WATERCRAFTS

CHAPTER 11

Article 9.1 General Conditions and Requirements

This chapter covers electrical equipment and wiring installed on and within the following:

a.) Watercraft without limitations

b.) Watercraft with special limitations

c.) Watercraft navigating in Philippine waters

Classifications of Watercraft:

- Passenger ship or ferry boat, hydrofoil or hovercraft
- Cargo vessel
- Vessel for carriage of all classes of dangerous cargoes
- Tankship
- Yacht for pleasure use
- Exposhp and watercraft for amusement and display purposes
- Fishing boat
- Vessel/barge for salvaging, dredging, pile-driving
- Watercraft for cable-laying or pipe-laying operations
- Floating power plant barge

Classifications of Watercraft:

- Training or hospital ship
- Tugboat or pusher boat, workboat or supply boat
- Fireboat for firefighting
- Floating tourist hotel, restaurant, casino
- Watercraft for pollution control
- Watercraft for geodetic and ocean research
- Search and rescue vessels
- Motor launches for pilotage use
- Patrol boat or speed boat
- Mobile offshore oil drilling rig/ production platform and habitat
- Survey and exploration ship

Electrical Plan Requirements:

- ✓ Title Block or Nameplate
  - –name and identification number
  - – type of service operation
- ✓ Equipment Lay-out

- Main and emergency generators,
- Accumulator batteries,
- Transformers, power rectifiers and inventers,
- Switchboards, distribution panels, and panelboards,
- Electrical propulsion machineries,
- Motors,

- Steering gear machineries
- Lighting fixtures,
- Navigational lights and navigational instruments, and
- Signaling and communications equipment.

✓ Schematic or Line Diagram

- Main generator supply,
- Emergency power,
- Electric propulsion,
- Steering gear,
- Navigational lights,
- Fire protection,
- Ground protection,
- Shore power supply, and
- Survival crafts

✓ Wiring Plan

1. Power Circuits

- Generator,
- Accumulator batteries,
- Switchboard and metering instrument,
- Circuit breakers/fuses,
- Motors and control devices.

2. Lighting and Receptacle Circuits

- Lighting and receptacle outlets for main and emergency systems,
- Lighting fixtures: location, type and rating,
- Complete feeder list and branch circuit load with voltage drop for longest run of each size cable.

3. Navigation and Communication Circuits

- Navigation light, and navigation indicator panel,
- Navigation equipment,
- General alarm, fire alarm and emergency alarm systems,
- Electronic and communications equipment,
- Rudder angle, propeller pitch and shaft speed indicators

4. Instrumentation and Control Circuits

- Generators and synchronizing devices,
- Accumulator batteries,
- Motors and controls,
- Propulsion system,
- Steering gear system,
- Waterlight doors,
- Refrigerated cargo space.

- ✓ Design Computation
- ✓ Schedule of Loads
- ✓ Legend

Specifications and Data Requirements:

- ➢ Propulsion Machinery, Main and Emergency Generators, and Vital Motors 100kW and Over
- ➢ Main and Emergency Generators, and Vital Motors Below 100kW Rating

Motor Control Equipment

- ➢ Short Circuit Data
- ➢ Cable Grouping
- ➢ Special Equipment

-transformers inventers, rectifiers, heaters, x-ray apparatus, electric welding equipment and others.

General Requirements:

- Equipment Location
- Protection from Bilge Water
- Accessibility
- Watertight Equipment
- Materials
- Lubricating System
- Equipment and Cables Locations from Magnetic Compass
- Electrical Hardware
- Insulating Materials and Insulated Winding
- Hazardous Locations, Installations and Equipment
  - Electrical Equipment
  - Cables
  - Lighting Circuits

- Precautions Against Shock, Fire, and Other Hazards of Electrical Origin.

Passenger Ships and Cargo Ships

1. Exposed Metal Parts and Frame
2. Main and Emergency Switchboard
3. Hull Return
4. Cables
5. Lighting Fittings
6. Wiring
7. Accumulator Batteries
8. Communication Wiring System

- Passenger Ships Only
    1. Distribution System
    2. Cables
    3. Hazardous Spaces
    4. Lighting Circuit
    5. Joints
    6. Wiring Systems
- Cargo Ships Only

Article 9.2 - Special Requirements for Certain Locations and Systems

LOCATIONS

- Hospital or Dispensary Spaces Certified for Use on Watercrafts
- Locations Where Gasoline or Other Highly Volatile Motor Fuel Is Stowed
- Equipment installed within 460 mm above the deck
- Equipment installed at or over 460 mm above the deck
- Submersible Motor-Driven Bilge Pumps

Installation

- Continuous Operation
- Location
- Master Switch

AUXILIARY SYSTEMS

- Electrically Operated Watertight Door System
  - Power Supply
  - Cables
- Fire-Screen Door Holding and Release Systems
  - Fire-Screen Door Holding and Release Mechanism
  - Fire-Screen Door Holding Circuit
  - Central Control Station and Local Control
  - Simultaneous Release
  - Electrical Supply Arrangement
  - Power Supply
  - Subdivided Circuits

- Electric Motor for Lifeboat Handling
  - Waterproof
  - Enclosure Test Methods
  - Additional Test
  - Enclosure Considered Spraytight
- Wiring of Lifeboat Winch Components
  - Main Line Emergency Switch
  - Switch Disconnect
  - Davit Arm Limit Switches
  - Main Line Emergency, Clutch Interlock, and Master Switches
  - Power Disconnecting Means
  - Location

- Electric Heater
  - Risk of Fire
  - Heating by Convection
  - Overheating Protection
  - Maximum Temperature of Deck or Bulkhead Surface
  - Control Switch
- Electric Cooking and Motor-Driven Commissary Equipment
  - Grab Rails
  - Sea Rails on Ranges
  - Grease or Fat Collector
  - Suitable Mounting and Anchorage
  - Disconnecting Means
  - Watertight Enclosure

- Electric Steering System
- Two Steering Systems
- Separate Installation
- Interlocks
- Short-Circuit Protection
- Pilot Light
- Automatic Indicator
- Tank Vessels of 10,000 Gross Tonnage and Above
- Two or more identical steering gear power units
- An alternative power supply
- Main steering gear control

- Control of Ship
  - Passenger Ships and Cargo Ships
  - Passenger Ships Only
- Maneuvering Controls
  - Indicating Lights
  - Alternative control
  - Suitable Interlocks
- External Electrical Supply
  - Shore Power Connection Box
  - Grounded Terminal
  - Indicator
  - Polarity Checking
  - Full Information Notice

- Fire Detection and Extinguishing Systems
  - Power Supply
  - Served by Two Circuits
  - Additional Requirement for Passenger Ships
- Remote Stops for Ventilating Fans and Pumps
  - Means for Stopping Ventilating Fans
  - Fitted with Remote Controls
  - For Passenger Ships Carrying More Than 36 Passengers
- Discharge Protection
  - Means for Limiting Induced Voltage for Protection of Field Windings/Cables
  - Means to limit Induced Voltage at Busbars
  - Shunt Resistors

- Electrical Equipment for Use in Explosive Gas Atmosphere
  - Safe Type
  - Types of Protection
  - In Hazardous Zones
- Safety Devices
  - Means to Prevent Reversal of Direction of Rotation of DC Generator
  - Means for Absorbing/Limiting Regenerated Energy
  - Means for Forcibly Opening of Contactors and Switches
- General Alarm
  - Shall be provided and operable from the navigating bridge.

Article 9.3 - Systems of Supply and Distribution

- Wiring Systems
- Parallel Systems with Constant Pressure
- With Hull Return
- DC two-wire
- AC single-phase, two-wire
- AC three-phase, three-wire
- AC four-wire with neutral grounded but without hull returns
- Passenger Ships, Cargo Ships, and Tankers/Supertankers (No Hull Return)
- DC two-wire, insulated
- AC single-phase, two-wire, insulated
- AC three-phase, three-wire, insulated

System Voltages shall not exceed:

500 V for cooking and heating equipment;

250 V for lighting, heaters in cabins and public rooms; and

55 V for emergency systems.

- Series Systems with Constant Current

High Voltage System

- System Voltage

  7000 V ac or 1500 V dc for electric propulsion equipment; and

  7000 V ac for large generators and ac power equipment.

- Voltage Supply and Primary Distribution

Low Voltage System

- System Voltage

  Shall not exceed 55 V.

- Wiring Installation

Standard Frequency -60 Hertz

Operation Under Voltage and Frequency Fluctuations

- DC Equipment
  - Operate under voltage fluctuation of +6% or –10%
- AC Equipment
  - Under voltage fluctuation +6% or –10% at rated frequency, and under frequency fluctuation of + or – 5% at the rated voltage
- Contactor and Similar Equipment
  - Shall not drop out a or above 85% of the rated voltage

ARTICLE 9.4 – GROUNDING SYSTEM

9.4.1 General

9.4.1.1 Requirements

(A) **Grounding**. No current-carrying parts of an insulated distribution system shall be grounded (refer to Section 2.50.2.7). However, components used for the suppression of radio interference may be connected between the insulated system and ground.

9.4.1 General

(B) **Indication.** Every insulated distribution system shall be provided with lamps or other means to indicate the state of insulation from ground.

(C) **Protection.** Current-carrying parts with voltage to ground shall be protected against accidental contact.

(D) **Detection.** A ground detector device for insulated system shall be installed to continuously monitor the insulation level, particularly of circuits (other than intrinsically safe circuits) which pass through dangerous or hazardous zones or spaces or which are connected to apparatus installed in such zones or spaces. The device shall operate an alarm in the event of abnormally low level of insulation.

9.4.1 General

(E) **Metallic Riggings.** All metallic riggings shall be grounded by flexible galvanized steel cables lashed to the rigging and securely fastened by solderless lug connectors to the metal hull.

9.4.2 Grounding Electrical Equipment

9.4.2.1 **Portable Electrical Equipment**. Metal frames of all portable lamps, tools and similar apparatus supplied as service or unit's equipment and rated in excess of 55 volts shall be grounded through a suitable conductor unless equivalent safety provisions are made such as by double insulation or by an isolating transformer.

9.4.2 Grounding Electrical Equipment

9.4.2.2 **Permanent Electrical Equipment.** In general, the frames or casings of all permanently installed generators, motors, controllers, instruments, and similar equipment, for which the arrangement and method of installation does not assure positive grounding, shall be permanently grounded through separate conductor and protected against damage.

9.4.3 Grounded Neutral Systems

9.4.3.1 **Grounding Resistor.** When the grounded neutral system of generation and distribution is used, grounding shall be through a resistor. The resistor shall be such that ground-fault-current is limited to a value which is not greater than the full-load current of the largest generator on a switchboard section nor less than three times the minimum current required to operate any device against ground fault.

9.4.3 Grounded Neutral Systems

9.4.3.2 **Harmonic Content**. Generator neutrals may be connected in common, provided that the third harmonic content of the waveform of each generator does not exceed 5%.

9.4.3.3 **Dual Voltage AC Distribution.** An ammeter shall be provided to indicate current flowing in the ground connection. The ammeter shall have a full scale range of 10 amperes. An ammeter switch of the spring return to ON (ammeter read) type shall be provided.

9.4.3 Grounded Neutral Systems

9.4.3.4 **Dual Voltage DC Distribution.** For three-wire dual voltage, grounded neutral, dc distribution systems, shall be solidly grounded at the generator switchboard with a zero-center ammeter shall have a full-scale reading of 150% of the neutral-current rating of the largest generator and shall be marked to indicate the polarity of grounds.

9.4.3 Grounded Neutral Systems

9.4.3.5 **Connection to the Metal Hull.** All grounding resistors shall be connected to the metal hull. In order to eliminate possible interference with radio, radar and communication circuits, it is recommended that grounding resistors be bonded together on the hull side of the resistors, and that the means of bonding be separate from that provided by the hull.

9.4.3 Grounded Neutral Systems

9.4.3.6 **Switchboard Grounding.** Where a switchboard is split into sections operated independently or where there are separate switchboards, a grounding resistor shall be provided for each section or for each switchboard. Means shall be provided to ensure that the ground connection is not removed when generators are isolated.

9.4.3 Grounded Neutral Systems

9.4.3.7 **Emergency Switchboard.** No direct ground connection shall be solidly and permanently connected to the neutral bus of the main switchboard. No interrupting device shall be provided in the neutral conductor of the bus-tie feeder connecting the two switchboards.

9.4.3.8 **Ampacity.** The ampacity of the neutral conductor of a dual-voltage feeder shall be 100% of the ampacity of the ungrounded conductors.

9.4.4 Bonding Ground System

9.4.4.1 **Watercrafts with Fixed Electrical Installation.** All watercrafts provided with fixed electrical installation shall be equipped with a bonding system to:

(A) Prevent stray current corrosion by confining stray current leakage inside the hull.

(B) Provide a low resistance path to ground for voltages that may be considerably in excess of those for which the system is designed.

9.4.4 Bonding Ground System

9.4.4.2 **Ground Connection at One Point.** On watercrafts with grounded electrical systems, the bonding ground system and the system ground connection shall be made at one point.

9.4.4.3 **Independent System.** The bonding ground system shall be independent of the electrical system ground conductors except at the common ground point.

9.4.5 Grounding Conductor

9.4.5.1 **Material.** Grounding conductor shall be copper or other approved material and shall be protected against damage and, where necessary, from electrolytic action.

9.4.5.2 **Size.** The size of grounding conductor shall be equal to the cross-section of the current-carrying conductor up to $14mm^2$. Above this figure they shall be equal to at least half the cross-section of the current-carrying conductor with a minimum of $14mm^2$.

9.4.6 Ground Indicators/Detectors

9.4.6.1 Lamp Indicators

(A) **Power and Lighting Systems.** Power and lighting system isolated from a watercraft's main power and lighting distribution by the transformers or motor-generator shall be provided with a means of detecting grounds. If lamps are used for ground detection, they shall have a rating of not more than 25 volts.

(B) **Excitation Circuits.** Excitation circuits shall be provided with lamps, voltmeters or other means to indicate continuously the state of the insulation of the excitation circuits under running conditions.

9.4.6.2 Ground Leakage Detection

(A) **Main Propulsion Circuit.** The main propulsion circuit shall be provided with means for detecting ground faults. For dc equipment exceeding 500 volts and for all ac equipment, aural and visual alarms shall be automatically operated on the occurrence of a ground fault, but the operation of such devices is not to interrupt the power supply.

(B) **Automatic Opening.** If a ground connection is used for operating the detector arrangements, then in dc systems the ground circuit shall be automatically opened in order to stop the circulation of fault current. In ac systems, the fault current shall be interrupted or limited to a safe value.

9.4.6.2 Ground Leakage Detection

(C) **Ground Leakage Devices.** Ground leakage devices shall be arranged to function for all ground faults exceeding 5 amperes. In three-phase star-connected ac generators and motors with neutral points grounded, the ground leakage devices shall operate on the occurrence of a ground fault in the windings of the machine, provided that 5% of the coils at the neutral and of each phase may be left unprotected by the device. In high voltage ac systems, where the capacitive leakage current is high, consideration shall be given to increasing the figure to 5%.

9.4.7 Grounding of Metal Coverings of Cables

9.4.7.1 **Metal Covering of Cables.** Metal covering of cables shall be effectively grounded at both ends of the cable, except in final sub-circuits other than those installed in hazardous zones and spaces.

9.4.7.2 **Electrical Continuity.** The electrical continuity of all metal coverings of cables throughout the length of the cable, particularly any joints and tappings, shall be ensured.

9.4.7.3 **Lead-Sheathed Cables.** The lead sheath of lead-sheathed cables shall not to be used as the sole means of grounding the noncurrent-carrying parts of equipment.

9.4.8 Ground Continuity

9.4.8.1 **Ground Continuity.** Means shall be provided for ascertaining that all ground continuity are effective and that the bonding and grounding of metallic conduit and/or sheathing of metallic conduit and/or sheathing of cables is effective.

9.4.9 Grounding of Metal Conduit System

9.4.9.1 **Metal Conduit Systems**. Metal conduit systems shall be grounded and shall be mechanically and electrically continuous across joints. Individual short lengths of conduits need not be grounded.

9.4.10 Grounding Pole for Receptacle Outlets and Attachment Plugs

9.4.10.1 **Receptacles Outlets.** Receptacle outlets operating at 50 volts or more shall have a grounding pole.

9.4.10.2 **Attachment Plugs.** Attachment plugs for permanently fitted equipment operating at 50 volts or more shall have a grounding pole and grounding conductor in the portable cord to ground the noncurrent-carrying parts of the equipment.

9.4.11 Grounding of Instrument Transformers

9.4.11.1 **Secondary Winding.** The secondary windings of instrument transformers shall be grounded

ARTICLE 9.5 – LIGHTNING PROTECTION SYSTEM

9.5.1 General

9.5.1.1 **Requirement.** Lightning conductors shall be provided for the following watercrafts:

(A) Each wooden mast or topmast of all wooden fiberglass, composite and steel ships;

(B) Steel ships having steel masts or topmasts need not be provided except tank vessels, tankers, tankships or supertankers;

(C) Mobile offshore oil drilling rig/production platform and habitat.

9.5.1.2 Construction.

(A) **Wooden Masts or Topmasts**. In wooden, fiberglass and composite watercrafts provided with wooden masts or topmasts, the lightning conductors shall be composed of continuous copper tape and/or rope, having a section not less than $100mm^2$ which shall be riveted with copper rivets or fastened with copper clamps to a suitable copper spike not less than 13mm in diameter, projecting at least 150mm above the top of the mast or topmast.

9.5.1.2 Construction.

(B) **Steel Mast or Topmast.** In wooden, fiberglass and composite watercrafts provided with steel masts or topmasts, each mast or topmast shall be connected to a copper plate in accordance with (a) above, the copper rope being securely attached to and in good electrical contact with the mast or topmast at or above the point at which the shrouds leave the mast or topmast.

9.5.1.2 Construction.

(C) **Steel Ships.** In steel ships provided with wooden masts or topmasts, the lightning conductors shall be composed of copper tape or rope terminating in a spike, as set forth in (a) above. At the lower end this copper tape or rope shall be securely clamped to the nearest metal forming part of the hull of the watercraft.

9.5.1.2 Construction.

(D) **Size of the Lightning Conductor.** A lightning conductor shall run as straight as possible and sharp bends in the conductor shall be avoided. All clamps shall be brass or copper, preferably of the serrated contact type, and efficiently locked. No connection shall be dependent on a soldered joint.

9.5.1.2 Construction.

(E) **Resistance of the Lightning Conductor.** The resistance of the lightning conductor, measured between the mast head and the position on the copper plate or hull point to which the lightning conductor is grounded is not to exceed 0.02 ohm.

9.5.1.3 Protection of Sailboats (Nonmetallic)

(A) **Sailboats.** Sailboats with metallic standing rigging shall be adequately protected that all riggings are grounded, so that the mast and rigging will serve as the protective mast, and shall comply with Section 9.5.1.2(B).

(B) **Open Day Sailers.** Open sailboats shall be adequately protected if any shroud and back stays, and any continuous metallic track on the mast and boom are grounded to a copper plate of $0.093 m^2$ exposed area or to a metal rudder or metal center keel.

9.5.1.3 Protection of Sailboats (Nonmetallic)

(C) **Cruising Sailboats.** All stays and all sail tracks of cruising sailboats shall be grounded since it is assumed that persons will be in proximity of fore-stays as well as after-stays.

9.5.1.4 Protection of Small Watercrafts. Small watercrafts may be protected by means of a temporary lightning protective mast, which shall be built when lightning conditions are observed in the distance.

Grounding provisions shall be made by means of flexible copper tape or rope of not less than $80mm^2$ cross-sectional area to a copper plate of $0.093m^2$ exposed area.

ARTICLE 9.5 – DISTRIBUTION SYSTEM PROTECTION

9.6 Distribution System

- Overload Protection

  Two-wire DC or single-phase AC system

  - Insulated three-phase AC system
  - Grounded three phase system
- No Fuse, Non-Linked Switch or Non-Linked Circuit Breaker shall be inserted in a grounded conductor
- Insulation and protection of each main distribution circuit shall be ensured by a multi-pole circuit breaker or switches and fuses
- Circuits which supply motors shall be provided with short-circuit protection only
- Lighting Circuits shall be provided with overload and short-circuit protection

- The primary circuits of power transformer shall be protected against short-circuit by circuit breakers or fuses
- Protection shall be provided for voltmeters, voltage coils of measuring instruments ground indicating devices and pilot lamps
- Fuses of appropriate size shall be connected in the capacitor circuit
- Power circuits and lighting circuits shall be supplied from a switchboard independently
- Insulation and protection of each main distribution circuit shall be ensured by a multi-pole circuit breaker or switches and fuses

- Circuits which supply motors shall be provided with short-circuit protection only
- Lighting Circuits shall be provided with overload and short-circuit protection
- The primary circuits of power transformer shall be protected against short-circuit by circuit breakers or fuses
- Protection shall be provided for voltmeters, voltage coils of measuring instruments ground indicating devices and pilot lamps
- Fuses of appropriate size shall be connected in the capacitor circuit
- Power circuits and lighting circuits shall be supplied from a switchboard independently

LIGHTING CIRCUITS

- Rating
  - The number of lighting points supplied by a final sub-circuit of rating 15A or less shall not exceed:

    10 for 24-55 volts circuits

    14 for 110-130 volts circuits

    18 for 220-250 volts circuits
- In Machinery Spaces
  - Lighting shall be supplied from at least two final sub-circuits and from the emergency system.
- In Hazardous Areas
  - Switches shall be of the double pole type and located in non-hazardous area.

- In Unattended Spaces
  - Lighting shall be controlled by multi-pole linked switches situated outside such spaces.
- In Pump Rooms
  - Pump rooms may be lighted permanently fitted glass lenses or ports fitted in the bulkheads or deck.

UNBALANCED LOAD

- Three-wire DC Systems
  - Unbalanced loads between an outer conductor and the middle wire at the switchboards, section boards and distributions boards is not to exceed 15% of the full load current.
- Three-wire AC Systems
  - Unbalanced loads on each phase at the switchboards, section boards and distributions boards is not to exceed 15% of the full load current.

ESSENTIAL SERVICES

a) Air compressors for heavy oil engines
b) Air pumps
c) Ballast pumps
d) Bilge pumps
e) Circulating and cooling water pumps
f) Condenser circulating pumps
g) Extraction pumps
h) Fans for forced draft to boilers
i) Feed water pumps
j) Fire pumps
k) Fuel valve cooling pumps
l) Lubricating oil pumps

m) Main lighting system for those parts of the watercraft normally accessible to and used by personnel

n) Navigational aids where required

o) Navigational lights and special purpose lights where required

p) Oil fuel pumps and oil fuel burning units

q) Oil separators

r) Scavenge blowers

s) Steering gears

t) Ventilating fans for engine and boiler rooms; and

u) Windlasses

- Duplication of Services
  - Essential Services that are duplicated shall be served by individual circuits separated through their length
- Excess Non-Essential Load
  - Arrangement shall be made to disconnect automatically the excess nonessential load when the generators are loaded

CIRCUITS IN VICINITY OF MAGNETIC COMPASS

- Apparatus and Wiring Connection Precautions

WATERCRAFT'S SERVICE POWER CIRCUITS

- Segregation of Vital Circuits
- Independently Supplied Circuits
- Power Feeders to Be Disconnected
- Drainage Pumps
- Cargo Spaces

DISTRIBUTION CIRCUITS FOR PASSENGER SERVICES

- On watercraft for passenger service constructed with fire screen bulkheads forming fire zones, distribution circuits shall be so arranged that fire in any main fire zone will not interfere with essential services in any other fire zone.

EMERGENCY SYSTEMS

- Feeders
  - Watercraft with Fire-Screen Bulkheads Forming Fire Zones
  - Emergency Feeders
  - Emergency Cables
  - Separate Emergency Lighting Feeders
  - Separate Emergency Feeder

NAVIGATION LIGHTS

- Navigation lights shall be connected separately to a distribution board
- Each navigation light shall be controlled and protected in each insulated pole by a switch and fuse or circuit-breaker

BRANCH LIGHTING CIRCUITS

- shall be protected by overcurrent protective devices rated or set at not more than 30A

PILOT LADDERS

- shall be provided to illuminate pilot ladders at night

CALL BELL CIRCUITS

- shall be run in suitable tubing or molding

OIL PUMP ROOMS AND SPACES ADJOINING OIL TANKS

- shall be lighted by lamps wired entirely with explosion-proof wiring or with lead-covered armored cable

MOTOR OF 0.25 HP OR MORE AND APPARATUS OF MORE THAN 660 VA

- shall not be connected to lighting circuits unless specially approved

RECEPTACLE OUTLETS

- Watertight Receptacle Outlets
- Nonwatertight Receptacle Outlets
- Number of Receptacle Outlets

LIGHTING FIXTURES

- General Requirements
  - Permanent Watertight Lighting Fixtures
  - Open Arc Lamps
  - Fixture Globes
  - Incandescent Lamps Lighting Fixtures
  - Construction/Installation
  - Not to be Used as Connection Boxes
- Lighting Fixture Installation and Construction
  - Exposed to Weather
  - In Wet or Damp Locations
  - Covered with Noncombustible Material
  - Outlet Cover
  - Support
  - Pendant Fixtures

GROUNDING OF LIGHTING EQUIPMENT

- Lighting equipment shall be grounded
- Lighting equipment shall be considered as grounded

FINAL SUBCIRCUITS

- Motor Circuits
- A separate final sub-circuit shall be provided for every motor for special use and for every motor rating at 1kW or more
- Final Sub-circuits for Lighting
- Lighting Fittings Supply
- Final Sub-circuit of Rating 15A or less
- For Panel Lighting and Electrical Signs
- Heater Connection

CIRCUIT PROTECTION

- Feeders and branch circuits shall have each undergrounded conductor protected by a circuit breaker or fuse of suitable interrupting capacity
- Circuit Breakers may be equipped with time trips
- System Protection
  - Dual-voltage systems having a grounded neutral shall not have fuses in the neutral conductor
- Overcurrent Protection Devices
  - Fuse ratings and ratings of time delay trip elements of circuit breakers shall not exceed the rated current capacity of the conductor

Motor Branch Circuits

- DC Motor Branch Circuits
  - The maximum fuse rating shall be the standard rating or setting equal to or next above 150% of the full load rating of the motor.
- AC Motor Branch Circuits
  - Squirrel-cage and Synchronous Full-voltage, Reactor- or Resistor-Starting (250%)
  - Autotransformer Starting (200%)
  - Wound Rotor (150%)
- Steering Gear Motor Circuits

PROTECTION OF WATERCRAFT'S SERVICE GENERATORS

- Generators of less than 25kW not arranged for parallel operation shall be protected by fuses.

- AC Generators
  - Circuit breakers shall be provided with short-time delay trips
- DC Generators
  - Circuit breakers shall be provided with an instantaneous trip
- Protective Device Tripping
- Generator Circuits for Parallel Operation

THREE-WIRE DUAL VOLTAGE DC SYSTEM

- Three-wire DC Generators
  - Separate circuit-breakers poles shall be provided for the positive, negative, neutral and for the equalizer leads unless protection is provided by the main poles
- Neutral Grounding
  - The neutral of three-wire dual voltage DC systems shall be solidly grounded at the generator switchboard
  - No direct ground connection shall be provided at the emergency switchboard
  - The ampacity of the neutral conductor shall be 100% of the ampacity of the ungrounded conductors

STEERING GEAR CIRCUITS

- Electric and hydraulic steering gear shall be served by two circuits fed from the main switchboard.
- Protection
  - Short Circuit Protection
    - DC Motors
    - AC Motors
    - Fuses as Motor-Feeder Protection
- Emergency Power Supply for Steering Gear
  - shall be provided automatically within 45 seconds for all watercrafts having a required upper rudder stock diameter of 230mm or more.

PROPULSION CIRCUITS

- AC propulsion circuits shall be provided with a ground detector alarm or indicator.

DC PROPULSION CIRCUITS

- It shall not have fuses fitted, but each circuit shall be protected by overload relays.

PROPULSION EXCITATION

- Excitation circuits shall not be fitted with overload circuit-interrupting devices.
- Excitation supply service connection shall be made to the generator side of the generator circuit breaker

AC THREE-PHASE SYSTEM

- Three phase, 3-wire AC circuits shall be protected by a triple-pole circuit breaker with three overload trips.

ELECTRIC DEPTH-SOUNDING DEVICES AND IMPRESSED CURRENT CATHODIC PROTECTION

- Electric depth-sounding devices hermetically enclosed shall be provided with feeder cable installed in heavy gauge steel pipes with gastight joints up to the main deck.
- Where impressed current cathodic protection systems are fitted, the cables shall be installed in heavy gauge steel pipes with gastight joints up to the main deck.
- Corrosion-resistant conduits shall be used in compartments.

ARTICLE 9.7 – LIGHTING FITTINGS, HEATING APPLIANCES AND WIRING ACCESORIES

Lighting Fittings

- Construction and Location
  - Enclosures Composition- shall be composed of metals, glass or synthetic resin having a sufficient degree of protection depending on their location.
  - Terminal Box and the Leading-in Part of Cables- Shall be of construction suitable for marine cables.
  - Protection- lighting fittings installed in the machinery spaces or similar spaces which are exposed to the risk of mechanical damage shall be provided suitable grilled metallic guards and glass globes to protect their lamps against such damage.

- Fluorescent Lighting Fittings
  - Mounting- reactors, capacitors and other auxiliaries shall not be mounted on surfaces.
  - Protection- every capacitor of 0.5 microfarad or more shall be provided with a protective leak or other protective means which reduces the voltage to not more than 50 volts within one minute after disconnection from the supply source.
  - Installation- inductors and high reactance transformers shall be installed as close as practicable to the associated discharge lamps.

Heating Appliances

- Construction and Location
  - Not allowable- in principle, no bare heating element shall be used.

- Protection- high temperature parts of electric heating appliances shall be protected as to be kept from the risk of a combustible material coming in touch under normal working condition.
- Installation- space heaters shall be installed in such manner as to have no risk of dangerous heating of the deck or bulkhead or other surroundings.

- Control switches- heating appliances shall be controlled by a fixed switch.

Wiring Accessories

- Material
  - Metal or Flame-Retardant- enclosures shall be of metal or flame-retardant material.
  - Flame-Retardant and Non-Hygroscopic- the insulating material of energized parts shall be flame-retardant and non-hygroscopic material.
- Temperature Rise- the temperature rise on energized parts shall not exceed 30ºC.
- Switches- shall be capable of breaking and making safely a load current equal to 150% of their rated current at the rated voltage.

- Plugs and Receptacle-Outlets
  - Switch interlocked- receptacle-outlet of rated current exceeding 15 amperes shall be provided with a switch so interlocked that the plug cannot be inserted or withdrawn when the switch in in the ON position.
  - Design- where distribution systems of different voltages are in use, the receptacle outlets and plugs shall be of such design that an incorrect connection cannot be made.
  - Additional Contact for Grounding Conductor- each receptacle outlet and plug for 100 volts or more dc and 55 volts or more ac shall be provided with an additional contact for grounding conductor, except those for double insulated appliances and for small electrical appliances having no noncurrent-carrying metal parts for which grounding is required.

- Construction- receptacle outlet and plugs shall be so constructed that they cannot readily short-circuited whether, the plug is in or out, and so that a pin of the plug cannot be made to ground either pole of the receptacle outlet.
- Effectively Shielded- on weather deck, galleys, laundries, machinery spaces and all wet situations, receptacle outlet and plugs shall be effectively shielded against rain and spray shall be provided with means of maintaining quality after removal of the plug.

Luminaires

- Material- lighting which is essential for the safety and the working of the unit shall comply the following requirements of Sections 9.7.2.2,9.7.5.2,9.7.5.3.

- Incandescent Lighting
  - Voltage Limit- the voltage of tungsten filament lampholders shall not exceed:

(1) Bayonet Fitting

Normal	B 22	250V
Small (Single Contact)	B 15s	130V
Small (Double Contact)	B 15d	130V

(2) Screw Fitting

Goliath	E 40	250V
Medium	E 27	250V
Small	E 14	250V
Miniature	E10	24V

- Wattage Limit- lamps shall be in accordance with the ff.

B 22 up to 200 W

E 27 up to 200

E 40 no limit

- Construction- lampholders shall be constructed of flame-retarding and non-hygroscopic material. All metal parts shall be of robust construction. Goliath lampholders shall be provided with means for locking the lamp in the holder. The temperature of the cable connection shall not exceed the maximum conductor temperatures permitted for the cable.

- Discharge Lighting
  - Warning Notice- where cold cathode luminaire discharge lamps of normal operating voltage above 250 volts are used, a warning notice calling attention to the voltage shall be displayed at points of access to the lamps and where otherwise necessary.

ARTICLE 9.8 – Switchboards, Section and Distribution Boards

9.8.1 General Requirements

A. Scope. Requirements in this article applies to the **regulation** and **distribution** of generated power through control equipment and protective devices of switchboards, section and distribution boards for compliance.

B. Controlling equipment. Equipment controlling propulsion and various service equipment of the watercraft **shall include** the apparatus necessary for **starting, stopping, reversing and controlling** the **speed** of motors, together with essential safety devices. All wearing parts of controllers shall be readily renewable.

C. Switchboard installation and Location.

a. In Dry Places. Switchboards shall be installed and **away** from the vicinity of steam, water, and oil pipes, and shall be accessible. Pipes shall not be installed directly above or in front of or behind switchboards. If unavoidable suitable protection shall be provided.

b. Secured to Solid Foundation. The switchboard, clear overhead deck beams by at least **100mm,** bulkheads by at least **460 mm**, and shall be either self-supported or braced to bulkhead or deck above. Means of bracing shall be **flexible** to allow deflection of the deck w/o buckling the control cell or assembly structure.

D. Space for Operation and Maintenance. Switchboard **shall be** provided with a clear working space of at least **1000mm** at the front and at rear not less than given in table 9.8.1.4 for switchboards. Clearance at the rear **will not be** required unless necessary for cooling. The working space shall permit operation and maintenance of disconnecting switch, and other devices.

E. Switchboard Mechanical Safety Protection. Where the energized parts of the switchboards are adjacent to a passageway, the following means shall be provided.

Table 9.8.1.4 Rear Clear Working Space

Potential Between Phases or Conductors of Opposite Polarity	Switchboard Width	Clear Working Space in Rear of Switchboard in Millimeters	
		Accessible From One End Only	Accessible From Two Ends
250 volts or less	Single panel not exceeding 1 000 mm in width	610*	500
	More than one panel or single panel exceeding 1000 mm in width	800*	610
Over 250 volts but less than 600 volts	Single panel not exceeding 1000 mm in width	800*	610
	More than one panel or single panel exceeding 1000 mm in width	950*	800
600 volts or over	Any width	1000*	1000

*May be reduced by not more than 150 mm by use of stiffeners and frame or by equipment on a single panel in the switchboard.

a. **Non-conducting handrails and guardrails.** Non-conducting handrails at front and guardrails at rear.

b. **Non-conducting Mats or Gratings** on deck flooring at the sides and rears of switchboards to protect personnel in contact with energized parts to ground.

c. **Drip-Covers.** Over top of switchboards when subject to damage by leaks or falling objects.

d. Positioners and Stops. shall be provided with Hinged panels of dead front switchboards.

e. Enclosure. Sides of switchboards shall be enclosed and space in rear shall be made inaccessible to others than qualified persons.

f. Clear of any Object. Rear of switchboards shall always be cleared of any object.

F. Protection of Instrument Circuits.

a. Overcurrent Protective Device. Switchboard devices, such as pilot lights, ground detectors, lights for illumination, potential transformers, instrument and meters, shall be supplied by circuits protected by overcurrent devices.

b. Not to be Protected Against Overcurrent. Circuits, the opening of which would create a hazard in the operation of the watercraft, shall not be protected against overcurrent. Such circuits usually include electric propulsion control circuits, etc.

c. Grounded. Metal casings of instruments, relays, meters, and the secondary windings of instrument transformers located on the switchboard shall be grounded.

9.8.2 Switchboard Construction

A. Enclosures and Assemblies. Switchboard enclosures and assemblies shall be constructed of steel or other suitable incombustible, moisture-resistant materials and reinforced as necessary to withstand stresses (mechanical, thermal, and electrical) likely to be encountered in service and shall be protected against corrosion. Insulating materials used in switchboard shall be flame-retardant and moisture resistant.

B. Panels. Should be made impregnated ebony asbestos, laminated phenolic material or the equivalent. They should be made of metal if the mountings are properly insulated. The supporting framework for all panels shall be of rigid construction. No wood shall be used in the construction of switchboards, except that non-conducting handrail shall be provided.

C. Dead Front. Switchboards of the metal clad type shall be used where voltage to ground or between poles exceeds 55V AC or DC.

D. Short Circuit Rating. Circuit Breakers and busbars shall be so mounted, braced and located as to withstand the thermal effects and magnetic forces resulting from the maximum prospective short circuit current. Switchboard instruments, controls, etc. shall be located with respect to circuit breakers so as to minimize the thermal effects due to short circuit currents.

E. Terminal Arrangements. All generators shall be protected against accidental contact, mechanical damage and where necessary, against dripping moisture by drip shields or drip proof enclosures. Where cables enter drip proof enclosures from the side or the top, they shall be provided with terminal tubes.

F. Mechanical Strength of Working Parts. All levels, handles, hand wheels, interlocks and their connecting links, shafts and bearings for the operation of switches and contactors shall be of such proportion that they will not be broken or distorted by manual operation.

G. Nameplates. Shall be provided for each piece of apparatus to indicate clearly its service. Nameplates for feeders and branch circuits shall include the circuit designation, description of the load served, and the rating or setting of the overcurrent protection.

H. Cable Entries. Cable entries of switchboards shall be so constructed that no water leakage is permitted into the switchboard along the cables.

I. Insulating Materials. Insulating materials used in the construction of switchboards shall be mechanically strong, flame retardant and moisture-resistant.

J. Switchboard Mounting. Busbars, circuit breakers and other electrical equipment of the switchboard shall be so arranged that the important electrical equipment installed in duplicate will not become unusable simultaneously by a single fault.

9.8.3 Switchboard Busbars and Contacts

A. Requirements.

a. Generator switchboard. Shall be provided for each generator, and the switchboards adjoining each other shall be partitioned by the walls of steel of flame-retardant material. In case **total output** of main generators **is not greater** than 3 Megawatts, the requirements may be exempted. Where the total installed electrical power of the generating sets is in excess of 3000 kW, the main busbars shall be subdivided into at least **two parts** which shall be connected by removable links or other approved means.

b. Generator Busbars. Shall be designed on a basis of maximum generating power.

c. Ampacity. Ampacity of connection busbars for each generating unit shall not be less than the continuous rating of the generator plus 25% overload.

c. Other Busbars and Busbar Connections. Shall be designed for at least 75% of the combined full-load rated currents of all apparatus they supply, plus not less than 50% of the combined ratings of the spare switches or circuit breaker elements connected to the busbar except the when they supply one unit or any group of units in continuous operation they shall be designed for full load.

B. Arrangements.

a. Busbars and Wiring. Its arrangements of on the back of switchboard shall be such that all lugs are readily accessible. Soldering lugs, where used, shall have a solder contact length of at least one and one-half times the diameter of the conductor.

b. Nuts and Connection. Shall be fitted with locking devices to prevent loosening due to vibration.

C. Busbar Capacity. For more than one generator, with all generating capacity feeding through one section of the busbar, the capacity of the busbar shall be 125% of the largest generator plus 80% of the continuous rating of each added generator.

D. Conductivity. Busbars shall be of copper having the conductivity 97% or more.

E. Resistance to corrosion and oxidation. Busbar connections shall be so made to inhibit corrosion and oxidation.

F. Support. Busbar and Busbar connection shall be so supported as to withstand the electromagnetic force resulted from short-circuiting.

G. Maximum Allowance Temperature. The maximum allowable temperature of busbars, connecting conductors and their connections shall not exceed 90°C when carrying full load current.

9.8.4 Equalizer for DC Generator

A. Current Rating of Equalizer Connections and Equalizer Switches. The current rating of equalizer connections and equalizer switches shall not be less than half of the rated full-load current of the generator.

B. Current Rating of the Equalizer Busbars. The current rating of the equalizer busbars shall not be less than half of the rated full-load current of the largest generator in the group.

9.8.5 Measuring Instruments for Switchboards.

A. Watercraft Service DC Generator Panels. Shall at least be provided with the instruments given in table 9.8.5.1.

B. Watercraft Service AC Generator Panels. Shall at least be provided with the instruments given in table 9.8.5.2.

9.8.6 Switchboard Equipment Requirements

A. ACB Contact Clearance from Watercraft Structure. Air circuit breaker contacts shall be shall be kept at least **3000 mm** from watercraft structure unless insulation barriers are installed.

B. Clearance for Energized front switchboards. On this the current carrying parts base channel shall not be less than 100mm.

C. Voltage Regulator Element. Shall be totally enclosed.

D. Ventilated and Isolated. Rheostat or other devices that may operate at high temperature shall be naturally ventilated and so isolated by barriers as to prevent transfer of excessive heat to adjacent devices.

E. Fuses Mounting. in general, all fuses shall be mounted so as to be readily renewable.

F. Wiring Protection. All wiring on the back of boards for voltmeter, pilot and the ground lamps shall be protected by fuses.

9.8.7 Instrument Scales

A. Ammeter. The upper limit of the scale of every ammeter shall be approximately 130% of the normal rating of the circuit.

B. Voltmeter. The upper limit of the scale of every voltmeter shall be approximately **120%** of the normal rating of the circuit.

C. Ammeter and Wattmeter. Ammeters for use with dc generators and wattmeters for use with ac generators, which may operate in parallel, shall be capable of indicating reverse, current or reverse power up to **15%** respectively.

9.8.8 Ground Indication

A. Ground Indication. Every insulated distribution system shall be provided with lamps or other means to indicate the state of insulation from ground.

9.8.9 Switchboard Wiring

A. Instrument and control Wiring. Shall be of stranded type not smaller than 1.25mm^2 have flame-retardant and moisture resistant insulation having the maximum permissible conductor temperature not less than 75°Celsius.

B. Hinged Panels Wiring. Wiring from hinged panels shall be of the extra flexible type.

C. Ducts and Strap Wiring. ducts and straps for wiring shall be of the flame-retardant, material.

D. Conductor of Different Circuits. Insulated wires for control and instrument circuits shall not be bunched together with wires for main circuits, unless the rated voltage and permissible temperature of both wires are the same.

9.8.10 Protective Device

A. **General.**

a. Overcurrent protection. Electrical installations of watercrafts shall be protected against accidental overcurrents including short circuit.

b. Short Circuit Protection. Each pole and phase of all insulated circuits except neutral and equalizer circuits shall be provided with short-circuit protection.

c. Overload Protection. All circuits liable to be overloaded shall be provided with overload protection as indicated in the ff.

1. Two-wire dc or a single-phase system - at least one line or phase.
2. Three-wire dc system – both outer lines.
3. Three-wire, three-phase system – each phase.
4. Three-phase, four-wire system – each phase.

d. Fuse, Non-linked Switch or Non-linked Circuit Breaker. Shall not be inserted in a grounded conductor and a neutral line.

B. Circuit Breakers and Fuses

a. Compliance with Chapter 2, 3, 4. Circuit breakers and fuses shall comply with the requirement within chapters mentioned.

b. Repairing and Replacing. Circuit breakers shall be such that repairing and replacing can be made switching off the power source. In case where isolation switch is provided additionally, the requirement should be exempted.

c. Adjustable Current Setting and Time-delay Characteristics. Overcurrent relays of circuit breakers, except molded-case circuit breakers shall be capable of adjusting their current setting and time delay characteristics.

C. Protection Against Overload.

a. Thermal Capacity. The overcurrent trip characteristics of circuit breakers and the fusing characteristic of fuses shall be chosen suitably taking into consideration the thermal capacity of electrical equipment and cables to be protected thereby.

b. Fuses Above 200 Amperes. Shall not be used for overload protection.

D. Protection Against Short-circuit.

a. Breaking Capacity. Breaking capacity of every protective device shall not be less than the maximum value of the short circuit current which can flow at the point of installation at the instant of contact separation.

b. Not in Compliance. In case where the rated breaking capacity of short-circuited protection is not in compliance with the requirement of (a) above, fuses or circuit breakers having the breaking capacity not less the prospective short-circuit current shall be provided at the power source side of the foregoing short circuit protection. The circuit breakers connected to the load side shall not be excessively damaged and shall be capable of further services in the following conditions:

condition 1: when the short circuit current is broken by the back-up circuit breaker or fuse.

condition 2: when the circuit breaker connected to the load side is closed on the short circuit current, while the back-up circuit breaker or fuse is broken.

c. Making Capacity. Of every circuit breaker or switch intended to be capable of being closed, shall not be less than the maximum value of short circuit current at the point of installation.

d. Alternative. In the absence of precise data of rotating machine, the following short circuit currents at the machine terminals shall be assumed. Where the load are motors, the short circuit current shall be the sum of short circuit currents of generators and that of motors.

1. **Dc System.** Ten times the full load current for generators normally connected. **Six times** the full load current for motors simultaneously in service.
2. **Ac System.** Ten times the full load current for generators normally connected. **Three times** the full load current for motors simultaneously in service.

E. Protection of Generators.

a. Short-circuit and Overcurrent protection. Generators shall be protected against short-circuit and overcurrent by a multiple circuit breaker arranged to open simultaneously all insulated poles, or in the case of generators less than 50kW not arranged to run in parallel, shall be protected by a multiple linked switch with fuse or a circuit breaker in each insulated pole.

b. DC Generators in Parallel Operation. For dc generators arranged to operate parallel, in addition to the requirement in (a) above an instantaneous reverse-current within the limits of 2% to 15% of the rated current of generators, shall be provided.

c. AC Generators in Parallel Operation. For ac generators arranged to operate parallel, in addition to the requirement in (a) above, a reverse-power protection, with time delay, selected and set within the limits of 2% to 15% of the full load to a value fixed in accordance with the characteristics of the prime mover, shall be provided.

F. Protection of Power and Lighting Transformers.

a. Primary Circuits. The primary circuits of power and lighting shall be protected against short-circuit and overload by circuit breakers or fuses.

b. Parallel Operation. When the transformers are arranged to operate in parallel, means of isolation shall be provided in the secondary circuits. Switches and circuit breakers shall be capable of withstanding surge currents.

G. Protection of Motors.

a. In accordance with article 4.30. Shall be in accordance with the provision of article 4.30.

b. Motor of More than 0.5 Kw. Motors of rating exceeding 0.5 kW and all motors for essential (vital) use shall be provided individual against overload and short-circuit, except the motors for steering-gears.

c. Delay Characteristics. The protective device shall have a delay characteristics to enable the motors to start.

d. For Intermittent Service. For motors for intermittent service, the current setting and the time delay shall be chosen in relation to the load factor of the motor.

H. Protection for Feeder Circuits.

a. Circuit breakers or Fuses. Supply circuits to section boards, distribution boards, ground starters and the like shall be protected with circuit breakers or fuses.

b. Supply Circuit with Overload Protection. Each supply circuit for the motor fitted with overload protection should be provided with short-circuit protection only.

c. Protection Against Single Phasing. When fuses are used to protect polyphase ac motor circuits, consideration shall be given to protect against single phasing.

d. Overload Protective Device. In case where condensers for phase advance are used, overvoltage protective device shall be installed as required.

I. Protection of Essential (vital) Services. Where generators are operated in parallel and essential (vital) machinery in electrical driven, arrangement shall be made to disconnect automatically the excess non-essential (non-vital) load when the generators are overloaded.

J. Protection of Batteries. Batteries other than engine starting batteries shall be protected against overload and short-circuit with devices placed as near as practicable to the batteries. Emergency batteries supplying essential or emergency services may have short-circuit protection only.

K. Protection of pilot Lamps and Control circuits.

a. Fuses fitted to each insulating pole. Protection shall be provided for voltmeter, voltage coils of measuring instruments, ground indicating devices and pilot lamps with their connecting leads by means of fuses fitted to each insulating pole.

b. Insulated Wires for Control and Instrument Circuits. Insulated wires for control and instrument circuits, directly led from busbars and generators mains shall be protected by fuses at the nearest location to the connecting points.

9.8.11 Section Board and Distribution Board

A. Location. Section Board and Distribution Board should be located in accessible positions and not in such spaces as bunkers, store rooms, cargo holds or compartment allotted alternatively to passenger or cargo.

B. Protective Enclosure. Section Board and Distribution Board shall have suitable protective enclosures that are mechanically strong.

C. Switchboard-Type Distribution Panels. Distribution panels of the switchboard type, unless installed in machinery spaces or in compartment assigned exclusively to electric equipment and accessible only to authorized personnel, shall be completely enclosed or protected against accidental contact and unauthorized operation.

D. Safety-type boards or Panels. If the method of operation demands the handling of switches by unfamiliar personnel with electrical equipment, the section and distribution boards or panels shall be of the safety type.

E. Arrangement of Equipment. Incase where the same section-board or distribution board is used for the supply circuits having different voltages, all equipment shall be so arranged that he wires of different rated voltages can be laid without contacting each other within the boards.

F. Circuit-Disconnecting Means. Panelboards for distribution to motor, appliance, lighting or other branch circuits, shall be fitted with multiple switches having a pole for each conductor. Overload protection shall be provided for each ungrounded conductor of feeders and each conductor of final branch circuit.

ARTICLE 9.9 – Sources of Electrical Power

9.9.1 General

A. Propulsion Use. The electrical power for the propulsion equipment should be derived from one or more propulsion generators whose exciters may either be direct-connected or independent.

B. Various Service Use. At least two main generating sets of sufficient capacity to carry the necessary sea load essential for the navigation and safety of the watercraft and everybody on board, preservation of cargoes and provisions under normal condition, and continuity of services need for the specific operation, with any one generator in reserve.

C. Emergency Use. A storage battery and/or self-contained generators, driven by a suitable prime mover with an independent fuel supply and with approve starting arrangements, the fuel used shall have a flashpoint of not less than 43ºC.

FPN: for small watercrafts in domestic trade, a shaft generator belt-driven from the shaft of the propulsion engine should be used.

a. Emergency loads. Following emergency loads shall be supplied with emergency power.

1. Navigation lights.
2. Daylight signaling lamp, if electricity operated from the main source of power.
3. Machinery spaces and control stations.
4. Generating set spaces, and their control stations.
5. Accommodation and service spaces.
6. Alleyways, stairways, exits.

7. Public spaces, such as mess hall, lounge spaces.

8. Navigating bridge and chat rooms.

9. Radio and communication rooms.

10. Inert gas and oil pump room control stations.

11. General alarm including electric signaling equipment for emergency calls.

12. Engine order telegraph, if electrically operated from the main source of power.

13. Main steering gear power unit compartment.

14. Watertight door gears, and indicating and sound signals.

15. Every survival craft stations and storage areas on deck and over sides, also lighting of embarkation stations during the preparation for the process of launching.

16. Refrigeration spaces and their alarm circuits.
17. Sprinkle pump.
18. Emergency fire/bilge pump.
19. Fire detectors.

D. Transitional (temporary) Use in Emergency. Two banks or more storage battery, with one bank in operation and the other banks in reserve , capable of carrying the emergency loads as specified in section 9.9.1.3 are used, and shall operate even when the watercrafts is inclined 22.5^{o} and the trim is 10^{o}.

E. Charger or Alternator. For watercrafts in domestic cargo carrier trade with not more than 4 hours of navigation from point coastwise, charger or alternator shall be used to power the navigation and general lighting and bilging equipment.

F. Shore Power. During the dry docking of the watercraft, shore electrical power shall be supplied through the shore connection safety switch box of the watercraft, for general lighting, cooking and services for accommodation spaces, and for radio equipment.

a. Installation of Connection Boxes. Where arrangements are made for the supply of electricity from a source on shore, a connection box shall be installed in a suitable position in the watercraft.

b. Connection Boxes. The connection box shall contain terminals to facilitate a satisfactory connection and a circuit breaker or an isolating switch with fuses.

c. Cables Between Connection Box and Switchboard. The cables between the connection box and switchboard shall be permanently fixed and a pilot lamp for source and a switch or a circuit breaker shall be provided on the switchboard.

ARTICLE 9.10 – GENERATORS

9.10.1 General

A. Scope. Generators for propulsion and for various watercraft services shall comply with the minimum requirements in this article.

B. Power Requirement. Electric power may be derived from two or more constant voltage propulsion generators usually provided in watercrafts propelled by electric power. Additional watercrafts service generators needed not be fitted provided that with one propulsion generator out of service a speed of 7 knots or one-half of the design speed whichever is the lesser can be maintained.

> **a. Propulsion.** The power for each propulsion should be derived from a single generator.

b. Service Generator. Watercraft using electricity for service power or light shall be provided with at least two electric generators for the watercraft service electric demand.

1. **Number and Rating.** Shall be sufficient to ensure the operation when one of the generators set is out of service.
2. **Capacity.** The capacity of the generator set or sets shall be sufficient to carry the necessary sea load essential for the safety of the watercraft, preservation of the cargo, propulsion power and minimum comfortable conditions of hospitability under normal operation with any one generator set in service.

c. Shaft Generator. A generator driven by a main propulsion unit (shaft generator) which is intended to operate at constant speed, e.g. a system where watercraft speed and direction are controlled only by varying propeller pitch, should be considered to be one of the required generators.

d. Sizing AC Generators. In selecting the capacity of an ac generating plant particular attention shall be given in the starting current forming part of the system. With one generator held in reserve as a standby, the remaining generator set operating in parallel and initially carrying various load necessary for operating the watercraft shall have sufficient capacity with respect to the largest idle motor on the watercraft.

e. Independent Starting. Where only two main generators are provided, of which one depends on the functioning to the propulsion machine, due consideration shall be given so that the propulsion machine can be started independently of these two generators.

f. Associated Load Management System. Where the electrical power system is designed with an associated load management system, the application of load in multiple steps of less than 50% of rated load shall be given special consideration.

C. Fault Current. Service generators shall be capable of withstanding the mechanical and thermal effects of fault current for the duration of any time delay, which may be fitted in a tripping device for selecting tripping.

D. Excitation.

a. Service Generators and Emergency Generator. Excitation current for service and emergency generator shall be provided by attached rotating exciters or by static starters deriving their source of power from the machine being excited.

b. Propulsion Generators. Excitation current for propulsion generators shall be derived from attached rotating exciters, static starters, excitation MG sets, or special purpose generating unit.

c. Propulsion Arrangements. Arrangements for propulsion generators shall be such that propulsion can be maintained in case of failure of an excitation system or failure of a power supply for an excitation systems.

d. AC and DC Exciters. Rotating exciters shall be conform to all applicable requirement requirements for generators.

e. Shaft Current. Means shall be taken to prevent the ill effects of flow of current circulating.

E. Precaution of the effect of Condensation of Moisture. Where they may be fear of deterioration of insulation due to condensation of moisture in the machine with idle, suitable means shall be provided to avoid it.

9.10.2 Generator Construction

A. Frames and Pedestals. Magnets frames and pedestals may be separated but shall be secured to a common foundation.

B. Shafts. Shafting for generators shall meet the requirements for turbine rotors. Tube shafts, tail shafts, and coupling bolts shall meet the requirements for propulsion and line shaft bearing location.

C. Circulating Currents. Means shall be provided to prevent circulating currents from passing between the journal and the bearings, where the design and arrangement of the machine is such that damaging current may be expected.

D. Terminal Arrangements. All generator terminals shall be protected against accidental contact, mechanical damage, and where necessary,, against dripping moisture by drip shields or drip proof enclosures.

E. Nameplates

a. All Generators. Shall be fitted with nameplates of corrosion-resistant material marked with the following information.

1. Manufacturer's type and frame designations;
2. Output;
3. Kind of rating;
4. Temperature rise at rated load and design ambient temperature;
5. Revolution per minute at rated load;
6. Voltage;
7. Amperes at rated load; and
8. Type of winding (dc machines)

b. AC Generators. Addition to the application above, the following shall be included for ac generators.

1. Number of phases;
2. Frequency;
3. Power factor;
4. Exciter voltage;
5. Exciting current in amperes at rating.

F. Temperature Detectors. Ac generators rated above 500 kVA shall be provided with means for obtaining the temperature of the stationary windings. A minimum of one embedded detector per phase shall be provided for these purpose for the hot end of the machine.

G. Propulsion Generators.

a. Ventilation and protection. Propulsion generators shall be enclosed ventilated or be provided with substantial wire or mesh screen to prevent personnel injury or entrance of foreign matters.

b. Fire Extinguisher Systems. Propulsion generators which are enclosed or in which the air gap is not directly exposed shall be fitted with fire extinguishing systems suitable for fires in electrical equipment.

c. Air Coolers. Air cooling system for propulsion generators shall be in accordance with requirement of lube oil pumps and sea suctions.

H. Insulation of windings. Armature and field coils shall be treated to resist oil and water.

I. Lubrication. In general all generators shall be located with their shafts in a fore-and-aft direction on the watercraft and they must lubricate and operate satisfactorily in accordance with the inclination requirements.

9.10.3 Voltage Regulation

A. Service Generator Sets. Shall have voltage regulation-characteristics so that the watercrafts supply voltage will be maintained within plus or minus 4% at rated full load.

B. DC Generators. Where automatic voltage regulators are not supplied, the dc generators shall be approximately flat-compounded except that, if the load fluctuations does not interfere with the operation of essential auxiliaries, shunt-wound generators without voltage regulators or stabilized shunt-wound machines may be used.

C. AC Generators.

a. In general a separate regulator shall be supplied for each ac generator. When it is intended that two or more generators will be operated in parallel, reactive-droop compensating means shall be provided to divide the reactive power properly between the generators.

b. Short-circuit Conditions. Under steady-state short-circuit conditions, the generator together with its excitation system shall be capable of maintaining a current of not less than 3 times its rated full load current for a period of 2 sec. or of such magnitude and duration as required to properly actuate the associated electrical protective devices.

9.10.4 Parallel Operation

A. General. when the installation is such that two or more generators are operated in parallel, the load on any generator shall not differ more than plus 15% of its rated kW load from its proportionate share, based on the generator ratings, of the combined load or any steady state condition in the combined load between 20% and 100% of the sum of the rated loads of all generators.

B. AC Generators. For ac generating sets intended to operate in parallel, facilities shall be provided to adjust the governor sufficiently fine to permit an adjustment of load not exceeding 5% of the rated load at normal frequency.

C. DC Generators. Which operate in parallel shall be provided with a switch which will trip the generator circuit breaker upon functioning of over speed device.

D. Turbine-Driven DC Generators Operating in Parallel. Where arranged to run in [parallel with either generators, a switch shall be fitted on each turbine emergency governor to open the generator circuit breaker when the emergency governor functions.

ARTICLE 9.11 – TRANSFORMERS

9.11.1 General

A. Scope. Transformers rated at 1 kVA or more for single phase and at 5 kVA or more for 3-phase shall comply with requirements in this article.

B. Number and Ratings of Transformers. For important use shall be sufficient to ensure the operation of essential service even when one of the transformers is out of service.

C. Type of Cooling. Transformers in accommodation spaces shall be of dry, naturally-cooled type.

D. Windings of Transformers.

- **a. Moisture, Sea Atmosphere, and oil Vapors Resistants.** Transformer winding shall be treated to resist moisture, sea atmosphere and oil vapors.
- **b. Double Windings Transformers.** Transformers except those for motor starting shall be double wound.

E. Precautious Against Short-Circuit Current. Transformers shall be capable of withstanding, without damage, the thermal and mechanical effects of short-circuit at the terminals of any winding for two seconds.

9.11.2 Temperature Rise

A. Limit of Temperature Rise of Transformers. Temperature rise of transformers shall not exceed the values in table 9.11.2.1 during continuous operation at the rated output, where, however, the ambient temperature is not more than 40°C, shall be increased by the difference from the values in the table.

9.11.3 Main Transformer

A. Main Transformer. Where transformer or converters J an essential part of the propulsion or watercrafts service supply system, the system shall be arranged to ensure at least the same continuity of supply as required in section 9.10.1.2 for generators.

9.11.4 Voltage Regulation

A. Voltage Regulation of Transformer. The voltage regulation of transformers shall not exceed the following values at full-load and 100% power factor.

a. Single phase 5kVA or more, and three-phase 15 kVA or more 2.5%

b. Single-phase less than 5 kVA, and three-phase less than 15 kVA 5.0%.

ARTICLE 9.12

STORAGE, BATTERIES, BATERRY ROOMS AND ASSOCIATED EQUIPMENT

9.12.1.1 **SCOPE**

Storage batteries and their associated equipment for light and power and for engine starting shall comply with the requirements in this article in addition to article 4.80

9.12.1.2 **CONSTRUCTION**

Onboard batteries on watercrafts shall be heavy duty with the cell so constructed and secure to prevent spilling of electrolyte due to motion.

9.12.1 GENERAL

- 9.12.2.1 **Power And Lighting Batteries**. Arrange that trays are accessible and with not less than250mm head room.
- 9.12.2.2 **Location.**

A. **Near The Engines**

Shall be located closely as possible to the engine served

B. **Not Exposed To Excessive Heat, Extreme Cold, Etc.**

Battery might impair performance or accelerate deterioration

C. **Not in the same room**

Alkaline and lead batteries shall be in the same room however shall be identified as to type and segregated as possible.

D. **In Living Quarters, Work Spaces And Store, And Paint Rooms**

Shall not be place here

9.12.2. Arrangements and installation

- 9.12.2.3 **Large Batteries**

Those connected in charging device of more than 2 kw, shall be installed in assigned battery room only, but may installed in locker if that room is not available.

No equipment subject to sparking shall be installed in battery room except explosionproof type.

- 9.12.2.4 **Moderate Size Battery**

Those connected to a charging device with a power of 0.2 kw

- 9.12.2.5 **Small Batteries**

May store in battery box and may arrange as desired

- 9.12.3.1 **Battery Trays**

Should be chocked in wood strips or equivalent to prevent movement and shall be fitted with nonabsorbent insulating support in bottom.

- 9.12.3.2 **Battery Types**

9.12.3 Battery Trays and Types

- 9.12.4.1 **Battery Rooms**

A) **Clearances**

Battery rooms shall be ventilated in accordance with section 4.80.1.9A and have 50 mm, front and back for air circulation

B) Natural ventilation or ventilating fans

C) **Natural Ventilation Allowed**

If ducts are run directly from the top of the battery room to open air above

D) **Mechanical Exhaust Ventilation**

If natural ventilation Is impracticable, mechanical exhaust shall be provided with fan intake at the top of the room that can change the air for 2mins

9.12.4 ventilation

- E) **Opening Near The Floor Surface**
- For effective air inlet
- F) **Construction**
- Ventilating fan shall be constructed and to be of such a material as to tender sparking impossible.
- G) **Location**
- Exhaust fan placed outside the duct
- G) **Ventilating Ducts**
- Shall be in 1250 mm above.

- 9.12.4.2 **Battery Lockers**

Louvers or equivalent shall be provided near the bottom for entrance of the air.

- 9.12.4.3 **Deck Boxes**

The entire deck box including opening for ventilation shall be water tight to prevent entrances of spray or rain

- 9.12.4.4 **Small Battery Boxes**

Boxes for small batteries require no ventilation other than openings near the top to permit escape of gas

- 9.12.5.1 **Lighting Fittings**

Shall be flameproof

- 9.12.5.2 **Electrical Equipment**

Switches ,fuses, or other electrical equipment liable to cause an arc that not be installed in battery compartments.

- 9.12.5.3 **Cables**

Cables with the exception of the appertaining to the battery or the local lighting that not be installed in battery shall not be installed in battery compartments except when the installation in other location in impracticable

9.12.5 Electrical installation in battery compartment

- 9.12.6.1 **Cables At Battery Rooms**

All connection within battery rooms shall be resistant to the electrolyte cables shall be sealed to resist the entrance of electrolyte by spray or creepage.

- 9.12.6.2 **Size Of The Cable**

shall be based on current carrying capacities and starting rate of charge or maximum discharge rate whichever is greater shall be taken in determining the battery cable size

9.12.6 Battery cables

9.12.7 overhead and reverse current protection

- 9.12.7.1 **Protective Devices**
- The charging equipment except rectifiers for all batteries with a voltage more than 20% of the line voltage shall provide automatic protection against reversal of current
- 9.12.8 **Protection Against Corrosion**
- 9.12.8.1 **General**
- The interiors of battery rooms including structural parts and shelves therein, as well as ventilation inlets and outlets shall be protected with corrosion resistant paint

- 9.12.8.2 **Lead-Acid Battery Compartment**
- Protection with lead-sheet lining of 1.6 mm thick of corrosion resistant paint is made in accordance with the ff. requirements
- **Watertight** : entire room and walls up to 150mm high shall be watertight
- **Electrolyte-resisting coating**: battery shelves and wooden crate shall be coated with electrolyte-resisting coating.
- .

- **Line with lead sheet** : battery trays and sulfuric acid bottle based shall be lined with lead sheet
- **Corrosion resistant** : ventilating ducts and fans or their interior surface rendered corrosion resistant
- 9.12.8.9 **Alkaline Battery Compartment**
- Shall be similarly lined with steel not less than 75mm thick. For small batteries lining to a depth of 75 mm shall be provided

- 9.12.9 **Charging Facilities**
- 9.12.9.1 **Maximum Battery Voltage**
- For floating service where the load is connected to the battery while it is in charge, the max battery voltage shall not exceed the safe value of any connected apparatus. A voltage regulator may provided
- 9.12.9.2 **DC Generator And Series Resistor**
- Shall be provided with protection against reversal of current when the charging of voltage is 20% of the line voltage or higher

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS AND CONTROLLERS

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Installation Approval
  - Where permitted, motors of the explosion proof type and intrinsically safe electrical instruments, circuitry and devices shall be of an approved type. (what are types of approval)

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

Name Plates

- All motors
  - All motors shall be fitted with nameplates of corrosion-resistant material marked in accordance with Section 4.30.1.7.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

Motor Temperature Ratings

- Maximum Allowable Temperature
  - The maximum allowable temperature for propulsion motors and those for engine and fire room auxiliaries, based on an ambient temperature of 50ºC.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Ambient Temperature at 40ºC
  - Where provisions is made for insuring an ambient temperature being maintained at 40ºC or less, as by air cooling or by location outside of the boiler and engine rooms, the allowable temperature of the winding hall be 10ºC higher.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Deck-winch and Direct-acting Capstan Motors
  - Deck-winch and direct-acting capstan motors shall be rated on a full-load run at least 0.5 hour.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Direct-acting Windlass Motors
  - Direct-acting windlass motors shall be rated on a full-load run of at least 0.25 hour.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Hydraulic Transmission Operation
  - Those operating through hydraulic transmission shall be rated for 30 minutes idle pump operation.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

Watercraft's Service Motors

- General
  - Motors for use in the engine room or spaces where subject to mechanical injury, or dripping of oil or vapour or water, shall be of the open type if protected by drip covers, otherwise they shall be waterproof or drip proof.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Pump Motors
  - Motors for operating plunger and close-coupled pumps shall have the driving end entirely enclosed or designed to prevent leakage from entering the motor.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Motors on Weathers Decks
  - Motors for use on weather decks shall be of the watertight type or shall be enclosed in watertight housings.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Motors Below Decks
  - Motors installed below decks shall be located in as dry a place as practicable and proximity to steam, water and oil pipings shall be avoided.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Motors for Bulk-Carriers
  - For use of motors on vessels of the bulk-oil-carrier type and vessels carrying oil having a flash point less than 80ºC only explosion-proof types of construction shall be used. (See article 9.19)

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

Motors Controller Installation, protection and Disconnecting Means, and Branch Circuits

- General
  - Motor controllers, controller installation, protection and disconnecting means and branch circuits shall be in accordance with Article 4.30 and in compliance with the provisions in this part.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

General

- Low Voltage and Running Protection
- Accessibility
- Low-Voltage Release
- Sequential Starting

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Enclosure and Corrosion
  - All controllers except those on main and distribution switchboards shall be protected by enclosing cases suitable for their location but shall not be less than drip proof protected. Parts liable to damage by corrosion shall be rendered corrosion-resistant.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Manual Controllers
  - Manually operated controllers, if watertight, shall be arranged for operation without opening the enclosing case. In the panel type, the starting arm shall be arranged so that the motor will stop if the arm is left on a starting point.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Magnetic Starters
  - Magnetic starters used for adjustable-speed motors which cannot be safely started under weak field conditions shall be .provided with a magnetic relay to short-circuit the field rheostat during starting until full voltage is across the motor armature.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- AC Motor Manual Auto-Starters
  - AC motor manual auto-starters with self-contained auto-transformers shall be provided with switches of the quick-break-and-make type, and the starter shall be arranged so that it will be impossible to throw to the running position without having first thrown to the starting position. Switches shall be preferably of the contactor or air-break type.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Disconnect Switches and Circuit Breakers
  - For motors rated not more than 1.5 kW and not more than 250 volts, the starting switch should serve as a disconnect, provided it has an ampere rating not less than twice the rated current of the motor.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Resistor for Control Apparatus
  - The resistor shall be protected against corrosion either by rust proofing or embedding in a protective material.

ARTICLE 9.13 – MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

- Controller Installation
- Motor protection and Disconnecting Means
- Motor Branch Circuits
- Motor Control Center

ARTICLE 9.14 – PERMANENT WATERTIGHT FIXTURES, PORTABLE EQUIPMENT, PLUGS, RECEPTACLES, AND OTHER SIMILAR APPARATUS

ARTICLE 9.14 – PERMANENT WATERTIGHT FIXTURES, PORTABLE EQUIPMENT, PLUGS, RECEPTACLES, AND OTHER SIMILAR APPARATUS

General

- Permanent Watertight Fixtures
  - Corrosion Resistant
  - Exception

- Receptacles and Plugs of Different Electrical Ratings
  - Receptacles and plugs of different electrical ratings shall not be interchangeable. In cases where it is necessary to use 230 volts portable equipment, the receptacles for their attachments shall be a type, which will not permit attaching 115 volts equipment.

- Portable Equipment and Outlets
  - Portable apparatus is any apparatus served by a flexible cord. Portable apparatus shall not be used in cargo oil pump rooms or other hazardous locations nor are portable lights shall be used for berth lights in passenger accommodations or crew’s quarters.

- Portable Equipment and Outlets
  - Watertight Outlets
  - Grounding
  - Splices

ARTICLE 9.15 – FUSES, CIRCUIT-BREAKERS AND MAGNETIC CONTACTORS

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

General

- Application
  - The requirements in this article shall apply to the semiconductor rectifiers including thyristor for power rating not less than 5 kW.

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

Construction and Location

- Construction
  - Removable
  - Suitably Installed or Protected
  - Air-cooled semiconductor Rectifiers Need Not Be Used
  - Series or Parallel Connection

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

- Location
  - Circulation of Cooling Air
  - Separated from Sources of Radiant heat

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

Protection

- Protective Devices
  - Forced Cooling
  - Protection Against Transient Overvoltage
  - Fuses for Rectifier Cells

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

- Temperature of Rectifier Cells
  - The maximum permissible temperature of junction of rectifier cells shall be as specified by the manufacturer.
    - Selenium rectifier, 70ºC;
    - Silicon rectifier, 150ºC; and
    - Silicon controlled rectifier (Thyristor), 125ºC.

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

- Transformer for Rectifiers
  - Transformer for rectifiers shall be of two separate windings.

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

Thyristor Control

- Gate Control Circuits
  - Gate control circuits shall comply with the following requirements:
    - Arrangement
    - Series or parallel Connection

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

- Thyristor Control for DC Motor
  - Where dc motors are controlled by thyristors, the following requirements shall be applied:
    - Harmonic Effect
    - Lower Power Factor Effect
    - Changing-over the field polarity

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

Semiconductor Rectifiers for Propulsion

- General
  - Corrosion-Resistant
  - Performance Criteria
  - Inlet Cooling Water Temperature

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

- Nameplates
  - The following information shall be included on the rectifier nameplate:
    - Marine semiconductor rectifier;
    - Manufacturer's name and address;
    - Serial number;
    - Type (silicon, copper oxide, etc.);
    - Rated ac volts;

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

Rectifiers Nameplates Con.

- Rated ac amperes;
- Number of phases;
- Frequency;
- Rated dc volts;
- Rated dc amperes;
- Ambient temperature range; and
- Cooling medium

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

- Installation and Location
  - Away from Sources of Radiant Energy
  - Non-flammable Liquid
  - Forced Cooling
  - Enclosure

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

- Terminals
  - The alternating current terminals shall be marked with the letters ac. The direct current terminals shall be marked with a plus (+) on the positive terminal and a minus (-) on the negative terminal.

ARTICLE 9.16- SEMICONDUCTOR RECTIFIER FOR POWER

- Transformers
  - Transformers used with semiconductor rectifiers shall have their windings treated to resist moisture, sea atmosphere and oil vapors.

ARTICLE 9.16– SEMICONDUCTOR RECTIFIER FOR POWER

ARTICLE 9.16 – SEMICONDUCTOR RECTIFIER FOR POWER

- **Application.** The requirements in this article shall apply to the semiconductor rectifiers including thyristor for power rating not less than *5 kW*.

Construction and Location

- **Construction.**

(A) Removable. Rectifier units, rectifier stacks or cells shall be so arranged that they can be removed from equipment without dismantling the complete unit.

(B) Suitably Installed or Protected. Air-cooled rectifiers shall be suitably installed or protected against the effects of *salty air* and *humidity*.

(C) Self-cooling and Air-cooled Semiconductor Rectifiers Need Not To Be Used. In areas where *mercury vapor* is liable to be generated.

(D) Series or Parallel Connection. Where rectifier elements are connected in series or parallel they shall be so arranged that the *voltage* or *current* in each element will become equal as far as practicable.

- **Location.**
  - **A. Circulation of Cooling Air is Not Obstructed.**
  - **B. Separated from Sources of Radiant Heat** (*i.e. resistors, steam pipes, etc.*).

• Protection.

➢ **Protective Devices.**

(A) Forced Cooling. In which the rectifier cannot remain loaded unless effective cooling is maintained.

(B) Protection Against Transient Overvoltage. (caused by switching and breaking of the circuits and dc voltage rise due to regenerative power).

(C) Protecting Fuses for Rectifier Cells.

- **Temperature of Rectifier Cells.** The maximum permissible temperature of junction of rectifier cells shall be as specified by the *manufacturer.*

Where information is not available, the maximum permissible temperature of junction of rectifier cells shall not exceed the following values:

(A) ***Selenium rectifier****, 70 ℃*

(B) ***Silicon rectifier****, 150 ℃*

(C) ***Silicon controlled rectifier (Thyristor)****, 125 ℃*

- **Transformer for Rectifiers.** Transformer for rectifiers shall be of two separate windings.

• Semiconductor Rectifiers for Propulsion

A. Corrosion-Resistant. Shall be made of corrosion-resistant material or of a material rendered corrosion-resistant.

B. Performance Criteria. The temperature rise under all conditions shall be limited to such a value as will permit the rectifier to meet the specified performance criteria.

C. Inlet Cooling Water Temperature. In the case of water-cooled rectifiers the inlet cooling water temperature shall be considered at 30 ℃, unless otherwise approved.

- **Nameplates.** The following information shall be included on the rectifier nameplate:

1. ***Marine semiconductor rectifier;***
2. ***Manufacturer's name and address;***
3. ***Serial number;***
4. ***Type (silicon, copper oxide, etc.);***
5. ***Rated ac volts;***
6. ***Rated ac amperes;***
7. ***Number of phases;***
8. ***Frequency;***
9. ***Rated dc volts;***
10. ***Rated dc amperes;***
11. ***Ambient temperature range; and***
12. ***Cooling medium.***

- **Installation and Location.**

A. Away from Sources of Radiant Energy. (circulation of air is of restricted).

B. Nonflammable Liquid. Immersed-type rectifiers shall use a nonflammable liquid.

C. Forced Cooling. In which the rectifier cannot remain loaded unless effective cooling is maintained.

D. Enclosure. Rectifier stacks shall be inside a drip proof enclosure or better and mounted in such a manner that they may be removed without dismantling the complete unit.

- **Terminals.** The alternating current terminals shall be marked with the letters ac. The direct current terminals shall be marked with a plus (+) on the positive terminal and a minus (-) on the negative terminal.

- **Transformers.** Transformers used with semiconductor rectifiers shall have their windings treated to resist moisture, sea atmosphere and oil vapors.

ARTICLE 9.17– CONTROL GEARS

Construction

- **General.**

A. Durable Construction. (with efficient means of starting, stopping, reversing and speed control of motors together with essential safety devices).

B. Protective Enclosure. Control gears shall have suitable protective enclosures depending on their location and shall be so constructed that operators can handle them safely.

- **Wearing Parts.** All wearing parts of control gears shall be readily renewable and accessible for inspection and maintenance.

- **Control gears for Motors Larger than 0.5 kW.** Shall be provided with the following apparatus:

A. Means to Prevent Undesired Restarting. (after stoppage due to low voltage or complete loss of voltage).

This requirement does not apply to motors, the continuous availability of which is essential to the safety of the watercraft and the automatic operation.

B. Isolating Means. Shall be provided so that all voltages may be cut off from the motor, except where the means of isolation (e.g. switchboard, section board, distribution board, etc.) are adjacent to the motor.

C. Automatic Disconnection. Means of automatic disconnection of the supply shall be provided in the event of excess current due to mechanical overloading of the motor.

This requirement shall not apply to the motors for steering gear power units (steering motors).

- **Clearances and Creepage for Control gears.**

A. Insulation Clearances and Creepages. (shall be in accordance with the requirement in Table 9.17.1.4(A).

B. Insulating Clearances and Creepages of Small Control gears. (of 10 amperes and less installed in drip proof enclosure, shall be as required in Table 9.17.1.4(A).

C. Exceptions. The requirements in (A) and (B) shall not apply to the following items:

1. ***Spark gaps;***
2. ***Devices used in secondary windings of induction motors;***
3. ***Oil immersed devices;***
4. ***Pilot lamp fittings and sockets;***
5. ***Small switches in living quarters;***
6. ***Semiconductor devices including printed boards, resistors, condenser, etc.; and***
7. ***The sealed portion of the devices which are of sealed construction.***

- **Magnetic Contactors and Overcurrent Relays for Motors.**

A. Construction.

(1) Malfunction. Magnetic contactors shall be such that no accidental opening and closing occur due to either the vibration of a watercraft, or the listing of the boat at an angle 0f 30 degrees in any direction.

(2) Interchangeability. The contact pieces and magnetic coils shall be readily interchangeable.

B. Rating. Each magnetic contactor shall clearly indicate its rated voltage, rated current, the rated voltage and frequency for control circuits, rated interrupting current capacity, rated momentary current capacity. It shall also indicate the number of poles.

(C) Performance.

(1) Maximum Temperature. (on the coils and contact piece)

(2) Current Capacity. (depending on application)

(3) Overcurrent Relays. (for motors shall have suitable characteristics in relation to the rated current and thermal ratings of motors).

- **Grouped Starters.**

A. Duplicate Starters. (for important motors are grouped in a starter panel, the busbars, and other devices shall be arranged that a fault on one device and circuit does not render the motor for the same use unusable.

B. Power Supply Transformer. Transformers for power supply of control circuits shall be provided for each motor or each group of motors incorporated in the devices. They shall be of the two winding type.

- **Maximum Allowable Temperature.** Given in Table 9.17.1.7 under the specified current and rated voltage.
- **Emergency Stopping Means.** Accessible from positions outside the space concerned, means shall be provided for stopping ventilators, blowers, fuel oil transfer pumps, fuel oil burning units and other similar fuel oil pumps and cargo oil pumps, when a fire occurs in the place where they are located or within the vicinity.
- **Starters for Steering Motors.**

A. Low Voltage Release Type. (arranged in such a way that the steering motors are restarted automatically and safely when electric power is restored after a power failure).

B. Rudder Indicators. (for rudder positions of steering gear shall be installed in the navigating bridge and at the main engine maneuvering station).

C. Overload Alarms. (for power unit of electric or electrohydraulic steering gears shall be provided at the main engine maneuvering stations or other suitable positions).

- **Magnetic Brakes.**

A. Magnetic Brakes of Watertight-Type Motors. (electrical parts applied shall be watertight).

B. DC Shunt-Wound Brakes and (shall release at 85% of the rated voltage at the maximum working temperature) in **DC Compound-Wound Brakes** (shall release at 85% of the starting current at the maximum working temperature).

C. DC Series-Wound Brakes. (shall release during starting and at 40% or more of the full load current. They shall engage at 10% or less of the full load current).

D. AC Magnetic Brakes. Shall meet the following requirements:

(1) shall release satisfactorily at 80% of the rated voltage at the maximum working temperature; and

(2) shall not be noisy due to magnetic action in the working condition.

ARTICLE 9.18 – ELECTRIC PROPULSION PLANT

- **Scope.** This article covers the requirements of the rotating machines, control gears, excitation apparatus and cables for the electric propulsion
- **Motor Torque**

A. Stopping or Reversing of the Watercraft. (shall be available when running at the maximum service speed).

B. Torque Margin. (shall guard against the motor from pulling out of synchronism during rough weather).

- **Protection Against Torsional Vibration**
- **Protection Against Overload**

- **Rotating Machines**

- **Construction.** (rotors shall withstand the overspeed for over two minutes)
- **Collector Rings and Commutators Arrangements.** (shall be suitably arranged for easy maintenance).
- **Protection.** (prevent accumulation of moisture and condensation).

➢ **Generators and Motors.**

A. AC Generators and Motors. (of 500 kW or larger, embedded temperature detectors shall be provided in the stator windings)

B. DC Motors. (for dc motors liable to overspeed excessively, overspeed protection devices shall be provided)

- **Exciter.**
  - **Separately Excited Rotating Machines.** (shall be provided with at least two independent sources of excitation, one of which shall be supplied from the auxiliary generating set for power and lightning).
- **Control gears for Propulsion Equipment**
  - **Means of Limiting Regenerated Energy** (stopping or reversing the propeller transmits the energy to the prime mover)
  - **Manual Operation** (satisfactory operation)
  - **Mechanical Interlocks** (prevent wrong operation)
  - **Prevention to Contact with Energized Parts** (in cases of leakage, steam or oil)
  - **Power-Aided Control** (restore control in the event of power failure)

- **Location of Maneuvering Control.**
- **On the Bridge or Deck.** (Alternative control in the engine room)
- **Two or More Control Stations.** (indicated and cannot be operated simultaneously from different stations).
- **Main Circuit and Control Circuits.**
- **Two or More Generators or Motors on One Propeller Shaft.** (any unit can be taken out of service and isolated electrically).
- **Cables.** The conductors of cables and wiring shall consist of not less than seven strands and the conductors of a cross-section smaller than 2.0 mm^2 shall not be installed except cables or wiring for automatic equipment not directly connected to main circuits.

ARTICLE 9.19 – EXPLOSION-PROOF ELECTRICAL EQUIPMENT

- **Kind of Explosion-Proof Construction.** used for electrical equipment onboard watercrafts shall generally be as follows:

(A) *Flameproof type;*
(B) *Intrinsically safe type;*
(C) *Increased safety type; and*
(D) *Pressurized protected type.*

➢ **Materials**

Materials for Construction. (adequate electrical, mechanical, thermal, and chemical resistance against environmental condition and flammable gases or vapors at the location of the electrical equipment concerned).

- **Portable Appliances.** (minimize risk of spark by friction)
- **Compounds.** (insulating and sealing compound shall have no harmful expansion, contraction, softening or crack found during service and is flame retardant in insulating compounds applied to bare energized)

➢ **Construction**

- **Sturdy Metallic Guards**
- **Electrical Equipment totally enclosed construction**
- **Type Indication** (kind of gases for which the equipment is designed)
- **Ambient Temperature.** (reference ambient temperature foe explosion-proof electrical equipment shall be 50℃.

- **Special Requirements**

A. Flameproof Electrical Equipment

1. Lighting Fittings (fitted through bulkheads)
2. Drain Discharging Devices

B. Increased Safety Electrical Equipment

1. Lighting Fittings (flame-retardant)
2. Connection Boxes (insulating compounds)

C. Intrinsically Safe Electrical Equipment

1. Safety Barrier (interconnection intrinsic and non)
2. Feeders (e.g. by means of isolating transformers)
3. Metallic Partitions (installed independently, otherwise installed with grounding)

- **Intrinsically-Safe System.** (shall be completely separated and independent of all electrical systems.)

Intrinsically-Safe System Cables shall have shielded conductors or shall be installed at a minimum of ***50 mm*** from other electric cables and shall not occupy an enclosure (such as a junction box or terminal cabinet) with non-intrinsically-safe circuits.

- **Pressurized Protected Electrical Equipment**

1. Safe Zone (air is used as the pressurized medium)

2. Interlock Device (air or inert gas is pressurized at least 10 times the free volume before energized)

3. Loss of Pressure (automatically disconnects or may operate an alarm device only)

Article 9.20 - Special Requirement for watercraft’s Certified for Carriage in Bulk Flammable Liquids and Liquefied Flammable Gases

9.20.1.1 Application

- The requirement of the article shall apply to all tankships or tank vessels especially constructed or converted to carry liquid cargo in bulk.

9.20.1.2 Location of Cables

A. Where Grades A,B,C and D liquid Cargo is Carried. Electric cables shall be located well inboard from the sides, preferably along or near the centerline, to reduce the risk of injury in the event of collision. But it shall be kept clear of cargo tank opening.

B. Where Grade E Liquid Cargo is Carried. Feeders shall be run as far as practicable to avoid cargo pump rooms and enclosed spaces immediately adjoining cargo tanks.

9.20.1.3 Equipment Location

A. Switching Devices. Switchboards, distribution panels, switches, fuse and other circuit interrupting or power devices shall not be installed in cargo pump rooms nor in enclosed spaces immediately above or adjacent to cargo tanks filled with all grades of liquids except Grades E.

B. Storage Batteries. Storage batteries shall not be located in cargo pump room regardless of the grade of liquid cargo bundled.

9.20.1.4 Portable Equipment

A. **Approved Type**. Illumination may be obtained in any compartment by the one of approved explosion-proof, self-contained, battery-fed lamps.

B. **Condition of Use**. No portable electrical equipment of any type shall used in bulk cargo tanks, fuel oil tanks, cargo pump rooms, or enclosed spaces immediately above or adjacent to bulk cargo tanks unless all the following conditions are met.

Condition 1:The compartment itself is gas free, this means the area is free from dangerous concentration of flammable or toxic gases.

Condition 2:The compartment adjacent are either gas free, filled with water contained Grade E liquid only, are closed and secured or the spaces are not normally expected to accumulate flammable vapors and gases; and

Condition 3: All other compartments of the watercraft in which flammable vapors and gases normally may be expected to accumulate are closed and secured.

9.20.1.5 Installation Requirements on Watercrafts Handing Grade A, B, C, or D Liquid Cargoes.

A. Lighting of Cargo Pump Rooms.

(1) **Fixed Glass Lens**. Cargo pump rooms shall be lighted through permanently fixed glass lenses fitted in the bulkhead and or overhead.

(2) **Construction and Arrangement**. Each fixed glass lens shall be of rugged construction and arranged to maintain the watertight and gastight integrity of the structure. The fixed glass lens may from a part of lighting fixture provided that all of the following conditions are complied with.

Condition 1: No means of access to the interior of the fixture from the pump is provided.

Condition 2: The fixture is vented to the engine rooms or similar nonhazardous area.

Condition 3: The fixture is wired from outside the pump room; and

Condition 4: The maximum observable temperature on the pump room surface of the glass lens based on the ambient temperature of 40°C shall not exceed 80°C.

(3) Alternative Fixture. Approved explosion-proof lighting fixture may installed, where the location of a cargo pump room does not permit the lighting arrangement as defined in (1) and (2) above.

B. Lighting of Enclosed Spaces. Lighting of the enclosed spaces immediately above or adjacent to cargo tanks shall be as required in (A) above.

C. Wiring.

(1) **Cable Requirement.** Wiring shall be in armored, lead-covered cable run through approved gastight fittings having stuffing glands at inlets and outlets.

(2) **Through Runs Allowed.** Through runs of electric cable are permitted in any enclosed space immediately above adjacent to cargo.

(3) **Through Runs Prohibited.** Through run of electric cables regardless of how they may be protected, are prohibited in cargo pump rooms.

D. Weather Decks Electrical Equipment.

(1) **Explosion-proof**. Motors, their control equipment, and other electrical equipment and installation located on or above the weather deck within 3000mm of the cargo tank openings cargo pump room doors or ventilation outlets, or cargo tank vent terminations, shall be explosion-proof.

(2)**Waterproof**. Explosion-proof equipment installed in locations exposed to the weather shall be waterproof or shall be enclosed in watertight housings, or protected against the entrance of water by other approved means.

(3) **Ventilation Requirements**. Motors shall be either totally enclosed or ventilated to the atmosphere by suction and discharge air ducts. Separately ventilated motors shall have pressure type ventilation with an automatic shut-off to open the circuit when the ventilating fan stops. The system shall be so interlocked that the pump motor cannot be started (restarted) prior to a circulation of air. The air duct shall lead to and from the atmosphere outside the pump room to terminate not less than 900 mm above the deck and not less than 1800 mm from any cargo vent.

E. **Boxes**. Joints in wiring shall be made only in wiring appliances or junction boxes, etc. Such boxes shall be completely metallic and gastight.

Article 9.21 Watercrafts Carrying Liquefied Gases in Bulk

9.21.1 General

(A) **Application.** The provision in the following sections are applicable to watercrafts carrying flammable products.

Requirements

(1) **Electrical Installation**. Shall be such as to minimize the risk of fire and explosion from flammable products.

(2) **Electrical Equipment**. Electrical equipment and wiring shall not be installed in gas-dangerous spaces or zones, unless essential for operation purposes.

(3) **Approve Types**. Where electrical equipment installed in gas-dangerous spaces or zones they shall be of the approved types for use in the flammable atmosphere concerned.

9.21.1.2 Types of Equipment. Certified safe type equipment, submerge cargo pump motors and their supply cables, may be fitted in gas-dangerous spaces or zones in accordance with the following.

(A) **Types of equipment allowed**. Intrinsically safe electrical equipment and wiring shall be fitted in all gas-dangerous spaces and zones.

(B) **Cargo Containment Systems**. Arrangement shall be made automatically shut down the motors of submerged cargo pumps in the event of low liquid level, low pump discharge pressure, and low motor current. The shutdown should be alarmed at the cargo control station.

(C) **Requiring Secondary Barrier.** Hold spaces where cargo is carried in a cargo containment system requiring a secondary barrier.

(1) Supply cables for Submerge cargo pump motors.

(D) **Not requiring Secondary Barrier.** Hold spaces where cargo is carried in a cargo containment system not-requiring a secondary barrier.

(1) Through runs of cable.

(2) Lighting fittings with pressurized enclose of the flame-proof type. All switches and protective devices shall interrupt all poles or phase and shall be of certified safe type.

(3) Electrical depth sounding or log devices and impressed current cathodic protection system anodes or electrodes. These device should be housed in gastight enclosures.

(E) **Separated by Gastight Boundary.** Spaces separated by a single steel gastight boundary from a hold space where the cargo containment system requires a secondary barrier, except those spaces on the weather deck which would otherwise be gas-safe.

(1) Equipment permitted by (D) above.

(2) Flame proof motors, controllers and switches for cargo or ballast system valve operation.

(3) General audible alarm indicators and instrumentations.

(4) Other Items of flame-proof equipment required

(F) Cargo Pump/Motors and Cargo Compressor Rooms:

(1) **Lighting Fitting.** With pressurized enclosures or of the flame-proof type. All switches and protective devices shall interrupt all poles or phases and shall be of certified safe type.

(2) **Electric Motors.** For driving cargo pumps or cargo compressors shall be separated from these spaces by a gastight bulkhead or deck. Flexible couplings or other means of maintaining alignment shall be fitted to the shafts between the driven equipment and its motors and, in addition suitable glands shall be provided where the shafts pass through the gastight bulkhead or deck.

(3) **Alternative Types.** Where operational of structural requirements are such as to make it impossible to comply with the methods described in (F) (2) above, motors of the following certified safe types may be installed in cargo pump rooms or cargo compressor rooms, provided they are of:

a. Increase safety type with flame-proof enclosures, or

b. Pressurized type.

(4) **Indicator.** Flame-proof general alarm audible indicator.

(G) Open Spaces. Zones on open decks or non-closed spaces on open deck within three meters of any cargo tank, outlet, gas or vapor outlet, cargo pipe flange, cargo valves or entrances and ventilation openings to cargo pumps and compressor rooms.

(1)Certified safe type equipment.

(2) Through runs of cable

(H) Where Pipes are Located. Enclosed or semi-enclosed space in which pipes containing cargo products are located and compartments for cargo hoses;

1. Lighting fittings with pressurized enclosures or of the Flame-proof types. All switches and protective devices shall interrupt all poles and phases and be of certified safe type.

2. Through runs of cable.

(I) Into Gas-dangerous Spaces. Enclosed or semi enclosed spaces having direct opening into any gas-dangerous space or zone shall have electrical installations complying with the requirements for the space or zone on which the opening leads.

Article 9.22-Electrical Equipment of Tankers

9.22.1 General

9.22.1.1 Scope. Electrical equipment for the tankers carrying oil having a flashpoint of 60°C or less shall comply with the requirements in this article and article 9.19.

9.22.1.2 Dangerous Spaces. In tankers, the following spaces and zone shall be considered as dangerous spaces:

A. Cargo tanks;

B. Cofferdams, double bottoms and duct-keels adjoining cargo tanks;

C. Enclosed or spaces immediately above cargo tanks or having bulkheads above and in the line with cargo tank bulkheads;

D. Other spaces adjoining cargo tanks than those specified in (B) and (C);

E. Cargo pump rooms;

F. Enclosed or semi-enclosed spaces in which cargo pipes are fitted.

G. Compartments for cargo hoses;

H. Zones on open deck of semi-enclosed spaces on open deck, within at least 3m of any cargo tank outlet or gas or vapor outlet;

I. Zones on open decks within 9m of ventilation openings of cargo tanks and the zones downward from there to the deck;

J. Zones on open deck immediately above all the cargo tank and to the full width of the watercraft plus 3m before and after on open deck, up to a length of 2.4m above the deck;

K. Enclosed or semi-enclosed spaces immediately above cargo pump room or above vertical cofferdams adjoining cargo tanks unless separated by a gastight deck and suitably mechanically ventilated and

L. Enclosed or semi-enclosed spaces having a direct openings into any of the spaces or zone stipulated in the above.

9.22.1.3 Supply of Power

A. Power Supply System. The system of power supply shall be as follows,

(1) Two-wire insulated for dc;

(2) Two-wire insulated for single-phase ac; and

(3) Three-wire insulated for three-phase ac.

B. Generator, Power Supply and Distribution circuits. Shall not be grounded nor depend hull return system except the following:

1. Impressed current cathodic protection system for outer hull protection only;
2. Ground indicating devices or other alternative means, in no case shall the circulation current to exceed 30mA;
3. Limited and locally grounded system and ignition system of internal combustion engines; and
4. Electrical circuits having no fear of causing hull current to the dangerous space.

9.22.1.4 Insulating Means. Distribution circuit for the electrical equipment installed in dangerous spaces shall be provided on each circuit with multipole linked isolation switches in a safe space.

9.22.1.5 Ground detection. Excluding intrinsically safe circuits, the feeders and distribution circuits to be connected to the electrical equipment in the dangerous spaces or to run through the dangerous spaces shall be provided with such devices that keep monitoring the insulation levels and will give an alarm in case of abnormally lo level.

9.22.2 Wiring in Dangerous Spaces

9.22.2.1 **General.**

(A) Dangerous Spaces. Cable shall not generally be installed in the dangerous spaces specified in section 9.22.1.2.

(B) Unavoidable Installation. Where installation of cables in such spaces is unavoidable, it shall comply with the requirements in section 9.22.2.2 to 9.22.2.5.

9.22.2.2 Selection of Cables. Shall be one of the following, where corrosion may be expected a non metallic impervious sheath shall be applied over metallic sheaths or armor of cable for corrosion protection.

(A) Mineral insulated and metallic sheathed;

(B) Lead sheathed and armored, and;

~~(C) Nonmetallic impervious sheathed and armored.~~

9.22.2.3 Installation of Cables.

A. Close to Hull Center Line. Cables shall be installed as close to the hull center line as practicable.

B. Distant from Decks, Etc. Cables shall be installed sufficiently distant from decks, bulkheads and pipes.

C. Protection Against Mechanical Damage. Cables which are installed on the fore and aft gangways and the decks shall be protected against mechanical damage. Further, the cables and their support shall be fitted in such a manner as to withstand expansion and contraction and other effect of the hull structure.

D. Gastightness. The penetration part of the cables or cable pipe through decks and bulkheads of the dangerous spaces shall be constructed so as to maintain gastightness and liquidtightness as the case may require.

E. Good Termination. When mineral insulated cables are used, special protection shall be taken to ensure good termination.

9.22.2.4 Grounding of Cables. All metallic protective covering of power and lighting cables passing through dangerous spaces or connected to equipment in such spaces, shall be grounded at each end.

9.22.2.5 Intrinsically-Safe Circuits.

A. Exclusive Use. Th cables for intrinsically-safe circuits associated with intrinsically-safe type electrical equipment shall be of exclusive use, being installed separately from cables for general circuits.

B. Wired Individually. Shall generally be wired to use a multi-core cable in common, a cable which has shields by each core or each pair of cores shall be used, having such shields grounded effectively.

9.22.3 Electrical Equipment in Dangerous Spaces

9.22.3.1 General.

A. Dangerous Spaces. Electrical equipment shall be not generally installed in the dangerous spaces specified in section 9.22.1.2. Where installation of electrical equipment is unavoidable in these dangerous spaces it shall comply with the requirements part 9.22.3.

B. Explosion Proof Equipment. Shall comply with requirements for use with explosive gases and vapors.

C. Intrinsically-Safe Type. Electrical measuring monitoring, control and communication apparatus shall be of intrinsically type.

D. Portable Lamps. Portable lamps shall be of intrinsically -safe or flame-proof type with self contained battery.

E. **Lighting Fittings.** Lighting fittings of increase safety type shall be of a type accept for oil tankers.

9.22.3.2 All Dangerous Spaces Specified in Section 9.22.1.3. Intrinsically-safe type electrical Equipment shall be installed in all dangerous spaces specified in section 9.22.1.2

9.22.3.3 Dangerous Spaces Specified in section 9.22.1.2(B).

A. Transducer. Shall be of totally enclosed type, to housed in a gastight enclosure clear of the cargo tank. The cables to the transducers shall be installed in heavy gauge galvanized steel pipes with gastight joints up to the main deck.

B. Anodes or Electrodes. Cables of an impressed current cathodic protection system for outer hull protection are installed in such spaces, the requirements in (A) above shall be applied.

C. Lighting Fittings. Lighting fitting of flameproof type or intrinsically-safe type shall be installed in double bottom and duct keels equipped with machinery which shall be manned for operation on at least two independent circuits.

9.22.3.4 Dangerous Spaces Specified in Section 9.22.1.2(C).

A. Lighting Fittings. Lighting fittings of flameproof type or intrinsically –safe type shall be installed. Lighting fittings in the spaces which are normally attended by the personnel shall be supplied by at least two independent circuits.

B. Cables. Cables may run through these spaces.

9.22.3.5 Dangerous Spaces Specified in Section 9.22.1.2(D).

A. Electrical Equipment. Specified in section 9.22.3.3 may be installed.

B. Lighting fittings. Lighting fittings in flameproof type or intrinsically type shall be installed in the spaces equipped with machinery which shall manned for operation and watch.

C. Cables. Approved through runs of cable may be installed.

9.22.3.6 Dangerous Spaces Specified in Section 9.22.1.2(E).

A. Electrical Equipment. Specified in section 9.22.3.3 may be installed.

B. Lighting fittings. Lighting fittings in flameproof type or intrinsically type shall be installed. The lighting fittings shall be arrange on at east two independent circuits.

C. Cables. Where cables are run through cargo pump room entrance, they shall be installed in heavy gauge steel pipes or steel ducts with gastight joints.

9.22.3.7 Dangerous Spaces Specified in Section 9.22.1.2(F) and (G).

A. Lighting fittings. Lighting fittings of flameproof type(explosion proof) or intrinsically-safe type shall be installed.

B. Cables. Where cables are run through these space, they shall be installed in heavy gauge of steel pipes or steel ducts with gastight joints.

9.22.3.8 Dangerous Spaces Specified in Section 9.22.1.2(H), (I), (J), and (K).

A. Electrical Equipment. Electrical equipment of flameproof type, and increased safety type shall be installed.

B. Cables. Shall be run through the spaces. However, no cable expansion bends shall be provided in the spaces specified in section 9.22.1.2(H) as far as practicable.

9.22.3.9 Dangerous Spaces Specified in Section 9.22.1.2(L). These spaces shall be considered as equivalent to the adjacent dangerous spaces having direct openings, and the electrical installation shall be in compliance with the corresponding requirements in the preceding section 9.22.3.1 to 9.22.3.8.

9.22.3.10 Electric Motor Driving Equipment in Cargo Pump room. Shall be installed in the space partitioned from these space by a gastight bulkhead and deck. In addition, suitable stuffing boxes shall be fitted where shafts pass through gastight bulkheads and decks.

9.22.3.11 Lighting in Dangerous Spaces. Where dangerous spaces are lighted by the lamps located in the adjacent safe spaces through glazed ports fitted in the bulkheads or decks, these glazed ports shall be so constructed as not to impair the watertight, gastight and strength integrity of the bulkheads and decks. Due consideration shall be given in the ventilation of the lighting fittings so that the excessive temperature rise is not carried in the glazed parts.

9.22.3.12 Electric Motors Driving Ventilation for Dangerous Spaces. Electric motors driving the ventilation for cargo pump rooms and the exhaust ventilators for other dangerous spaces shall be installed in ventilating ducts.

Article 9.23-Watercraft Carrying Liquefied Gasses at or Near Atmospheric Pressure and of Temperature Below Atmospheric.

9.23.1.1 General. Electrical installation and equipment of watercrafts carrying liquefied gasses in bulk shall comply with the provisions of articles 9.20 and 9.21.

9.23.1.2 Submerge Motor Cargo Pump.

A. Design. Layout and details shall be approved type.

B. Motor Operation. Motors shall be capable of being energized for discharging purposes only when the conditions (under cargo pump) are specified by such means as the use of a pressure cut-out switch with a manual reset.

Article 9.24 – WATERCRAFT CARRYING VEHICLES WITH FUEL IN THE TANKS

9.24.1.1 Ventilation

- An effective power ventilation system, sufficient to give at least six (6) air changes per hour, based on the volume of the empty enclosed space in which vehicles are to be transported or stored, shall be provided.
- Exhaust duct inlets shall be located within 450 mm above the vehicle deck.
- Means shall be provided to indicate on the navigating bridge or other appropriate locations any loss or reduction of the required ventilating capacity.

9.24.1.2 Equipment Location and Construction

- In general, the electrical equipment shall be installed within a zone extending from the vehicle deck to 450 mm above the vehicle deck in enclosed or semi-enclosed space.
- Any equipment necessary for the safe operation of the watercraft may be fitted in this zone provided it is intrinsically-safe or of the explosion-proof type.
- Any electrical equipment installed in a duct exhausting from a space of 450 mm of the vehicle deck shall be of the explosion-proof or intrinsically-safe type, however, squirrel-cage induction motor s without arc-producing devices may be used.

Article 9.25 – Electrical Equipment of Motor Vehicle Carriers and Coal Carriers

9.25.1.1 General

The requirements in this article apply to the electrical equipment installed in the cargo holds and the compartments adjacent thereto of motor vehicle carriers and coal carriers.

9.25.1.2 Motor Vehicle Carriers

(A) Electrical Equipment in Car Deck and Cargo Holds.

(1) Within 450 mm. In principle no electrical equipment shall be installed within a height of 450 mm above each car deck. Where it is unavoidable due to operational reasons, to fit electrical equipment into this zone, the equipment shall be of the explosion-proof type.

(2) Above 450 mm. All electrical equipment situated at more than 450 mm above car deck shall be at least of dust-proof and watertight constructions, and to be interlocked with the ventilation of the cargo holds. Where explosion-proof electrical equipment is used for gas detection system is provided, the interlocks may be emitted.

(A)Electrical Equipment in Car Deck and Cargo Holds.

(3) In Exhaust Ventilation Ducts. Any electrical equipment installed in the exhaust ventilation ducts of the cargo holds shall be of explosion-proof type.

(4) Portable Electrical Appliances. In principle no portable electrical appliances shall be located in the holds.

(5) Fire and Gas Detection System. Fire and Gas detection systems and the like which are installed in the cargo holds shall be of explosion-proof type.

(A) Electrical Equipment in Car Deck and Cargo Holds.

(6) Isolating Switches. All electrical circuits terminating in the cargo holds shall be provided with multiple linked isolating switches situated outside the cargo holds, and accessible only to authorized personnel. Provision shall be made for isolation, and for locking in the OFF position of the control switch of such circuits. However, this requirement does not apply to safety devices such as fire, smoke or gas detection.

9.25.1.3 Coal Carriers

Electrical equipment in Cargo Holds.

- In principle no electrical equipment shall be installed in the cargo holds. Where it is unavoidable to install electrical equipment in the holds, the equipment shall comply with the following requirements;

(1)Switches and Outlets. Switches and socket outlets shall not be installed except those connected to intrinsically-safe circuits;

(2) Explosion-proof Type. In case where other electrical equipment than those specified in (1) above is installed, the equipment shall be of explosion-proof type, and such equipment and its associated cables shall be installed so as to be kept from mechanical damage.

(3) Cables. The cables passing through cargo holds shall be led in gaslight heavy gauge steel pipes, and the both ends if the pipes shall be sealed using cable glands and the like through the boundaries of the cargo holds.

(B) Electrical Equipment in the Compartments Adjacent to Cargo Holds.

(1) Cargo Holds with non-gaslight Doors.

- The electrical equipment which is installed in the compartments adjacent to the cargo holds and having an opening such as non-gaslight door, batch and the like explosion-proof type.

(2) Vicinity of Ventilation Openings.

No electrical equipment except those of explosion-proof type shall be installed in the vicinity of ventilation openings of the cargo holds.

(C) Cargo Lamps .

Cargo Lamps used in the cargo holds shall be of special type or equivalent and approved for this particular use or of listed type.

ARTICLE 9.26---ELECTRICAL AND ELECTROHYDRAULIC STEERING GEARS

9.26.1 Scope. The requirements of this shall apply to all types of watercrafts having electric and electrohydraulic steering gears.

9.26.1.2 Passenger Ships and Cargo Ships.

(A)Main and Auxiliary Gears. Ships shall be provided with a mean steering gear and an auxiliary steering gear.

(B) Main Steering Gears. The main steering gear shall be adequate and sufficient to steer the watercrafts at maximum service speed. The main steering gear and the rudder stock shall be so designed that they are not damaged at maximum aster speed.

(C) Auxiliary Steering Gear .

The auxiliary steering gear shall be of adequate strength and sufficient to steer the watercrafts at navigable speed and capable of being brought speedily into action in an emergency.

(D) Rudder Position Indicator.

- The exact position of the rudder, of power operated, shall be indicated at the principal steering station.

(E) Indicator Location.

- Indicators for electric and electrohydraulic steering gear shall be installed in a suitable location in the navigating bridge.

(F) Communication.

- Ships shall be fitted with two means of communicating orders from the bridge to the engine room , one of which shall be an engine room telegraph.

9.26.1.3 All Passenger Ships (Irrespective of tonnage) and Cargo Ships of 5000 Gross Tonnage and Upward.

(A) Two Circuits.

- Electrical and Electrohydraulic steering gear shall be serve by two circuits fed from the main switchboards.
- One of the circuits may pass through the emergency switchboard.

(B) Short Circuit Protection.

- Short circuit protection only shall be provided for these circuits and meters.

9.26.1.4 Cargo Ships of Less than 5000 Gross Tonnage.

(A) Sole Source of Power.

- Cargo ships in which electrical power is the sole source of power for both main and auxiliary steering gear shall comply with Section 9.26.1.3,
- Except that if the auxiliary steering gear is powered by a motor primarily intended for other services,

Section 9.26.1.3(B) may be waved, provided that the protection arrangement is satisfactorily adequate.

(B) Short Circuit Protection.

- Short circuit protection only shall be for motors and power circuits of electrically or electro-hydraulically operated main steering gear.

9.26.1.5 Tankers/Supertankers.

Tankers/Supertankers 10000 Gross Tonnage and Upwards (New and Existing).

(1) Control Circuits.

- Two remote steering gear control circuits shall be provided, each of which shall be operable separately from the navigating bridge. This does not require duplication of the steering wheel or steering lever.

2) Load Control.

- Control of the main steering gear shall also be provided in the steering gear compartment.

(3) Load Disconnect.

- Means shall be provided in the steering gear compartment to disconnect the remote steering gear control system from the power circuit.

(4) Communication.

- A means of communication shall be provided between the navigating bridge and the steering gear compartment.

(5) Rudder Position Indicator.

- The exact angular position of the rudder shall be indicated in the navigating bridge.
- The rudder angle indicator shall be independent of the remote steering gear control system.

(6) Local Indicator.

- The angular position of the rudder shall be recognizable in the steering gear compartment.

(B) For Every New Tanker/Supertanker of 10000 Gross Tonnage and Upwards. In addition to the requirements of (A) above, the following shall apply;

(1) Identical Power Units.

- The power units for the main steering gear shall consist of two or more identical units and each shall be capable of operating the rudder.
- The main steering gear shall be so arranged that a single failure in its raceway or in one of the power units will not impair the integrity of the remaining parts of the steering gear.

(2) Main steering Gear Capability.

- The main steering gear shall, with the tanker/supertanker at its deepest sea going draft, be capable of putting the rudder from 35 degrees on one side to 35 degrees on the other side in not more than 28 seconds with the tanker running ahead at maximum service speed.

(3) Automatic Operation.

- The main steering gear power units shall be arranged to start automatically when power is restored after a power failure.

(4) Alarm.

- In the event of failure of any of the steering gear power units an alarm shall be given at the navigating bridge.
- Every steering gear power unit shall be capable of being brought into operation either automatically or manually from a position on the navigating bridge.

(5) Alternative Power Supply.

- An alternative power supply, at least sufficient to supply a steering gear power unit, so as to enable it to move the rudder as specified below, and also to supply its associated remote steering gear control system and the rudder angle indicator, shall be provided, automatically, within 45 seconds, either from the emergency source of electrical power, or from another independent source of power located in the steering gear compartment.
- This independent source of power shall be used only for this purpose and shall have a capacity sufficient for half an hour of continuous operation.

(5) Alternative Power Supply. (continuation…)

- The steering gear power unit, when being supplied by the alternative power unit, shall at least be capable of putting the rudder from 15 degrees on one side to 15 degrees on the other side in not more than 60 seconds with the tanker (tankship) at its deepest sea going draft while running at one half of its maximum service speed ahead or 7 knots whichever is greater.

ARTICLE 9.27-MOBILE OFFSHORE OIL DRILLING RIG/PRODUCTION FLATFORM AND HABITAT UNIT

9.27.1 General

9.27.1.1 Descriptions.

(A)Rotary Oil Drilling Rig.

-The main components of the rotary oil drilling rigs are:

(1) Draw works.

- The control center from which the driller operates the rig.
- It houses the clutches, chains, sprockets and engine throttle and includes the main winch mounted on the rig floor.

(1) Draw works. (continuation…)

- The draw works is used to raise and lower drill pipes, tubing, casings, and liners, by dc motors which are either explosion-proof or fresh air purged;

(2) DC Motors.

- These shunt type motors operate from the three phase voltages by full wave SCR controls;

(3) Rotary tables.

- These tables rotate the drill string and support the string during a make or break operation by dc motors with SCR speed and reversing control;

(4) AC Motors.

- Constant speed ac motors are used in the mud tanks for blending the mud homogeneously;

(5) Mud Circulation System.

- The system keeps the bore-hole and drill bit clean, provides lubrication and cooling.
- It maintains adequate hydrostatic pressure on the formation to prevent hole cave-in or blow-out due to abnormal bottom hole pressures.

(6) Cementing System.

- Motors for the cement pump, low-pressure jet pump, lube pump, pressurizer pump, blowers and air compressors to fill with cement the spaces surrounding the casing to prevent contamination caused by the migration of fluids from the formation during the drilling thus provided mechanical support for the casing and the blow-out preventer (BOP).
- The BOP will eventually be replaced by a stock of assorted delivery valves when the drilling is over and the oil well comes into service, and;

(7) SCR System.

- Silicon Controlled Rectifier (SCR) or thyristor as mentioned in article 9.16 operates on the principle of solid state logic and switching components with the Power Factor Controller (PFC),
- The solid state logic produces the firing impulses that control the on/off switching of the SCR.
- SCR provides smooth uniform voltage control to the monitor and balance currents on the ac lines for better power utilization from the ac generators.
- Pairs of SCR's are fired sequentially in the proper phase sequence to ensure that equal currents flow through each SCR.

(B) Production Platform.

- Production platform is a gravity base steel structure that is dynamically positioned offshore to received and store the crude oil coming out from the oil wells, and also process some for fuel of the gas turbine driving the main generators and multi-stage air compressor and sea water injection facilities.
- The platform consists of 3 or more bottle-like tank legs for crude oil storage and ballast with iron-ore aggregates for stability during the in-service life.

(B) Production Platform. (continuation…)

- The upper structure of Hi-deck structure comprises three levels, namely the main deck where the electrical power sources and utilities for oil and gas handling equipment, drilling work over rigs are located, the lower and mezzanine decks for personal use and helideck.

9.27.1.2 Requirements.

(A) Electrical Power Source.

- The unit shall be provided with a main source of electrical power which should include at most five (5) sets of gas turbine generator sets, a back-up source of electrical power of at least two (2) sets of diesel engine-driven generator sets, and storage batteries for emergency and transitional source of electrical power.

(B) Electrical Service to Be Ensured.

- All electrical service for power utilities, lighting, communications, alarm and control and navigation necessary in normal and emergency conditions for operational and habitable situations of the dynamically positioned oil drilling rig/production platform and habitat unit, shall be ensured.

(C) Back-up Power.

- All service of the rotatory oil drilling rig for the uninterrupted operation of the main component, such as the draw works, mud circulating system and cementing system shall be ensured in case of failure of the main power source with the takeover of the back-up power source, and by the Silicon Controlled Rectifier (SCR) system.

(D) Production Equipment.

- All service of the processing electrical equipment to handle oil and gas production shall be ensured for continuous operation by the main power source and the back-up power source.

(E) Safety of Unit.

- Electrical services essential for the safety of the unit and personnel from electrical fire, shock and hazards shall be assured.

(F) Hotel Facility.

- Electrical services for the accommodation of personnel and hotel facility which is located below the main deck, such as the 24-hour air conditioning service, preservation of provisions and supply, main kitchen and laundry electrical equipment, etc. shall be assured.

9.27.2 Sources of Electrical Power

9.27.2.1 Main Source of Electrical Power.

(A)Gas turbine Generator.

- The main power source which consist of five (5) sets of gas turbine generator sets shall have sufficient capacity to ensure the functioning of services referred to in part 9.27.1.
- Under normal conditions, four sets run at anytime with the fifth set on standby.
- Produced and processed gas or distillate fuel is used for the gas turbine with automobile change-over from one to the other.

(B) Transformers or Converters.

- Where transformers or converters constitute an essential part of the system.
- The system shall be so arranged as to ensure the same continuity of the supply as stated in (A) above.

9.27.2.2 Paralleling and Controlling Methods of Generated Power by the main Generator Sets.

- Parallel operation of the main ac generators arranged in bank and bay shall be done to ensure the continuous operation of the unit for better utilization from the ac generators by SCR system.

FPN No. 1

- Two methods of paralleling and controlling generator voltage are the “Reactive droop compensation” method and the “Reactive differential compensation” which is more commonly know, the “Cross-current compensation” method, of generators to a common ac bus.

FPN No. 2 – Parallel Operation Scheme.

- When two or more generators are in parallel, the voltage regulators sense voltage and current to maintain equal voltages and minimize circulating current between generators.
- Presetting the voltage-adjusting potentiometer to a minimum circulating current minimize the correction required by the regulator.

FPN No. 2 – Parallel Operation Scheme. (continuation…)

- When a generator is removed from the line and is no longer in parallel with the other generators, it will short-out its current transformer to prevent false signal transmission to the cross-current compensation network.
- Should one of the generators receive more power that is delivering it will be receiving reverse power and may over speed the prime mover.
- Once this occurs, the reverse power sensor and relay open the generator circuit breaker and remove the generator from the ac line.
- If desired, the voltage of each generator can be controlled manually or automatically by proper selection of manual/select switch.
- A switch can also manually or automatically synchronize the generator to the ac bus.

FPN No. 2 – Parallel Operation Scheme. (continuation…)

- Should an under frequency or over voltage condition occur beyond preset levels, the generator will be turned off and the generator removed from the line.
- Also, if a fault such as an ac ground occurs, an alarm will be actuated or the generator will be removed.
- The generator ac circuit breaker operates continuously under the full load kVA of the generator and functions to protect the generator.

FPN No. 2 – Parallel Operation Scheme. (continuation…)

- Engine protection is a separate function determined by its kW rating, the circuit breaker is not sized to protect it, but to protect the generator.
- Fault current analysis determines the interrupting capacity rating of the circuit breaker.
- Most circuit breakers have adjustable current trip settings in addition to an under voltage release sensor and auxiliary contacts.

9.27.2.3 Protective and Controlling Devices.

- The following electrical protective and controlling devices shall be provided for each generating set, namely;

(A) Electronic engine governor

(B) Speed adjusting potentiometer

(C) Governor selection switch

(D) Voltage regulator

(E) Voltage adjusting potentiometer

(F) Auto/overvoltage sensor and control

(G) Generator circuit breaker

(H) All indicating and measuring instruments for ac generators

9.27.2.4 Back-up and Emergency Source of Electrical Power.

(A) General Requirements.

(1) Self-Contained Emergency Source.

- The unit shall be provided with a self-contained emergency source of electrical power which may either be a generator or storage battery.

(2) General Location.

- The emergency source of power, the transitional source of emergency power and the emergency switchboard shall be located on or above the uppermost continuous deck and not formward of the collision bulkhead, and readily accessible from an open deck.

(A)General Requirements (continuation…)

(3) Location in Relation to Main Power Source.

- The location of the emergency source of power, the transitional source of power and the emergency switchboard in relation to the main source of electrical power should be such as to ensure that a fire or other casualty in the space containing the main source of electrical power or in any machinery space essential for the operation of the rig will not interfere with the supply or distribution of emergency power.

General Requirements (continuation…)

(4) Diesel Generator.

- The emergency diesel generator may be used for short period to supply non-emergency circuits provided suitable measures are taken to safeguard the independent emergency operation under all circumstances.

(B) Service Requirements.

- The emergency electrical power shall be sufficient to supply all those services that are essential for safety in an emergency and capable of supplying simultaneously at least the following services for the periods specified hereunder:

(B) Service Requirements. (continuation…)

(1) Emergency Lighting for a Period of 18 Hours;

a. At every embarkation station on deck and oversides,
b. In all service and, accommodation alleyways, stairways and exits, personnel lift cars, and personnel lift trunks,
c. In the machinery space and main generating stations including their control positions,
d. In all control stations and in all machinery control rooms,

Emergency Lighting for a Period of 18 Hours, (continuation…)

e. In all spaces from which control of the drilling process is performed and where controls of machinery essential for the performance of this process, or devices for emergency switching-off of the power plant are located,

f. At the stowage position(s) for firemen’s outfits,

g. At the sprinkler pump if any, at the fire pump referred to in (B)(4) below at the emergency bilge pump, if any, and at their starting positions

h. On helicopter landing deck.

(B) Service Requirements. (continuation…)

(2) Navigation Lights, Other Lights and Sound Signals, Required by the International Regulations for the Prevention of Collision at Sea, for a Period of 18 Hours;

a. Any signaling lights, or
b. Sound signals which may be required for marking of offshore structures,

(3) Internal Communication, Detection and Alarm, for a Period of 18 Hours;

a. All internal communication equipment that is required in an emergency,
b. Fire detection and its alarm systems,
c. Intermittent operation of the manual fire alarms and all internal signals that are required in an emergency, and
d. The capability of closing the blow-out preventer and of disconnecting the unit from the well head arrangement, if electrically controlled.

(4) One of the Fire Pumps if Dependent Upon the Emergency Generator for its Source of Power, for a Period of 18 Hours; and

(5) Permanently Installed Diving Equipment if Dependent Upon the Unit's Electrical Power, for a Period of at least 18 Hours.

9.27.2.5 Diesel Generators as the Emergency Source of Electrical Power.

(A) Driven by Prime Mover.

- Driven by a suitable prime mover with an independent supply of fuel, having a flashpoint of not less than 43°C.

(B) Started Automatically.

- Started automatically upon failure of the normal electrical supply unless a transitional source of emergency power in accordance with (C) below if provided; where the emergency generator is automatically started, it should be automatically connected to the emergency switchboard; those services referred in section 9.27.2.7 should the be connected automatically to the emergency generator and unless a second independent means of starting the emergency generator is provided.

(C) Transitional Power Source.

- Provided with a transitional source of emergency power as specified in section 9.27.2.7 unless the emergency generator is capable of supplying the services mentioned in section 9.27.2.7 and of being automatically started and supplying the required load as quickly as safe and practicable but in not more than 45 seconds.

9.27.2.6 Storage Battery.

- Storage battery as the emergency source of electrical power shall be capable of:

9.27.2.6 Storage Battery. (continuation…)

(A) Carrying Emergency Load.

- Carrying the emergency load without recharging while maintaining the voltage of the battery throughout the discharge period within plus or minus 12% of its nominal voltage.

(B) Automatic Operation.

- Automatically connecting to the emergency switchboard in the event of failure of the main power supply; and

(C) Immediate Operation.

- Immediately supplying at least those services specified in Section 9.27.2.7.

9.27.2.7 Transitional Source(s) of Emergency Power.

- The transitional source(s) of emergency power, where required by Section 9.27.2.5(c) shall consist of an storage battery suitably located for use in an emergency,
- which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within plus or minus 12% of its nominal voltage,
- and be of sufficient capacity and so arranged as to supply automatically, in the event of failure of either the main or the emergency source power, the following services for half an hour at least if they depend upon an electrical source for their operation.

(A) Lightning Required by Section 9.27.2.4 (B)(1) and (B)(2).

- For transitional phase, the required emergency lighting with respect to the machinery space and accommodation and service areas, maybe provided by permanently fixed, individual storage battery lamps which are automatically charged and operated.

(B) Internal Communication Equipment.

- All essential internal communication equipment required by section 9.27.2.4 (B)(3)a and (B)(3)b.

(C) Equipment of Intermittent Operation.

- Intermittent operation of services referred to in Section 9.27.2.4 (B)(3)c and (B)(3)d.

Exception: Unless in respect of Section 9.27.2.7 (B) and (C) they have an independent supply from a storage battery suitably located for use in an emergency and sufficient for the period specified.

9.27.2.8 Emergency Switchboard.

(a) Location.

- The emergency switchboard shall be installed as near as is practicable to the emergency source of power and, where the emergency source of power is a generator, the emergency switchboard should be preferably be located in the same space.

(b) Not in the Same Space.

- No storage battery fitted in accordance with this requirement for emergency or transitional power supply shall be installed in the same space as the emergency switchboard, unless appropriate measures are taken to extract the gases discharged from the said batteries.
- An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries consisting either the emergency source of power or the transitional source of power referred to in Sections 9.27.2.6 and 9.27.2.7 are being discharged.

(c) Emergency Switchboard.

- The emergency switchboard shall be supplied in normal operation from the main switchboard by an inter-connector feeder which shall be adequately protected at the main switchboard against overload and short-circuit.
- The arrangement at the emergency switchboard shall be such that the inter-connector feeder is disconnected automatically at the emergency switchboard upon failure of the main power supply.
- Where the system is arranged for feedback operation, the inter-connector feeder shall also be protected at the emergency switchboard at least against short-circuit.

(d) Automatic Disconnection.

- In order to ensure ready availability of emergency supplies, arrangements should be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that power is available automatically to the emergency circuits.

9.27.2.9 Installation Requirements of the Emergency Power Source.

- The emergency generator and its prime mover and any emergency storage battery shall be designed to function at full rated power when it is upright and when inclined up to the maximum angle of heel in the intact and damaged condition at 22.5 degrees about the longitudinal axis and/or 10 degrees about the transverse axis.

9.27.2.10 Periodic Testing of the Complete Emergency system.

- Provisions shall be made for the periodic testing of the complete emergency system and shall include the testing of automatic starting arrangement.

9.27.2.11 Starting Arrangement for Emergency Generators.

(A) Cold Starting.

- Emergency generators shall be capable of being readily started in their cold condition.
- If this is impracticable, consideration shall be given to the provision and maintenance of heating arrangements, so that ready starting will be assured.

(B) Capacity of Starting Batteries.

- Each emergency generator which is arranged to be automatically started shall be equipped with starting arrangements with a storage energy capability of at least three consecutive starts.
- A second source of energy shall be provided to an additional three starts within 30 minutes unless hand (manual) starting can be demonstrated to be effective.

9.27.3 Main and Emergency Switchboards Arrangements

9.27.3.1 Easy Access.

- Switchboards shall be so arranged as to give easy access needed to apparatus and equipment, in order to minimize danger to attendants.
- The side and backs and where necessary, the fronts of switchboards, shall be suitably guarded.
- Exposed energized parts shall not be installed on the front of such switchboards.
- There shall be non-conducting mats or gratings at the front and rear, where necessary.

9.27.4 Distribution System

9.27.4.1 Hull Return.

- Distribution systems with hull return shall not be installed, but this does not preclude under approved conditions the installation of: (a) impressed current cathodic protective systems; (b) limited and locally grounded systems (e.g. engine starting systems); (c) limited and locally grounded welding systems; and (d) insulation monitoring devices provided the circulating current does not exceed 30 milliamperes under the most unfavorable conditions.

9.27.4.1 Hull Return. (continuation…)

- When a distribution system, whether primary or secondary, for power, heating or lighting, with no connection to ground is used, a device capable of continuously monitoring the insulation level to ground and of giving an audible or visual indication of abnormally low insulation values should be provided.

9.27.5 Internal Communication

9.27.5.1 Intercommunication.

- Internal means of communication should be available for transfer of information between spaces where action may be necessary.

9.27.6 Electrical Installation in Hazardous Areas

9.27.6.1 Installation.

- Electrical equipment and cables installed in hazardous areas shall be limited to those necessary for operational purposes.
- They shall be excluded from any compartment in which explosives are stored.
- Where lighting is required, it should be achieved through the boundaries of the compartment.
- If electrical equipment cannot be excluded from such a compartment it shall be so designed and used as to minimize the risk of fire or explosion.

9.27.6.1 Installation. (continuation…)

- In paint lockers, acetylene stores and similar spaces where flammable gases are liable to collect as well as any compartment assigned principally to storage batteries, no electrical equipment shall be installed unless it is:
- Essential for operational purposes;
- Of a type which will not ignite the mixture concerned;
- Appropriate for the space concerned; and
- Appropriately certified for safe usage in the vapor or gases likely to be encountered.

9.27.7 Automatic Control and Other Loads

9.27.7.1 Electric Power.

- Electric power is required for monitoring and measuring drilling and rig activity, including computers, data logging equipment, vessel controllers, undersea TV, communications equipment, work area, laboratories, test equipment and maintenance facilities.

9.27.8 Propulsion Machinery for Drilling Units

9.27.8.1 Application.

This part applies to drilling units designed to undertake self-propelled passages without external assistance and are not applicable to units which are fitted only with means for the purpose of positioning or of assistance in towing operations.

9.27.8.2 Capable of operating.

- Main propulsion machinery and all auxiliary machinery essential to the propulsion and the safety of the unit shall be capable of operating when unit is upright and when inclined at any angle of list up to and including 15 degrees either way under static conditions and 22.5 degrees under dynamic conditions (rolling) either way and simultaneously inclined dynamically (pitching) 7.5 degrees by bow stern.

9.27.9 Lighting Protection

9.27.9.1 Adequate Lighting Protection.

- The offshore oilrig whose mast extends several hundred meters from the open sea surface shall be provided with adequate lighting protection as specified in Article 9.5

ARTICLE 9.28
EMERGENCY ELECTRICAL SYSTEM

9.28.1.1 General.

(A) Independent Supply. Every watercraft shall be provided with a self-contained emergency source of power which is independent from the main electric power plant and electric repulsion plant, and shall function satisfactory when the watercraft is listing or inclined 22.5degrees and/or the trim is 10 degrees.

(B) Emergency Lights. The emergency lights shall be lighted automatically upon failure of the main source of power.

(C) STORAGE BATTERY. No emergency storage battery shall be installed in the same space as emergency switchboard.

9.28.1.2 Location.

(A) **Location Requirement**. The location of emergency source of power in relation to the main source of electric power shall be such as to ensure that a fire or other casualty will not interfere with the supply and or distribution of emergency power. The emergency source of electric power shall not be forward of the collision bulkhead.

(B) **On Watercraft for Passenger Service.** On watercraft for passenger service the emergency power source and emergency switchboard shall be located above uppermost continuous deck and outside the machinery casing or above the freeboard deck, whichever is higher.

(C) **On Watercraft for Cargo Carrier.** On watercraft for cargo carrier and miscellaneous crafts including tankers, the emergency power source and an emergency switchboard shall be located above the uppermost continuous deck and outside the machinery casing.

9.28.1.3 Common Boundaries of Emergency Power Source Compartment and Adjoining Spaces. Where a compartment containing emergency source of electric power, or vital components thereof, adjoining spaces containing either the main service generators, an oil combustion engine, or any internal combustion engines shall be protected by adequate structural insulation material to isolate the emergency power source compartment from nearby fire or mechanical damage.

9.28.1.4 Type and Capacity of Emergency Source of Electric Power.

(A) SOURCES. The emergency source of electric power shall be either a generator and/or storage battery.

(1) Emergency Generator. When the source of electric power is generator, it shall be automatically started and connected to the emergency switchboard within 45 seconds of loss of the main source of electrical power. It shall be driven by a prime mover with an independent fuel supply having a flashpoint of not less than 43 degree.

(2) Storage Battery. Where the emergency source of electric power is a storage battery, it shall be capable of supplying the emergency loads enumerated in Table 9.28.1.4 without recharging while maintaining the voltage of the battery throughout the discharged period within 12% of its nominal voltage, and shall be automatically connected to the emergency switchboard upon failure of the main source electrical.

(B) Emergency Switchboard. The emergency switchboard shall be located in the same space as the emergency source of electrical power if it is a generator. If the emergency source is an storage battery, the switchboard shall be located as near as practicable to but not on the same space as the accumulator battery.

FPN. Storage batteries, except those for starting emergency generator sets, shall not be installed in the same space as the emergency switchboard.

9.28.1.5 Period of Operation. The emergency generator or storage battery shall operate continuously the emergency loads specifies in Table 9.28.1.4, except as modifies by Section 9.28.1.6.

9.28.1.6. Emergency Lights

(A) Part of Regular Lighting System. Emergency lights supplied by an automatic emergency power system shall form part of the regular lighting system, and shall be continuously lighted at all times that the normal lighting system is used, except that emergency light consisting or relay-controlled battery-operated lanterns and emergency lights for illumination of survival crafts, embarkation decks, assembly stations, wheelhouse, chart room and navigating instrument need not be continuous lighted but shall be controlled by switches located in wheelhouse.

(B) Marking. Emergency lights shall be marked with the letter "E" at least 12 mm in height.

(C) Period of Navigation. No emergency lighting system is required if the period of navigation is only between sunrise and sunset.

(D) Area of Operation. An emergency lighting system should not be required if there are of operation is not more than 28 km offshore, provided the following 2 conditions are compiled with:

Condition 1: The source of supply for the general lighting is independent of the propulsion plant.

Condition 2: On watercraft required to have at least one standard compartment of subdivision, the source of power for general lighting is located above the continuous uppermost deck.

(E) Without Sleeping Accommodations. Where there are no sleeping accommodations for passengers and where not more than 10 emergency lights are required, the automatic emergency lighting system and need not be continuously lighted.

(F) Acceptable Emergency Lights. Individual storage battery-operated automatic battery chargers and with sufficient capacity for not less than 6 hour continuous operation, shall be acceptable in lieu pf a single source emergency lighting system.

9.28.1.7 Emergency Lighting and Power Loads Arrangements

(A) Emergency Load Arrangements. The emergency load as specified in section 9.9.1.3 shall be so arranged so that they can energized from the emergency power source and capable to operate as specified in Sections 9.28.1.5 and 9.28.1.6.

(B) Sufficient Number of Lights. A sufficient number of lights throughout machinery spaces and shaft tunnel, if any, to permit the performance of essential operation and observations under emergency conditions and to facilitate restoration of normal service condition.

(C) Adequate Lighting for Passageways. An adequate lighting for passageways, stairways, exits or escape trunk in passenger quarters, machinery spaces and work areas, to permit passengers and crew to find their way to open decks and assembly stations with all watertight doors and fire screen doors closed.

(D) Exit Signs. Illuminated signs bearing the work EXIT in red letters installed in such locations throughout a passenger watercraft so that the direction of escape to open deck will be apparent.

(E) Lighting over Watertight Doors. Illumination for safe operation of watertight doors, if installed.

(F)Lighting in Galleys. One or more light in galleys, panties, crew's mess and recreation rooms.

9.28.1.8 Emergency Electrical System for Cargo Ships.

(A) Cargo Ships pf 5000 Gross Tonnage and Upwards.

(1) Self Contained Emergency Power Source. Located above the uppermost continuous deck and outside the machinery to ensure its functioning in the event of fire or other casualty causing failure to main electrical installation.

(2) Six-hour Operation. Power available shall be adequate for at least 6 hours continuous operation.

(3) Tilt and Trim. Arrangements shall be such that the complete emergency installation will function when watercraft is inclined 22.5 degrees or when trim is 10 degrees.

(4) Periodic Testing. Provisions shall be made for the periodic testing of the entire emergency installation.

(B) Cargo Ships of Less than 5000 Gross Tonnage.

Same requirements as in (A) above except that the power available for continuous operation of the emergency loads as specified is good for 3 hours.

9.28.1.9 Emergency Electrical System for Passenger Ships.

(A) Independent Emergency Power Source. All passenger ships of any tonnage either for coastwise and international service shall be provided w/ an emergency source of electric power.

(B) Storage Battery. Where the emergency source of electric power is a generator as specified, there shall also be provided w/ a temporary source of emergency power of an storage battery of sufficient capacity.

(1) Half hour Duration. To supply emergency lighting continuously for half an hour;

(2) Watertight Doors. To close the watertight doors but not necessarily to close them all simultaneously;

(3) Indicators for Watertight Doors. To operate the indicators which show whether power operated watertight doors are open or close; and

(4) Sound Signals. To operate the sound signals which give warning that operated watertight doors are about to close.

(4) Sound Signals. To operate sound signals which give warning that power operated watertight doors are about to close.

FPN. The arrangement shall be such that the temporary source of emergency power will come into operation automatically in the vent of failure of the emergency power supply.

(C) Adequate Capacity for Safety of Crew. The emergency power available shall be sufficient to supply all service necessary for the safety of passengers and crew in an emergency.

(D) Adequate Capacity for Emergency loads. Power shall be adequate to energize the emergency load for 36 hours.

(E) Periodic Testing. Provision shall be made for the periodic testing and testing of automatic arrangement of the emergency source of power and the temporary source of power.

(F) Storage Battery Indicator. An indicator shall be mounted in the machinery space, preferably on the main switchboard to indicate when any storage battery is discharged.

9.28.1.10 Emergency Electrical System for Mobile Offshore Drilling Units and Habitat.

9.28.1.11 Emergency Equipment and Installation Collision bulkhead.

ARTICLE 9.29- HIGH VOLTAGE ELECTRICAL INSTALLATION

9.29.1 General

9.29.1.1 Scope. This article shall apply to high voltage electrical installations over 600 volts ac. The high voltage electrical installations shall meet the requirements in this article.

9.29.1.2 Distribution Systems. The following distribution systems shall be considered standard;

(A) Three-phase, three-wire, insulated system; and

(B) Three-phase, four-wire, neutral grounded system.

9.29.1.3 Three-Wire Insulated System. High voltage equipment shall withstand the transient over voltages which may arise from ground-faults.

9.29.1.4 Four Wire Neutral Grounded System. High voltage equipment shall withstand ground-gault currents.

9.29.2 Construction and Location

9.29.2.1 General.

(A) Protection. High voltage electrical equipment shall be so protected that the operators can not touch the energized parts of equipment.

(B) Marking. High voltage electrical equipment and cables shall not be so marked at visible places as to identify them as much.

(C) Construction. High voltage electrical equipment shall be of such construction as to facilitate leading of cables, preparation of cable ends & connection of cables. It shall prevent accidental contact between high and low voltage circuits.

(D) Moisture and Condensation. For rotating machines and transformers, effective means shall be provided to prevent accumulation of moisture and condensation within machines.

9.29.2.2 Rotating Machines.

(A) Stator Windings. Shall have all phase-ends brought out in the terminal box.

(B) Terminals. Higher voltage terminals shall never be combined with lower voltage terminal in the same box, unless measures are taken to ensure that it can be obtained without danger.

9.29.2.3 Switchboards and Control Boards.

(A) Enclosed Type. High voltage switchboards and control boards shall be of enclosed type of having door with locking devices except for those in exclusive compartment.

(B) Partitions. Main switchboard shall be partitioned into 2 independent sections so that the machinery and appliances for important use can be operated even in the case of a fault in any section.

(C) Separation. Apparatus for lower voltage circuits shall be separated from those for higher voltage circuits, and shall be so arranged to avoid touching the energized parts of higher voltage circuits.

(D) Draw out Type. Circuit breakers may be of the withdrawable type or arrangements permitting safe maintenance while the bus bars are energized.

(E) Locking. Withdrawable circuit breakers, switches, and the like shall be provided with mechanical locking.

(F) Clearances and Creepages. The clearances and creepages of high voltage circuits shall not be less than the values given in table 9.29.2.3(F).

Rated Insulation Voltage (V)	High Voltage Control Equipment		Uninsulated Busbar	
	Clearance (mm)	Creepage (mm)	Clearance Between Phases (mm)	Creepage Bet. Uninsulated Live parts and Grounded metals (mm)
601-1500	20	30	30	30
1501-3600	30	50	45	40
3601-7200	60	90	70	60

9.29.3 Protection

9.29.3.1 Generators.

(A) Electrical Faults Protection. Generators shall be protected from electrical faults.

(B) Excitation System. Shall be so designed that the can de-excited automatically under abnormal condition.

9.29.3.2 Transformers.

(A) Short-circuit Protection. Circuit breakers shall be generally be used for short circuit protection at the primary side.

(B) Overload Protection. Where the total connected load of all outgoing circuits on the secondary side exceeds rated load overload protection shall be provided

(C) Parallel Operation. When transformers are connected in parallel , tripping of the protective device at the primary side shall be followed by manual switching of the switch at the secondary side.

(D) Current Limiting. Transformers should have current limiting devices, of necessary in order to prevent excessive voltage drop due to current inrush.

9.29.3.3 Step-up Transformer. When a single load is supplied directly at a higher voltage via step up transformer, the transformer shall be protected at the lower voltage side.

9.29.3.4 Voltage Transformers. Shall be protected against short-circuit.

9.29.3.5 Protection for Secondary Circuit of Step-down Transformer. Low voltage circuits fed through step-down transformers from high voltage circuits shall be protected so as not to induce high voltage due to primary-to-secondary fault in transformer.

9.29.3.6 Ground-Fault Monitoring. Means of indicating by alarm in any ground-fault in the system shall be provided.

9.29.4 High Voltage Cables

9.29.4.1 Installation

(A) Metallic Protection. High voltage cables shall have a metallic sheath or armor .

(B) Mechanical Damage. High voltage cables shall be installed far apart from lower voltage cables to avoid mechanical damage.

(C) Not Run Through Accommodation Spaces. Where practicable, high voltage cables shall not be run through accommodation spaces.

ARTICLE 9.30- SHIPBOARD AUTOMATIC AND REMOTE ELECTRICAL/ ELECTRONIC CONTROL SYSTEMS

9.30.1.1. General

(A) System Capability. Where the centralized control system having one or more control stations and employing different types of automatic and remote control of the propulsion plant, service boilers and firefighting equipment, control system shall be designed, assembled and installed to assure system capability.

(B) Fail-Safe Condition. Where the automatic and remote control system is of solid state electronic type, the integrated circuit elements to be fitted onboard shall be designed, assembled and installed to assure fail-safe condition.

(C) Effective Function Operations. Where the shipboard electrical automatic and remote control systems are fitted onboard they shall be designed, assembled and installed to assure effective function operations.

(D) Operation at Inclined Angle. The entire control, actuating, monitoring and alarm circuitry shall be designed to operate successfully when inclined at an angle of 30 degrees in any direction.

(E) Self-Monitoring Type Alarm. The control stations whether main or secondary shall be provided with alarms with self monitoring type and arranged such that a circuit failure will cause an alarm condition.

(F) Instrumentation and Alarms. Shall provide all information necessary for monitoring the operation of the repulsion, main and emergency electrical systems.

(G) Electrical Communication System. Shall be provided and arranged such that the bridge, engine room, main control station and any other control stations can intercommunicate at all times.

(H) Monitoring and Controlling Direction of Rotation and Speed. Effective means shall be provided for monitoring and controlling direction of rotation and speed of the propeller for the safe operation of the propulsion plant from STANDBY condition at departure to through normal operation FINISHED WITH ENGINE at the end of the voyage.

9.30.1.2 Application. Automatic and remote controls necessary for operation of the following machinery and systems shall be in accordance with the requirements in this article:

(A) Main engine and its directly relevant auxiliaries;

(B) Controllable pitch propellers;

(C) Steam generators;

(D) Electric generating plant;

(E) Lubricating and fuel oil systems;

(F) Bilge systems;

(G) Cargo pumping systems and inert gas systems(for tankers)

(H) Ballast systems;

(I) Hatch cover operating equipment;

(J) Windlasses; and

(K) Other facilities which are considered necessary by the government agency during jurisdiction.

9.30.1.3 Control Systems.

(A) General conditions. In case where the automatic and remote control systems are adopted, the following shall be considered;

(1) The controlled variables shall be selected from easily measurable object;

(2) In the functional parts, dislocation of mechanism, hysteresis, time-lag, friction loss etc. shall be minimized;

(3) The dynamic characteristics concerning manipulated variables of the control system shall be investigated.

(4) Consideration shall be given to the possible effect on the control system exerted by other such systems, and remedial measures shall be taken up; and

(5) The resources and causes of disturbance shall be investigated and their effects shall be minimized.

(B) Characteristics.

(1) Transfer Control. When the propulsion machinery is arranged to be controlled from two or more stations, the main control from a secondary station shall have the means of transferring control from secondary to main station at all times and blocking any unauthorized control from secondary station.

(2) Secondary Control. Shall be kept simple as possible and provided with only those indicators and controls necessary for the effective control of the speed and direction of the propulsion engine.

(3) Indicator. Transfer of control from one station to another shall be possible only of acknowledgement by the receiving station. The main control and secondary control station shall have an indicator showing which station is in control.

(4) Simultaneous Alarm. If the control system automatically shuts down the propulsion engine, this shall be alarmed at the main control and secondary control station when in control.

(5) Local Manual Control. Means shall be provided for local manual control in the machinery space in the event of failure of a particular control in the centralized control system.

(6) Effective Means for Monitoring. The main control station shall provide effective means for monitoring temperature, pressures, fluid and gas flows, liquid levels and other variables essential for propulsion plant operation.

(7) Design. Control function from the console shall be designed for either remote, manual or automatic control.

(C) Power Supply

(1) The control system shall be served by two feeders from main switchboard, with one of the feeders interconnected to the emergency switchboard if provided.

(2) The above-mentioned feeders shall supply power for the control system only.

9.30.1.4 Environmental Condition. Control equipment and measuring instruments shall be capable of withstanding the environmental conditions such as temperature and vibrations.

9.30.1.5. Manual Operation. Shall be provided for manual operation of the main engine and important auxiliaries

9.30.1.6. Fail-Safe. Control equipment shall be designed to act as far as possible, in fail-safe so as not to endanger operators or damage the control system in the event of failure of the equipment.

9.30.1.7 Protection for Main Engine. Emergency stop for the main engine shall be provided to prevent stopping of their function or to permit its continuous operation in fail-safe.

9.30.1.8 Circuit Protection.

(A)Feeder Protection. The feeder supplying power shall be provided with short-circuit protection at the main and emergency switchboard.

(B) Subdivided and Arranged. Control system protection shall be subdivided and arranged so that failure of one set circuit breakers will not cause non-operation or malfunction of another system or system.

9.30.9 Continuity of Power Supply.

(A) Standby Generator. Preferably of the same size and capacity as the main service generator shall be provided to assure continuity of power supply

(B) Emergency Source. The power for monitoring, alarms, and emergency tripping shall be supplied from an emergency source upon failure of main service and stand by generator.

9.30.10 Electric Cables and Console Wiring

(A) Approved Type. All electric cables shall be of the approved type of adequate voltage rating and ampacity.

(B) Flame-retarding Type. Cable and wiring for control and monitoring shall be of the flame retarding type.

(C) Solid Conductors. Cable and wiring having solid conductors shall be used in low energy circuits provided they are not subject to undue vibration and movement.

(D) Need Not Be Sheathed and Armored. Cable and wiring used within control consoles need not be sheathed and armored.

(E) Shielded. Cables for monitoring circuits which carry information-level signals should be provided with shields to minimize introduction of spurious signals.

9.30.1.11 Accessibility and Protection.

(A) Accessibility. Supply cable and wiring inside console shall be arranged to provide readily accessibility to parts requiring inspection, adjustment, maintenance and testing.

(B) Effective Protection. Supply cable and wiring inside consoles shall be effectively protected from steam, water and oil pipings.

(C) Mounting. Control consoles shall be rigidly mounted with the side and backs suitably protected

9.30.1.12 Voltage and Frequency Tolerances.

(A) Transient Voltage Suppressors. Shall be fitted to the control equipment to take care of voltage transients which may cause malfunctioning or damage to control and monitoring devices.

(B) Tolerances. Consoles feeders should be steady within plus or minus 10% voltage variation or plus or minus 15% frequency variation of its normal rating.

9.30.1.12 Electric Control Actuators and Servo-Motors.

(A) Availability. Electrically powered actuators shall be available onboard for the performance of control commands.

(B) Ambient Temperature. The rating of actuator coils shall be based on ambient air temperature 50 °C when located in the machinery space and 40 °C when outside.

(C) Windings. The windings of the actuator shall be treated to resist oil and water.

(D) Corrosion-Resistant Enclosures. Shall be fitted to the actuators and servo-motors where installed at exposed location.

(E) Over 100 Volts. All electrical circuits supplying power to servo motors and actuators rated over 100 volts shall be subjected to dielectric test.

9.30.1.14 Electrical and Electronic Devices.

(A) General. All electrical and electronic devices shall be suitable for use in sea atmospheres, resistant for corrosion, not affected by watercraft vibration and disturbance, capable of performing their intended function at ambient temperature.

(B) Semiconductor Devices. Should preferably be of silicon and selenium where their characteristics are favored for use onboard and selected on the basis of ambient air temperature ranging from 0 °C to 50 °C for interior and 0 °C to 60 °C inside console

(C) Logic Circuit Features. Indicator should be provided at the control consoles to show essential steps of successful completion of the sequence of operations by logic circuits.

9.30.1.15 Automation System. Watercrafts shall be fitted w/ microcomputers and microprocessor for monitoring control of the electric propulsion plant, diesel genset, and for navigational operation.

9.30.1.16 Maintenance and Inspection.

(A) Arrangement. When sequential and programmed controls are adopted, arrangement of the components shall be such that the order, time etc. of their operation can be easily inspected.

(B) Control Equipment. Shall be of simple structure and easy handling as much as possible.

(C) Instruction Books. Watercrafts shall be provided with instruction books on the monitoring facility, alarm and control system, circuit diagrams, inspection manual and list of specification of the equipment, necessary for maintenance and inspection.

Article 9.31- NAVIGATION COMMUNICATION SIGNALING AND ALARM EQUIPMENT

- **Scope**: this article covers the requirement of equipment essential for navigation, communication, signaling and alarm systems of watercrafts for reliable use during normal and emergency conditions, independent and self-sustaining to ensure the safety of life and property at sea.
- **Equipment:** equipment forming part of the operating system for navigation, communication signalling and alarm are follows:

(A) **Wireless Communication Equipment:** covers equipment for vessel-to-shore or vessel-to vessel communication either via satellite facilities or direct to land radio stations.

(1) Radio transmitter (main and emergency)

(2) survival craft radio transceivers.

(3) Radio phone and telegraph apparatus.

(4) electronic data transfer, facsimile, telex machine, television

(B) Interior Communication Equipment. Covers equipment for communication between stations within the watercraft

(1) Portable radio transceivers

(2) Telephone and voice tube

(3) Loudspeakers, amplifiers, and megaphones

(4) Call bell system

(5) Computers and television sets

(6) Watchman supervisory equipment

(7) Emergency squad equipment

(8) engine order telegraph

(9) Rudder angle indicators

(10) Controllable pitch propeller indicators

(11) Shaft (revolution) speed indicators

- (C) Navigation (Running) Light and Navigation Indicator Panel.

(1) Signaling (daylight) lights

(2) Signaling mirrors

(3) Signaling flags

(4) signal letters (call sign)

(5) Whistle signals

(6) Distress signals

- (E) **Fire Protective equipment**: Smoke and fire detectors.
- (F) **Alarm Equipment**: General fire and cols storage alarms
- (G) **Navigational Aids/Instruments**

    (1) Marine radar

    (2) marine sonar

    (3) marine loran

    (4) echo sounder

    (5) gyro-compass/standard magnetic compass

    (6) Radar direction finder

    (7) Marine global positioning system (GPS) navigator

    (8) Doppler log

    (9) Color video sounder

Location/installation. The navigational, communication, signaling and alarm equipment shall be located or installed as a system between each of the following:

(A) Navigating bridge (wheelhouse)

(B) Radio room, main and emergency

(C) Telegraph and telephone booths

(D) Machinery spaces, engine room, boiler/turbine rooms

(E) Captain and chief engineer, radio officer and chief steward rooms

(F) main propulsion control station

(G) Local control station for main propulsion engines and controllable pitch propeller indicator stations

(H) Steering gear compartment

(I) main switchboard and control gear spaces

(J) Navigational aid rooms, such as radar, loran, gyro-compass, and radio direction finder

(K) Survival-craft embarkation stations

(L) mustering stations

(M) accommodation and pilot ladder areas; and

(N) Lookout stations

Wireless Communications Equipment

- **Application.** Wireless communication equipment installation shall apply to watercrafts for international, short international, domestic or coastwise service, inland operation, and fishing operation.
- **Compliance.** The wireless communication equipment installation shall comply with the latest rules and regulations of Safety of Life at Sea (SOLAS) and the National Telecommunication commission (NTC), for licensing and registration.

Installation.

(A) **Watercrafts for International/Short international Trade/ Operation.** Every watercraft, regardless or gross tonnage, engaged in international/short international shall be fitted with wireless radio equipment.

(B) **Watercrafts for Domestic Trade.** Every watercraft of 350 gross tonnages and over authorized for carriage of passenger (liners) and cargoes (freight service),and tankers for carriage of liquids shall be fitted with wireless radio equipment, registered and issued a SHIP RADIO STATION LICENSE.

(C) **Watercrafts for Coastwise Service.** Every watercraft of over 1000 gross tonnage engaged in either international fishing or fishing within the territorial waters of the Philippines shall be fitted with wireless radio equipment, registered and issued a SHIP RADIO STATION LICENSE.

(D)Watercrafts for Inland Operation. Every watercraft over 100 gross tonnage engaged in bay, river and lake operation shall be fitted with wireless radio equipment (SSB or VHF), registered and issued a SHIP RADIO STATION LICENSE.

(F)Watercrafts for Fishing Operation. Every watercraft over 1000 tonnage engaged in either international fishing of fishing within the territorial waters of the Philippines shall be fitted with wireless radio equipment, registered and issued a SHIP RADIO STATION LICENSE. For those engaged in international fishing an EXEMPTION CERTIFICATE is also issued.

(G)Other Watercrafts. All watercrafts for coastwise or inland operations should be fitted with wireless radio equipment for the good and safety of the owner/operator.

Interior Communications Equipment

General. Watercrafts equipped with interior radio, telephone and other internal communication installations shall be provided with a means of system communication between the radio room and the navigating bridge (wheelhouse) and other key control stations from which the watercraft may be navigated under normal conditions.

Portable Radio Transceivers. There shall be a sufficient number of radio transceivers for use in a working shift. They shall be hooked-up to charging facilities after shift duty for ready use by the incoming shifters.

Cut-Out Switch. The bow or forward lookout telephone station if included in the same circuit with the station needed under (3) and (4) above, shall be provided with a wheelhouse cut-out switch if the station is exposed to weather.

Not to Be Utilized. Jack boxes or head-sets shall not be utilized on the telephone installation that includes any of the stations required by this section.

(B) Detail Requirements

- Watertight. Sound powered telephone stations installed in locations exposed to the weather shall be watertight construction, and the audible signal shall be mounted external to the station enclosure.
- **Dripproof.** Sound powered telephone stations in wheelhouse or machinery spaces shall be of drip proof construction.

- **Telephone Booth.** In noisy locations, a telephone booth or other equipment shall be provided so that a telephone conversation can be carried on.
- **Supplementary Sound Signal**. In noisy locations where the magnet-operated telephone station sound signal cannot be heard, a supplementary telephone bell or sound signal energized from watercraft electrical system shall be installed.
- **Station Indicator.** When two or more telephone stations are located in close proximity to each other, a suitable mean shall be provided to indicate the station called.
- Electrically Independent. The sound powered telephone talking circuit shall be electrically independent of the calling circuits.
- Telephone Cables. Telephone cables shall be run as close to the force and aft centerline of the watercraft as is practicable and through runs of cable should avoid such spaces as machinery room and galleys.

Loudspeakers and Amplifiers, and Megaphones.

- **(A) General**

(1) Loudspeaker System. All watercraft certified to carry 500 or more passengers including officers and crews, for ocean and coastwise service, and/or all watercraft certified to carry passengers whose survival crafts are stowed more than 30m from the navigating bridge shall be equipped with an approved loudspeaker system which shall enable an officer on the bridge to broadcast separately or collectively to the following stations:

a. Lifeboat station, portside;

b. Lifeboat station, starboard side;

c. Lifeboat embarkation stations, portside;

d. Lifeboat embarkation stations, starboard side;

(2) Control. The system shall be controlled from a single location on the navigating bridge.

(3) Arrangement. Loudspeakers at lifeboat/liferaft embarkation station shall be arranged for 2-way conversation with the navigating bridge.

- (B) Power Supply. The loudspeaker shall be energized from the source of emergency, lighting and power, or through conversion equipment.
- (C) location of Loudspeakers and Amplifiers.

e. Public spaces used for passengers assembly station; and

f. Crew quarters.

- **(C) Location of Loudspeakers and Amplifiers.**

  (1) General

  a. loudspeakers shall be located with due regard to the intended service and to minimize feedback and other interference.

  b. Loudspeakers on open deck shall be directed toward the near end of the watercraft and outward by angle of proximately 15 degrees.

  (2) Boat Deck Loudspeakers. A loudspeaker shall be located at each lifeboat/liferaft handling station.

(3) Survival Craft Embarkation and Passengers Assembly station Loudspeakers.

a. Loudspeakers shall be distributed throughout the lifeboat/ liferaft embarkation deck and locations by the watercraft's station bill for the assembly of passengers in an emergency so as to provide an even distribution of sound at level not less than those specified.

b. An even distribution of sound level is considered satisfactory if the variation does not exceed plus or minus 3 decibels.

(4) Crew Quarters Loudspeaker. Loudspeakers shall be distributed in passageways throughout crew quarters to provide a sound level not less than those specified in each room with the doors closed.

- (D) Minimum Sound Level Requirements for Loudspeaker System. Sound levels shall be measured with sound level meter to demonstrate that listening level are met.
- (E) Amplifiers. The emergency loudspeakers amplifiers if not located in the same enclosure with the control panel, shall be located in the wheelhouse or in the compartment adjoining or opening into the wheelhouse.

Call Bells. Call bell system shall be installed in the Captain, Chief Engineer, Radio Officer, and Chief Steward rooms, and in the navigating bridge, machinery spaces, steward rooms, steward department and radio equipment rooms.

Engine Order Telegraph.

(A)General Requirements.

(1) Transmitting and Acknowledging Order. All watercrafts shall be provided with an efficient means of transmitting orders from the wheelhouse to the engine room and acknowledge such orders from the engine room at the wheelhouse.

a. On watercrafts with more than one propulsion engine, the means of transmitting engine orders shall be provided for each engine.

b. On double-ended watercraft, such as Roll-on/Roll-off (RO-RO) vessels, with two wheelhouse, this means of transmitting engine orders shall be provided between the engine room and each wheelhouse.

c. On watercraft provided with the means of steering from the top of the wheelhouse as well as from the wheelhouse, this means of transmitting engine orders shall also be provided for both locations.

(2) Means of Transmitting. The means of transmitting engine orders shall be of the electric engine order telegraph type.

(B) Specific Requirements.

(1) **Transmitter and Indicators.** Electric engine order telegraph system shall consist of transmitters and indicators electrically connected to each other.

(2) Dials transmitters and Indicators shall be provided with dials divided into sectors or division with the various engine orders engraved thereon, such as:

a. Stop

b. Ahead

c. Astern

d. Half ahead

e. Half astern

f. Finished engine

(3) **Synchronize.** Rotation of the transmitter handle and its associated pointer shall drive the receiver indicator pointer in synchronism.

(4) **Audible Signals.** Audible signals associated with the system shall consist of a vibrating bell at each instrument. The vibrating bell as both transmitter and indicator shall ring continuously at all times when the transmitter arrow and the reply arrow do not point to the same order.

(5) **Illumination.** The dials transmitter instruments shall be illuminated in such a manner as not to interfere with navigating the watercraft at night.

(6) **Size**. Transmitter and indicator operating handle shall be of substantial size so that the engine order may be determined from a distance.

- (C) Detailed Requirements.

  (1) **Watertight.** Telegraph instruments shall have a watertight enclosures for the electrical components and shall be corrosion- resistant.

  (2) **Cables.** Electric cables shall be specified in Section. In addition, watertight boxes shall be provided in the installation as may be required.

  (3) **Automatic Alarm Device.** Each system shall be provided with an alarm device which automatically sounds audibly and indicates visually in the event loss of potential in the system.

  a. This alarm device shall be located in the wheelhouse.

  b. Means shall be provided to silence the audible signal.

c. Where the supervisory power supply is dry cell battery or some other low capacity source, there shall be no electric drain on the supervisory power supply after audible signal has been silence; the visible indication should be extinguished to effect this.

Rudder Angle Indicator

- (A) Watercraft to Be Provided with Rudder Angle Indicator. All self-propelled watercraft of 5000 gross tonnage or over, and watercraft of any tonnage certified to carry 250 passengers or more, shall be provided with a device indicating continuously the position of the rudder in the wheelhouse or any other station desired

- **(B) Arrangement.**

(1) Motors Connection. The equipment shall consist of two motors wound identically with their fields and armatures connected together such that when energized the movement of one motor is always identical to the each other.

(2) Separate Rudder Angle Indicator System. When non-follow-up steering control is installed at the after steering station, a separate rudder angle indicator system shall be installed for station.

(3) Method of Transmitting. The method of transmitting rudder movement between the transmitter and the indicator(s) should be either by self-synchronous generator and motor(s), by mechanical telegraphs or by other equivalents means.

Navigation (Running) Lights and Indicator Panel

- **Application.** The requirements of this part shall apply to all watercrafts, as appropriate.
- **Purpose.** The purpose of this requirement is prevention of collision by the use of navigational lights. The requirements are:

  (A) Accuracy. For accuracy in estimating the aspect of the observed watercraft.

  (B) Transmissibility and Right Chromaticity. For the effective transmissibility and right chromaticity of navigation lights

  (C) Safety. For promotion of safety of life and property of the sea.

Navigation Light Indicator "Tell-Tale" Panel.

- (A) Running Lights Control. Self-propelled watercrafts of 1600 gross tonnage and over shall be provided with a navigation light indicator Tell-Tale panel located in the wheelhouse to control the running lights.
- (B) Visible and Audible Indicator. The panel shall provide visible and audible indications of the failure of any of the lights controlled thereof.
- (C) The lamps used in these light fixture shall be of the double-filament type although 2 single-filament lamps should be used provided (B) above is complied with.

Positioning of Running Lights(Navigation Lights).

- (A) Vertical Positioning of Masthead Lights. The vertical distance between the masthead lights shall be such that in all normal conditions if trim the aft lights shall be seen over and apart from the firelight at a distance of 1000 mm from the stern when viewed from sea level.
- (B) Positioning of Sidelights. The sidelights shall be positioned at height not greater than 0.75 of the height of the firelight above the hull.
- (C) Horizontal Separation of Masterhead Lights. Horizontal separation of foremast and main mast light shall not be less than 0.5 of the total length of the watercraft, and the firelight shall not be more than 0.25 the length of the watercraft from the stem.

Vertical Sectors. The vertical sectors of running lights shall ensure that:

- (A) Minimum Intensity. At least the prescribed minimum intensity is maintained at all angle s from 5 degrees above the horizontal to 5 degrees below
- (B) Sixty-percent of Minimum Intensity. At least 60% of the prescribed minimum intensity is maintained from 7.5 degrees above the horizontal to 7.5 degrees below.

Horizontal Sectors.

- (A) Minimum Intensity. The horizontal sectors of running lights shall ensure that at least the minimum intensities are maintained over the arc of the horizontal.
- (B)Consideration. In the forward direction, port and starboard lights as fitted on the watercraft shall allow the minimum prescribed intensities; these must decrease outside the prescribed sectors. At 22.5 degrees abaft the beam, the following considerations apply:
- (1) from 5 degrees inside the prescribe sectors the latera intensity may decrease by 50% up to prescribed limit;
- (2) It shall decrease steadily to reach cut-off between 2 degrees to 5 degrees outside the prescribed limit.

- Sidelight Fixtures. Sidelight fixtures for power-driven watercrafts while underway, shall be fitted with:
- (A) Green and Red lights. On the starboardside, a light fixture showing GREEN, and on the portside a light fixture showing RED so constructed to show an unbroken light over an arc of horizon of 112.5 degrees, so installed as to show the light from the right ahead to 22.5 degrees abaft the beam on the starboadside or portside, and of such character as to be visible at a distance of at least 5.6 km
- (B)Light Screens. The sidelight fixtures referred to in (A) above shall be fitted with light screens as specified, so as to prevent said lights from being seen across the bow pf the watercraft.

Alternative to Masthead Lights. Motor driven watercrafts which are not under command shall comply with the following:

(A) **Two Light Fixtures.** Tw light fixtures both showing RED, in lieu of the masthead lights required that shall be in a vertical line one over the other not less than 1800 mm apart, and o such a character as to be visible all round the horizon at a distance of at least 5.6 km

(B) **Two Black Balls.** Two BLACK BALLS by day, each not less than 600 mm diameter shall be installed in a vertical line one over the other of the distance as in (A) above.

Anchor Light Fixtures.

- (A) White Light Fixture. For watercrafts of less than 45m in length while at anchor, shall be fitted in the forepart, with a light fixture showing WHITE, visible all around the horizon at a distance of at least 3.75 km.
- (B) Two White Light Fixtures. Watercrafts of more than 45m in length while at anchor, shall be fitted with two light fixtures both showing WHITE, visible at a distance of at least 5.6 km all around the horizon.
- (C) One Black Ball. Between sunrise and sunset, every watercraft when at anchor, in lieu of electrically energized anchor lights, shall display in the forepart of the watercraft where it can best be seen, one BLACK BALL not less than 600 mm in diameter.

- Pilot-Watercrafts on Pilotage Duty. Pilot-watercrafts when engaged on pilotage duty and not underway.
- Pilot-Watercraft on Pilotage Duty. Pilotage duty, shall be fitted to show the lights for a similar watercraft of her length.
- **Signaling "Daylight" Lights.**

(A) Application. The requirements in this part of the article shall apply to watercrafts that are engaged in international voyage of over 150 gross tonnage.

(B) Technical Requirements.

- (1) Signaling Light. The signaling light shall consist of a device which produces a narrow high intensity beam of light suitable for daylight blinkers communication at speeds up to 9 words(180 dots and or dashes) per minute.
- (2) Luminous Intensity at 6 Degrees Divergence. The luminous intensity of the beam shall be not less than 60000 candela. The beam shall have a total horizontal and vertical divergence of approximately 6 degrees.
- (3) Luminous Intensity in Every Direction. The luminous intensity of the beam in every direction within an angle of 0.7 degree from axial shall not be less than 50% of luminous intensity in candela.

(4) Sighting Arrangement. The signaling light shall be fitted with a suitable sighting arrangement capable if directing the beam on to the receiving station.

(5)Effectivity. Signaling may be effected by keeping the current through the lamp by movement of shutters, or by other approved means.

(6) Mounting. The signaling light may be either a fixed unit mounted in the top of the wheelhouse, a semi-fixed unit with arrangement for quick mounting at either wing of navigating bridge, or a portable unit.

(7) Power Supply.

- a. Fixed of Semi-fixed Signaling Light. Fixed or semi-fixes signaling light shall be energized from the emergency lighting power system.
- b. Portable Signaling Light. Portable signaling unit shall be energized from a self-contained storage battery capable of operating the unit for two hours continuously without recharging.

(8) Lamp. The lamp of the signaling light shall be permanently fixed above the navigating bridge and equipped with a Fresnel lens and high-speed bulb, operated by a weatherproof key, fitted with a suitable condenser.

Fire Protection System

- General.

(A) The fire protection system shall consist of one or combination of the following:

(1) Automatic fire detecting system

(2) Smoke detecting system.

(3) Fire alarm system

(B) The following shall be provided with fire protection system:

(1) Any watercraft engaged in international, short international, and domestic or coastwise operation;

(2) Any watercraft of more than 45 m in length having sleeping accommodation for passengers and

(3) Any watercraft of 45m or less in length engaged in coastwise trade having sleeping accommodation for 50 or more passengers.

Automatic Fire Detecting System.

A. Types of Fire Detectors. An automatic fire detecting system consists of fire and/ or smoke detectors, power supply, control unit, and fire alarms signals. The fire detectors shall be one of the following types or a combination thereof:

(1) Electrically operated thermostats, thermostatic wire, or other devices operated by heat, flame and/ or smoke and

(2) Electrical system using pneumatic tube or hydraulic tube detectors operated by heat.

- (B) Location

(1) A fire detecting and alarm system shall be capable of having alarm signals initiated an heard at the following locations:

a. Public spaces

b. Staterooms, offices, crew's cabin

c. Motion picture booths and film lockers

d. room with highly inflammable materials

e. Mail and specie rooms

f. storage and baggage rooms

g. Cargo spaces

h. trunks to cargo spaces

i. Spaces where motor vehicles are stowed

j. Coal Bunkers.

- (2) Manual and automatic system may be combined.

- **Smoke Detecting System.** Smoke emanating from fire zone or space will be monitored to the smoke detection equipment located in the navigating bridge.
- **Depth Sound Devices(Sonar)**

  (A) Master Compass. Indicates true north and transmits this information electrically to compass repeaters at different parts of the watercrafts. The following are additional units connected to the master compass:

  (1) Course Recorder. Makes a continuous graphic record of watercraft's course, showing all changes to course, in degrees, and the time at which they occur; and

(2) Gyro-Pilot. Keeps watercraft automatically and accurately on course.

(3) Compass Repeaters. Receive and indicate true watercraft’s heading transmitted from the master compass.

(4) Alarm Unit. Provides a buzzer alarm to indicate failure of the watercraft’s supply or the repeater supply.

(5) Motor Generator. Converts the watercrafts supply to the voltages required by the compass equipment. A starter, furnishing protection against low voltage and overload accompanies the unit.

(6) Relay Transmitter Panel. Required if the electrical load of the repeaters and other units exceeds the capacity of the master compass transmitter.

Radio Direction Finder. Watercraft equipped with radio direction finding apparatus shall be provided with an efficient means of communication between the wheelhouse and the radio direction finder room.

Satellite Navigator. A highly sophisticated navigational instrument equipped on watercrafts for international/short international operations through transceiving information via satellite.

Article 9.32 - SHIPBOARD WIRING SYSTEMS

- **Scope and Application**

  Scope. Wirings for connection to systems of electrical machines and electrical/electronic equipment in various operation in watercrafts shall comply with the requirements in this article.

  Applications. The requirements in this article as well as the applicable requirements mentioned above shall apply to the permanent shipboard installation of fixed cables, flexible cables, and insulated conductors and fixture wires for propulsion, distribution of main emergency power, lighting, navigational, communication, signaling, heating or cooling, remote control and other utility circuits.

Cable Construction, Types of Cable Insulation and Classification of Insulation Materials

- Cable construction. Electric cables of recognized marine standards shall have conductors, insulation and moisture-resistant jacket.
- (1) Material of conductor. Conductors shall be made of copper not less than 1.0mm2 in cross-section and stranded in all sizes.
- (2) Type of cable insulation. The electric cables shall be at least of a flame retardant type. Flame retardant marine cables which have not passed the bunched cable. Communication wires not bunched nor braided together may be considered, provided they are installed on approved metallic bus duct.
- (3) Fiber Optic Cables. Fiber optic cables shall be constructed and tested to a recognized optic cable construction standard.

T/N Cable Construction. Cables constructed with Type T insulation may have insulation thickness as indicated below when a moisture resistant nylon jacket is provided on each individual insulated conductor. The maximum voltage rating for these cables is 750 volts.

Table 9.32.2.1(B) Types of Cable Insulations

Type Designation	Cable Insulation	Maximum Conductor Temperature, (°C)
T, T/N	Polyvinyl Chloride-Heat and Moisture Resisting	75
B	Butyl	80
X	Cross-Linked Polyethylene	85
E	Ethylene Propylene Rubber	85
M	Mineral (MI)	95*
S	Silicone Rubber	95

*A maximum conductor temperature of 250C is permissible for special applications and standard end fittings may be used provided the temperature does not exceed 85°C at the end fittings, however, when the temperature at the end fittings is higher than 85oC, special consideration will be given to an appropriate end fitting.

Table 9.32.2.2 Minimum Average Thickness of Type T Insulation and Nylon

Conductor Size (mm^2)	Type T Insulation Thickness (mm)	Nylon Jacket Thickness (mm)
Up to 3.5	0.38	0.1
5.5	0.51	0.1
8.0 - 14	0.76	0.13
22 - 30	1.02	0.15
38 - 100	1.27	0.18
125 - 250	1.65	0.2
325 - 500	1.78	0.23

9.32.2.3 Insulation Tests on Finished Cable.

If the cable is designed for an operating voltage between conductors and ground, different from that between

Insulation test on Finished Cable

(1) Dielectric Strength of Cable;

a. Test Voltage. Test shall be made by subjecting the insulation to an alternative voltage for 5 consecutive minutes; the initially applied voltage shall not exceed the working voltage and the rate of increase shall be uniform (not over 110% in 10 seconds nor less than 100% in 60 seconds) over the appropriate voltage required in Table 9.32.2.3(A)(1).

b. Frequency. The frequency of the applied voltage shall not exceed 100 hz and shall approximate a sine wave as closely as possible.

c. Multi-conductor Cable Test. If a multi-conductor cable is designed for the same operating voltage between conductors and ground between conductors, each conductor shall be tested against the other conductors connected together and to the sheath or water.

(2) Insulation Material.

a. Class A insulation. Materials or combination of materials such as cotton, silk and paper when suitably impregnated and coated or when immersed in a dielectric liquid such as oil.

b. Class B Insulation. Materials or combination of materials such as mica, glass fiber, asbestos, etc., with suitable bonding substances.

c. Class E Insulation. Materials or combinations of materials which, by experience or accepted test, can be shown to be capable of operation a 120 degrees Celsius.

d. class F insulation. Materials or combinations of materials such as mica, glass fiber, asbestos, etc., with suitable bonding substances. Not necessarily inorganic.

e. Class H insulation. Materials or combination of materials such as silicone elastomer, mica, glass fiber, asbestos, etc., with suitable bonding substance such as appropriate silicone resins.

Cable Insulation Resistance for New Installations. Each power and light circuit shall have an insulation resistance between conductors and between each conductor and ground of not less than the following values:

Up to 5 amperes load	2000000 ohms
10 amperes load	1000000 ohms
25 amperes load	400000 ohms
50 amperes load	250000 ohms
100 amperes load	100000 ohms
200 amperes load	50000 ohms
Over 200 ampere load	25000 ohms

- If the above values are not obtained, any of all appliances connected to the circuit may be disconnected for this test.

9.32.2.5 Cable Application

(A) Propulsion Cables. Ethylene-propylene rubber, crosslinked polyethylene, silicon rubber, or asbestos varnished cloth insulated cables shall be used for propulsion power cables except that polyvinyl chloride insulated cables may be used where the normal ambient temperature will not exceed 50 degrees C.

(B) Distribution Cables. All electrical cables for power, lighting, communication, control and electronic circuits shall have insulations suitable for a conductor temperature of not less than 60 degrees C.

(C) Portable and Flexible Electric Cables. In general, portable cables and cables subject to flexible service need not be armored.

(D) Battery cables. Where battery cable enter battery room, the holes shall be bushed and provided with pipe sleeves or stuffing tube with watertight packings.

(E) Control gear cables. Cables for control gears shall consist of not less than 7 strands and the conductors of a cross-sectional smaller than 2.0 mm2 shall not be installed except cable or wirings.

F) Generator cables. The power cables connecting the generator to the circuit breaker and busbar of the switchboard shall comply with the requirements for propulsion cables, and shall not be installed in bilges.

(G) Switchboard wires. Switchboard wires shall be of the stranded type not smaller than 1.25 mm2 and shall have flame-retardant and moisture-resistant insulation having the maximum conductor temperature not less than 75oC.

(H) Cables for Control, Monitoring and Instrumentation Circuits. Insulated wires for control and instrument circuits shall not be bunched together with wires for main circuits.

(I) Cables for Power and Lighting. Mineral-insulated cables provided with approved fittings for terminating and connecting to boxes, outlets and other equipment may be used for any service up to 600 volts.

(1) Feeders and Subfeeders. Feeders and subfeeders of any description shall be located as far as practicable, from spaces where excessive heat and gases may be encountered and exposed sides of deckhouses. They shall not enter oil tanks and cofferdam immediately adjacent to and extending below the top of the oil tanks except intrinsically-safe circuits with gastight fittings.

(2) Branch Circuits. Branch circuits shall have insulation suitable for a temperature of not less than 60oC.

(J) Cables for Essential Services. Cables for essential services and important for the propulsion and safety of the watercraft shall be of the flame-retardant type, mechanically protected and corrosion-resistant sheathed in locations where required. Essential services that are duplicated shall be served by individual circuits separated throughout their lengths as widely as is practicable, and without the use of common feeders, protective devices or control circuits. The following are examples of essential services.

(1) Air compressors for engine starting;

(2) Air compressor for heavy oil and for tanker washing of holds;

(3) Air pumps for general use;

(4) Ballast pump;

(5) Bilge pump;
(6) Brine pump;
(7) Cargo oil pump;
(8) Cargo refrigerating compressors;
(9) Condensate pump;
(10) Cooling water pump;
(11) Converters;
(12) Extraction pump;
(13) Fans for forced draft to boilers;
(14) Feedwater pump;
(15) Fire pump;
(16) Fuel oil burning units;
(17) Fuel oil pump;
(18) Fuel valve cooling pump;
(19) General service pump;

(20) Hoist shafts;

(21) Inert gas equipment;

(22) Inverter;

(23) Lift shafts;

(24) Lubricating oil pump;

(25) Main lighting system for those parts of the watercraft normally accessible to and used by crews and passengers;

(26) Motor-generator sets;

(27) Navigational aids where required by statutory regulations;

(28) Navigational lights and special purpose lights where required by statutory regulations;

(29) Oil separators;

(30) Oil drilling/production and habitat equipment;

(31) Potable water pump;

(32) Radio communication equipment;

(33) Sanitary pump;

(34) Scavenging blowers;

(35) Steering gears;

(36) Survival craft launching gears;

(37) Thrasher propellers;

(38) Transformers;

(39) Ventilating fans for machinery spaces, engine and boiler rooms;

(40) Ventilating fans for gas-dangerous rooms and for non-gas-dangerous rooms in the cargo tank area and adjacent to this area; and

(41) Winches and windlasses;

(K) Cables for Non-essential Services. Cables used for non-essential services shall be rated not less than the rated voltage and maximum current the cables are subjected to.

(L) Cables Associated with Intrinsically-safe Circuits. Cables associated with intrinsically-safe circuits shall be used only for such circuits. They shall be physically separated from cables associated with non-intrinsically-safe circuits.

(M) Cables for Explosion-proof Electrical Equipment. The lead-in part of cables for explosion-proof electrical equipment shall be of a construction suitable for watercraft cables. Consideration shall be given so that the cable can be rigidly secured at the lead-in part, except when the cables are installed in steel circuits.

(N) Cables for Alternating Current. Generally in ac installations, the wiring shall be made with multicore cables. The following precautions shall be observed:

(1) Single-Core Cables.

a. Non-magnetic Material. Cables shall be either non-armored or if armored it shall be with non-magnetic material.

b. Belonging to the Same Circuit. Where installed in pipe or conduit, cables belonging to the same circuit shall be contained within the same pipe or conduit.

c. Two, Three or Four Single-Core Cables. When installing 2, 3 or 4 single-core cables forming respectively single-phase circuit, three-phase circuit and neutral circuit, the cables shall be, in close contact with one another.

d. Installed Against Steel Bulkhead. Where single-core having a nominal rated current of 250 A or more, are installed against a steel bulkhead, the distance between the cables and bulkhead shall not be less than 50 mm. When the current exceeds 300 A, the distance shall not be less than 75 mm.

e. Pass Through Steel Plates. Where single-core cables pass through steel plates, all cables of the same circuit shall pass through a plate or gland so constructed that there is no magnetic material between the cables, and suitable clearance is provided between the cable core and magnetic material.

f. Glands for Passage of Cables. Glands for the passage of cables through bulkheads and decks shall be of non-magnetic metal. In addition, it may become necessary to place non-magnetic plates of sufficient size to obviate heating of the steel plating.

g. Skin Effect and Additional Losses. In ascertaining the size of cables, it is necessary too take into account the skin effect and additional losses in sheaths and armors, and the effects of bulkheads, ~~when cable runs pass along metallic plates or trough bulkheads of~~ magnetic metal.

h. Impedance. Impedance of circuits of considerable length, of large cross-section and consisting of single-core cable shall be, as far as possible, equalized. For this purpose, the phase may be transposed at intervals not exceeding 15 m or any other appropriate means used.

i. Cable of the Same Phase. In the case of circuits including several cables in parallel per phase, the cables of the same phase shall be, as much as possible, alternated with those of other phases.

~~(2) Multi-Conductor Cables. Multi-conductor ac cables~~ shall be mounted on supports.

(3) Single Conductor Cables. Single conductor cables may be used for power distribution provided the following arrangements are complied with:

(a) Cables are supported on non-fragile insulators;

(b) Protective metal covering, if provided, is grounded at the middle;

(c) There are no magnetic circuits around individual cable and no magnetic materials between cables of a group; and

(d) Single conductor cables shall be used when carrying negligible current;

(O) Cables for Emergency Alarm and Fire Detection. Cables used for emergency alarm and fire detection circuits shall be arranged to avoid galleys, machinery spaces and other enclosed spaces having high risk of fire, except where necessary to provide communication or to give alarm within these spaces to detect dire occurrences.

(P) Cables for Communication. All cables for communication shall be either lead-sheathed and armored, impervious-sheathed and armored or mineral-insulated metal-sheathed. In hazardous zones or spaces the cable shall be of flame-retardant type.

(Q) Electric Cables and Console Wiring. Refer to Section 9.30.1.10.

(R) High Voltage Cables. Refer to Sections 9.29.4.1 and 9.32.3.10.

9.32.3 Special Requirements

9.32.3.1 Tankers Intended for the Carriage in Bulk of Oil, Liquefied Gases and Other Hazardous Liquids.

(A) In Dangerous Zones or Spaces. Electric cables shall not be installed in dangerous zones or spaces except as permitted in this section, or when associated with intrinsically-safe circuits.

(B) Exposed to Cargo Oil, Oil Vapor or Gas. All cables which may be exposed to cargo oil, oil vapor or gas shall be sheathed with at least one of the following:

(1) Copper sheath (for mineral insulated cables);

(2) Lead alloy sheath plus further mechanical protection, e.g. armor or non-metallic impervious sheath; or

(3) Nonmetallic impervious sheath pus armor (for mechanical protection and ground detection).

(C) Where Corrosion May Be Expected. Where corrosion may be expected, nonmetallic impervious sheath shall be applied over metallic sheath or armor of cables.

(D) Against Mechanical Damage. Cables installed on deck and or on fore or aft gangways shall be protected against mechanical damage.

(E) Avoid Strain or Chafing. Cables shall be installed so as to avoid strain or chafing, and due allowance shall be made for expansion or working of the watercraft structure. Where expansion bends are fitted, they shall be accessible for maintenance.

(F) Pass Through Gastight Bulkheads or Decks. Where cables pass through gastight bulkheads or decks, separating dangerous zones or spaces from non-dangerous zones or spaces, arrangement shall be such that the gastight integrity of the bulkhead or deck shall not be impaired.

(G) Installed in Heavy Gauge Steel Pipes. Cables installed in pump rooms shall be suitably protected against mechanical damage. They shall be installed in heavy gauge steel pipes with gastight joints.

(H) Used in Safe Circuits. Cables to be installed shall be of intrinsically-safe or explosion-proof types as defines in Section 9.32.2.5(L) and (M), and for instrumentation, monitoring, control, communication circuits, and for power and lighting in hazardous spaces see Section 9.32.2.5(H) and (I).

(I) Distant from Decks. Cables shall be installed sufficiently distant from decks, bulkheads, tanks and various kind of pipes.

(J) Close to Hull Centerline. Cables shall be installed as close to the hull centerline as practicable.

(K) Grounding of Metal Covering. Metal covering of cables shall be grounded in accordance with Part 9.4.7 except that cables in final-subcircuits installed in dangerous zones of spaces shall be effectively grounded at both ends.

9.32.3.2 Electric Propulsion Systems.

(A) Essential for Maneuvering or Maintenance. Cables essential for maneuvering or maintenance of propelling power shall be stranded, having not less than 7 strands, and shall have a nominal cross-sectional area of not less than 3.5 mm2.

(B) Slip Rings of Synchronous Motors. Cables which are connected to the slip rings of synchronous motors shall be suitably insulated for the voltage to which they are subjected during maneuvering.

9.32.3.3 Cargo Ships with Spaces for Carrying Vehicles with Fuel (Other than Diesel Oil in their Tanks).

(A) Certified Safe Type. If electrical circuits if the gas detection system are located in the cargo hold they shall be of certified safe type.

(B) Terminating in Cargo Hold. All electrical circuits terminating in the cargo hold shall be provided with multipole linked isolating switches located outside the cargo hold. Provision shall be made for locking in the OFF position.

9.32.3.4 Motor Vehicle and Coal Carriers. Cables passing through the cargo holds shall be installed in gastight heavy gauge steel pipes, with both ends sealed using cable glands at the boundaries of the cargo holds.

9.32.3.5 Electric and Electrohydraulic Steering Gears. Electric and electrohydraulic steering gears shall be served by two circuits fed from the main switchboard. One of the circuits may pass through the emergency switchboard, if provided. Each circuit shall have adequate capacity for supplying all the motors which are normally connected to it and which operate simultaneously.

9.32.3.6 Automatic and Remote Electrical/Electronic Control Systems. The cables and console wirings of the automatic and remote electrical/electronic control shall comply with the following:

(A) Adequate Voltage Rating and Ampacity. All cables for power supply and wirings associated with the control system shall be of the listed types of adequate voltage rating and ampacity;

(B) Flame-retarding Type. All cables and wirings for control and monitoring circuits shall be of the flame-retarding type;

(C) Properly Supported. Cables and wiring having solid conductors shall be used in low energy circuits provided they are properly supported and not subjected to undue vibration and movement;

(D) Unsheathed and Unarmored. Cables and wiring used within control consoles need not be sheathed and armored.

(E) Shielded. Cables for monitoring and control circuits which carry low-level or information-level signals shall be provided with shields so as to minimize the introduction of spurious signals.

9.32.3.7 Lift or Hoist Shafts.

(A) Supplied form Main Switchboard. Lifts or hoists shall be supplied form the main switchboard, either directly or through a section board or sub-panelboard by cables which do no supply other equipment.

(B) Mechanically Protected. All cables other than traveling cables shall be armored, enclosed in metallic conduits, or protected with strong metallic guards. When metallic conduits are used, the control and power cables shall not be placed within the same conduit.

(C) Motor Cable and Flexible Traveling Cable. Cables supplying the lift shall not be incorporated within the flexible traveling cable used in connection the safety devices.

9.32.3.8 Tankers for the Carriage in Bulk of Oil Cargo Having a Flash Point Below 60oC (Closed Cup Test).

(A) Cofferdams Adjoining Cargo Tanks.

(1) Electric Depth-Sounding Devices. Electric depth-sounding devices hermetically enclosed, located clear of the cargo tank bulkhead, shall be provided with cables installed in heavy gauge steel pipes with gastight joints up to the main deck.

(2) Impressed Current Cathodic Protection Systems. Where impressed current cathodic protection systems are fitted, and it is essential for the connection cables to pass through the cofferdams, the cables shall be installed in heavy gauge steel pipes with gastight joints up to the main deck.

(3) Permanent Ballast Tanks. Cables passing through permanent ballast tanks (compartment filled with sea water) shall be protected with corrosion-resistant pipes for adequate mechanical protection.

(4) Other Cables. Where it is necessary for cables to pass through cofferdams adjoining cargo tanks, other than those supplying the equipment describe in (1), (2), and (3) above, they shall be installed in heavy gauge steel pipes with gastight joints.

(B) Cargo Pump Room.

(1) Same requirements as in (A) above.

(2) Cables for Lighting. Lighting cables shall be located in the non-dangerous space. Where it is necessary for cables other than those supplying lighting to pass through cargo pump room entrances, they shall be installed in heavy gauge steel pipes with gastight joints.

9.32.3.9 AC Installation and Special DC Installations.

(A) AC Installations.

(1) Multicore Cables. Multicore cables shall be used in ac installation. On three-phase, four-wire circuits, the cross-section of the neutral core shall be the same as for a phase core up to 16 mm2, and at least 50% of that of a phase core for larger cross-section up to 50 mm2.

(2) Single-Core Cables. Where single-core cables are used, the requirements in Section 9.32.2.5(N)(1) a to i shall be complied with.

(B) DC Installations. The above requirements for ac installations shall also apply for dc installations with a high “Ripple” content.

9.32.3.10 High Voltage Cables.

(A) Mechanical Protection. High voltage cables shall have a metallic sheath or armor. Where the high voltage cables having neither metallic sheath nor armor are used, they shall be protected by metallic ducts or pipes throughout their lengths. The metallic pipes or ducts shall be assured of their electrical continuity with ground.

(B) Not Run Through Accommodation Spaces. Where practicable, high voltage cables shall not be run through accommodation spaces.

(C) Segregated from Cables of Lower Voltages. High voltage cables shall be segregated, as far as practicable, from cables operating in lower voltages.

(D) Identifiable. All high voltage cables shall be readily identifiable by suitable marking.

(E) Circulating Currents. Where single-core cables are used, precautions shall be taken against circulating currents in the sheath or armor and the cables shall be transposed at intervals of about 16 m.

(F) Adequate Space. All high voltage equipment shall be so designed and located that adequate spaces are provided to ensure efficient cable terminations.

(G) Barriers. Wherever practicable, all conductors shall be effectively covered with suitable insulating material. In terminal boxes, if conductors are not insulated, phases shall be separated from grounding and each other by substantial barriers of suitable insulating material.

9.32.3.11 Lightning Ground Conductors. Each wooden mast or topmast shall be fitted with lightning ground conductors. They shall not be fitted to steel mast.

9.32.4 Installation Requirements

9.32.4.1 Propulsion Cables. (See Parts 9.6.31 and 9.6.32). Propulsion cables shall not have splices or joints except terminal joints and all cable terminals shall be sealed against the admission of moisture or air; similar precautions shall be taken during installation by sealing all cable ends until the terminals are permanently attached.

(A) Alternating-current Cable Installation. In general, in order to avoid overheating by induction, all phase wires shall be contained within the same sheath by use of multiple conductor cables.

(B) Multi-conductor AC Cables. Multi-conductor alternating-current cables shall be mounted on supports.

9.32.4.2 Generator Cables. Cables for main generator shall as far as possible be divided between two or more cable runs and separated as far as practicable. Generator cables shall not be installed in the bilges.

9.32.4.3 Feeders. Feeders shall avoid as far as practicable, spaces where excessive heat and gases may be encountered, also spaces where they may be exposed to damage.

9.32.4.4 Essential and Emergency Feeder and Branch Circuits. As far as practicable, circuits for essential or emergency equipment shall not pass through Category A machinery spaces, spaces containing internal combustion engines or oil fired units, galleys or laundries.

9.32.4.5 Internal Communication Cables. Cables used for internal communication shall be installed in a similar manner as cables installed for lighting and power.

9.32.4.6 Watercraft's Service Cables.

(A) Cable Joints and Sealing. Cables not having a moisture-resistant insulation (such as varnished cambric or mineral insulated) shall be sealed against the admission of moisture by methods such as taping in combination with insulating compound or sealing devices.

(B) Cable Support and Radii of Bends. Where cables are run in groups, they are preferably to be supported in metal hangers arranged as far as practicable to permit painting of the surrounding structure without undue disturbance to the installation.

(C) Cable Run in Bunches. Where cables which may be expected to operate simultaneously are laid close together in a cable bunch in such a way that there is an absence of free air circulation around them the following derating factor shall be applied to the current rating:

Number of Cables in One Bunch	Derating Factor
1 to 3	1.0
4 to 6	0.80
7 to 24	0.70
25 to 42	0.60
43 and above	0.50

(D) Alternating-current Cable Installations. Alternating-current cable installations shall comply with Section 9.32.4.1(A).

(E) Deck and Bulkhead Penetrations. Where cables pass through watertight, firetight, or smoke-tight bulkheads or decks, the penetrations shall be made through the use of approved stuffing tubes, transit devices, or pourable materials which will maintain the watertight, firetight, or smoke-tight integrity of the bulkheads or decks.

(F) Grounding of Cable Metallic Covering. Each armored cable and each mineral-insulated metal-sheathed cable shall have the metallic covering electrically and mechanically continuous and grounded to the metal hull at each end of the run except that final subcircuits may be grounded at the supply end only.

(G) Mechanical Protection. All cables liable to damage, such as in locations in way of cargo ports, hatches, tank tops, open decks subject to seas, and where passing through decks, shall be protected by substantial metal shields, structural shapes, pipe or other equivalent means.

(H) Mineral-insulated Metal-sheathed Cable. At all points where mineral-insulated metal-sheathed cable terminates an approval seal shall be provided immediately after stripping to prevent entrance of moisture into the mineral insulation.

9.32.4.7 Choice of Cable Runs.

(A) Straight and Accessible. Cable runs shall be, as far as practicable straight and accessible.

(B) Cables Behind Paneling and in Dome Fixtures. Cables may be run behind paneling, provided all connections are readily accessible without removal of the panels, and the location of concealed connection boxes is indicated.

(C) Cables Behind Sheathing. Cables may be installed behind sheathing, but they shall not be installed behind nor embedded in structural insulation, they shall pass through such insulation at right angles and shall be protected by a continuous pipe or duct with stuffing tube at one end.

(D) Cables Installed Well Clear of Substantial Heat Sources. Cable runs shall be installed well clear of substantial heat sources such as boilers, heated oil, tanks, steam, exhaust or other heated pipes, unless it is ensured that the insulation type and current rating is adapted to the actual temperature at such spaces.

(E) Cable Trays, Pipes or Ducts. Cable trays, pipes or ducts are generally not be used for other purposes.

(F) Different Routes of Duplicate Cables. The cables for duplicated steering gear motors shall follow different routes and shall be separated throughout their lengths as widely as practicable.

(G) Cables for Main Generators. (See Section 9.32.4.2).

(H) Cables Serving Essential and Important Loads. Cables supplying essential or important loads shall generally not to pass through such rooms which enclose compartments for fuel or lube oil purifiers, paint stores, welding gas bottles, galleys, laundries, and other high fire risk areas.

(I) Cables for Emergency Use. Emergency cable runs shall not be carried through rooms with excessive fire hazard as mentioned in (H) above.

(J) Across Expansion Joints. The installation of cables across expansion joints in any structure should be avoided.
(K) Cables of Different Maximum Rated Conductor Temperature. Cables with different temperature ratings shall not be bunched together.

(L) Voltages up to 100 Volts. Cables for voltages up to 1000 volts shall not be bunched together or run through the same pipes or ducts, or be terminated in the same box as cables for higher voltages.

(M) Damage to Covering of Other Cables. Cables having protective covering which may damage the covering of other cables shall not be bunched with those other cables.

(N) Increase Personnel Safety. To increase personnel safety (e.g. for socket-outlets in locations where extra precautions against shock are necessary), the cables for lower voltage shall not be bunched together with or run through the same pipes or ducts as cables for lower voltages above 600 volts.

9.32.4.8 Minimum Internal Radius of Bend of Cable. The minimum internal radius of bend of cable shall be in accordance with Table 9.32.4.8 [See Section 9.32.4.6(B)].

9.32.4.9 Securing Cables. [See Section 9.32.4.6(B)].

(A) Effectively Supported. Cables shall be effectively supported and secured without their covering being damaged, except cables of portable appliances and of those installed in pipes, conduits or special casings.

(B) Distance Between Supports. The distances between supports shall not be more than distances given in Table 9.32.4.9(B) and in accordance with the type of cable.

9.32.4.10 Cable Clips and Accessories.

(A) Sturdy and Surface Area. Clips shall be sturdy and shall have surface areas so large and shaped that the cables remain tight without their coverings being damaged.

(B) Corrosion-Resistant. Clips and accessories shall be of corrosion resistant material.

(C) Flame-Retardant. Clips made of material other than metal shall be flame-retardant.

(D) Release of Cables During Fire. Cables not laid on top of horizontal cable trays or cable supports but are supported by means of clips referred to in (C) above, special considerations shall be given in order to prevent the release of cables during a fire.

9.32.4.11 Cable Supports. [See Section 9.32.4.6(B)].

(A) Run in Groups. Where cables are run in groups, they shall be supported by metal hangers arranged, as far as practicable, to permit painting of the surrounding structure without undue disturbances to the installation.

(B) Single Cable Run. Single cable run shall be supported by metal clips screwed to deck or bulkhead, except on watertight bulkheads or decks.

(C) Cables Grouped in Single Hanger. Cables grouped in a single hanger shall be limited preferably to two banks.

(D) Spacing. Supports for cables shall be spaced in accordance with Table 9.32.4.9(B). For cables run in groups see Section 9.32.4.18, and for propulsion cable supports shall not be spaced more than 915 mm apart, and arranged to prevent chafing of the cable.

(E) Cables Running Transversely. Cables running transversely to and supported by clips or straps on the underside of beams shall be run on backing plates, cable racks or the equivalent between beams.

(F) Metal Supports. Metal supports shall be designed to secure cables without damage to insulation or armor and shall be so arranged that the cable will bear over a length of at least 13 mm.

Insulation	Finish	Overall Diameter	Minimum Internal Radius of Bend (Times Overall Diameter of Cable)
Rubber PVC (circular copper conductors)	Wire braid armored and unarmored	Not exceeding 10 mm	3
		Exceeding 10 mm but not exceeding 25 mm	4
			6
		Exceeding 25 mm	6
	Spiral steel wire armored	Any	8
Rubber or PVC (shaped copper conductors)	Wire braid armored, spiral steel wire armored or unarmored	Any	
Mineral	Copper sheathed with or without PVC covering	Any	4

Overall Diameter of Cable (mm)	Distance Between Supports (mm)		
	Non-armored Cables	Armored Cables	Mineral Insulated Cables
Not exceeding 7.6	200	250	300
Exceeding 7.6 not exceeding 12.7	250	300	370
Exceeding 12.7 not exceeding 20	300	350	450
Exceeding 20 not exceeding 30	350	400	450
Exceeding 30	400	450	450

9.32.4.12 Cable Joints. If a joint is necessary it shall be made so that all conductors are adequately secured, insulated and protected from atmospheric action.

(A) Flame-Retardant. Joints in cables shall be made flame-retardant for circuits serving appliances.

(B) Sealed Against Admission of Moisture. Cables not having a moisture-resistant insulation shall be sealed against the entry of moisture.

(C) Carried in Suitable Box. Joint of cable shall be made in a suitable box, except where method of connections causes n possible risk of affecting physical, mechanical or electrical characteristics of cables.

(D) Corrosive Soldering Parts. Soldering fluxes containing corrosive substances shall not be used in soldering the joints.

(E) Length of Soldering Fluxes. The length of soldered part of copper tube terminals shall not be less than 1.5 times the diameter of the conductor.

9.32.4.13 Cable Splicing. [See Section 9.32.4.6(A)].

(A) Splicing of Propulsion Cables. Propulsion cables shall not have splices or joints except terminal joints and all cable terminals shall be sealed against entry of moisture or air.

(B) Splicing of Electrical and Fiber Optic Cables.

(1) Continuous Lengths. Electric cables shall be installed in continuous lengths between terminations.

(2) Replacement Insulation and Jacket. Replacement insulation shall be fire resistant and equivalent in electrical and thermal properties to the original insulation. Splices shall be made using an approved splice kit which shall contain the following:

a. Connector of correct size and number;

b. Replacement insulation;

c. Replacement jacket; and

d. Instructions for use.

(3) Splices. Splices shall be made after the cable is in place and accessible for inspection. The conductor splice shall be made using a pressure type butt connector and a compression tool.

(4) Location. Splices may be located in protected enclosures or open wireways. Armored cables having splices shall not be required to have the armor replaced provided that the remaining armor has been grounded in compliance.

(5) Hazardous Location. No splices shall be allowed in hazardous locations except in intrinsically safe circuits.

(6) Fiber Optic Cables. Splicing of fiber optic cables shall be by means of approved mechanical or fusion methods.

9.32.4.14 Terminals and Terminal Boxes.

(A) Terminals. Terminals shall be of dimensions adequate for the cable rating and shall have sufficient contact surface and pressure.

(B) Terminal Boxes. Terminal boxes shall be secured in place and the moisture-resistant jacket shall extend through the cable clamp. [See Section 9.32.4.6(A)].

9.32.4.15 Enclosures. Enclosures for outlets, switches and similar fittings shall be flame-resistant and moisture-resistant, and of adequate mechanical strength and rigidity to protect the contents and to prevent distortion under all likely condition of services. [See Section 9.32.4.6(A)].

9.32.4.16 Mechanical Protection of Cables.

(A) Risk of Mechanical Damage. Cables exposed to risk of mechanical damage, such as in locations in way of cargo holds, tank tops, bunkers and open decks exposed and subjected in sea water splashing, in way of vehicle, cargo and van handling, and where passing through decks, shall be protected by substantial metal shields.

(B) Drainage Holes. Horizontal and vertical pipes or ducts used for cable protection shall be provided with drainage holes at its lowest portion to prevent water accumulation in the pipes or ducts.

(C) Water or Gas Tightness. Where cables provided with mechanical protection of pipes and ducts passes though decks and bulkheads, arrangements shall be made to insure the integrity of the water or gas tightness of the structure.

(D) Sturdy and Corrosion-Resistant. Mechanical protections shall be sturdy and of corrosion-resistant material or suitably corrosion inhibited before erection.

(E) Effectively Grounded. The mechanical protection shall be effectively grounded to the metal hull.

9.32.6.1 Definition.

Ambient Temperature. Means surrounding temperature.

9.32.6.2 Ambient Temperature of 45°C. The current ratings are based on an ambient temperature of 45°C.

9.32.6.3 Correction Factor. For other values of ambient temperatures, the correction factors given in Table 9.32.6.3 shall be applied.

Insulation	Correction Factor for Ambient Temperature, (°C)						
	25	30	35	40	45	50	55
Rubber PVC (General purpose)	1.53	1.41	1.29	1.15	1	0.82	0.58
PVC (Heat-resisting quality)	1.29	1.22	1.15	1.08	1	0.91	0.82
Butyl rubber	1.25	1.2	1.13	1.07	1	0.93	0.85
Ethylene propylene rubber, cross-linked polyethylene	1.22	1.17	1.12	1.06	1	0.94	0.87
Mineral, Silicone rubber	-	-	-	1.05	1	0.95	0.89

Correction Factor	Half-hour Rating		One Hour Rating	
	With Metallic Sheath (mm^2)	Without Metallic Sheath (mm^2)	With Metallic Sheath (mm^2)	Without Metallic Sheath (mm^2)
1	Up to 20	Up to 75	Up to 67	Up to 230
1.1	21-40	76-125	68-170	231-400
1.15	41-65	126-180	171-290	401-600
1.2	66-95	181-250	291-430	-
1.25	96-130	251-320	431-630	-
1.3	131-170	321-400	-	-
1.35	171-220	401-500	-	-
1.4	221-270	-	-	-

ARTICLE 9.33 – ADDITIONAL REQUIREMENTS FOR WATERCRAFTS CARRYING HAZARDOUS CARGOES

9.33.1 Watercrafts of the Bulk-oil-carrier Type and Watercrafts Carrying Oil Having a Flash Point of 60°C or Less.

9.33.1.1 Equipment Location. Electrical equipment of the intrinsically0safe type only shall be installed in cargo-pump rooms, ‘tween decks, cofferdams, enclosed spaces immediately adjoining the cargo oil tanks, or any similar spaces where vapor or gas may normally be expected to accumulate.

9.33.1.2 Cable Installation. A grounded distribution o a hull-return system shall not be used.

9.33.1.3 Cable Type. All cables installed within the hazardous zones on deck and in spaces described in Section 9.33.1.1 shall be moisture-resistant jacketed and armored or mineral-insulated metal-sheathed and all metallic protective coverings shall be grounded in accordance with Section 9.33.4.6(F).

9.33.1.4 Electrical Instrumentation. Low-energy electrical measuring or recording equipment may be installed in the tank or in enclosed spaces immediately adjoining the cargo oil tanks.

9.33.1.5 Pump-room Lighting. The lighting fixtures for pump-room spaces are to be permanently wired and fitted outside of the pump room except as noted below.

9.33.1.6 Pump Room Ventilation. Cargo oil pump rooms shall have a mechanical ventilating system capable of providing at least twenty air changes per hour based on the gross volume of the pump room.

9.33.1.7 Duct Keel Ventilation and Lighting. Where a permanent lighting system is installed in enclosed spaces such as pipe tunnels, double bottoms, or duct keels it shall be in accordance with Section 9.33.1.5.

(A) Ventilation. A mechanical ventilating system capable of providing at least eight air changes per hour based on the gross volume of the space shall be provided.

(B) Gas Detection System. An approved gas detection system shall be provided. Gas detection system shall be located as required to adequately monitor the double bottom (pipe trunk) spaces.

ARTICLE 9.34 – ADDITIONAL REQUIREMENT FOR RO/RO WATERCRAFTS

9.34.1.1 Ventilation Systems. Closed ro/ro spaces shall be provided with an effective power ventilation system sufficient to provide at least six air changes per hour based on an empty hold. The system shall be separated from other ventilating systems and the ducts, including dampers, shall be made of steel.

No. of Cores	Conductor			Nominal Diameter Over Sheath mm	Diameter of Metal Wire for Braid mm	Nominal Overall Diameter mm	Tolerance of Diameter Over Sheath and Overall Diameter ±mm	Approx. Weight kg/km	Conductor Resistance (20°C) Ω/km	Test Voltage V	Insulation Resistance (20°C) MΩ/km	Standard Length m
	Nominal Sectional Area mm²	No. and Diameter of Wires mm	Diameter mm									
3	1.25	7/0.45	1.35	13.1	0.32	14.7	0.6	340	17.10	2500	1500	500
	2.0	7/0.6	1.8	14.1	0.32	15.7	0.6	390	9.61	2500	900	500
	3.5	7/0.8	2.4	15.8	0.32	17.4	0.7	500	5.30	2500	800	500
	5.5	7/1.0	3.0	17.0	0.32	18.6	0.7	610	3.36	2400	700	500
	8.0	7/1.2	3.6	18.5	0.32	20.1	0.8	730	2.33	2400	600	500
	14	7/1.6	4.8	21.8	0.32	23.4	0.9	1020	1.31	2500	500	250
	22	19/1.2	6.0	25.0	0.32	26.6	1.0	1350	0.860	2500	400	250
	30	19/1.4	7.0	28.4	0.32	30.0	1.1	1760	0.631	2500	400	250
	38	19/1.6	8.0	31.2	0.32	32.8	1.2	2150	0.484	2500	350	100
	50	19/1.8	9.0	34.0	0.32	35.6	1.3	2580	0.382	2500	350	100
	60	19/2.0	10.0	36.7	0.32	38.3	1.4	3060	0.310	2500	350	100
	80	37/1.6	11.2	40.0	0.32	41.6	1.6	3640	0.248	2500	350	100
	100	37/1.8	12.6	44.0	0.32	45.6	1.6	4440	0.196	2500	300	100

1. Construction
(1) Coated, annealed copper wire, stranded
(2) Butyl rubber or rubber insulation
(3) Cloth tape (identified)
(4) Cabling (With jute)
(5) Cloth tape
(6) P.V.C. sheath
(7) Metal wire braid
(8) Paint

2. Test item
(1) Construction test
(2) Conductor resistance test
(3) Dielectric strength test
(4) Insulation resistance test
(5) Bending test
(6) Flammability test (Fire resisting)
(7) Material test

Notes
(1) Working Voltage:
a.c. 660V or less
d.c 1000V or less
(2) Maximum rated conductor temperature
Butyl rubber insulation : 80°C
Rubber insulation : 75°C

No. of Cores	Conductor			Nominal Diameter Over Sheath mm	Diameter of Metal Wire for Braid mm	Nominal Overall Diameter mm	Tolerance of Diameter Over Sheath and Overall Diameter ±mm	Approx. Weight kg/km	Conductor Resistance (20°C) Ω/km	Test Voltage V	Insulation Resistance (20°C) MΩ/km	Standard Length m
	Nominal Sectional Area mm^2	No. and Diameter of Wires mm	Diameter mm									
	1.25	7/0.45	1.35	6.1	0.32	7.7	0.4	120	16.70	1500	900	500
	2.0	7/0.6	1.8	6.7	0.32	8.3	0.4	145	10.42	1500	700	500
	3.5	7/0.8	2.4	7.3	0.32	8.9	0.4	170	5.20	1500	600	500
	5.5	7/1.0	3.0	8.1	0.32	9.7	0.4	210	3.29	1500	500	500
1	8.0	7/1.2	3.6	9.1	0.32	10.7	0.4	260	2.29	1500	500	500
	14	7/1.6	4.8	10.5	0.32	12.1	0.5	350	1.29	1500	400	500
	22	19/1.2	6.0	12.1	0.32	13.7	0.5	460	0.843	1500	350	500
	30	19/1.4	7.0	13.3	0.32	14.9	0.6	565	0.619	1500	350	500
	38	19/1.6	8.0	14.9	0.32	16.5	0.7	700	0.474	1500	350	500

1. Construction
(1) Coated, annealed copper wire, stranded
(2) Butyl rubber or rubber insulation
(3) Cloth tape (identified)
(4) P.V.C. sheath
(5) Metal wire braid
(6) Paint

2. Test item
(1) Construction test
(2) Conductor resistance test
(3) Dielectric strength test
(4) Insulation resistance test
(5) Bending test
(6) Flammability test (Fire resisting)
(7) Material test

Notes
(1) Working Voltage;
a.c. 250 V or less
d.c 450V or less
(2) Maximum rated conductor temperature;
Temperature : 75°C

No. of Cores	Conductor: Nominal Sectional Area mm²	Conductor: No. and Diameter of Wires mm	Conductor: Diameter mm	Nominal Diameter Over Sheath mm	Diameter of Metal Wire for Braid mm	Nominal Overall Diameter mm	Tolerance of Diameter Over Sheath and Overall Diameter ±mm	Approx. Weight kg/km	Conductor Resistance (20°C) Ω/km	Test Voltage V	Insulation Resistance (20°C) MΩ/km	Standard Length m
2	1.25	7/0.45	1.35	10.6	0.32	12.2	0.5	240	17.10	1500	900	500
	2.0	7/0.6	1.8	11.5	0.32	13.1	0.5	280	9.61	1500	700	500
	3.5	7/0.8	2.4	12.9	0.32	14.5	0.6	350	5.30	1500	600	500
	5.5	7/1.0	3.0	14.9	0.32	16.5	0.7	455	3.36	1500	500	500
	8.0	7/1.2	3.6	16.5	0.32	18.1	0.7	555	2.33	1500	500	500
	14	7/1.6	4.8	19.5	0.32	21.1	0.8	775	1.31	1500	400	500
	22	19/1.2	6.0	22.5	0.32	24.1	1.0	1030	0.860	1500	350	250
	30	19/1.4	7.0	25.1	0.32	26.7	1.1	1280	0.631	1500	350	250
	38	19/1.6	8.0	27.7	0.32	29.3	1.2	1560	0.484	1500	350	250

1. Construction
(1) Coated, annealed copper wire, stranded
(2) Butyl rubber or rubber insulation
(3) Cloth tape (identified)
(4) Cabling (With jute)
(5) Cloth tape
(6) P.V.C. sheath
(7) Metal wire braid
(8) Paint

2. Test item
(1) Construction test
(2) Conductor resistance test
(3) Dielectric strength test
(4) Insulation resistance test
(5) Bending test
(6) Flammability test (Fire resisting)
(7) Material test

Notes
(1) Working Voltage;
a.c. 250 V or less
d.c 450V or less
(2) Maximum rated conductor temperature;
Temperature : 75°C

No. of Cores	Conductor			Nominal Diameter Over Sheath mm	Diameter of Metal Wire for Braid mm	Nominal Overall Diameter mm	Tolerance of Diameter Over Sheath and Overall Diameter ±mm	Approx. Weight kg/km	Conductor Resistance (20°C) Ω/km	Test Voltage V	Insulation Resistance (20°C) MΩ/km	Standard Length m
	Nominal Sectional Area mm²	No. and Diameter of Wires mm	Diameter mm									
4	1.25	7/0.45	1.35	12.3	0.32	13.9	0.6	320	17.1	1500	900	500
5	1.25	7/0.45	1.35	13.4	0.32	15.0	0.6	370	17.1	1500	900	500
7	1.25	7/0.45	1.35	14.9	0.32	16.5	0.7	450	17.1	1500	900	500
9	1.25	7/0.45	1.35	17.1	0.32	18.7	0.7	550	17.1	1500	900	500
12	1.25	7/0.45	1.35	19.3	0.32	20.9	0.8	685	17.1	1500	900	500
16	1.25	7/0.45	1.35	21.5	0.32	23.1	0.9	825	17.1	1500	900	250
19	1.25	7/0.45	1.35	22.8	0.32	24.4	1.0	930	17.1	1500	900	250

1. Construction
   (1) Coated, annealed copper wire, stranded
   (2) Butyl rubber or rubber insulation
   (3) Cloth tape (identified)
   (4) Cabling (With jute)
   (5) Cloth tape
   (6) P.V.C. sheath
   (7) Metal wire braid
   (8) Paint

2. Test item
   (1) Construction test
   (2) Conductor resistance test
   (3) Dielectric strength test
   (4) Insulation resistance test
   (5) Bending test
   (6) Flammability test (Fire resisting)
   (7) Material test

Notes
   (1) Working Voltage;
   a.c. 250 V or less
   d.c 450V or less
   (2) Maximum rated conductor temperature;
   Temperature : 75°C

ARTICLE 9.35.1.1(H)

250V Double core, rubber insulated and polyvinylchloride sheathed flexible cord. (250V-DNP)

250V Three core, rubber insulated and polyvinylchloride sheathed flexible cord..

Symbol	No. of Cores	Nominal Sectional Area mm^2	No. and Diameter of Wires mm	Diameter mm	Nominal Overall Diameter mm	Tolerance of Diameter Over Sheath and Overall Diameter ±mm	Approx. Weight kg/km	Conductor Resistance (20°C) Ω/km	Test Voltage V	Insulation Resistance (20°C) MΩ/km	Standard Length m
250V-DNP	2	0.75	30/0.18	1.2	9.2	0.4	115	26.4	1500	900	200
		1.25	50/0.18	1.5	9.8	0.4	140	15.8	1500	800	200
		2.0	37/0.26	1.8	10.8	0.4	175	10.3	1500	700	200
		3.5	45/0.32	2.5	13.0	0.5	260	5.41	1500	600	200
		5.5	70/0.32	3.1	14.4	0.6	340	3.48	1500	500	200
		8.0	50/0.45	3.7	16.2	0.6	440	2.46	1500	450	200
		14	88/0.45	4.9	19.6	0.8	680	1.40	1500	400	200
250V-TNP	3	0.75	30/0.18	1.2	9.7	0.4	135	26.4	1500	900	200
		1.25	50/0.18	1.5	10.7	0.4	170	15.8	1500	800	200
		2.0	37/0.26	1.8	11.4	0.5	205	10.3	1500	700	200
		3.5	45/0.32	2.5	13.7	0.5	315	5.41	1500	600	200
		5.5	70/0.32	3.1	15.4	0.6	415	3.48	1500	500	200
		8.0	50/0.45	3.7	17.3	0.7	540	2.46	1500	450	200
		14	50/0.45	4.9	20.9	0.8	840	1.40	1500	400	200

(continues)

Symbol	No. of Cores	Nominal Sectional Area mm^2	No. and Diameter of Wires mm	Diameter mm	Nominal Overall Diameter mm	Tolerance of Diameter Over Sheath and Overall Diameter ±mm	Approx. Weight kg/km	Conductor Resistance (20°C) Ω/km	Test Voltage V	Insulation Resistance (20°C) MΩ/km	Standard Length m
250V-FNP	4	0.75	30/0.18	1.2	10.9	0.4	165	26.4	1500	900	200
		1.25	50/0.18	1.5	11.8	0.5	210	15.8	1500	800	200
		2.0	37/0.26	1.8	12.5	0.5	250	10.3	1500	700	200
		3.5	45/0.32	2.5	15.3	0.6	395	5.41	1500	600	200
		5.5	70/0.32	3.1	17.0	0.7	520	3.48	1500	500	200
		8.0	50/0.45	3.7	19.3	0.8	690	2.46	1500	450	200
		14	88/0.45	4.9	23.5	0.9	1085	1.40	1500	400	200

1. Construction
(1) Coated, annealed copper wire, stranded
(2) Paper tape
(3) Rubber insulation (identified)
(4) Cabling
(5) P.C.P. sheath

2. Test item
(1) Construction test
(2) Conductor resistance test
(3) Dielectric strength test
(4) Insulation resistance test
(5) Bending test
(6) Flammability test (Fire resisting)
(7) Material test

Notes
(1) Working Voltage;
a.c. 250 V or less
d.c 450V or less
(2) Maximum rated conductor temperature;
Temperature : 75°C

No. of Cores	Conductor: Nominal Sectional Area mm²	Conductor: No. and Diameter of Wires mm	Conductor: Diameter mm	Nominal Diameter Over Sheath mm	Radial Thickness of Tape mm	Diameter of Metal Wire for Braid mm	Nominal Overall Diameter mm	Tolerance of Diameter Over Sheath and Overall Diameter ±mm	Approx. Weight kg/km	Conductor Resistance (20°C) Ω/km	Test Voltage V	Insulation Resistance (20°C) MΩ/km	Standard Length m
3	1.25	7/0.45	1.35	11.2	0.5	0.32	13.8	0.6	755	17.10	1500	900	500
	2.0	7/0.6	1.8	12.3	0.5	0.32	14.9	0.6	900	9.61	1500	700	500
	3.5	7/0.8	2.4	13.6	0.5	0.32	16.2	0.6	1050	5.30	1500	600	500
	5.5	7/1.0	3.0	15.8	0.5	0.32	18.4	0.7	1370	3.36	1500	500	500
	8.0	7/1.2	3.6	17.7	0.5	0.32	20.3	0.8	1670	2.33	1500	500	500
	14	7/1.6	4.8	20.9	0.5	0.32	23.5	0.9	2210	1.31	1500	400	500
	22	19/1.2	6.0	24.1	0.5	0.32	26.7	1.1	2820	0.860	1500	350	250
	30	19/1.4	7.0	26.9	0.5	0.32	29.5	1.1	3420	0.631	1500	350	250
	38	19/1.6	8.0	29.7	0.5	0.32	32.3	1.3	4080	0.484	1500	350	250

1. Construction
   (1) Coated, annealed copper wire, stranded
   (2) Rubber insulation
   (3) Cloth tape (identified)
   (4) Cabling (With jute)
   (5) Cloth tape
   (6) Lead alloy sheath
   (7) Bituminous Compound
   (8) Cloth tape
   (9) Metal wire braid

2. Test item
   (1) Construction test
   (2) Conductor resistance test
   (3) Dielectric strength test
   (4) Insulation resistance test
   (5) Bending test
   (6) Flammability test (Fire resisting)
   (7) Material test

Notes
(1) Working Voltage:
a.c. 250 V or less
d.c 450V or less
(2) Maximum rated conductor temperature:
Temperature : 75°C

No. of Cores	Conductor			Nominal Diameter Over Sheath mm	Radial Thickness of Tape mm	Diameter of Metal Wire for Braid mm	Nominal Overall Diameter mm	Tolerance of Diameter Over Sheath and Overall Diameter ±mm	Approx. Weight kg/km	Conductor Resistance (20°C) Ω/km	Test Voltage V	Insulation Resistance (20°C) MΩ/km	Standard Length m
	Nominal Sectional Area mm^2	No. and Diameter of Wires mm	Diameter mm										
3	1.25	7/0.45	1.35	11.2	0.5	0.32	13.8	0.6	755	17.10	1500	900	500
	2.0	7/0.6	1.8	12.3	0.5	0.32	14.9	0.6	900	9.61	1500	700	500
	3.5	7/0.8	2.4	13.6	0.5	0.32	16.2	0.6	1050	5.30	1500	600	500
	5.5	7/1.0	3.0	15.8	0.5	0.32	18.4	0.7	1370	3.36	1500	500	500
	8.0	7/1.2	3.6	17.7	0.5	0.32	20.3	0.8	1670	2.33	1500	500	500
	14	7/1.6	4.8	20.9	0.5	0.32	23.5	0.9	2210	1.31	1500	400	500
	22	19/1.2	6.0	24.1	0.5	0.32	26.7	1.1	2820	0.860	1500	350	250
	30	19/1.4	7.0	26.9	0.5	0.32	29.5	1.1	3420	0.631	1500	350	250
	38	19/1.6	8.0	29.7	0.5	0.32	32.3	1.3	4080	0.484	1500	350	250

1. Construction
   (1) Coated, annealed copper wire, stranded
   (2) Rubber insulation
   (3) Cloth tape (identified)
   (4) Cabling (With jute)
   (5) Cloth tape
   (6) Lead alloy sheath
   (7) Bituminous Compound
   (8) Cloth tape
   (9) Metal wire braid

2. Test item
   (1) Construction test
   (2) Conductor resistance test
   (3) Dielectric strength test
   (4) Insulation resistance test
   (5) Bending test
   (6) Flammability test (Fire resisting)
   (7) Material test

Notes
(1) Working Voltage:
a.c. 250 V or less
d.c 450V or less
(2) Maximum rated conductor temperature:
Temperature : 75°C

Conductor Size mm^2	Conductor Construction (n/mm)	Conductor Diameter mm	Insulation Thickness mm	Diameter Over Sheath mm	Wire Diameter for Braid mm	Nominal Overall Diameter mm	Conductor Resistance Ω/km	Test Voltage V	Packing Length m
2.0	7/0.6	1.8	1.2	5.8	0.32	7.4	9.42	2500	500
3.5	7/0.8	2.4	1.2	6.4	0.32	8.0	5.20	2500	500
5.5	7/1.0	3.0	1.2	7.0	0.32	8.6	3.29	2500	500
8.0	7/1.2	3.6	1.6	8.	0.32	10.0	2.29	2500	500
14	7/1.6	4.8	1.6	9.6	0.32	11.2	1.29	2500	500
22	19/1.2	6.0	1.6	10.8	0.32	12.4	0.843	2500	500
30	19/1.4	7.0	1.6	11.8	0.32	13.4	0.619	2500	500
38	19/1.6	8.0	2.0	14.4	0.32	16.0	0.474	2500	500
50	19/1.8	9.0	2.0	15.4	0.32	17.0	0.375	2500	250
60	19/2.0	10.0	2.0	16.4	0.32	18.0	0.304	2500	250
80	37/1.6	11.2	2.0	17.6	0.32	19.2	0.244	2500	250
100	37/1.8	12.6	2.0	19.0	0.32	20.6	0.192	2500	250
TWO - CONDUCTOR (600V -DYYCuB)									
2.0	7/0.6	1.8	1.2	10.8	0.32	12.4	9.61	2500	500
3.5	7/0.8	2.4	1.2	12.0	0.32	13.6	5.30	2500	500
5.5	7/1.0	3.0	1.2	13.2	0.32	14.8	3.36	2500	500
8.0	7/1.2	3.6	1.6	16.6	0.32	18.2	2.33	2500	500
14	7/1.	4.8	1.6	19.0	0.32	20.6	1.31	2500	500
22	19/1.2	6.0	1.6	22.4	0.32	24.0	0.860	2500	250
30	19/1.4	7.0	1.6	24.4	0.32	26.0	0.631	2500	250
38	19/1.6	8.0	2.0	28.0	0.32	29.6	0.484	2500	250
50	19/1.8	9.0	2.0	30.0	0.32	31.6	0.382	2500	100
60	19/2.0	10.0	2.0	32.0	0.32	33.6	0.310	2500	100
80	37/1.6	11.2	2.0	34.4	0.32	36.0	0.248	2500	100
100	37/1.8	12.6	2.0	37.2	0.32	38.8	0.196	2500	100
THREE - CONDUCTOR (600V -TYYCuB)									
2.0	7/0.6	1.8	1.2	11.45	0.32	13.05	9.61	2500	500
3.5	7/0.8	2.4	1.2	12.74	0.32	14.34	5.30	2500	500
5.5	7/1.0	3.0	1.2	14.64	0.32	16.24	3.36	2500	500
8.0	7/1.2	3.6	1.6	17.65	0.32	19.25	2.33	2500	500
14	7/1.6	4.8	1.6	20.24	0.32	21.84	1.31	2500	250
22	19/1.2	6.0	1.6	23.83	0.32	25.43	0.860	2500	250
30	19/1.4	7.0	1.6	25.98	0.32	27.58	0.631	2500	250
38	19/1.6	8.0	2.0	29.86	0.32	31.46	0.484	2500	100
50	19/1.8	9.0	2.0	32.02	0.32	33.62	0.382	2500	100
60	19/2.0	10.0	2.0	34.17	0.32	35.77	0.310	2500	100
80	37/1.6	11.2	2.0	36.76	0.32	38.36	0.248	2500	100
100	37/1.8	12.6	2.0	39.77	0.32	41.37	0.196	2500	100