so that the loud-speaker will be disconnected when phones are plugged into the panel jack.

The equipment shall be energized from the 115 volt AC interior communications panelboard in the Wheelhouse.

94.6. GYRO COMPASS, COURSE RECORDER, RATE OF TURN INDICATOR, AND REPEATERS

A complete recorder of the gyro compass repeater type shall be provided in the Chart Room. Each chart roll shall be sufficient for a continuous course record of 30 days. Alternatively, a DGPS driven position, bearing and speed log with both magnetic and hard copy outputs may be used.

A rate of turn indicator shall be provided in the Wheelhouse.

The repeaters, each with proper mount, shall be located as follows:

1 - Open scale steering repeater on either the gyro pilot stand or steering control section of the bridge control console, as applicable.

1 - Full scale steering repeater for bulkhead mounting in Wheelhouse, or in lieu thereof the master compass may be mounted forward of helm.

2 - Bearing repeaters - column stand mounted, with covers, on bridge wings with one portable azimuth circle.

1 - Open scale repeater in Steering Gear Room at trick wheels.

1 - Repeater, in radio direction finder (furnished with radio direction finder).

1 - Repeater in main radar indicator (furnished with radar).

1 - Repeater in auxiliary radar (furnished if stabilized display is provided).

1 - Repeater in course recorder in Chart Room (furnished with course recorder).

1 - Repeater in collision avoidance system (furnished with collision avoidance system).

The system shall be energized by an independent feeder from the emergency switchboard.

A magnetic compass electronic digital readout system may be provided as a backup for the gyro compass.

94.7. STEERING CONTROL SYSTEM

A dual control steering system, providing control in three separate modes (automatic through gyro compass input; full-follow-up hand electric; and emergency non-follow-up) employing two independent steering transmission systems, shall be provided.

A single steering stand shall contain the wheel, the mode selector switch, the steering system selector switch (for automatically starting the selected main steering gear pump motor) and a combined wheel position and rudder order indicator and steering repeater, illuminated by red light as specified in SECTION 92. The stand shall also have independent indicator lights with dimmers, alarms, and weather and rudder adjustments control components for each system. The steering stand may be installed in a bridge console.

Each control system shall be capable of (either automatically by gyro compass control or by manual control) regulating the stroke of its respective steering gear pump, through a rotary hydraulic power servo unit mounted at the pump, and thus controlling the rudder.

Limit switches shall be provided to prevent the rudder from moving more than 35° on each side of midship position.

Each steering control transmission system shall be energized by 115 volts, single phase, AC service obtained from an independent transformer in the steering gear pump motor feeder.

94.8. WHISTLE CONTROL (MECHANICAL AND ELECTRICAL)

Provide a whistle system actuated by ship's service air, or steam, having both a manual (whistle pull type) and electric control.

A mechanical whistle control shall be provided with a lever whistle pull in the Wheelhouse.

Electrical control of the whistle shall be provided by means of three control switches, timer box with timing contactor, and solenoid operated whistle valve. A control switch with neutral and at-will positions shall be located in the bridge console and one at-will switch shall be provided on each bridge wing. The timing contactor shall have provisions for automatic timing cycles to affect the required whistle signals specified by Regulatory Body(ies).

The air whistle diaphragm housing shall be encased in a weatherproof box equipped with electric heater and heater control box with indicator lamp for mounting in the Wheelhouse.

The system shall be energized from the 115 volt AC interior communications panelboard in the Wheelhouse.

94.9. RUDDER ANGLE INDICATOR

An electric rudder angle indicator system capable of accurately indicating the position of the rudder shall be provided. The system shall include a transmitter in the Steering Gear Room, and an indicator installed on the Wheelhouse bulkhead. A watertight indicator shall be installed on each bridge wing where required for docking of large ships.

The indicator shall show angular position of the rudder in single degrees up to and including 35° right and left, accurate to 1°.

The system shall be energized from the 115 volt AC interior communications panelboard in the Wheelhouse.

94.10. PROPELLER SHAFT REVOLUTION INDICATOR SYSTEM

A propeller shaft revolution indicator system shall be provided for each propeller shaft.

The major components shall be located as follows:

Location	Components
Propulsion Shafting	Transmitter with Mechanical Revolution Counter.
Engine Room Control Console	100 mm Dial Speed Indicator with Revolution Counter.
Wheelhouse	200 mm Dial Speed Indicator without counter, bulkhead or console mounting as applicable.
Bridge Wings (Port & Starboard)	Speed Indicator (watertight) without counter, of size and mounting to suit design, where required for docking of large ships.

The revolution counter on the Engine Room console shall be unidirectional and shall be provided with at least seven digits. The speed indicators shall have a zero center scale graduated at least every two revolutions per minute, and shall encompass an arc of at least 250°. As an alternative to the dial type instruments, installation of digital type speed indicators will be given consideration.

The system shall be energized from the 115 volt AC interior communications panel board in the Engine Room.

94.11. ELECTRONIC FOG BELL AND GONG SIGNALS

The system shall provide electronic fog signals to automatically sound a simulated single stroke gong signal at the stern of the ship and a bell signal at the bow of the ship. The system shall operate through the amplifier and control panel of the Public Address System, at intervals required by Regulatory Body(ies).

94.12. WIND SPEED AND DIRECTION INDICATOR

A wind speed and direction indicator shall be provided with direct indicating instrumentation mounted in the Chart Room or Wheelhouse.

Transmitter shall combine wind speed and wind direction components in a single unit. Wind speed shall be measured by a rotor driving a DC magneto with magneto generating a voltage proportional to wind speed and transmitting this voltage to the indicator. Wind direction shall be determined by position of a vane and synchro motor mounted in vane housing transmitting vane position to synchro in indicator.

Power supply shall be from the 115 volt AC interior communications panelboard in the Engine Room.

94.13. SPEED LOG

A speed and distance system shall be provided with readout display mounted in the Wheelhouse or in Wheelhouse console.

Equipment shall be complete and may be of: (1) the electromagnetic type with retractable monel rodmeter and hydraulic hoist with local and remote controls, or (2) doppler sonar type with transducer array mounted external to hull or in a recessed hull penetration, or (3) transducer mounts in a sea chest with a gate valve.

Doppler sonar speed log may be combined with doppler sonar docking system.

Power supply shall be from the 115 volt AC interior communications panelboard in the Engine Room.

94.14. DOPPLER DOCKING SYSTEM

A system shall be provided which is capable of providing ship's velocities and direction, with respect to the ocean bottom, at low ship's speed in relatively shallow water and with high resolution. Accurate velocity data shall be presented in the fore/aft direction and port/starboard directions of the bow and stern. Indicated velocities shall be compensated for variations in water temperature and transmitted frequency.

The system shall be implemented with transducers provided at the bow and stern sections of the ship. Displays shall be mounted in the Wheelhouse and at both wings of the bridge. The equipment shall be complete and entirely self-contained without the aid of shore based components. The velocity data shall be obtained by making measurements of relative motion between the ship and ocean bottom. The system shall operate on the principle of ship's speed being proportional to the doppler shift of the emitted frequency.

94.15. INTEGRATED CONNING SYSTEM

In lieu of any of the special-purpose navigation systems provided for in this SECTION, the Owner may elect to specify a computer based centralized bridge system incorporating various ship conning functions, including position fixing, route planning, route tracking, collision avoidance and auto pilot. Electronic Chart Display and Expert Piloting Systems may be incorporated as long as they are Regulatory Body(ies) approved systems. Systems, controls, and displays (to be installed in the console(s) specified herein) are of two categories.

Category I equipments shall be computer integrated for automatic operation. The computer shall generate illuminated digital status displays as applicable for real-time navigational data such as speed, heading, latitude, longitude, and time of fix; and optionally where adequate interfaces exist, data on rudder angle and water depth shall be included. These displays may be installed in one or more locations in order to suit Wheelhouse console arrangement.

Category II devices are capable of independent operation from the integrated system and may include any of the equipment, controls; displays and alarms listed in SECTIONS 93, 94, 95, and 99.

The computer system may be utilized for such additional applications as engine order logging and data logging as, now specified in SECTION 99 as well as cargo loading and ship administration computations.

(a) Bridge Consoles

System components shall be housed in one or more modular consoles. These consoles, which shall be arranged in the Wheelhouse as specified by the Owner, may be mechanically and electrically integrated into sections for steering control, propulsion control, navigation control, collision assessment, communications control, chart plotting and other required functions or groupings.

(b) Computer System and Hardware

A digital multi-processing computer or a series of dedicated computers shall be provided. Special consideration shall be given to filtered ventilation, shielding, interference susceptibility, and servicing factors.

(c) Computer Peripherals

System peripheral and displays, including Category I devices such as track plotter and CRT, shall be provided as required for specific applications selected.

(d) Computer Software

All acceptance-tested and documented software, shall be provided with the computer system.

(e) Power Supply

Primary power source for computers, peripherals, and other integrated system components shall be supplied through an isolation transformer from the emergency switchboard. AC transient (high voltage spike) suppression shall be provided.

94.16. SEARCH AND RESCUE/HOMING

Provide the GMDSS required 406 MHz Satellite Emergency Position Indicating Radio Beacons (EPIRB) with integral 121.5 MHz homing beacon and flashing light as defined in the RTCM SC110 - Recommended Standards for 406 MHz EPIRB. Two units shall be provided with at least one being an automatic float-free assembly.

Provide the GMDSS required 9 GHz Search and Rescue Transponder (SART). There shall be two provided and they shall be capable of manual transport to a survival craft.

SECTION 95

INTERIOR COMMUNICATIONS

95.1. GENERAL

Interior communications (IC) systems such as alarm systems, telephone systems, navigational sensor systems and elements of the ship's control systems shall be designed in accordance with Regulatory Body(ies) requirements.

Instruments that are weather-exposed or may be subject to salt spray, dirt, or moisture under any operating condition shall be of fully watertight construction and shall be of brass, bronze, or primary aluminum.

All signal and control relays, other than for power applications, shall be of the plug-in type. In addition, the maximum utilization of plug-in solid state electronic modules to permit easy removal and replacement of components is preferred in lieu of discrete wired equipment.

All level alarms shall have suitable time delay or be so located in the tanks as to avoid unnecessary sounding of alarms due to roll or pitch of the ship. Equipment shall be of such design as to avoid emission of radio interference of any type that may have an effect on operation of the ship's electronic equipment.

All alarm circuits shall have automatic reset on the audible alarm.

Electronic equipment shall be energized through a shield-type isolation transformer as described in SECTION 93.

95.2. SHIP CONTROL SYSTEMS

(a) Telephones - General

Telephones at locations exposed to the weather shall be provided with watertight enclosures and electric heating elements to prevent condensation of moisture within the unit.

(b) Sound Powered Telephone Systems

A sound powered telephone circuit in accordance with Regulatory Body(ies) requirements shall be provided for emergency communications between the following locations:

Wheelhouse
Engine Room (Central Control Room)
Steering Gear Room

Emergency Diesel Generator Room

Additional stations desirable for safe operation of the vessel may be included on this circuit.

(c) Automatic Telephone system

Provide an automatic telephone system consisting of a centrally located automatic switchboard connected to telephones, in all important locations such as:

- Wheelhouse
- Engineering Spaces
- Steering Gear Room
- Cargo Control Stations
- Primary Deck Machinery Stations, such as but not limited to Anchor Windlass and Deck Cranes
- Staterooms and Day Rooms
- Officers' and Crews' Mess
- Recreation Rooms
- Port and starboard gangway locations
- Galley
- Various Offices

Party line extensions shall be provided in related areas such as port and starboard gangways and in Staterooms associated with Day Rooms. Extension bells shall also be provided.

In noisy locations external bells of adequate size shall be provided for ringing, and in quiet locations, buzzers may be provided.

The Captain's, Chief Engineer's, Pilot House and Central Control Room telephones shall be fitted for executive-right-of-way to override a busy signal and connect himself to busy line by pressing a button on the telephone. The Wheelhouse phone shall be provided with an illuminated dial and dimmer.

Handset mounting in the cradle shall prevent it being thrown out during heavy seas.

The switchboard enclosure shall be dripproof. The automatic switching shall be accomplished by plug-in trays on which are mounted all of the electro-mechanical parts for the operation of the switchboard.

The system shall be energized from the 115 or 220 volt AC interior communications panelboard in the Wheelhouse.

(d) Shore Side Telephone Outlets

A watertight telephone connection box shall be provided on the inside of bulwark in a protected location by the gangway, port and starboard, for connection to shore telephone lines. A shore type telephone jack box shall be provided at each gangway and connecting boxes in the Master's, Ship's and Chief Engineer's Offices. System shall consist of two separate lines from each of the above five locations to the connection boxes and allow for two conversations of incoming and outgoing calls. One portable and three fixed shore type telephones shall be provided.

(e) Public Address System

An intercommunication system shall be provided for transmission of voice announcement from the Wheelhouse to appropriate stations around the ship depending on type of ship and service. The public address system can be a part of the automatic telephone system.

System shall also serve to transmit electronic fog bell signal forward and fog gong signal aft.

System can also serve for intercommunication between Wheelhouse and bridge wings. A weatherproof speaker arranged for talking in either direction shall be provided on each bridge wing.

The circuit shall be so arranged that a ground, short or open circuit will have no disabling effect on the rest of the system.

Loudspeakers located in finished areas shall be flush mounted type.

Loudspeakers shall be provided with volume adjustment taps to permit reduction of sound output from FULL to 18 db in three six-decibel steps.

The system shall be energized from the 115 or 220 volt AC, interior communication panelboard in the Wheelhouse.

(f) Crane Loudspeaker System (If Installed)

A loudspeaker system for clear spoken communication from the crane operator to workers beneath the crane, comprising a unidirectional fixed microphone, control and solid state amplifier located in the crane cab within easy reach of the operator, shall be provided for each crane. Hands-off operation shall be provided with push-to-talk switch, located on the crane control lever or foot operated, as appropriate.

Weathertight loudspeakers as required shall be mounted port, starboard and centerline on the underside of the upper crane structure.

A monitor loudspeaker, having 2 watts minimum audio power and local volume control, shall be provided in the the crane cab.

The system shall be energized from the 115 or 220 volt AC lighting panelboard in the crane cab.

(g) Barge Control Loudspeaker System (If Installed)

A loudspeaker system for clear spoken communication overside to bargemen in the stern area, comprising wireless microphones, solid state amplifier, control, monitor, and loudspeakers fitted around the stern, shall be provided.

The system shall be energized from the nearest emergency lighting panelboard.

(h) Bridge Control Console - Navigation Control System

The navigation control section of the bridge control console shall consolidate all associated navigational aids and communications listed below and shall be constructed in general accordance with the requirements for the bridge control console as described in SECTION 99.

(1) Sound powered telephone circuits*

(2) Radio-telephone remote station with handset*

(3) VHF radiophone*

(4) Echo depth sounder indicators

(5) Shallow water depth alarm

(6) Whistle control including hand, automatic and timer switches

(7) Control switch for lifeboat floodlights

(8) Control switch for lights on deck that may interfere with navigation

(9) Navigation light panel

(10) Control switches for deck floodlights

(11) General Alarm contact maker

(12) Wheelhouse alarm panel and buzzer

(13) Log desk area

(14) Chart table type light with dimmer control

(15) Dimmer control for all instrument lighting

(16) Master digital clock with local readout and controls

(17) Public Address System Control Panel and handset

(18) Wind Speed and Direction Indicator

(19) Speed Log Indicator

*These items may be provided on the forward bulkhead.

(i) Salinity Indicator Systems (If Installed)

Electrical salinity indicator systems shall be provided for the feed and condensate system and for the desalination units. Each system shall have a dripproof modular type indicator panel, with individual monitoring sections, one for each salinity cell circuit, which are readily removable for replacement, and an audible alarm.

The salinity indicator system for the desalination units shall control an electrically tripped automatically reset dump valve, as specified in SECTION 55. The solenoid operated dump valve point shall be adjustable. Dumping of processed water shall actuate the alarm.

The systems shall be energized from the 115 or 220 volt AC interior communications panelboard in the Engine Room.

(j) Tank Level Indicators

Remote reading tank level indicating systems for intrinsically safe electrical types designed for marine service may be provided in tanks as listed in SECTION 71. Arrangement, location and size of indicators shall be as specified for pneumatic systems.

The systems shall be energized from the 115 or 220 volt AC interior communications panelboard in the Engine Room.

95.3. ALARM SYSTEMS

(a) General Alarm

In compliance with Regulatory Body(ies) and SOLAS requirements, a general alarm system shall be provided, with approved warning devices in spaces where people may be at any time.

The system shall be energized from the DC distribution section of the emergency switchboard.

(b) Wheelhouse Power Failure Alarm Panel

Provide a miniature type alarm panel in the Wheelhouse incorporating a common audible signal and individual visible signal for the following services:

System	No.	Alarm	Signal
Alarm Power On	(1)	--	Voltmeter (miniature)
Rudder Angle Indicator	(1)	Power Failure	Red Light
Gyro Compass	(1)	Power Failure	Red Light
Steering Control	(2)	Power Failure	Red Light
Engine Order Telegraph	(1)	Power Failure	Red Light
Smoke Detection	(1)	Power Failure	Red Light
Bridge Throttle Control	(1)	Power Failure	Red Light
Shallow Water Depth Alarm	(1)	Power Failure	Red Light

A pushbutton shall be provided for silencing the buzzers and dimming the indication until the cause has been corrected, at which time the circuit shall be automatically restored to normal condition.

The system shall be energized from the DC distribution section of the emergency switchboard.

(c) Fire Detecting System

A fire detecting system shall be provided in conjunction with SECTION 13.

The system shall be energized by dual feeders, (1) from the 115 or 220 volt AC distribution section of the main switchboard, and (2) from the 115 or 220 volt AC distribution section of the emergency switchboard.

(d) Fuel Oil Standpipe Alarm

Contact makers shall be provided in the fuel oil system standpipe to actuate alarms on high oil level in the standpipe. An alarm bell, indicating light and bell silencing switch shall be provided at the fuel oil filling station.

The system shall be energized from the 115 or 220 volt AC interior communications panelboard in the Engine Room.

(e) Steering Gear Alarms

Alarms shall be provided on the Engine Room control console for each steering motor and feeder circuit breaker.

The system shall be energized from the DC bus in the Engine Room console.

(f) Fuel Oil Settling, Fuel Oil Day and Diesel Oil Day Tanks High and Low Level Alarms

An alarm system to indicate when any fuel oil settling, fuel oil day, and diesel oil day tank is nearly full or nearly empty shall be provided in accordance with Regulatory Body(ies) requirements.

The system shall be energized from the 115 or 220 volt AC interior communications panelboard in the Engine Room.

(g) Emergency Generator Diesel Engine Alarms

A visual and audible alarm panel for the diesel engine shall be provided in the Emergency Generator Room. The panel shall have a dripproof enclosure and shall contain alarms for high jacket water temperature, hydraulic starting low pressure and low lubricating oil pressure in addition to other Regulatory Body(ies) requirements. The panel shall be provided with switches for testing alarms, for silencing the audible alarm and for normal operating set up. The audible alarm shall be an electric horn located adjacent to the engine.

High jacket water temperature and low lubricating oil pressure alarms shall be automatically deactivated when engine is shut down.

The system shall be energized from the 120 or 220 volt AC distribution section of the emergency switchboard.

(h) Oil Overboard Discharge Alarm System

A visible and audible alarm on the Central Control Room console shall be provided to actuate on passage of oil content in each overboard discharge in excess of requirements in accordance with SECTION 70.

The system shall be energized from the 115 or 220 volt AC bus in the Engine Room console.

(i) Control Air and Ship Service Air Pressure Alarm System

A low pressure alarm circuit, actuated by a pressure switch, shall be provided for each system to indicate, on the Engine Room control console, when the air receiver pressure falls 0.5 MPa below the air compressor start up pressure.

The system shall be energized from the DC bus in the Engine Room console.

(j) Bilge Wells Level Alarm System

A bilge alarm system shall be provided to activate visual and audible alarms on the Engine Room console of high level in all bilge wells in machinery spaces, shaft alley, and Pump Room (if provided).

The system shall be energized from the DC bus in the Engine Room console.

95.4. SHIP SERVICE SYSTEMS

(a) Ship's Entertainment System

(1) The radio entertainment system shall consist of separate or combination AM/FM receivers with matching loudspeakers, with an AM frequency coverage of 540 kc to 30 mc and FM frequency band, 98 to 108 mc, provided in the Officer's Lounge, Passenger's Lounge, and Crew's Lounge. Each receiver shall be connected to the broadcast antenna system specified in SECTION 93 for antenna connection and power.

(2) The television entertainment system shall consist of television receivers provided in the Officer's Lounge, Passenger's Lounge, and Crew's Lounge. Each receiver shall be connected to the antenna/amplifier distribution system specified in SECTION 93 for antenna connections and power.

(b) Hospital Call System (If Provided)

A Hospital call bell system shall be provided with an annunciator in the Wheelhouse or in an alternate specified manned space. Pushbuttons shall be provided at the berths in the Hospital space.

Each pushbutton plate is to be inscribed "Emergency Call Only".

The system shall be energized from the nearest 115 or 220 volt AC interior communications panelboard.

(c) Ship's Electric Clock System

An electric clock system shall be provided consisting of a master control in the Chart Room and bulkhead mounted secondary clocks with shatterproof lenses provided in the following spaces:

Captain's Office
Chief Engineer's Office
Ship's Office
Galley

Crew Mess Room
Wheelhouse
Radar and Gyro Room
Recreation Spaces
Officer's Mess and Lounge
Engine Room Control Console
Chart Room, where not integrated with Wheelhouse

The master time control shall contain a synchronous motored master clock with battery-powered frequency standard for driving the master clock with an accuracy within 1 minute per month. In event of power failure, the battery shall have sufficient capacity for operation of the master clock for at least 12 hours.

The master clock shall be enclosed in a cabinet having a door with dust seal and window for viewing the clock dial.

When crossing into a new time zone, it shall be possible to reset the master and all secondary clocks back or forward one hour rapidly from the master unit.

The system shall be energized from the 115 or 220 volt AC interior communications panelboard in the Wheelhouse.

As alternatives to the electric clock system described above, the installation of a remote digital clock system in which the remote clocks displaying hours and minutes are driven from the digital clock on the bridge propulsion control console may be specified.

(d) Engineer's Assistance Needed Alarm System

(e) Cargo Conditioning Control System (If Installed)

Atmospheric and cargo conditions in the cargo compartments shall be recorded by means of multi-point strip chart electronic recorders mounted on the Cargo Conditioning Control Console located in the Wheelhouse or Chart Room.

The Console shall provide control and recording services as described in SECTION 69.

The system shall be energized from the 115 or 220 volt AC interior communications panelboard in the Wheelhouse.

(f) Refrigerated Container Monitoring System (If Installed)

Watertight multipole monitoring receptacles shall be provided for use with refrigerated cargo and ship's stores containers, one located adjacent to each refrigerated container power receptacle. The monitoring receptacles shall be connected, by multi-conductor cables, to a monitoring panel located at the refrigeration control board.

The monitoring panel shall provide visual indications for "temperature in limits", "defrost" and "unit operating", in a unit annunciator window, for each refrigerated container. A "power on" indication and common pushbutton for testing all indicating lights, shall be provided. The circuitry and operating voltage shall be compatible with the signal sources provided in the refrigerated containers. Portable cord, one for each receptacle, shall be provided for interconnecting each monitoring receptacle and container.

The system shall be energized from the 115 or 220 volt AC interior communications panelboard in the Engine Room.

95.5. CARGO AND SHIP'S REFRIGERATION CONTROL BOARD (If Installed)

A refrigeration control board shall be provided in the Engine Room convenient to the Engine Room control console. It shall provide for the remote control and monitoring of the cargo refrigeration system and monitoring of ship's service refrigeration, air conditioning and liquid cargo temperatures. It shall also provide for remote starting, stopping and testing of all refrigeration and air conditioning compressors, cargo refrigeration fans and cargo refrigeration unit defrosting. Where required, a dripshield with continuous strip lighting shall be provided at the top with light control switch on the bench section.

Suitable heating elements with watertight connection boxes, magnetic contactors and control thermostats shall be provided with the cooling units.

All controls and electrical actuating devices, that for practical reasons must be located locally in the various Fan Rooms or elsewhere within the refrigerated cargo spaces, shall be watertight.

Ship's service solenoid valves shall be actuated by the thermostat in the compartment and shall have their power supply from the nearest lighting panelboard. Cargo solenoid valves shall be supplied from the cargo and ship's Refrigeration Control Board.

The control board shall contain the following equipment for the various control and monitoring systems:

(a) A series of alarm annunciators, in conjunction with the alarm bell and extension alarm to the Engine Room control console, to indicate alarms listed in the Information List following.

(b) Multiple record strip chart type temperature recorders for the cargo refrigeration spaces.

(c) Multiple record strip chart type temperature recorder for recording the temperatures of the cargo oil tanks as specified in SECTION 68.

(d) Temperature indicator with multipoint selector switch for indicating the temperature in each ship's refrigerated stores compartment. Two or more resistance temperature detectors with stainless steel cases shall be provided in each compartment.

(e) "Run-Stop" illuminated pushbutton for control of each air conditioning compressor, when its respective local control switch is in "auto" position.

(f) "On-off" pushbutton type selector switches, in interlocked sets, for selection and control of the defrosting heaters for the cooling coils.

CARGO & SHIP'S REFRIGERATION CONTROL BOARD
INFORMATION LIST

Information Acquired & Processed	Display Device	Designations	Alarm	Remarks
A. Cargo Refrigeration				
Compressor control	IPB	Auto. Stop Test	S	
Refrigerant Solenoid Valves	IPB	OP, CL		
Thermostat control	C	--		Remote control with follow-up indication
Temperature recorders	C	--	-	Discharge and Return Air
Temperature recorders	C	--	-	Lock type: Refrig. Spaces
Recirculating fans control	IPB	FS, SS, Stop	S	
Exhaust fans control	IPB	FS, SS, Stop	S	
Supply fans control	IPB	FS, SS, Stop	S	
Damper controls	C	OP, CL		Remote control position selector switches
Cooling Water	A	--	S	Water failure
Refrig. coil Differential press.	D	--	-	Gang PB Selector Sw.
Defroster Selector	A	On, Off	-	Gang PB Selector Sw. interlocked with auto control to indicate location

Information Acquired & Processed	Display Device	Designations	Alarm	Remarks
B. Liquid Cargo				
Temperature recorder	C	--	-	
C. Ship's Service Refrigeration				
Compressor control	IPB	Auto. stop test	S	
Temperature indicator	D	--	-	Via selector Sw.
Cooling Water	A	--	S	Water failure
D. Air Conditioning				
Compressor control	IPB	Rung stop	S	Auto/Stop/Test Sw. at compressor
Cooling cycle	A	on	-	
Heating cycle	A	on	-	
Cooling water	A	--	S	Water failure
Temperature indicator	D	--	-	Via selector Sw.

LEGEND:

A Annunciator Indicator
C Continuous Display on meter or gage
D Demand display on meter via selector switch and pushbuttons
OP Open/Ann. Indic.
CL Closed/Ann. Indic.
PB Pushbutton
IPB Illuminated Pushbutton
S Stopped Alarm & Ann. Indic.
FS Fast Speed
SS Slow Speed
(V) Vital Circuit (others not marked are non-vital)

SECTION 96

STORAGE BATTERIES

96.1. GENERAL

Storage batteries shall be of the nickel cadmium alkaline type or the nickel iron alkaline type to suit the specific application. All exterior metal parts of the cells, including the connectors, shall be nickel plated. Connectors shall be provided for terminating the ship's service cables. Batteries shall be designed, constructed, and selected to provide a life expectancy of 5 years in an ambient temperature of 40°C. The batteries shall be delivered fully formed, charged and ready for service. Suitable charging facilities for the storage batteries shall be provided as described in SECTION 89, Article 4(b)(3).

96.2. I.C. BATTERIES

Duplicate sets of storage batteries shall be provided for supplying power to the interior communication services, one serving as standby for the other.

96.3. RADIO BATTERIES

Radio batteries or Uninterrupted Power Supply (UPS) with internal battery backup shall be provided with the radio communications equipment and shall be of a capacity to suit SOLAS and applicable society standards. Charging facilities for the radio battery shall be provided as an integral part of the radio communications equipment.

96.4. EMERGENCY DIESEL GENERATOR STARTING BATTERIES

If the emergency diesel generator is provided with an electric starter, batteries provided should be of sufficient capacity to suit current standards.

96.5. SPECIAL TOOLS

Special Tools as may be required in addition to the following shall be provided as recommended by the manufacturer.

- 2 Hydrometers, complete
- 2 Hydrometer floats
- 2 Glass barrels for each size hydrometer used
- 2 Spirit thermometers, minus 20°C to plus 75°C scale
- 1 Voltmeter, 3-0-3 volt scale, with leads
- 1 Small jack or pliers for removing cell connectors from tapered posts
- 1 Post nut wrench for each size of terminal nut
- 1 Filler bulk

1 Portable non-metallic distilled water container (not to be contained in spare parts box)

The special tools shall be stored in a spare parts box. 5

Where the radio batteries are located remote from the Battery Room, any associated spares and special tools shall be separately boxed and stored in the vicinity of the batteries.

SECTION 98

TEST EQUIPMENT, ELECTRICAL

98.1. PORTABLE INSTRUMENTS

The instruments listed below shall be procured by the Contractor and stored aboard the vessel. Instruments shall be complete with carrying cases, batteries, and test leads as applicable.

1 - Insulation resistance tester, 500 volts, hand operated.

1 - AC clamp type volt-ammeter with minimum of four current and two voltage scale ranges, minimum high ranges 300 amperes and 600 volts.

2 - AC-DC volt-ohm-milliammeters.

1 - Portable tube tester, roll-cart type.

1 - Transistor/FET tester capable of in-circuit testing.

The above list is not all inclusive. Alternate or additional instruments shall be considered.

98.2. TEST RECEPTACLES

Combination interlocking switch and receptacles, rated 20 amperes, shall be provided on the bulkhead above a workbench in the Electric Workshop to provide the primary and secondary AC and DC power supplies for testing purposes.

Provide matching plugs with 3.3 m long cords having insulated clips with phases, polarity and ground conductors marked and stow convenient to the receptacles. Circuit breakers adjacent to or integral with the receptacles shall be provided for disconnection and overcurrent protection.

Receptacles or lamp holders shall be provided as necessary to permit convenient one person testing of each type and size lamp installed on the ship.

SECTION 99

CENTRALIZED ENGINE ROOM AND BRIDGE CONTROL - *SLOW SPEED DIESEL (ONLY)*

99.1. GENERAL

A centralized Engine Room and Bridge Control System shall be furnished providing centralized remote control and information display of the machinery plant. The plant shall respond automatically to either Bridge or Engine Room throttle control over the complete range of plant operation without the intervention of the engineering watch personnel. The centralized Engine Room control shall permit the operator to observe all the important operating conditions and initiate functions from the console as specified herein.

During all cruising and maneuvering modes, the centralized Engine Room control system shall continuously monitor all important temperatures, pressures, flows, levels, and electric load characteristics which are essential for propulsion plant operation, as specified herein. Abnormal conditions shall be sensed by the controls and shall actuate an alarm to warn of the condition. A data logger of digital type shall be installed to provide the operator with trends in plant conditions.

The centralized Engine Room control system shall provide effective unattended Engine Room control during all cruising and maneuvering modes and shall meet the following general requirements:

(a) The main propulsion system shall be started at the centralized Engine Room control console before the Bridge control console is used to control the main propulsion engine.

(b) System shall comply with criterion for periodic unattended machinery space operation as defined by the Regulatory Body(ies).

(c) Local, automatic, and remote operation of all vital auxiliaries shall be provided as required by Regulatory Body(ies).

(d) Vital sea valves, valves associated with the diesel generators, emergency fire pump, ship service and regulating valves shall be arranged for remote control, or automatic functioning to maintain desired operating conditions for the plant.

(e) The control pushbuttons for the remote-operated valves specified shall have valve position indicators presented conclusively accurate open and closed condition on the Engine Room control console.

(f) The following pumps shall have automatic, sequenced start up capability upon failure of the running pump (as applicable to the engine provided):

Main engine lube oil
Main engine fuel oil service
Main engine jacket, piston and fuel injector cooling water
Sea water service pumps
Central F.W. Cooling Pump

99.2. ENGINE ROOM CONTROL CONSOLE

(a) General

The Engine Room control console shall be provided in the totally enclosed air conditioned central Control Room as shown on the machinery arrangement plans. The Room shall be constructed of incombustible material.

(b) Environmental Conditions

Consideration shall be given in the design of all equipment specified herein to the environmental conditions of shipboard service with particular emphasis being placed on corrosion, temperature, vibration, position, power supplies, and electrical interference effects. The below listed specifications shall prevail:

(1) Ambient Environmental Temperatures

Ambient temperature range up to 50°C.

(2) Vibration

Equipment shall be capable of satisfactory operation when it is subjected to shipboard environmental vibrations as specified below:

Frequency Range CPS	Displacement Single Amplitude $\pm$ mm
5 to 15	$\leq$ 0.914
16 to 25	$\leq$ 0.610
26 to 33	$\leq$ 0.305

(3) Noise

The room shall be soundproof to the maximum practical extent and in no case shall noise levels exceed those specified in SECTION 1.

(4) Position

The conditions of roll, pitch, trim, and list shall be as specified in SECTION 1.

(5) Humidity

Maintain 10 to 95 percent relative humidity at 50°C.

(c) Design and Arrangement

Console shall be arranged systematically into the following groups: propulsion control, generator prime mover control and ship service control. The generator prime mover control section of the console shall be located nearest to the main switchboard such that complete generating plant control shall be from that one location in the central Control Room operating station. Within each group, location of displays shall be keyed to the functions and data necessary for control of the particular machinery in that group.

All instruments exposed on the operating console shall be recess mounted with the controls, meters, and other items, as nearly flush as practicable. Miniaturized equipment may be used in order to limit the size of the console. Consoles and panels, including surface and/or flush mounted instruments and controls shall be of dripproof construction. The console shall be substantially tight to exclude, dust, moisture, oily vapor and dirt.

In general, display accuracy shall be at least ±5 percent of full scale span, or the scale division whichever is smaller, at the rated normal operating condition. Monitoring and logging accuracy shall be at least ±1 percent of full scale span at the rated normal operating condition. The above accuracies shall be met for the end product (i.e., the displayed, logged, or monitored variable) and shall include all the individual errors in sensing and signal transmission. Special consideration shall be given to critical variables which shall have a greater accuracy if required.

All electrical and electronic circuits shall include fault-finding means to permit an operator to locate a non-functioning element. Test means shall discriminate to within two or three modules and shall not require detailed knowledge of the module circuitry.

(d) Construction

The length of the console shall be kept to a minimum consistent with a compact and logical arrangement. In general, human engineering principles shall be applied in the design and arrangement of the console and the selection and positioning of all displays, indicators, push-buttons, and other items. The consoles shall be provided with grab rails.

The console shall be constructed of steel or aluminum plate of sufficient thickness and with adequate support members and stiffening to resist vibration. It shall be painted when necessary to prevent corrosion and glare and to present a pleasing appearance and suitable background for the instruments, devices, and other items, located thereon. Ease and accessibility for servicing shall be one of the prime requisites in the design and construction of the console. Access to inside of console or component assembly shall be provided through removable panels fitted with captive quick-acting retaining screws or switchboard type "open and stop" or three point latches, as necessary to protect instrument faces. Rear access will be subject to special consideration. Panels shall be as lightweight as possible and shall be provided with handles to facilitate removal for hook-up and service.

Foundation shall be designed to suitably support the console and may be welded directly to the deck. Details of the foundation shall be furnished as soon as developed so that suitable back-up structure may be provided beneath the deck prior to installation of the console.

Each console group shall have provision for bottom cable entry area. These entry areas shall be clearly indicated on the outline and foundation plans.

Thermostatically controlled heaters shall be provided for humidity and temperature control for cold ship conditions. Available cooling air for electrical or electronic equipment located in central Control Room operation station will be filtered ambient air up to 65°C and relative humidity of from 10 to 95 percent at 65°C. Air circulators shall be provided in the console sections if necessary for proper cooling.

(e) Power Supplies

The central Control Room operating station console shall receive electrical power from three sources as follows:

> 115 Volt, 60 cycle, single phase from the emergency switchboard. This power source is the normal supply.
>
> 115 Volt, 60 cycle, single phase from the main switchboard. This power supply is the alternate supply.
>
> 24 Volt, DC, single phase from the emergency switchboard battery bus. This power supply is the emergency supply for monitoring, alarms and emergency action.

Within the console shall be provided a means for effective automatic transfer to the alternate supply from the normal supply upon failure of the normal supply.

White "power-on" indicating lights shall be provided for the three electrical power sources to the console. A power supply transfer alarm shall be provided for the automatic transfer of normal supply to alternate supply.

In the case of power failure of the propulsion control system, both audible and visual alarms shall be actuated on the Bridge and the central Control Room operating station consoles.

Within the console shall be provided, if required, a modular type static power 115 volt, 60 cycle, single phase to 24 volt DC converter unit to serve as a controlled power source for instruments, digital clocks, relays, and other components requiring voltage and frequency stability exceeding that of the ship's generating plant. The control system shall operate satisfactorily with a voltage variation of ±5 percent and a frequency variation of ±3 percent. Temporary voltage dips of 20 percent shall not cause damage to equipment or interruption of service.

Within the console shall be provided, if required, a modular type static power 115 volt, 60 cycle, single phase to 24 volt DC converter unit to serve as a controlled power source for critical circuits. Upon loss of the 115 volt, 60 cycle, single phase power supply to the console an effective automatic transfer to the 24 volt DC power supply from the emergency switchboard supply shall be provided within the console.

Conducted interference, including power frequency harmonics, spikes and surges, plus radio frequency energy shall be excluded by means of isolation and filtering networks as necessary.

(f) Control Air

The Engine Room console and other control equipment shall receive control air from the control air system per SECTION 72.

All pneumatic tubing connections shall be in tubing terminal blocks located conveniently around the perimeter of the console. Terminals shall not interfere with proper maintenance of internally located console equipment.

(g) Label Plates

Labels shall be designed to be read easily and accurately at the anticipated operational reading distances and illumination levels specified per SECTION 92. Labels should identify what is being measured rather than indicate an instrument title, e.g., "Main L.O. Pressure", not "Main L.O. Meter". Labels shall be placed consistently either below or above each component identified, with the above location preferred.

Label plates may be plastic or engraved on metal. Plastic plates shall be machined on black laminated phenolic having a white center or of other plastic material as approved.

Sizes of label plates shall be proportioned to the item(s) it references.

Label plates character height shall be designed in accordance with IEEE 45 recommendations.

Lettering shall be clear and concise with the minimum of abbreviations.

(h) Annunciators and Alarms

The various alarms and annunciator systems shall be fed from the electrical power supply furnished to the console unless otherwise specified.

Pumps, systems or components essential for the operation of the propulsion or ship's service electrical system shall be provided with a first cause or first out annunciator on the engine control console to more accurately identify the cause of failure.

The alarm system shall be arranged to respond to off-normal values as detected, either by the data logger or display sensor, or by independent primary sensors as assigned and shall not be affected by any malfunctions of the display instrument or logging system.

Visual signals shall be presented on annunciators in the appropriate console section using miniature annunciator panels. Each annunciator shall have an approved legend illuminated by lamps, a color filter suitable for the service and two incandescent lamps in parallel. All low voltage illuminated indicators, including illuminated pushbuttons, shall have two lamps for each indication. All illuminated devices shall use lamps of the same type as far as practicable. 28 volt long-life incandescent lamps shall be provided on 24 volt circuits. Miniaturized mimic diagrams serving as annunciators may have only one lamp within the annunciator display provided a second alarm display with two lamps for the mimic section is also provided.

In cases where an alarm condition also requires automatic shut-down of the machinery, or where other automatic functions are actuated, the testing of the alarm lights or audible signal shall not influence operation of the monitored unit.

When a fault occurs the audible signals shall be energized and the identifying device for the particular conditions shall be illuminated by flashing lamps. The audible alarm shall be capable of being manually silenced by depressing the "acknowledge" pushbutton on that section without inhibiting the audible signal from the sounding when a fault condition occurs on another circuit. When the audible alarm is so silenced, the visual alarm shall remain actuated in a steady state of illumination until the off-normal condition is corrected. However, after a malfunction alarm, the red light indicating this fault shall cease to show after the "Stop" pushbutton of the auxiliary involved is actuated.

Deliberate stoppage of auxiliaries shall not actuate a malfunction alarm unless the auxiliary is serving an operating engine.

An individual annunciator with concise identification shall be provided for each alarm-monitored item. The annunciators shall be grouped in approved logical arrangements.

Alarm circuits monitored by switching devices shall be designed so that the sensor will maintain a normal condition with a closed circuit. An off-normal condition shall open the circuit to actuate the alarm. Thus, wiring, terminals and contacts are also monitored and any break in the circuit shall immediately show an alarm condition.

Visual rotating beacons shall be provided in conjunction with audible alarms.

Extended alarm panels indicating "vital" and "non-vital" engineering trouble alarm groups shall be located in all Engineers' Cabins, Engineers' Passage, Officers' Recreation Room, Mess Room, and Bridge. Audible alarm for the Engineers' Quarters panel shall only sound in the space selected by the Engineers' selector switch in the Control Room. Assistance needed alarm shall be supplied in accordance with Regulatory Body(ies) requirements.

Momentary contact pushbuttons, one for testing audible alarms and one for testing annunciator indicating lamps shall be provided on each section of the console.

(i) Indicating Lights and Pushbuttons

There shall be an obvious difference between alarm indicator lights and the pushbuttons. This does not, however, prevent illuminating a pushbutton as an alarm.

Where guarded switches or pushbuttons are required, a spring loaded clear plastic cover shall be provided.

The motors controlled from the Engine Room control console shall have color coded illuminated pushbuttons for control and indication.

The control pushbuttons for the remote operated valves specified shall have valve position indication presenting conclusively accurate open and closed condition. The position indications may be combined with pushbuttons in mimic diagrams. Both indicators shall be energized in any position between full open and full closed.

Lamp replacement shall be accomplished from the front of the console without the possibility of switch activation.

99.3. SYSTEM COMPONENTS

(a) Sensors, General

Sensors shall suit the application requirements as to type, range, accuracy, speed of response and environment and shall be compatible with data logger and/or display components.

Alarm sensors shall have an adjustable differential range between the off-normal and return-to-normal operating points which shall preclude repeated cycling.

Installation requirements for conductor shielding, twisted pairs, and other related items, shall be observed.

(b) Temperature Sensors

Temperature recording, indicating and monitoring shall be accomplished with resistance type sensor cells, single or dual element, rated for the temperature range sensed.

Each detector shall be fitted to a well of material compatible to the material of the unit to which it is attached. Materials should be of corrosion resisting steel for temperatures of 232°C and above and may be of brass for temperature below 232°C except that all wells used with oils shall have steel sockets, and all wells used in salt water shall have monel sockets. The thread of the detector-well joints shall permit emergency use of bi-metallic thermometers as temporary replacement of detector elements. It is preferred to have wells of 19 mm NPT size connection.

Thermocouples shall not be permitted for this service except for Diesel Engine Exhaust Temperature Sensors.

All resistance type temperature sensors shall have individual Bridge circuits incorporating individual zero and span adjustments.

(c) Pressure Sensors

Pressure monitoring shall be accomplished with pressure type transducers.

Off-normal pressure alarms shall be detected by separate pressure operated switches or electrical signal from the pressure transducer.

(d) Level Sensors

Level monitoring shall be accomplished by means of individual magnetic float-operated level switches, by individual pressure operated contact makers, transducers, or capacitance or conductance probes.

Level sensors in combustible atmosphere shall be intrinsically safe.

(e) Miscellaneous Sensor and System Component Requirements

Signal pickups for displays, logging, and alarms other than the above shall be obtained from sensors provided as part of the system including, but not limited to propeller shaft revolution indicators, salinity indicators, tank level indicators, emergency generator diesel engine alarms, turning gear signal circuit, engine order telegraph, and shaft horsepower.

Static devices for monitoring, amplifying and relaying, having satisfactory record of performance in like service shall be used.

Relays, where required, shall be of the enclosed plug-in units, hermetically sealed reed type where required, clearly identified on the case.

Monitoring circuits and devices shall be rugged, miniature, modular units.

Control transformers and rectifiers for power control monitoring and indicating systems shall be provided as necessary. Miniaturized equipment shall be used wherever practicable.

Control circuit fuses shall be grouped on accessible panels, behind hinged doors, and shall have blown fuse indication and permanent, easily legible circuit identification at each fuse, where practicable.

All electrical connections to the console shall be made at terminal blocks in the base of the console. Each wire shall be clearly marked with circuit and terminal number. Internal wiring from the terminal boards shall be furnished with the console, and shall be arranged in convenient groups with neatly arranged securing lacing. Low level signal wiring shall be shielded and conductor harness assignments shall be carefully segregated to eliminate interference from high level signals and preclude damage to vital circuits by a fault in any other conductor. All wiring shall be adequately protected from abrasion at all metal contact points. No fluid lines, no lube, diesel, or fuel oil vapor content air lines; no steam lines, or any air lines above 862 kPa shall be permitted inside the console or the central Control Room operating station.

Solid amplifiers shall be provided as necessary to preclude overloading transducers which are used as common signal source for display, logger and alarm.

To the maximum extent practicable, plug-in modules shall be used in the construction on the console, and except for external wiring to the console, all other connections shall be through the use of plug-in devices, to reduce field wiring.

All instruments, annunciators, and other related items, shall be matched in design and appearance, so far as practicable.

Audible and visual alarms shall be supplied for mounting in the machinery space to serve as the common signal for all vital and vital-shutdown alarms. A second horn of a different tone for non-vital alarms and miscellaneous functions shall also be provided. Extension audible alarms shall be provided, if necessary, so that alarm sound levels will be audible above normal machinery noise in all parts of the machinery space, including, but not necessarily restricted to the Purifier Room, the ship's Generator Room, and the shaft alley. Extension alarms with lower sound levels shall be supplied for the central Control Room operating station. The vital-shutdown and non-vital audible alarms in the central Control Room operating station and at remote locations shall be common to all circuits as applicable.

All necessary alarm safeguard circuits shall be provided including, but not limited to, interlocks to prevent starting of the main engines until vital permissives have been satisfied, and interlocks to prevent starting the engines while the jacking gear is engaged.

Provisions shall be made to prevent actuation of alarms because of ships roll. Non-vital level sensors shall have time delays if necessary to prevent false alarm signals,

99.4. BRIDGE CONTROL CONSOLE

(a) General

Provide a free standing console combination for control of propulsion, steering (located in the center) and navigation shall be installed in the wheelhouse, as per arrangement plan.

The console shall be constructed in general accordance with that specified for the central Control Room operating station console except that an air circulator will not be required, red light illumination with dimmer control shall be provided, and all instruments, switches, indicating lights, cabinets, consoles, and other related items, shall be of a dripproof construction.

Red filters transmitting red light of wave lengths not less than 5,900 angstroms and not greater than 0.34 candela/m^2 shall be provided on all instrument lighting which would interfere with night vision of personnel on watch. Light intensity shall be controlled by a series rheostat or a dial illuminator designed for cross dial illumination.

The control devices and instruments included on this console shall be systematically interlinked with the corresponding control and monitoring devices in the central Control Room operating station console and the circuitry shall be so arranged and interlocked that no conflicting operations of the propulsion system can take place as a result of possible adverse malfunctions of the controls at either control station under any selected control set-up.

Instruments, indicators, and panels, shall be designed for flush mounting; handsets, microphones, and contact makers, mounted on vertical structure of the console shall be recessed or semi-recessed into the console.

The propulsion control section shall incorporate the following:

- Propeller rpm Indicator
- Engine Order Telegraph
- Controllable Pitch Propeller Pitch Indicator (if provided)
- Throttle Control Lever
- Bridge Control Throttle Lever Position Indicator and light
- Central Control Throttle Lever Position Indicator and light
- Throttle control transfer selector switches with indicator lights and alarms (Bridge/Engine Room)
- Engine running indicator lights
- Emergency propulsion trips
- Propulsion machinery shutdown alarms, which include:
    - Loss of lubricating oil pressure
    - Overspeed
    - Other safety features
- Propeller shaft rpm indicator
- Throttle control power failure alarm
- Bow/stern thruster malfunction alarm
- Steering gear malfunction alarms
- Operational instructional nameplate
- Fire pump control
- Fire in machinery space alarm
- Machinery space high bilge level alarm
- Machinery space watertight door controls
- Digital clock
- Engine Room control console attendance monitor (one man watch)
- Duty engineer's alarm system alarm and indication
- Dimmer control
- Alarm test and lamp test pushbuttons
- Alarm shutdown
- Sound powered telephone to Engine Room console and engineer's accommodations

The Navigation Control section shall consolidate associated navigational aids and communications as described in SECTION 95.

The Steering section shall consolidate the steering control components and steering aids as described in SECTION 94.

(b) Power Supply

The Bridge console (propulsion control section only) shall be supplied with power from the Engine Room console.

All audible and visual alarms provided on the Bridge control console (propulsion control section only) should be actuated when on Bridge control and Engine Room control.

In the case of power failure of the propulsion control system, both audible and visual alarms shall be actuated on the Bridge and the central Control Room operating station consoles.

99.5. CENTRALIZED MACHINERY CONTROL SYSTEM

(a) Main Engine Control System

(1) General

The remote propulsion control system shall provide appropriate electric and/or pneumatic signals from the Bridge and the central Control Room operating station console throttle control levers which shall operate the main engine fuel rack control through the governor. Control signals shall be of the hydraulic, pneumatic or electrical/electronic type.

The control system should be made up of four separate circuits: mechanical, high pressure pneumatic, hydraulic and low pressure pneumatic systems.

The mechanical system should consist of the fuel control linkage between the governor output shaft and the fuel pumps and of the emergency manual engine control system.

The high pressure pneumatic system should consist of the complete engine air starting system, including the main starting automatic shut-down valve, pilot starting valve, starting air distributor and the individual starting valves in the cylinder heads.

The hydraulic system shall include the engine direction control (reversing) and safety interlock system. Reversing shall be accomplished by moving the throttle control lever through the center position detent and moving it to the astern position.

The throttle control lever shall have convenient calibrated reference marks for both the ahead and astern portions.

The safety interlock system shall prevent any possibility of mishandling the engine, which should automatically stop in case of failure of the main lubricating system, high bearing temperature or high oil mist concentration.

The hydraulic system should be operated from the main lubricating oil circuit.

The low pressure pneumatic system should consist of: engine direction selection control, starting and speed control, and other automatic functions for Engine Room and Bridge remote control.

The propulsion control system shall be designed to provide remote control of the direction and magnitude of propeller rpm from either the Engine Room console or the Bridge control station. This shall be done through a propulsion control system to free the operator from concern with timing and sequencing of events, while capitalizing on the unique advantages of the system. These features are inclusive of preventing operation of the air starting system while the engine is running, cutoff of starting air at a predetermined engine rpm, and prevent operation of certain alarm circuits before engine pressures have normalized (applicable to engine driven pumps).

(2) Interlock Circuits

The engine remote starting controls shall be interlocked to prevent being energized when:

Type A Interlock

Engine overspeed trip reset in machinery space on engine, has not been reset.

Automatic engine shutdown reset at central Control Room operating station, has not been reset.

Emergency engine shutdown reset, at central Control Room operating station, has not been reset.

Engine barring gear engaged.

Type B Interlock

Engine lube oil pressure not adequate.

Engine jacket water pressure not adequate.

Engine piston cooling water pressure not adequate.

Engine piston cooling water outlet flow rate not adequate.

An override for the Type B Interlocks shall be provided at the Engine Room console for capability of override in the event of a navigating emergency or checked out control interlock fault. Separate overrides shall be provided for engine starting.

(3) Shutdown Circuits

The main engine shall automatically shutdown for the following listed alarms:

Low lube oil pressure, after fault of the standby pump.
Engine overspeed (Note--No time delay and no override).
High crankcase oil mist detection.

(4) Slowdown Circuit

The main engine shall automatically slow down to a pre-determined rpm for the following listed alarms.

High jacket water outlet.
High bearing temperature.
High exhaust temperature.

Automatic shutdown shall always be preceded by a vital alarm, except for overspeed shutdown. Between the vital-shutdown alarm and the vital alarm there shall be a pre-established pressure, temperature, or concentration differential as applicable. During the period of vital alarm to vital-shutdown alarm the central control operating station shall have the capability to override the automatic shutdown in the event of a navigating emergency via an automatic shutdown override pushbutton. These override pushbuttons shall be operable only when the central Control Room operating station is in control. The same procedure shall apply for automatic slow down of main propulsion engine.

(5) Bridge and Engine Room Transfer

The following console mounted equipment shall be supplied for use in transferring control between the Bridge and the Engine Room control console.

Bridge control throttle lever position indicator.
Central control throttle lever position indicator.
Engine order telegraph.
Bridge and Engine Room console indicating lights.
Control transfer pushbutton.
Controllable pitch propeller pitch indicator (if provided).

The following sequence shall be followed in transferring from the

Engine Room console to Bridge control:

Bridge commands "Bridge Control" on E.O.T.

Engine Room operating station acknowledges E.O.T. command by placing E.O.T. in "Bridge Control". Acknowledgement of the E.O.T. illuminates the control transfer pushbutton on the Bridge.

The Bridge actuates the control transfer pushbutton and gains control. At this time the Engine Room console indicating light goes out and the Bridge control light is illuminated at all control stations.

The following sequence shall be followed in transferring from the Bridge to the Engine Room console under normal conditions:

The Bridge selects a command position on the E.O.T.

The Engine Room operating station acknowledges the command. Acknowledgement of the E.O.T. command automatically transfers control from the Bridge to the Engine Room operating station and illuminates the proper control indicating lights.

It shall be possible to gain propulsion control at the Engine Room operating station at any time by moving the E.O.T. to a position other than "Bridge Control". Transfer shall be immediate.

(6) Local Engine Station Control

The system shall be provided with a local machinery space control to provide emergency control in the event of remote control failure and for maintenance purposes, consisting of the following:

Local-Remote selector valve.
Bridge in control indicating light.
Central Control Room operating station in control indicating light.
Machinery space in control indicating light.
Engine start valve.
Engine stop valve.
Emergency engine shutdown valve.
Engine overspeed trip reset. (Note: usually engine mounted.)
Engine speed control.
Telephone. (Note: Quantity 1, refer to SECTION 95.)
Engine rpm indicator.
Engine lube oil inlet pressure gage.
Engine order telegraph indicator with reply back transmitter.

These devices shall be panel(s) mounted in a convenient arrangement for this station.

(b) Exhaust Gas and Oil Fired Boiler Control System

The exhaust gas and oil fired boilers shall be completely automatic with summary monitoring of their operations at the Engine Room console.

(c) Ship Service Generator Controls

Each ship service diesel generator shall be provided with a remote control system. The control system shall provide for automatic and remote manual starting, stopping, synchronizing and paralleling of each generator. The control system shall also provide automatic start up of the standby generator and load transfer in the event of low voltage or failure of the diesel generator in operation.

The generator control system shall consist of instrumentation and controls as required to accomplish the functions described above.

The instrumentation and controls for the ship service generator engines shall be on the Engine Room console while the instrumentation and controls for the ship service generators are on the ship's service generator and distribution switchboard.

Controls shall be provided that will permit automatic sequential start of propulsion plant machinery after the automatic start of the standby generator in the event of a power failure.

(d) Digital Clock

A solid state type digital clock shall be provided with distribution circuits for use with the digital type data and bell loggers. The clock, with local readout display and all adjusting controls, including adjustment to ship's time, shall be flush mounted in the Bridge propulsion control panel. The system shall be energized from the Engine Room console 24 volt DC power source. The clock shall have complete operating instructions mounted in a clear cover adjacent to the readout. The clock readout shall be two-tenths of a minute and shall have an accumulative error of not more than ± 15 seconds in 7 days.

There shall be a slave indicator supplied and mounted on the Engine Room console.

(e) Bell Logger

A bell logger of the digital type shall be provided in the Bridge area to record the following:

When the main propulsion plant is controlled from the Engine Room console the logger shall record time, central Control Room operating station throttle position, Bridge telegraph order, central Control Room operating station telegraph response, propeller shaft rpm and direction of shaft.

When the main propulsion plant is controlled from the Bridge the logger shall record time, Bridge throttle position, propeller shaft rpm and direction of shaft.

Space shall be provided on the printout for manual writing of the ship's name, date and a "Remarks" column for any necessary comments.

The digital bell logger shall printout in a tabular form, one set of readings with each movement of the Bridge or Engine Room operating station telegraph. Printout shall be in segment increments and nomenclature identical to the telegraph markings or in a suitably approved code. In addition, the bell logger shall also record all significant changes in the Bridge or central Control Room operating station throttle lever position which results in a propeller rpm change in excess of ± 5 rpm from the last logged information. In addition, a rough weather switch shall be provided on the bell logger which shall increase the logging requirements to 10 rpm for propeller rpm change.

Whenever the bell logger is actuated, it shall continue to print out at 12 second intervals until steady propeller rpm conditions are achieved.

Printout shall also be available at any time on demand.

Upon a malfunction of the data logger, the bell logger shall be arranged for use as an emergency printer. When so used, it need not be fitted to use the data logger format. In the event the bell logger is in use as a data logger, the system shall be so devised as to give priority to the bell logging function. If, under these circumstances a data log printout is stopped, the printer shall initiate a new printout when the bell logging function is completed.

Time input for the bell logger system shall be obtained from the digital clock on the Bridge control console.

The bell logger printer shall be identical to the data logger printer, concerning construction details and specifications. Provisions shall be made to hold a supply of paper for the printer.

Two identical printers shall be used for the data logger and bell logger printers. The printers shall be covered with a clear plastic cover. Printer for the bell logger shall automatically print headings after every tenth line of data on blank paper.

(f) Data Logger

A data logger of the digital type shall be provided as a portion of the central Control Room operating station console. The logger shall print automatically every hour and on demand. Off-normal values shall print immediately upon detection. In order to establish operating trends, the following data shall be logged:

Time of day.
Shaft horsepower (where provided).
Shaft torque.
Propeller shaft rpm.
Main engine turbocharger rpm(s).
Main engine scavenge air pressure.
Main engine scavenge air temperature(s) inlet/outlet of turbocharger(s).
All propeller shaft bearing temperature(s).
Main engine bearing temperature(s) including thrust bearing.
Main engine(s) individual cylinder exhaust temperatures.
Main engine lube oil inlet temperature.
Main engine jacket water inlet/outlet temperatures.
Main engine injector coolant water outlet temperature(s).
Main engine fuel oil inlet temperature.
Main engine operating fuel oil or diesel oil flow.
Steam pressure out waste heat boiler.
Exhaust gas temperature in/out of waste heat boiler.
Exhaust gas temperature inlet/outlet of turbocharger(s).
Sea water temperature.

The automatic data logger shall printout in tabular form all items listed to be logged. It shall be of modular design.

The logging system shall include all required sensing elements and transducers, scanners, amplifiers, converters, and a data printer.

The data logger shall use elements which can be removed from the panel by unplugging. Each element shall be a standardized unit designed for multiple use of minimal spare parts and shall bear permanent catalog number, identification and changeable functional identifications. All components on the elements shall be solid state (no vacuum tubes) and static (no contact making devices) except for the scanner and alarm memory circuits, which may use hermetically sealed reed relays or switches not affected by vibration.

The data logger shall be arranged for complete accessibility to permit "one-man" maintenance. Trouble shooting aids, such as light, switches and meters shall be liberally supplied on the front face of the access enclosures open for maintenance work. The identification of each element by catalog number shall be affixed to the inside of the panel.

The system shall be provided with a fixed logging program which shall be changeable to a minor degree by making minor panel wiring changes. The output information shall be tabulated in terms of engineering units. A movable carriage type printer will not be permitted. The printer shall be arranged to automatically print off-normal indicating in red. A preferred arrangement shall permit printing all the input signals listed on a single line so that all printed values for each variable shall appear in a single continuous vertical column. If the number of digits is too great for a single line, a second line may be used. The data appearing on the second line shall be coordinated so that the absolute values appearing in column are of the same magnitude. Proposed log sheets shall be submitted for approval.

The logger shall include the counting, registers, central logic and associated devices necessary to produce a typewritten log on an approved form. This will necessarily include signal amplifiers, and analog to digital converters.

Upon malfunction of the bell logger the data logger shall be arranged for use as an emergency printer. In the event the data logger is in use, the system shall be so devised as to give priority to the bell logging functions. If, under these circumstances, a data log printout is stopped, the printer shall initiate a new printout when the bell logging function is completed.

Time input for the data logger system shall be obtained from the digital clock on the Bridge control console.

The data logger printer shall be identical to the bell logger printer, concerning construction details and specifications.

Provisions shall be made to hold a supply of paper for the printer.

Two identical printers shall be used for the data logger and bell logger printers. The printers shall be covered with a clear plastic cover. Printer for the data logger shall automatically print headings and format on blank paper. Abnormal values shall be printed out in red type.

(g) Main Pumps

All main pumps shall be arranged for remote starting from the Engine Room console through a phased sequential starting operation, if required. Successful completion of each major sequential step is a requirement for the following sequential step to commence. Each major sequential step shall have an individual indicator on the Engine Room console. Should the oncoming pump fail to start, this indication will denote the area in which the sequential starting operation failed to complete.

Upon failure of the pump in operation, the standby pump shall automatically commence its sequentially starting operation. Generally, the sequential starting operation should be complete in no longer than 1 minute after initiation. An audible and visual alarm shall be activated to indicate failure of the running pump.

A constant differential pressure type of governor shall be provided for pump control, if required.

(h) Central Engine Room Console Attendance Monitor

A central Engine Room console attendance monitor system shall be provided to provide means of alerting the Bridge in event of machinery space watchstander emergency.

The system shall include on the Bridge control console, a master control station contactor, a power on-off switch, power on indicating light, a visual and audible alarm, test switches, and a cycling device. The cycling device, console interior mounted shall provide adjustability of 15 minutes to 2 hours.

On the Engine Room console a reporting pushbutton shall be provided with a visual and audible buzzer alarm to remind the watchstander to depress the report pushbutton.

Visual and audible alarm buzzer shall actuate 5 minutes before the alarm sounds on the Bridge. The system shall be designed so that depression of the reporting pushbutton for a period exceeding 20 seconds shall also sound the alarm in the Bridge.

Power supply shall be from the 115 volt, 60 cycle, single phase but of the central Control Room operating station console.

(i) Engineers' Assistance Needed Alarm System

An engineers' assistance needed alarm system shall be provided. This alarm shall produce a tone separate and distinct from the general alarm or other audible signals and the system shall cover the passageways and Lounge areas of the Licensed Engineers' Quarters. The alarm shall be capable of being heard in all rooms with the doors closed. The contact maker shall be located on the Engine Room console.

The engineers' assistance alarm shall be arranged to be automatically sounded upon power failure of the engineering trouble alarm system and when the engineering trouble is not acknowledged from the Engine Control Room station within a reasonable period of time.

Power shall be from the general alarm power supply.

(j) Duty Engineer's Alarm Panel

One machinery monitoring panel shall be provided in the engineer's quarters of the ship and shall be connected to the engineering trouble alarm system. The engineering trouble alarm or "alarm" as used herein, is the system or systems which respond as the alarms on the Engine Room control console. The panel shall consist of the following alarms and indicators:

Fire engine spaces	Alarm and indicator
High bilge level	Alarm and indicator
Machinery plant critical	Alarm and indicator
Machinery plant non-critical	Alarm and indicator
Steering gear malfunction	Alarm and indicator

Upon the automatic sounding of the engineer's duty alarm, the engineer responsible for that watch shall report to the monitoring panel and acknowledge the call by releasing the alarm. An on-off switch in each Licensed Engineer's Room and Lounge shall energize the alarm system.

A separate fire alarm shall sound throughout the Engineer's Quarters and Lounge spaces. Depressing the fire indicator on the panel shall notify the Bridge of fire in the Engine Room and silence the alarm.

The duty engineer's alarm panel shall also include a duty status indication for each engineer and an acknowledgement button whereby he can inform the Bridge that he is available and answering the alarm call. An alarm is provided on the Bridge console if the alarm call is not answered within 2 minutes.

(k) Fire Fighting Stations

A fire detection system shall be provided throughout the machinery spaces. The system shall be carefully selected based upon its sensitivity and compatibility with the environment.

The fire fighting control station shall be located in a single accessible location outside the machinery casing.

Control of all systems or functions relating to fire protection of the machinery space should be centralized at this location. The station shall be provided with alarms, devices, and remote manual controls for the following listed:

Stopping the machinery space ventilation blower and closing dampers.
Stopping all machinery forced draft blowers.
Stopping all fuel oil transfer, diesel oil transfer, fuel oil service pumps.
Stopping all fuel oil centrifuges.

Closing machinery space skylights.
Closing watertight and fire-resistant doors.
Closing suction valves from fuel-oil settling or day-service tanks.
Starting emergency generator.
Fire pump start/stop controls and fire main pressure gage.
Control of fixed extinguishing system.
Closing the shaft alley door.
Power available indicating light.
Lamp test pushbutton.
Acknowledge pushbutton.
Fire in machinery space alarm.
Bilge level alarms.

(l) Bilge Pump

Automatically controlled bilge pump shall be provided for the Engine Room bilges. The pump shall be: (1) "backed-up" by bilge level alarm which will sound when the pump fails or is inadequate to control flooding, (2) monitored to detect excessive running, and (3) equipped with an alarm and automatic shut-down in the event oil is detected in the pump discharge.

(m) Shaft Horsepower Indicating System

A shaft horsepower indicating system shall be supplied. System shall be capable of being used in sea trials and/or permanent installation for accurately determining the magnitude of continuous average rotational torque in conjunction with the simultaneous shaft speed in rpm, and the shaft's known Modulus of Rigidity to provide a continuous, instantaneous, direct shaft horsepower indicator readout. Thus, the amount of power produced by the propulsion plant and transmitted into the propeller is displayed. This power shall be compared to the fuel consumed during the same period to ascertain the specific fuel rate, which reflects plant efficiency.

The system shall include a shaft sensor unit on a section of the line shafting, a propeller tachometer, multiplier and indicators showing the instantaneous shaft rpm, torque and shaft horsepower.

This system shall be capable of measuring the shaft horsepower in both ahead and astern rotational direction of the shaft, with equal accuracy.

Shaft horsepower indicator may be included in the control panel or remotely located on the central control console and Bridge console for use with Bridge propulsion control. A digital print-out tape may be employed in lieu of a strip chart recorder.

The shaft horsepower meter system shall be capable of an accuracy of ± 1 percent of full scale. All electronics included into this system shall be of solid-state design.

Shaft horsepower, torque and rpm output signals shall be furnished for inputs to a data logger.

This system is to operate from the ship's input power of 115 volts AC, 60 Hz and the readout shall not be affected by line input variations in voltage of ± 7 volts and ± 3 Hz frequency. The input line power shall be isolated from the secondary measuring low voltage by an isolation stepdown transformer. The input power supply shall be connected to the Engine Room I.C. distribution panel.

(n) Machinery Performance Monitoring System (If provided)

A machinery performance monitoring or trend analysis system may be provided to serve as a diagnostic or evaluation aid for maintenance scheduling and overall machinery economic performance. The system should be designed so as to provide a thorough analysis of the machinery elements to be monitored on a continuous, real time basis in order to enhance failure detection and optimize machinery maintenance and repair scheduling.

Continuous monitoring of the selected machinery operational parameters should be compared to previously determined baseline data to establish trend analyses for those parameters, thus providing operating personnel both historic and on line data in logical, easily understood language for rapid evaluation. Basic computations evolve from design data and sea-trial performance of the chosen parameters. Monitored data may then be stored in some manner such as floppy discs so that the information may be retrieved for direct comparison to baseline data.

The system should be designed to be completely independent of the monitored components and should in no manner rely on, interfere with, or affect the operation of the ship's power plant. In addition the system should be of an automatic, computerized, self-monitoring, intrinsically safe nature capable of reliable performance under the environmental conditions stated in SECTIONS 1.11 and 99.2 of these Specifications.

The parameters to be monitored and type of sensors used are left to the discretion of the Owner provided they comply with the design criteria established by the Regulatory Body(ies) and are properly installed in accordance with good marine practice. All electrical, electronic components and power supplies for the system shall be in accordance with the applicable SECTIONS of these Specifications and the central computer or processing unit shall incorporate a power fail safe automatic restart feature in the event of a power supply failure or interruption. In general, the electrical power supply, display console construction, alarms, visual and audible indicators, selector switches, pushbuttons, and other circuit devices shall be in accordance with the requirements of SECTION 99.2. of these Specifications for Engine Room control console construction.

The system, in general, should be comprised of the following components: sensors, acquisition stations Or transmitting units, computer or central processing unit (analog/digital), recording unit for memory and data storage, display unit, and the associated wiring, keying or call devices, alarms, hard copy or teletype printer and other components necessary to accomplish the data acquisition and display. The console display unit for the system should be located in the proximity of the centralized Engine Room console or may be a portable unit which can be safely moved to the desired location, plugged in for data read out and then stowed in an approved manner when not in use. The display modes shall be optional and may be of the TV or CRT type, hard copy printer or data logger readout.

Various parameters may be monitored to optimize the utilization of the system as desired. Examples of parameters which may be monitored to analyze machinery performance include but are not necessarily restricted to the following items: exhaust gas temperatures; compression pressures; excessive vibration; shaft torque/horsepower; turbocharger performance; and engine rpm.

In general, the system sensors may be placed in any critical area to measure parameters that meet the operational requirements of the Owner in planning maintenance procedures and obtaining optimum machinery performance.

(o) Main Engine Service Time Clocks

Automatic cumulative engine operating hour meters shall be provided for the main engine. Meters shall be connected directly into the respective engines stop-start function to operate automatically whenever engines are running.

99.6. SHIP CONTROL SYSTEMS

(a) Engine Order Telegraph System

Provide an engine order telegraph system of an electrical self-synchronous type with instruments located as follows:

Location	Instruments
Wheelhouse, in Bridge Control Console, Propulsion Control Section	(1) Transmitter with replay-back indicator, S.E.D.F., Lever operated with 76 mm bell.
Central Control Room Operating Station Console, Propulsion Control Section	(1) Indicator with replay-back transmitter, S.E.S.F., knob operated with 203 mm bell.
Bridge Wings, Port & Stbd.	(1) Indicator, S.E.S.F., 192 mm diameter dial mounted on outside bulkheads of wheelhouse both port and stbd., watertight.
Local Engine Station Control	(1) Indicator with replay-back transmitter, S.E.S.F., knob operated with 203 mm bell.

The flush mounted instrument, having a knob-operated handle shall have the "ahead" position on the dial to the operator's right.

The system shall provide input signals to record the engine order commands and replies as part of the bell logger.

The console mounted instrument will connect to a bell within the console so that the bell will ring when an order is transmitted and continue to ring until the order is properly acknowledged.

A wrong direction audible and visual alarm shall be provided on the Engine Room and Bridge consoles. Controlling contact shall be operated by the shaft revolution sensing system and the ahead and astern position of the Engine Room operating station throttle level position. The alarm circuit shall be de-energized when transmitter and reply are in "Bridge Control", "Finished with Engine", "Stand-by", and "Stop" positions.

The following orders shall be provided on all instrument dials:

Stop	Bridge Control
Finished with Engine	Standby
Astern-Dead Slow	Ahead-Dead Slow
Astern-Slow	Ahead-Slow
Astern-Half	Ahead-Half
Astern-Full	Ahead-Full

The dials for all instruments shall be white with black (for ahead) and red (for astern) letters marked so that the dial markings and position of pointers are clearly visible at all times.

System shall be energized from the 115 volt AC, single phase, central Control Room operating station interior communication panel.

(b) Systems Test and Inspection

(1) Regulatory Body(ies) Test Procedures

Test procedures on the centralized control system in accordance with Regulatory Body(ies) requirements shall be prepared.

(2) Manufacturer's Factory Tests

The centralized control system shall be factory tested to insure proper functioning prior to shipment.

The instrumentation and alarm systems including sensors, transducers, and information display shall be tested as follows:

(i) Sensors and Transducers: tested and calibrated on a parameter equivalent to service conditions.

(ii) Information Display: simulation of signal input.

The control systems, such as the throttle control, shall be tested and calibrated using analog inputs to simulate actual shipboard operating conditions.

The seller shall subject the electronic equipment to a "burn in" period.

99.7. PREVENTIVE MAINTENANCE SCHEDULE

A comprehensive preventative maintenance schedule shall be provided to comply with Regulatory Body(ies) requirements. Schedule shall provide the recommended time periods for equipment and systems inspections, maintenance requirements, spare parts inventory control requirements and the necessary testing to determine the condition status of systems and components of the machinery plant.

SECTION 101

TEST AND TRIALS - *SLOW SPEED DIESEL (ONLY)*

101.1 GENERAL

All shop tests, ship installation tests, dock trials, and sea trials shall be scheduled and completed to demonstrate compliance with the requirements of the Specifications and shall be in accordance with the Classification Society(ies) requirements.

The Contractor shall prepare and install all maneuvering information required to be carried in the pilot house in accordance with SOLAS requirements. The Contractor shall use the Owner's standard form, and procedure for mounting. The necessary maneuvering trials to prepare the forms shall be performed as required under the Contract.

Installation tests verifying design parameters shall be performed on the lead ship of the class unless noted herein. Identical equipment on following ships shall only have operational tests performed.

The scope of dock and sea trials shall be to Contractor's standard practice. The Contractor shall prepare complete reports on all sea trials, dock trials, and events required by this SECTION. The trials shall not be considered complete until they have been documented in a comprehensive and concise report by the Contractor.

To demonstrate compliance or deviation from the performance provisions of the Contract, the following tests shall be included in the sea trials or dock trial as applicable.

101.2 PROGRESSIVE SPEED LEVELS

At fully loaded and normal ballast condition, with clean bottom in deep-sea, the vessel's speed shall be determined at engine loads of 1/2 MCR, 3/4 MCR, NCR (90% MCR), and MCR using heavy oil. The revolutions of the propeller at trial condition shall be restricted to the maximum rpm allowed by the main engine vendor, in which case the output of main engine may not reach the specified maximum continuous rating.

Trial speed shall be read at the specified maximum continuous output of main engine by means of extended power curve, when main engine does not develop maximum continuous horsepower under the above restrictions.

The trial speeds shall be adjusted by calculation to Sea State 0 and Beaufort 0 using a method acceptable to both the Owner and the Contractor.

Each trial speed at a particular power level shall be the weighted averaged (1, 2, 1) of three runs in alternating opposite directions at equal time intervals.

Shaft calibration is required for vessels which are to undergo progressive speed trials or are contractually subject to liquidated damages for exceeding specified fuel consumption rates. In all other cases where a torsion meter is to be used in the determination of shaft horsepower, a standard modulus of rigidity of 82×19^{9} Pa shall be specified for Grade 2 ABS steel shafting.

For duplicate vessels, trials shall only be required at 100% MCR at fully loaded draft.

101.3 ENDURANCE AND FUEL CONSUMPTION TRIALS

Two hours continuous run at normal continuous rating in the full load* condition shall be carried out and followed by 4 hours continuous run using heavy fuel oil at normal continuous rating. The rate of fuel consumption shall be measured during the above two runs for comparison purposes with guaranteed fuel rate measurement performed during engine shop trials.

101.4 MANEUVERING TRIALS AND TEST

The following maneuvering trials and tests shall be conducted:

a. Ahead Steering Gear Test

   To demonstrate the mechanical functioning of the steering gear, including auxiliary power unit, and to determine its adequacy to hold and move the rudder as specified in SECTION 81 of this Specification.

b. Circle Test

   To determine the turning diameter of the ship on fully loaded and normal ballast condition at helm angle of 10, 20, and 35 degrees (P&S sides) for full and half speeds.

c. Zig-Zag Maneuvering Test

   To determine the turning quality and the course keeping quality at helm angle of 35°, ballast condition, and full load* condition at full speed.

**Where it is not practical to reach a "fully loaded condition" at the time of sea trials, a maximum practical draft shall be used. Within 6 months of delivery of the ship, this information shall be obtained, and the results appended to the trial report called for in Item 101.1. above.*

d. Crash Stop Astern Test

To determine that astern power to be adequate to stop the ship and to determine the head reach and time to stop on fully loaded and ballast conditions from full and half speeds.

e. Crash Stop Ahead Test

To determine the stern reach and the time to stop the ship on fully* loaded and ballast conditions from steady astern.

f. Inertia Test

Inertia test to determine the ahead reach and time to bring ship to a stop from full speed ahead when engine being stopped on fully* loaded condition.

g. Astern Steering Test

For full astern, full load*, and ballast conditions to demonstrate steering capability.

h. Spiral Maneuver per SNAME T&R Bulletin No. 3-47.

i. Fire and Foam Tests.

j. Torsional Vibration Test to Determine First Critical and Measured Stress on the Line Shaft.

101.5 ANCHOR WINDLASS TEST

Anchor windlasses to be tested at sea with depth of about 200 meters from water line to demonstrate satisfactory operation and compliance with the duty requirements specified in SECTION 81 of this Specification.

101.6 BLACK-OUT TEST

Black-out test to be carried out by tripping the air circuit breaker (ACB). (This may be accomplished during dock trials if acceptable to Regulatory Body(ies).)

**Where it is not practical to reach a "fully loaded condition" at the time of sea trials, a maximum practical draft shall be used. Within 6 months of delivery of the ship, this information shall be obtained, and the results appended to the trial report called for in Item 101.1. above.*

101.7 CARGO AND BALLAST PUMP TEST

Running test of cargo oil and ballast pumping system utilizing fresh water shall be carried out. Ballast pumping system may be tested using sea water.

101.8 UNATTENDED MACHINERY OPERATION

A test shall be performed to demonstrate the automation system installed in the vessel and compliance with Regulatory Body(ies) requirements.

101.9 NOISE AND VIBRATION MEASUREMENTS

Noise and vibration measurements shall be taken with the vessel in the full load and ballast condition at MCR with air conditioning and refrigeration machinery running to demonstrate compliance with the requirements of SECTIONS 1 and 50 of these Specifications.

101.10 DUPLICATE VESSELS

In the case two or more vessels are embodied in the Construction Contract, circle test, zig-zag test, inertia test, astern steering gear spiral maneuver bow thruster test, torsional vibration test and inclining experiment may be omitted on the succeeding vessels.

The fuel consumption and endurance test may be run concurrently with the speed runs to minimize at-sea time.

101.11 REST PERIOD DURING TRIALS

Where the sea trial requires more than 24 hours continuous testing, a recuperation period of 6 hours shall be provided at the end of each 18-hour period wherein all testing shall be suspended.