RULES FOR BUILDING AND CLASSING

MOBILE OFFSHORE DRILLING UNITS 2008

PART 4
MACHINERY AND SYSTEMS

American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862

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Rule Change Notice *(2008)*

The effective date of each technical change since 1993 is shown in parenthesis at the end of the subsection/paragraph titles within the text of each Part. Unless a particular date and month are shown, the years in parentheses refer to the following effective dates:

(2000) and after	1 January 2000 (and subsequent years)	*(1996)*	9 May 1996
(1999)	12 May 1999	*(1995)*	15 May 1995
(1998)	13 May 1998	*(1994)*	9 May 1994
(1997)	19 May 1997	*(1993)*	11 May 1993

Listing by Effective Dates of Changes from the 2006 Rules

Notice No. 1 (effective on 1 January 2007) which is incorporated in the 2008 Rules, is summarized below.

EFFECTIVE DATE 1 January 2007 – shown as *(2007)*
(based on the contract date for new construction between builder and Owner)

Part/Para. No.	*Title/Subject*	*Status/Remarks*
4-2-2/7.3	Plans and Data to be Submitted	To outline documentation to be submitted for plastic piping approval. (Incorporates Notice No. 1)
4-2-2/7.5.4	Temperature	To allow the use of polyethylene, polypropylene and polybutylene pipes. (Incorporates Notice No. 1)
4-2-2/7.5.9	Marking	To add a date of production to the marking for the purpose of traceability. (Incorporates Notice No. 1)
4-2-2/7.9	Manufacturing of Plastic Pipes	To clarify acceptance of a manufacturer's quality system and the involvement of the Surveyor during testing. (Incorporates Notice No. 1)
4-2-2/7.19 (New)	Testing by Manufacturer – General	To provide requirements for testing by manufacturer. (Incorporates Notice No. 1)
4-2-2/Table 3 (New)	Standards for Plastic Pipes – Typical Requirements for All Systems	To provide a list of applicable Standards that may be used in testing rigid pipes, pipe joints and fittings, based on IACS UR P4.7 and IACS Recommendation 86. (Incorporates Notice No. 1)
4-2-2/Table 4 (New)	Standards for Plastic Pipes – Additional Requirements Depending on Service and/or Location of Piping	To provide a list of applicable Standards that may be used in testing rigid pipes, pipe joints and fittings, based on IACS UR P4.7 and IACS Recommendation 86. (Incorporates Notice No. 1)
4-2-3/1.9	Termination of Vent Pipes	To provide technical details regarding the construction of corrosion resistant flame screens. (Incorporates Notice No. 1)
4-2-4/7.1	General	To align the requirement with the original terminology and intent as originated in the *Steel Vessel Rules* (1997). (Incorporates Notice No. 1)
4-2-6/7.1	General	To clarify the requirements for hazardous areas associated with helicopter storage and refueling equipment, based on IMO Resolution A.855(20) "Standards for On-Board Helicopter Facilities". (Incorporates Notice No. 1)
4-3-2/15.5.2 (New)	Communication in Case of an Emergency	To clarify the requirements for interior communication systems for non-self-propelled units, based on 5.6 of the IMO MODU Code. (Incorporates Notice No. 1)
4-3-2/15.9	Public Address System	To add titles to clarify the requirements.
4-3-3/9.7.3	Type Test	To align the requirements with IACS UR F29 (Rev. 5). (Incorporates Notice No. 1)
4-3-4/3.11.2	Ambient Temperature	To clarify the requirements for temperature rise for rotating machines installed outside of machinery spaces. (Incorporates Notice No. 1)

Part/Para. No.	*Title/Subject*	*Status/Remarks*
4-3-4/3.21.2	Voltage Regulation	To align the requirements with IACS UR E13. To clarify the requirements for the limits of voltage variation from rated voltage during transient conditions. (Incorporates Notice No. 1)
4-3-4/13.1.1	General	To align the requirements with the Second Edition of IEC 60092-376 "Electrical Installations in Ships – Cables for control and instrumentation circuits 150/250 V (300 V)". (Incorporates Notice No. 1)
4-3-4/Table 3	Limits of Temperature Rise for Air-Cooled Rotating Machines	To update the table and to clarify the requirements for temperature rise for rotating machines installed outside of machinery spaces. (Incorporates Notice No. 1)
4-3-5/3.3	System Design	To incorporate requirements to address new designs for electric propulsion systems. (Incorporates Notice No. 1)
4-3-5/3.17.9	Semiconductor Converters for Propulsion	To update and clarify the requirements. (Incorporates Notice No. 1)

EFFECTIVE DATE 1 January 2008 – shown as *(2008)*
(based on the contract date for new construction between builder and Owner)

Part/Para. No.	*Title/Subject*	*Status/Remarks*
4-1-1/15 (New)	Ambient Temperature	To specify the ambient temperatures of air and seawater, in line with the *Steel Vessel Rules*, and based on IACS UR M28 and M40.
4-1-1/Table 2 (New)	Ambient Temperatures for Unrestricted Service	To specify the ambient temperatures of air and seawater, in line with the *Steel Vessel Rules*, and based on IACS UR M28 and M40.
4-2-2/21.9	Sea-Water Inlet and Discharge Valves	To clarify that remote position indication for shell valves is to be independent of the actuating system to assure accuracy of the valve position.
4-2-6/5.3.3	Electrical Installation in Storage Room	To specify the types of electrical equipment that may be installed in hazardous areas associated with oxygen-acetylene rooms.
4-2-6/7.1.2	Hazardous Areas	To clarify the required gas group and temperature class equipment permitted in hazardous areas associated with helicopter refueling facilities.
4-3-1/9	Voltage and Frequency Variations	To incorporate IACS UR E5 (Rev. 1). To specify voltage variations for DC distribution systems (based on IEC 60092-101) and for battery systems (based on IEC 60092-504).
4-3-1/Table 1	Voltage and Frequency Variations	To incorporate IACS UR E5 (Rev. 1). To specify voltage variations for DC distribution systems (based on IEC 60092-101) and for battery systems (based on IEC 60092-504).
4-3-2/5.5.4	Emergency Generator for Non-emergency Services	To clarify that the protection of the emergency generator from overload is to be automatic and to align the requirement with IACS UI SC3.
4-3-2/9.3.2	Trip Setting for Coordination	To provide references to 4-3-2/9.5.1 and 4-3-2/9.5.2(a).
4-3-2/9.5.1	Short-time Delay Trip	To require the current setting of the short time delay trip to be less than the steady state short circuit current of the generator ensure that the generator breaker will trip in the event of a short circuit. Also, for generators less than 200 kW, to clarify that the thermal withstanding capacity of the generator is to exceed the steady state short circuit current until the tripping system activates.
4-3-2/9.5.2(a)	Instantaneous Trip	To provide a reference to 4-3-2/9.3.2.
4-3-3/1.9 (New)	Maintenance Schedule of Batteries	To incorporate IACS UR E18.
4-3-3/3.7.2(a)	Large Batteries	To specify the types of electrical equipment that may be installed in hazardous areas associated with battery rooms.
4-3-3/3.7.5 (New)	Maintenance of Batteries	To incorporate IACS UR E18.

Part/Para. No.	*Title/Subject*	*Status/Remarks*
4-3-3/3.7.6 (New)	Replacement of Batteries	To incorporate IACS UR E18.
4-3-3/3.29 (New)	Services Required to be Operable Under a Fire Condition	To incorporate IACS UR E15 (Rev. 2). To define the services required to be operable under a fire condition.
4-3-3/3.31 (New)	High Fire Risk Areas	To incorporate IACS UR E15 (Rev. 2). To provide examples of high fire risk areas.
4-3-3/5.9.3(a)	Installations	To relocate the requirements for flame retardancy from 4-8-4/5.9.3(e).
4-3-3/5.9.3(b)	Safe Working Load	To add a reference to Appendix 4-8-4A1 of the *Steel Vessel Rules*.
4-3-3/5.9.3(d) (New)	Hazardous Areas	To clarify that cable trays and protective casings passing through hazardous areas are to be electrically conductive in all cases.
4-3-3/5.9.3(e)	Type Testing	To clarify that cable trays and protective casings are to be tested to at least the tests specified in Appendix 4-8-4A1 of the *Steel Vessel Rules*.
4-3-3/5.17.1	Location	To incorporate IACS UR E15 (Rev. 2). To bring the requirements in line with the *Steel Vessel Rules* and to more clearly indicate the intent of the requirements.
4-3-3/5.17.2 (New)	Services Necessary Under a Fire Condition	To incorporate IACS UR E15 (Rev. 2). To specify the criteria for cables passing through high fire risk areas when the cables are for services required to be operable under a fire condition
4-3-3/Figure 2 (New)	Cables within High Fire Risk Areas	To incorporate IACS UR E15 (Rev. 2). To specify the criteria for cables passing through high fire risk areas when the cables are for services required to be operable under a fire condition
4-3-4/7.3.1(d)	Battery Charger Units, Uninterruptible Power Supply (UPS) Units, and Distribution Boards	To incorporate requirements for Surveyor attendance for UPS units of 50 kVA and over and battery charger units of 25 kW and over.
4-3-4/7.19	Battery Systems and Uninterruptible Power Systems (UPS)	To clarify the application of the requirements.
4-3-4/7.19.1 (New)	Definitions	To add definitions for uninterruptible power systems.
4-3-4/7.19.2	Battery Charging Rate	To clarify application to battery charger units and UPS units.
4-3-4/7.19.3	Reversal of Charging Current	To clarify application to battery charger units and UPS units.
4-3-4/7.19.4 (New)	Design and Construction	To incorporate the requirements of IACS UR E21.
4-3-4/7.19.5 (New)	Location	To clarify the requirements for locating battery charger units, UPS units and the associated batteries.
4-3-4/7.19.6 (New)	Performance	To specify performance requirements for battery duration, battery capacity and battery recharging.
4-3-4/7.19.7 (New)	Testing and Survey	To specify the testing requirements for battery charger units and UPS units.
4-3-4/13.1.1	General	To incorporate the requirements of IACS UR E7 (Rev 3).
4-3-4/13.1.3	Fire Resistant Property	To incorporate IACS UR E15 (Rev. 2). To provide a cross reference to 4-3-3/3.29 and 4-3-3/5.17.
4-3-5/1.11.3(a)	Application	To update the references to the current IEC standards.
4-3-5/3.7.6 (New)	Direct-current (DC) Propulsion Motors Supplied by Semiconductor Converters	To require submission of the maximum time-current characteristics that can be commutated by a DC motor, as well as the time-current current characteristics of the protective features of semiconductor converters, in order to avoid flashovers.

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CHAPTER **1 Machinery, Equipment, and Their Installation**

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CHAPTER 1 Machinery, Equipment, and Their Installation

SECTION 1 General

1 Machinery and Equipment

Propulsion equipment, boilers, pressure vessels, heat exchangers, internal combustion engines, turbines, steering gear and other applicable equipment are to be in accordance with the requirements of the ABS *Rules for Building and Classing Steel Vessels (Steel Vessel Rules)*, except as modified herein.

3 Drilling Equipment

Equipment and systems used solely for drilling operations and complying with an applicable recognized standard need not be in accordance with these Rules or the *Steel Vessel Rules,* except where specifically stated in these Rules.

5 Certification of Machinery *(2003)*

5.1 Basic Requirements

The Rules define, to varying degrees, the extent of evaluation required for products, machinery, equipment and their components based on the level of criticality of each of those items. There are three basic evaluation constituents:

- Design review; prototype testing;
- Survey during construction and testing at the plant of manufacture; and
- Survey during installation onboard the vessel and at trials.

Where design review is required by the Rules, a letter will be issued by the Bureau upon satisfactory review of the plans to evidence the acceptance of the design. In addition to, or independent of, design review, the Bureau may require survey and testing of forgings, castings and component parts at the various manufacturers' plants, as well as survey and testing of the finished product. A certificate or report will be issued upon satisfactory completion of each survey to evidence acceptance of the forging, casting, component or finished product. Design review, survey and the issuance of reports or certificates constitute the certification of machinery.

Based on the intended service and application, some products do not require certification because they are not directly related to the scope of classification or because normal practices for their construction within the industry are considered adequate. Such products may be accepted based on the manufacturers' documentation on design and quality.

In general, surveys during installation onboard the vessel and at trials are required for all items of machinery. This is not considered a part of the product certification process. There may be instances, however, where letters or certificates issued for items of machinery contain conditions which must be verified during installation, tests or trials.

5.3 Type Approval Program

Products that can be consistently manufactured to the same design and specification may be Type Approved under the ABS Type Approval Program. The ABS Type Approval Program is a voluntary option for the demonstration of the compliance of a product with the Rules or other recognized standards. It may be applied at the request of the designer or manufacturer. The ABS Type Approval Program generally covers Product Type Approval [1-1-4/9.7.3 of the *Rules for Classification of Offshore Units and Structures (Part 1)*], but is also applicable for a more expeditious procedure towards Unit-Certification, as specified in 1-1-4/9.7.2 of the above-referenced Part 1.

See the *ABS Type Approval Program* in Appendix 1-1-A3 of the *Rules for Classification of Offshore Units and Structures (Part 1)*. The ABS *Type Approval Program* and the indicated references are available for download from the ABS website at http://www.eagle.org/absdownloads/index.cfm.

5.5 Non-mass Produced Machinery

Non-mass produced critical machinery such as propulsion boilers, slow speed diesel engines, turbines, steering gears and similar critical items are to be individually unit certified in accordance with the procedure described in 4-1-1/5.1. However, consideration will be given to granting Type Approval to such machinery in the categories of Acceptable Quality System (AQS) and Recognized Quality System (RQS). The category of Product Quality Assurance (PQA) will not normally be available for all products, and such limitations will be indicated in 4-1-1/Table 1 through 4-1-1/Table 6 of the *Steel Vessel Rules*. In each instant where Type Approval is granted, in addition to quality assurance and quality control assessment of the manufacturing facilities, the Bureau will require some degree of product specific survey during manufacture.

5.7 Details of Certification of Some Representative Products

4-1-1/Table 1 through 4-1-1/Table 6 of the *Steel Vessel Rules* provide abbreviated certification requirements of representative machinery based on the basic requirements of the Rules for machinery. The tables also provide the applicability of the Type Approval Program for each of these machinery items.

For easy reference, the tables contain six product categories, as follows:

- Prime movers
- Propulsion, maneuvering and mooring machinery
- Electrical and control equipment
- Fire safety equipment
- Boilers, pressure vessels, fired equipment
- Piping system components

7 Inclinations *(1995)*

All machinery, components and systems essential for propulsion or for safe operation of the unit are to be designed to operate under the inclinations as indicated for each of the conditions listed in 4-1-1/Table 1.

TABLE 1
Angle of Inclination *(1995)*

Condition	*Static*	*Dynamic*
Column-Stabilized Units	15° in any direction	22.5° in any direction
Self-Elevating Units	10° in any direction	15° in any direction
Surface Units	15° list and 5° trim simultaneously	22.5° rolling and 7.5° pitching simultaneously

9 Plans and Data to be Submitted

The following data are generally to be submitted in triplicate:

- Arrangement plans clearly indicating the hazardous areas as outlined in Section 4-1-3.
- A description of the ventilating system for all hazardous areas
- Complete particulars of the ventilating system including capacities of fans, number of complete changes of air per minute, air flows, areas subject to positive and negative pressure, and location and direction of opening of self-closing doors
- A description of the jacking or other elevating system for self-elevating units including design plans showing the arrangement and details of the elevating system and all electric or hydraulic controls, design calculations, hydraulic cylinder details, jacking motor specifications/operating characteristics and the design loadings transmitted through the system
- A description of equipment for moving cantilevers, skid beams or moveable substructures, including piping and electrical systems, details of mechanical components, including hold-down devices and applicable strength calculations

10 Blackout and Dead Ship Condition *(2004)*

10.1 Blackout

Blackout situation means the loss of the main source of electrical power resulting in the main and auxiliary machinery being out of operation.

10.3 Dead Ship Condition

Dead ship condition means a condition under which:

i) The main propulsion plant, boilers and auxiliary machinery are not in operation due to the loss of the main source of electrical power, and

ii) In restoring propulsion, the stored energy for starting the propulsion plant, the main source of electrical power and other essential auxiliary machinery is assumed to be not available.

11 Dead Ship Start *(2005)*

Means are to be provided to bring the machinery into operation from a "dead ship" condition, as defined in 4-1-1/10.3. See 4-3-2/3.1.4 and 4-3-3/3.27 for the required starting arrangements.

13 Unattended Machinery Spaces

Controls necessary for safe operation are to be provided for machinery in spaces which are not normally manned. Relevant data is to be submitted to permit the assessment of the effect of such controls on the safety of the unit. See 4-2-3/3.7 for bilge alarm systems and 5-3-1/15 for fire precautions for such spaces.

15 Ambient Temperature *(2008)*

For drilling units of unrestricted service, ambient temperature, as indicated in 4-1-1/Table 2, is to be considered in the selection and installation of machinery, equipment and appliances. For drilling units of restricted or special service, the ambient temperature appropriate to the special nature is to be considered.

TABLE 2
Ambient Temperatures for Unrestricted Service *(2008)*

	Location	*Range of Temperature*
Air	Enclosed spaces [1, 2]	0 to 45°C
	Open deck [1]	–25 to 45°C

	Temperature
Seawater	32°C

Notes:

1 Electronic equipment is to be suitable for operations even with an air temperature of 55°C. See also 4-3-1/17.3.

2 Electrical equipment in machinery spaces is to be designed for 45°C, except that electric generators and motors are to be designed for 50°C. Electrical equipment outside machinery space may be designed for 40°C.

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CHAPTER 1 Machinery, Equipment, and Their Installation

SECTION 2 Rotating Machinery

1 Drilling Units without Propulsion Machinery

Rotating mechanical and electrical machinery, except that used solely for drilling or related operations, is to be of approved type, but need not be inspected at the plant of the manufacturer whose guarantee of the machine will be accepted, subject to satisfactory performance witnessed by the Surveyor after installation.

3 Internal Combustion Engines Designed for Drilling Operations

Internal combustion engines used solely for drilling operations need not be of approved type and need not be inspected at the plant of manufacture. Such equipment need only be provided with the safety provisions below and 4-2-6/9.

3.1 Crankcase Ventilation *(1997)*

3.1.1 General

Provision is to be made for ventilation of an enclosed crankcase by means of a small breather or by means of a slight suction not exceeding 25.4 mm (1 in.) of water. Crankcases are not to be ventilated by a blast of air. Otherwise, the general arrangements and installation are to be such as to preclude the possibility of free entry of air to the crankcase.

3.1.2 Piping Arrangement

Crankcase ventilation piping is not to be directly connected with any other piping system. Crankcase ventilation pipes from each engine are normally to be led independently to the weather and fitted with corrosion-resistant flame screens. However, crankcase ventilation pipes from two or more engines may lead to a common oil mist manifold.

Where a common oil mist manifold is employed, the vent pipes from each engine are to be led independently to the manifold and fitted with a corrosion-resistant flame screen within the manifold. The arrangement is not to violate the engine manufacturer's recommendations for crankcase ventilation. The common oil mist manifold is to be accessible at all times under normal conditions and effectively vented to the weather. Where venting of the manifold to the weather is accomplished by means of a common vent pipe, the location of the manifold is to be as close as practicable to the weather such that the length of the common vent pipe is no greater than one deck height. The clear open area of the common vent pipe is not to be less than the aggregate cross-sectional area of the individual vent pipes entering the manifold, and the outlet to the weather is to be fitted with a corrosion-resistant flame screen. The manifold is also to be fitted with an appropriate draining arrangement.

3.3 Explosion Relief Valves

3.3.1 General

Explosion relief valves are to be installed on enclosed crankcases of all engines having a cylinder bore exceeding 200 mm (8 in.) or having a crankcase gross volume exceeding 0.6 m^3 (21 ft^3). The free area of each explosion relief valve is not to be less than 45 cm^2 (7 in^2), and the total free area of all relief valves is to be not less than 115 cm^2 for each cubic meter (one square inch for each two cubic feet) of crankcase gross volume. The volume of the fixed parts in the crankcase may be deducted in estimating gross volume. The explosion relief valves are to be of the return-seating type, are to relieve the pressure readily at not more than 0.2 bar (0.2 kgf/cm^2, 3 psi) and are to close quickly in order to prevent an inrush of air. In the arrangement and location of valves, consideration is to be given to minimizing the danger from emission of flame.

3.3.2 Location of Valves

All engines of this category having a bore exceeding 200 mm (8 in.), but not exceeding 250 mm (10 in.), are to have at least one valve near each end. However, for engines with more than 8 crank throws, an additional valve is to be fitted near the middle of the engine. Engines having a bore exceeding 250 mm (10 in.), but not exceeding 300 mm (12 in.), are to have at least one valve in way of each alternate crank throw, with a minimum of two valves. Engines having a bore exceeding 300 mm (12 in.) are to have at least one valve in way of each main crank throw. Each one of the relief valves to be fitted as required above may be replaced by not more than two relief valves of smaller area, provided the free area of each valve is not less than 45 cm^2 (7 in^2).

3.3.3 Additional Valves Required

Explosion relief valves are to be fitted in scavenge spaces in open connection to the cylinders for engines having a cylinder diameter greater than 230 mm (9 in.). Additional relief valves are to be fitted on separate spaces of the crankcase such as gear or chain cases for camshaft or similar drives when the gross volume of such spaces exceeds 0.6 m^3 (21 ft^3).

3.5 Fire Extinguishing Systems for Scavenge Manifolds

For crosshead type engines, scavenge spaces in open connection to the cylinder are to be permanently connected to an approved fire extinguishing system entirely separate from the fire extinguishing system of the engine room. A steam smothering system is acceptable for this purpose.

3.7 Warning Notices

Suitable warning notices are to be attached in a conspicuous place on each engine and are to caution against the opening of a hot crankcase for a specified period of time after shutdown based upon the size of the engine, but not less than 10 minutes in any case. Such notice is also to warn against restarting an overheated engine until the cause of overheating has been remedied.

3.9 Governor Control

All engines of this category are to be fitted with governors which will prevent the engines from exceeding the rated speed by more than 15%. For generator sets, see 4-2-1/7.5.1, 4-2-3/7.5.1 and 4-2-4/7.5.1 of the *Steel Vessel Rules*.

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SECTION 3 Jacking or Other Elevating Systems

1 General

The elevating system on self-elevating units is to be designed and constructed with sufficient redundancy so that upon failure of any one component, the system will be capable of continuing to jack or holding in place. Strength calculations of the elevating system are to be submitted in accordance with 4-1-1/9. Load calculations are to consider at least three conditions: maximum jacking load, maximum normal holding load and the maximum severe storm load. The elevated unit and elevated leg conditions are each to be considered for these calculations. Maximum jacking and maximum normal holding capacity may be considered as static conditions, as defined in 3-2-1/1.1i). Severe storm conditions are to include the most adverse combination of variable loadings, in accordance with 3-2-1/1.1ii) and 3-2-3/5.1.5. For hydraulic cylinder or yoke type systems, the cylinders are to be designed in accordance with 4-2-2/19.3.

For electric motor branch circuit protection, see 4-1-3/7.

3 Allowable Stresses

For the purpose of strength calculation of the jacking system and for designing mechanical components (including pins), the factor of safety, F.S., is to comply with 3-2-1/3.3, as applicable, except that high speed gear reducers (next to electric motors) are to comply with a recognized standard such as American Gear Manufacturers Association (AGMA) standards.

5 Material

The material specifications for jacking or other elevating systems are to be submitted by the designer. Material for the frame which attaches to the hull structure is to meet the toughness requirements for primary application (see 3-1-3/5.3.2) at the specified design temperature. Material for the frame which will be used in cases of floating jacking systems, or the yoke material of systems actuated by hydraulic cylinders, is to meet the toughness criteria for secondary application (see 3-1-3/5.3.1) at the specified design temperature.

7 Jacking Gear Motors and Motor Controllers

Jacking gear motor installations are to be in accordance with Part 4, Chapter 3, except that group motor installations will be permitted as follows.

7.1 Group Installations

On each leg, two or more motors of any horsepower may be connected to a single branch circuit.

7.3 Overcurrent Protection

The branch circuit is to be provided with short circuit protection set at not greater than ten times the sum of the full load currents of the motors.

7.5 Running Protection

A visual and audible alarm is to be given at the Jacking Control Station to indicate an overload condition in any of the jacking motors.

7.7 Metering

The ammeter or wattmeter required by 4-1-3/11 need only monitor the branch circuit and not each individual motor.

9 Hydraulic Cylinders

Hydraulic cylinder material is to be in accordance with 4-2-2/19.3.

11 Instrumentation

Suitable monitoring of the system is to be provided at the controls for elevating operations. As appropriate, this monitoring is to indicate availability of power, pumps running, position of yoke, out of level, pin position, jacking cylinder rod position, head end pressure, air pressure, hydraulic pressure, electrical power of current motor running and motor overload.

13 Other Components

For other component parts, such as pins, pinions, gears, couplings, coupling bolts and shafts of rack and pinion units, the material specifications will be subject to approval and are to be submitted by the designer. These specifications are to include as a minimum, chemical composition, ultimate tensile strength, yield strength, reduction of area, elongation, hardness for gears and coupling teeth, and where available, impact values for gears.

15 Inspection and Material Testing

All jacking or other elevating systems are to be constructed and installed to the satisfaction of the Surveyor in accordance with approved plans. Welded construction is to be in compliance with the applicable requirements of Sections 3-2-6 and 3-2-7 of these Rules and Chapter 4 of the ABS *Rules for Materials and Welding (Part 2)*. Material tests are to be carried out in accordance with Chapters 1 to 3 of the above referenced Part 2. Gears of the climbing pinion gear train are to be examined at the plant of the manufacturer by an approved crack detection procedure and such an examination is to be witnessed by the Surveyor. Acceptance of components manufactured at a plant which is under a Bureau approved quality assurance program will be subject to special consideration.

17 Low Temperature Operation

Jacking systems of units whose loading environmental criteria consider operation below –20°C (–4°F) will be subject to special consideration.

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CHAPTER 1 Machinery, Equipment, and Their Installation

SECTION 4 Thrusters and Dynamic Positioning Systems

1 Thrusters and Dynamic Positioning Systems

Compliance with the provisions of Section 4-3-5 of the *Steel Vessel Rules* is required for main propulsion thrusters in all cases and for propulsion assist thrusters, athwartship thrusters and dynamic positioning systems, including their thrusters, where an optional notation notation in accordance with 1-1-3/15 or 1-1-3/17 of the ABS *Rules for Classification of Offshore Units and Structures (Part 1)* is desired.

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CHAPTER 2 Pumps and Piping Systems

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CHAPTER 2 Pumps and Piping Systems

SECTION 1 General

1 General Requirements

Piping systems are to be in accordance with the applicable requirements of this Section. Piping systems used solely for drilling operations and complying with a recognized standard need not be in accordance with these Rules. All piping systems are to be installed and tested in accordance with the Rules or recognized standards to the satisfaction of the attending Surveyor. See also 4-1-1/9.

1.1 Damage Stability

When considering the design and layout of piping systems, consideration is to be given to the damage stability requirements and the assumed extent of damage for the type of unit under consideration, as outlined in 3-3-1/7.

1.3 Segregation of Piping Systems

Piping systems carrying non-hazardous fluids are to be segregated from piping systems which may contain hazardous fluids. Cross connection of the piping systems may be made where means for avoiding possible contamination of the non-hazardous fluid system by the hazardous medium are provided.

1.5 Piping Groups

To distinguish between detail requirements of the various systems, the piping is divided into two groups.

Group I, in general, includes all piping intended for working pressures or temperatures in various services, as follows.

Service	*Pressure bar (kgf/cm^2, psi)*	*Temperature °C (°F)*
Vapor and Gas	over 10.3 (10.5, 150)	over 343 (650)
Water	over 15.5 (15.8, 225)	over 177 (350)
Lubricating Oil	over 15.5 (15.8, 225)	over 204 (400)
Fuel Oil	over 10.3 (10.5, 150)	over 66 (150)
Hydraulic Fluid	over 15.5 (15.8, 225)	over 204 (400)

Group II includes all piping intended for working pressures and temperatures below those stipulated under Group I and such open-ended lines as drains, overflows, vents and boiler escape pipes.

3 Plans and Data to Be Submitted

3.1 Plans

Before proceeding with the work, plans are to be submitted, showing clearly the diagrammatic details or arrangement of the following.

- General arrangement of pumps and piping
- Sanitary system
- Bilge and ballast systems
- Compressed air systems
- Essential control-air systems
- Vent, sounding and overflow pipes
- Fuel-oil filling, transfer and service systems
- Boiler-feed systems
- Steam and exhaust piping
- Lubricating-oil systems
- Hydraulic power piping systems
- Essential sea-water and fresh-water service systems
- Starting-air systems
- Fire-main and fire-extinguishing systems (see Part 4, Chapter 4)
- Steering-gear piping systems
- Systems conveying toxic liquids, low flash point below 60°C (140°F) liquids or flammable gas.
- Exhaust piping for internal combustion engines and boilers
- All Group I piping systems not covered above, except for those which form part of an independently manufactured unit.
- A description of the bilge, ballast and drainage systems
- A description of the ballast control system for column-stabilized units
- A description and diagrammatic plans of all piping systems used solely for the drilling operations, including their cross connections, where applicable with other non-drilling related systems.
- *(1995)* Diagrams showing the extent to which the watertight and weathertight integrity is intended to be maintained, including the location, type and disposition of watertight and weathertight closures.

3.3 All Piping Systems

The plans are to consist of a diagrammatic drawing of each system accompanied by lists of material giving size, wall thickness, maximum working pressure and material of all pipes and the type, size, pressure rating and material of valves and fittings. Where superheated steam is used, the temperatures are also to be given.

3.5 Booklet of Standard Details

A booklet of standard piping practices and details, including such items as bulkheads, deck and shell penetrations, welding details including dimensions, pipe joining details, etc. is to be submitted. Pipe weld details are to comply with Chapter 4 of the ABS *Rules for Materials and Welding (Part 2)*. Applicable limitations should be specified.

5 Material Tests and Inspection

5.1 Specifications and Purchase Orders

The appropriate material to be used for the various pipes, valves and fittings is indicated in 4-1-1/5 to 4-2-2/19. The material is to be made in accordance with the requirements in Chapter 3 of the ABS *Rules for Materials and Welding (Part 2)*, except that tests of material for valves and fittings and fluid power cylinders need not be witnessed by the Surveyor. Where electric welding is used, the requirements in Chapter 4 of the above-referenced Part 2 are also applicable. Copies in duplicate of the purchase orders for material requiring test and inspection at the mills or place of manufacture are to be forwarded to the Bureau for the information of the Surveyor.

5.3 Special Materials

If it is desired to use special alloys or other materials not covered by the Rules, the use of such materials will be specially considered for approval.

9 General Installation Details

9.1 Protection

Pipes, valves and operating rods are to be effectively secured and adequately protected. These protective arrangements are to be fitted so that they may be removed to enable examination of the pipes, valves and operating rods protected.

9.3 Pipes Near Switchboards

The leading of pipes in the vicinity of switchboards is to be avoided as far as possible. When such leads are necessary, care is to be taken to fit no flanges or joints over or near the switchboards unless provision is made to prevent any leakage from injuring the equipment.

9.5 Expansion or Contraction Stresses *(2004)*

Ample provision is to be made to take care of expansion or contraction stresses in pipes due to temperature changes or working of the hull. Suitable provisions include, but are not limited to, piping bends, elbows, offsets, changes in direction of the pipe routing or expansion joints. Slip joints of an approved type may be used in systems and locations where possible leakage will not be critical. See also 4-2-4/5.3 and 4-2-4/11.3.

Where expansion joints are used, the following requirements apply:

- *Pipe support.* Adjoining pipes are to be suitably supported so that the expansion joints do not carry any significant pipe weight.
- *Alignment.* Expansion joints are not to be used to make up for piping misalignment errors. Misalignment of an expansion joint reduces the rated movements and can induce severe stresses into the joint material, thus causing reduced service life. Alignment is to be within tolerances specified by the expansion joint manufacturer.

- *Anchoring.* Expansion joints are to be installed as close as possible to an anchor point. Where an anchoring system is not used, control rods may be installed on the expansion joint to prevent excessive movements from occurring due to pressure thrust of the line.
- *Mechanical damage.* Where necessary, expansion joints are to be protected against mechanical damage.
- *Accessible location.* Expansion joints are to be installed in accessible locations to permit regular inspection and/or periodic servicing.
- *Mating flange.* Mating flanges are to be clean and usually of the flat faced type. When attaching beaded end flange expansion joints to raised face flanges, the use of a ring gasket is permitted. Rubber expansion joints with beaded end flange are not to be installed next to wafer type check or butterfly valves. Serious damage to the rubber flange bead can result due to lack of flange surface and/or bolt connection.

9.7 Molded Expansion Joints *(2004)*

Molded expansion joints may be Type Approved; see 1-1-A3/1 of the ABS *Rules for Classification of Offshore Unites and Structures (Part 1)*.

9.7.1 Circulating Water Systems

Molded expansion fittings of reinforced rubber or other suitable materials may be used in sea water piping systems in machinery spaces. Such fittings are to be oil-resistant. The maximum working pressure is not to be greater than 25% of the hydrostatic bursting pressure of the fitting as determined by a prototype test. Manufacturer's name and the month and year of manufacture are to be embossed or otherwise permanently marked on the outside edge of one of the flanges or other easily examined area of all flexible expansion joints intended for use in seawater piping systems over 150 mm (6 in.). Plans of the molded or built-up flexible expansion joints in seawater piping systems over 150 mm (6 in.), including details of the internal reinforcement arrangements, are to be submitted for approval.

9.7.2 Oil Systems

Where molded expansion joints of composite construction utilizing metallic material, such as steel or stainless steel or equivalent material, with rubberized coatings inside and/or outside or similar arrangements are proposed for use in oil piping systems (fuel, lubricating, or hydraulic oil), the following requirements apply:

9.7.2(a) Expansion joint ratings for temperature, pressure, movements and selection of materials are to be suitable for the intended service.

9.7.2(b) The maximum allowable working pressure of the system is not to be greater than 25% of the hydrostatic bursting pressure determined by a burst test of a prototype expansion joint. Results of the burst test are to be submitted.

9.7.2(c) The expansion joints are to pass the fire resistant test specified in 4-2-1/9.7.3, below.

9.7.2(d) The expansion joints are to be permanently marked with the manufacturer's name and the month and year of manufacture.

9.7.3 Fire Resistant Test

In order for a molded expansion joint of composite construction utilizing metallic material, as referenced in 4-2-1/9.7.2, to be considered fire-resistant, a prototype of the molded expansion joint is to be subjected to a fire test for at least 30 minutes at a temperature of not less than 800°C (1472°F) while water at the maximum service pressure is circulated inside. The temperature of the water at the outlets is not to be less than 80°C (176°F) during the test. The tested molded expansion joint is to be complete with end fittings, and no leakage is to be recorded during or after the test. In lieu of maximum service pressure, the fire test may be conducted with the circulating water at a pressure of at least 5 bar (5.1 kgf/cm^2, 72.5 lb/in^2), and with a subsequent pressure test to twice the design pressure.

9.9 Bulkhead, Deck or Tank-Top Penetrations

Where pipes pass through bulkheads, decks or tank tops, the penetrations are to be made by approved methods which will maintain the watertight, firetight or smoketight integrity of the bulkhead, deck or tank top. Bolted connections are to have the bolts threaded through the plating and welded connections are to be welded on both sides or with full-strength welds from one side.

9.11 Collision-bulkhead Penetrations

Pipes piercing the collision bulkhead on ship type units are to be fitted with suitable valves operable from above the bulkhead deck and the valve chest is to be secured at the bulkhead generally inside the forepeak. Cast iron is not to be used for these valves. The use of nodular iron, also known as ductile iron or spheroidal-graphite iron will be accepted, provided the material has an elongation not less than 12%.

Tanks forward of the collision bulkhead on surface-type units are not to be arranged for the carriage of oil or other liquid substances that are flammable.

9.13 Sluice Valves and Cocks

No valve or cock for sluicing purposes is to be fitted on a collision bulkhead on ship type units. Sluice valves or cocks may be fitted only on other watertight bulkheads when they are at all times accessible for examination. The control rods are to be operable from the bulkhead deck and are to be provided with an indicator to show whether the valve or cock is open or closed. Drains from spaces over deep tanks may be led to an accessible compartment, provided they do not exceed 89 mm O.D. (3 inches nominal pipe size) and are fitted with quick-acting self-closing valves accessibly located in the compartment where they terminate. Sluice valves may be fitted on deep tanks where they are necessary for trimming.

9.15 Relief Valves

All systems which may be exposed to pressures greater than that for which they are designed are to be safeguarded by suitable relief valves or the equivalent, and pressure containers such as evaporators, heaters, etc., which may be isolated from a protective device in the line are to have such devices either directly on the shell or between the shell and the cut-off valve.

9.15.1 Exceptions

In pumping systems such as boiler feed, oil piping and fire main, where ordinarily relief valves are required at the pump, such valves need not be fitted when the system is served only by centrifugal pumps so designed that the pressure delivered cannot exceed that for which the piping is designed.

9.17 Common Overboard Discharge

In general, various types of systems which discharge overboard are not to be interconnected without special approval; that is, closed pumping systems, deck scuppers, soil lines or sanitary drains are not to have a common overboard discharge.

9.19 Remote Operation

Where valves of piping systems are arranged for remote control and are power operated, a secondary means for either local or remote-manual control is to be provided.

9.21 Standard or Extra Heavy Pipe

Pipe thicknesses referred to as Standard or Extra Heavy are the equivalent of American National Standards Institute Schedule 40 and Schedule 80 pipe up to a maximum wall thickness of 9.5 mm (0.375 in.) and 12.5 mm (0.5 in.), respectively.

9.23 Instruments

9.23.1 Temperature

Thermometers and other temperature sensing devices registering through pressure boundaries are to be provided with instrument wells to allow for instrument removal without impairing the integrity of the pressurized system. Fuel oil tanks are to be provided with similar protection.

9.23.2 Pressure

Pressure sensing devices are to be provided with valve arrangements to allow for instrument isolation and removal without impairing the pressurized systems' integrity.

9.25 Hose *(1996)*

Hose assemblies may be installed between two points where flexibility is required, but are not to be subject to torsional deflection (twisting) under normal operating conditions. In general, hose is to be limited to the length necessary to provide for flexibility and for proper operation of machinery. Burst pressure of the hose is not to be less than four times the relief valve setting.

Where the use of non-metallic hose is permitted, the hose materials are to be suitable for the intended service. Hoses for oil service are to be fire-resistant and reinforced with wire braid or other suitable material.

In order for a nonmetallic flexible hose to be considered fire-resistant, a prototype of the hose is to be subjected to a fire test for at least 30 minutes at a temperature of not less than 800°C (1472°F) while water at the maximum service pressure is circulated inside. The temperature of the water at the outlets is not to be less than 80°C (176°F) during the test. The tested hose is to be complete with end fittings and no leakage is to be recorded during or after the test. As an alternative, the fire test may be conducted with the circulating water at a pressure of at least 5 bar (5.1 kgf/cm^2, 72.5 psi) and a subsequent pressure test to twice the design pressure.

A hose is to be complete with factory assembled end fittings or factory supplied end fittings installed in accordance with manufacturer's procedures. Hose clamps and similar types of attachments are not permitted.

Hose connections utilized in cooling systems for engines with cylinder bores equal to or less than 300 mm (12 in.) will be subject to special consideration.

9.27 Control of Static Electricity *(1994)*

Piping systems that are routed through hazardous areas are to be suitably grounded either by welding or bolting the pipes or their supports directly to the hull of the unit or through the use of bonding straps. In general, the resistance between ground points along the length, across joints and from pipe to ground is not to exceed 1 megohm. Where bonding straps are used, they are to be clearly visible, protected from mechanical damage and of a type not affected by corrosive products and paint. Bonding straps are required for tanks and piping systems which are not permanently connected to the hull, including independent tanks, tanks and piping systems which are electrically separated from the hull, and pipe connections arranged for removal of spool pieces.

Components of alarms and level indicating devices located within tanks are to be designed to account for conductivity.

9.29 Leakage Containment *(1994)*

9.29.1 Oil Leaks

For areas where leakage may be expected such as oil burners, purifiers, drains and valves under daily service tanks, etc., means of containing the leakage are to be provided together with adequate drainage. Where drain pipes are provided from collected leakages, they are to be led to a suitable oil drain tank not forming part of an overflow system.

9.29.2 Boiler Flats

Where boilers are located in machinery spaces on tween decks and the boiler rooms are not separated from the machinery space by watertight bulkheads, the tween decks are to be provided with coamings at least 200 mm (8 in.) in height. This area may be drained to the bilges.

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PART

4

CHAPTER 2 Pumps and Piping Systems

SECTION 2 Pumps, Pipes, Valves, and Fittings

1 General

1.1 Service Conditions

The piping details determined in accordance with 4-2-2/5 to 4-2-2/17, inclusive, are to be based on the maximum working pressure and temperature to which they may be exposed in service under normal sustained operating conditions. For boiler-feed and blow-off service, see 4-6-6/3.5, 4-6-6/3.15, and 4-6-6/5.3.1 of the *Steel Vessel Rules*.

1.3 Standards for Valves, Fittings and Flanges

The following requirements for valves, fittings and flanges are based upon standards of the American National Standards Institute. The suitability and application of those manufactured in accordance with other recognized standards will be considered.

3 Pumps

3.1 General Requirements *(1997)*

The following pumps are to meet the hydrostatic and capacity test requirements of 6-1-1/15 and 6-1-1/17, respectively.

- Hydraulic pumps for steering gear, anchor windlass and controllable pitch propellers
- Fire pump
- Bilge pump
- Ballast pump

These tests are to be carried out at the manufacturer's plant in the presence of the Surveyor. The capacity test will not be required nor will the hydrostatic test need to be witnessed by the Surveyor for individual pumps produced on a production line basis, provided the Surveyor is satisfied from periodic inspections and the manufacturer's quality assurance procedures that the pump capacities are acceptable and that hydrostatic testing is being performed.

5 Metallic Pipes

5.1 Test and Inspection Group I Piping

Pipes intended for use in Group I piping systems are to be tested in the presence of and inspected by the Surveyor in accordance with the requirements of Chapter 3 of the ABS *Rules for Materials and Welding (Part 2)* or such other appropriate material specification as may be approved in connection with a particular design. (See 4-2-6/3.5).

5.3 Steel Pipe

5.3.1 Seamless Pipe

Seamless-drawn steel pipe may be used for all purposes.

5.3.2 Welded Pipe

Electric-resistance-welded steel pipe may be used for temperatures up to 343°C (650°F). Consideration will be given to the use of electric-resistance-welded pipe for use above 343°C (650°F) where the material is shown to be suitable for the intended service. Furnace butt-welded pipe up to and including 115 mm O.D. (4-in. nominal-pipe size) may be used for Group II piping for temperatures up to 232°C (450°F), but is not to be used for flammable or combustible fluids.

5.3.3 Fuel-Oil-Pipe

Steel piping is required for fuel-oil lines and for all pipes passing through fuel-oil tanks.

5.5 Copper Pipe

Seamless-drawn and welded copper pipe, unless otherwise specified, may be used for all purposes where the temperature does not exceed 208°C (406°F) and within the limitations specified in the material specification. Copper pipe used for steam, feed and blow-off lines is to be properly annealed before installation.

5.7 Brass Pipe

Seamless-drawn brass pipe, unless otherwise specified, may be used where the temperature does not exceed 208°C (406°F).

5.9 Design

5.9.1 Maximum Allowable Working Pressure and Minimum Thickness

The maximum allowable working pressure and the minimum thickness of pipes are to be determined by the following equations, due consideration being given to the reduction in thickness at the outer radius of bent pipes.

$$W = \frac{KS(t-C)}{D-M(t-C)} \qquad t = \frac{WD}{KS+MW} + C$$

where

K = 20 (200, 2)

W = maximum allowable working pressure, in bar (kgf/cm^2, psi). See Note 1. (For feed and blow-off piping, see 4-6-6/3.5, 4-6-6/3.15 and 4-6-6/5.3.1 of the *Steel Vessel Rules*).

t = minimum thickness of pipe, in mm (in.). See Note 5.

D = actual external diameter of pipe, in mm (in.)

S = maximum allowable fiber stress, in N/mm^2 (kgf/mm^2, psi), from 4-2-2/Table 1. See Note 2.

M = factor from 4-2-2/Table 1

C = allowance for threading, grooving or mechanical strength.

= 1.65 (0.065 in.) for plain-end steel or wrought-iron pipe or tubing up to 115 mm O.D. (4 in. N.P.S.). See Note 3.

= 0.00 mm (0.000 in.) for plain-end steel or wrought-iron pipe or tubing up to 115 mm O.D. (4 in. N.P.S.) used for hydraulic piping systems. See Note 3.

= 0.00 mm (0.000 in.) for plain-end steel or wrought-iron pipe or tubing 115 mm O.D. (4 in. N.P.S.) and larger. See Note 3.

= 1.27 mm (0.05 in.) for all threaded pipe 17 mm O.D. ($^3/_8$ in.) and smaller.

= depth of thread h for all threaded pipe over 17 mm O.D. ($^3/_8$ in.). See Note 4.

= depth of groove for grooved pipe.

= 0.00 mm (0.0000 in.) for plain-end nonferrous pipe or tubing. See Note 3.

Notes:

1 The value of W used in the equations is to be not less than 8.6 bar (8.8 kgf/cm^2, 125 psi), except that for suction and other low-pressure piping of nonferrous material, the actual working pressure may be applied if a suitable addendum is provided against erosion and outside damage. However, in no case is the value of W to be less than 3.4 bar (3.5 kgf/cm^2, 50 psi) for use in the equations.

2 Values of S for other materials are not to exceed the stress permitted by ASME B31.1, "Code for Pressure Piping - Power Piping" for marine and utility systems and ASME B31.3, "Code for Pressure Piping - Chemical Plant and Refinery Piping" for systems used solely for drilling.

3 Plain-end pipe or tubing includes those joined by any method in which the wall thickness is not reduced.

4 The depth of thread, h, may be determined by the equation $h = 0.8/n$, where n is the number of threads per inch, or in metric units by the equation $h = 0.8n$, where n is the number of mm per thread.

5 If pipe is ordered by its nominal wall thickness, the manufacturing tolerance on wall thickness is to be taken into account.

5.9.2 Pipe Bending *(2005)*

Pipe bending is to be in accordance with 2-3-12/25 of the ABS *Rules for Materials and Welding (Part 2)*. Alternatively, bending in accordance with a recognized standard (e.g. ASME B31.1 – Section 129.1 and 129.3) or other approved specification to a radius that will result in a surface free of cracks and substantially free of buckles may be acceptable.

5.11 Working Pressure and Thickness – Alternative Consideration

Consideration will be given to the maximum allowable working pressure and the minimum thickness of piping determined from criteria of applicable recognized standards.

TABLE 1
Allowable Stress Values *S* for Piping N/mm^2 (kgf/mm^2, psi)

Material	Tensile	Service temperature									
ABS Gr. ASTM Gr. Nominal Composition	Strength N/mm^2 kgf/cm^2 psi	–29°C (0°F) to 344°C (650°F)	372°C 700°F	399°C 750°F	427°C 800°F	455°C 850°F	483°C 900°F	510°C 950°F	538°C 1000°F	566°C 1050°F	593°C 1100°F
M		0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.4	1.4	1.4
Gr.1 A53-FBW	310 31.5 45000	46.9 4.78 6800	46.6 4.75 6500								
Gr. 2 A53-A, ERW C, Mn	330 33.7 48000	70.3 7.17 10200	68.3 6.96 9900	62.8 6.40 9100	53.1 5.41 7700						
Gr.2 A53-A, SML C, Mn	330 33.7 48000	82.8 8.44 12000	80.6 8.22 11700	73.7 7.52 10700	62.1 6.33 9000						
Gr.3 A53-B, ERW C, Mn	415 42 60000)	88.3 9.0 12800	84.1 8.58 12200	75.8 7.73 11000	63.4 6.47 9200						
Gr.3 A53-B, SML C, Mn	415 42 60000	103.5 10.55 15000	99.2 10.12 14400	89.6 9.14 13000	74.4 7.59 10800						
Gr.4 A106-A C, Mn, Si	330 33.7 48000	82.8 8.44 12000	80.7 8.23 11700	73.7 7.52 10700	62.1 6.33 9000						
Gr.5 A106-B C, Mn, Si	415 42 60000	103.5 10.55 15000	99.2 10.12 14400	89.6 9.14 13000	74.4 7.59 10800						
Gr.6 A355-P1 1/2 Mo	380 39 55000	95.1 9.70 13800	95.1 9.70 13800	95.1 9.70 13800	93.1 9.49 13500	90.3 9.21 13100					
Gr. 7 A335-P2 1/2 Cr 1/2 Mo	380 39 55000	95.1 9.70 13800	95.1 9.70 13800	95.1 9.70 13800	93.1 9.49 13500	90.3 9.21 13100	88.3 9.0 12800	63.4 6.47 9200	40.7 4.15 5900		
Gr. 8 A135-A	330 33.7 48000	70.3 7.17 10200	68.3 6.96 9900	62.8 6.40 9100	53.1 5.41 7700						
Gr. 9 A135-B	415 42 60000	88.3 9.0 12800	84.1 8.58 12200	75.8 7.73 11000	63.4 6.47 9200						
Gr.11 A335-P11 1-1/4 Cr 1/2 Mo	415 42, 60000	103.5 10.55, 15000	103.5 10.55, 15000	103.5 10.55, 15000	103.5 10.55, 15000	99.2 10.12, 14400	90.3 9.21, 13100	75.8 7.73, 11000	45.4 4-64, 6600	28.2 2.88, 4100	20.7 2.11, 3000
Gr. 12 A335-P12 1 Cr 1/2 Mo	415 42 60000	103.5 10.55 15000	103.5 10.55 15000	103.5 10.55 15000	101.7 10.37 14750	91.9 9.98 14200	90.3 9.21 13100	75.8 7.73 11000	45.5 4.64 6600	28.2 2.88 4100	19.3 1.97 2800
Gr. 13 A335-P22 2-1/4 Cr 1 Mo	415 42 60000	103.5 10.55 15000	103.5 10.55 15000	103.5 10.55 15000	103.5 10.55 15000	99.2 10.12 14400	90.3 9.21, 13100	75.8 7.73 11000	53.7 5.48 7800	35.9 3.66 5200	28.9 2.95 4200

Notes

1. Intermediate values of *S* and *M* may be determined by interpolation.
2. For grades of pipe other than those given in this Table, *S* values may be obtained from ANSI/ASME B31.1 *Code for Pressure Piping*.
3. Consideration to be given to the possibility of graphite formation in the following steels: Carbon steel above 427°C (800°F); carbon-molybdenum steel above 468°C (875°F); chrome-molybdenum steel (with chromium under 0.60%) above 524°C (975°F).
4. For low temperature service, see 2-3-2/9 and Section 2-3-13 of the ABS *Rules for Materials and Welding (Part 2)*.

7 Plastic Pipes *(1997)*

7.1 General

Pipes and piping components made of thermoplastic or thermosetting plastic materials, with or without reinforcement, may be used in piping systems referred to in 4-2-2/Table 2, subject to compliance with the following requirements. For the purpose of these Rules, "plastic" means both thermoplastic and thermosetting plastic materials, with or without reinforcement, such as polyvinyl chloride (PVC) and fiber reinforced plastics (FRP).

7.3 Plans and Data to be Submitted *(2007)*

Rigid plastic pipes are to be in accordance with a recognized national or international standard acceptable to the Bureau. Specification for the plastic pipe, including thermal and mechanical properties and chemical resistance, is to be submitted for review, together with the spacing of the pipe supports.

The following information for the plastic pipes, fittings and joints is to be also submitted for approval.

7.3.1 General Information

i) Pipe and fitting dimensions

ii) Maximum internal and external working pressure

iii) Working temperature range

iv) Intended services and installation locations

v) Level of fire endurance

vi) Electrically conductive

vii) Intended fluids

viii) Limits on flow rates

ix) Serviceable life

x) Installation instructions

xi) Details of marking

7.3.2 Drawings and Supporting Documentation

i) Certificates and reports for relevant tests previously carried out. See 4-2-2/7.9

ii) Details of relevant standards. See 4-2-2/Table 3 and 4-2-2/Table 4

iii) All relevant design drawings, catalogues, data sheets, calculations and functional descriptions

iv) Fully detailed sectional assembly drawings showing pipe, fittings and pipe connections.

v) Documentation verifying the certification of the manufacturer's quality system and that the system addresses the testing requirements in 4-2-2/7.5.1 through 4-2-2/7.5.8. See 4-2-2/7.9.

7.3.3 Materials

i) Resin type

ii) Catalyst and accelerator types and concentration employed in the case of reinforced polyester resin pipes or hardeners where epoxide resins are employed *iii)* A statement detailing all reinforcements employed where the reference number does not identify the mass per unit area or the strand count (Tex System or Yardage System) of a roving used in a filament winding process

iv) Full information regarding the type of gel-coat or thermoplastic liner employed during construction, as appropriate

v) Cure/post-cure conditions. The cure and post-cure temperatures and times employ for given resin/reinforcement ratio

vi) Winding angle and orientation.

vii) Joint bonding procedures and qualification tests results. See 4-2-2/7.11

7.5 Design

7.5.1 Internal Pressure

A pipe is to be designed for an internal pressure not less than the design pressure of the system in which it will be used. The maximum internal pressure, P_{int}, for a pipe is to be the lesser of the following:

$$p_{int} = \frac{P_{sth}}{4} \qquad \text{or} \qquad p_{int} = \frac{P_{lth}}{2.5}$$

where

P_{sth} = short-term hydrostatic test failure pressure

P_{lth} = long-term hydrostatic test failure pressure (> 100,000 hours)

The hydrostatic tests are to be carried out under the following standard conditions:

Atmospheric pressure	=	1 bar (1 kgf/cm^2, 14.5 psi)
Relative humidity	=	30%
Fluid temperature	=	25°C (77°F)

The hydrostatic test failure pressure may be verified experimentally or determined by a combination of testing and calculation methods which are to be submitted to the Bureau for approval.

7.5.2 External Pressure

External pressure is to be considered for any installation which may be subject to vacuum conditions inside of the pipe or a head of liquid on the outside of the pipe. A pipe is to be designed for an external pressure not less than the sum of the pressure imposed by the maximum potential head of liquid outside of the pipe plus full vacuum, 1 bar (1 kgf/cm^2, 14.5 psi), inside of the pipe. The maximum external pressure for a pipe is to be determined by dividing the collapse test pressure by a safety factor of three.

The collapse test failure pressure may be verified experimentally or determined by a combination of testing and calculation methods, which are to be submitted to the Bureau for approval.

7.5.3 Axial Strength

7.5.3(a) The sum of the longitudinal stresses due to pressure, weight and other dynamic and sustained loads is not to exceed the allowable stress in the longitudinal direction. Forces due to thermal expansion, contraction and external loads, where applicable, are to be considered when determining longitudinal stresses in the system.

7.5.3(b) In the case of fiber reinforced plastic pipes, the sum of the longitudinal stresses is not to exceed one-half of the nominal circumferential stress derived from the maximum internal pressure determined according to 4-2-2/7.5.1, unless the minimum allowable longitudinal stress is verified experimentally or by a combination of testing and calculation methods.

7.5.4 Temperature *(2007)*

The maximum allowable working temperature of a pipe is to be in accordance with the manufacturer's recommendations, but in each case it is to be at least 20°C (36°F) lower than the minimum heat distortion temperature of the pipe material determined according to ISO 75 method A or equivalent. The minimum heat distortion temperature is not to be less than 80°C (176°F). This minimum heat distortion temperature requirement is not applicable to pipes and pipe components made of thermoplastic materials, such as polyethylene (PE), polypropylene (PP), polybutylene (PB) and intended for non-essential services.

Where low temperature services are considered, special attention is to be given with respect to material properties.

7.5.5 Impact Resistance

Plastic pipes and joints are to have a minimum resistance to impact in accordance with a recognized national or international standard such as ASTM D2444 or equivalent. After the impact resistance is tested, the specimen is to be subjected to hydrostatic pressure equal to 2.5 times the design pressure for at least one hour.

7.5.6 Fire Endurance

4-2-2/Table 2 specifies fire endurance requirements for pipes based upon system and location. Pipes and their associated fittings whose functions or integrity are essential to the safety of the unit are to meet the indicated fire endurance requirements which are described below.

i) Level 1 will ensure the integrity of the system during a full-scale hydrocarbon fire, and is particularly applicable to systems where loss of integrity may cause out-flow of flammable liquids and worsen the fire situation. Piping having passed the fire endurance test specified in 4-2-2/7.13 of a duration of a minimum of one hour without loss of integrity in the dry condition is considered to meet the Level 1 fire endurance standard (L1).

ii) Level 2 intends to ensure the availability of systems essential to the safe operation of the unit after a fire of short duration, allowing the system to be restored after the fire has been extinguished. Piping having passed the fire endurance test specified in 4-2-2/7.13 for a duration of a minimum of 30 minutes without loss of integrity in the dry condition is considered to meet the Level 2 fire endurance standard (L2).

iii) Level 3 is considered to provide the fire endurance necessary for a water filled piping system to survive a local fire of short duration. The system's functions are capable of being restored after the fire has been extinguished. Piping having passed the fire endurance test specified in 4-2-2/7.15 for a duration of a minimum of 30 minutes without loss of integrity in the wet condition is considered to meet the Level 3 fire endurance standard (L3).

Where a fire protective coating of pipes and fittings is necessary for achieving the fire endurance standards required, the following requirements apply.

i) Pipes are generally to be delivered from the manufacturer with the protective coating applied, with on-site application limited to that necessary for installation purposes (i.e., joints). See 4-2-2/7.7.9 regarding the application of the fire protection coating on joints.

ii) The fire protection properties of the coating are not to be diminished when exposed to salt water, oil or bilge slops. It is to be demonstrated that the coating is resistant to products likely to come in contact with the piping.

iii) In considering fire protection coatings, such characteristics as thermal expansion, resistance against vibrations and elasticity are to be taken into account.

iv) The fire protection coatings are to have sufficient resistance to impact to retain their integrity.

v) *(2007)* Random samples of pipe are to be tested to determine the adhesion qualities of the coating to the pipe.

7.5.7 Flame Spread

7.5.7(a) Plastic Pipes. All pipes, except those fitted on open decks and within tanks, cofferdams, void spaces, pipe tunnels and ducts, are to have low flame spread characteristics. The test procedures in IMO Resolution A.653(16) *Recommendation on Improved Fire Test Procedures for Surface Flammability of Bulkhead, Ceiling, and Deck Finish Materials*, modified for pipes as indicated in 4-2-2/7.17, are to be used for determining the flame spread characteristics. Piping materials giving average values for all of the surface flammability criteria not exceeding the values listed in Resolution A.653(16) are considered to meet the requirements for low flame spread.

Alternatively, flame spread testing in accordance with ASTM D635 may be used in lieu of the IMO flame spread test, provided such test is acceptable to the Administration.

7.5.7(b) Multi-core Metallic Tubes Sheathed by Plastic Materials (2005). The multi-core tubes in "bundles" made of stainless steel or copper tubes covered by an outer sheath of plastic material are to comply with the flammability test criteria of IEC 60332, Part 3, Category A/F or A/F/R. Alternatively, the tube bundles complying with at least the flammability test criteria of IEC 60332, Part 1 or a test procedure equivalent thereto are acceptable provided they are installed in compliance with approved fire stop arrangements.

7.5.8 Electrical Conductivity

7.5.8(a) Piping conveying fluids with a conductivity less than 1000 pico siemens per meter are to be electrically conductive.

7.5.8(b) Regardless of the fluid being conveyed, plastic pipes are to be electrically conductive if the piping passes through a hazardous area.

7.5.8(c) Where electrically conductive pipe is required, the resistance per unit length of the pipes and fittings is not to exceed 1×10^5 ohm/m (3×10^4 ohm/ft). See also 4-2-2/7.7.4.

7.5.8(d) If the pipes and fittings are not homogeneously conductive, the conductive layers are to be protected against the possibility of spark damage to the pipe wall.

7.5.9 Marking *(2007)*

Plastic pipes and other components are to be permanently marked with identification in accordance with a recognized standard. Identification is to include pressure ratings, the design standard that the pipe or fitting is manufactured in accordance with, and the material with which the pipe or fitting is made and the date of fabrication.

7.7 Installation of Plastic Pipes

7.7.1 Supports

7.7.1(a) Selection and spacing of pipe supports in shipboard systems are to be determined as a function of allowable stresses and maximum deflection criteria. Support spacing is not to be greater than the pipe manufacturer's recommended spacing. The selection and spacing of pipe supports are to take into account pipe dimensions, mechanical and physical properties of the pipe material, mass of pipe and contained fluid, external pressure, operating temperature, thermal expansion effects, loads due to external forces, thrust forces, water hammer and vibrations to which the system may be subjected. Combination of these loads are to be checked.

7.7.1(b) Each support is to evenly distribute the load of the pipe and its contents over the full width of the support. Measures are to be taken to minimize wear of the pipes where they contact the supports.

7.7.1(c) Heavy components in the piping system such as valves and expansion joints are to be independently supported.

7.7.1(d) The supports are to allow for relative movement between the pipes and the unit's structure, having due regard to the difference in the coefficients of thermal expansion and deformations of the unit's hull and its structure.

7.7.1(e) When calculating the thermal expansion, the system working temperature and the temperature at which assembling is performed are to be taken into account.

7.7.2 External Loads

When installing the piping, allowance is to be made for temporary point loads, where applicable. Such allowances are to include at least the force exerted by a load (person) of 980 N (100 kgf, 220 lbf) at mid-span on any pipe more than 100 mm (4 in.) nominal diameter.

Pipes are to be protected from mechanical damage, where necessary.

7.7.3 Plastic Pipe Connections

7.7.3(a) The strength of fittings and joints is not to be less than that of the piping they connect.

7.7.3(b) Pipes may be joined using adhesive-bonded, welded, flanged or other joints.

7.7.3(c) Tightening of flanged or mechanically coupled joints is to be performed in accordance with manufacturer's instructions.

7.7.3(d) Adhesives, when used for joint assembly, are to be suitable for providing a permanent seal between the pipes and fittings throughout the temperature and pressure range of the intended application.

Joining techniques are to be in accordance with manufacturer's installation guidelines. Personnel performing these tasks are to be qualified to the satisfaction of the Bureau, and each bonding procedure is to be qualified before shipboard piping installation commences. Requirements for joint bonding procedures are in 4-2-2/7.11.

7.7.4 Electrical Conductivity

Where electrically conductive pipe is required by 4-2-2/7.5.8, installation of the pipe is to be in accordance with the following:

7.7.4(a) The resistance to earth (ground) from any point in the system is not to exceed 1 megohm. The resistance is to be checked in the presence of the Surveyor.

7.7.4(b) Where used, earthing wires or bonding straps are to be accessible for inspection. The Surveyor is to verify that they are in visible locations.

7.7.5 Shell Connections

Where plastic pipes are permitted in systems connected to the shell of the unit, the valves and the pipe connection to the shell are to be metallic. The side shell valves are to be arranged for remote control from outside of the space in which the valves are located. For further details of the shell valve installation, their connections and material, refer to 4-2-2/21.

7.7.6 Bulkhead and Deck Penetrations

7.7.6(a) The integrity of watertight bulkheads and decks is to be maintained where plastic pipes pass through them.

7.7.6(b) Where plastic pipes pass through "A" or "B" class divisions, arrangements are to be made to ensure that the fire endurance is not impaired. These arrangements are to be tested in accordance with IMO Resolution. A 754 (18), Recommendation on Fire Resistance Tests for "A", "B" and "F" Class Divisions, as amended.

7.7.6(c) If the bulkhead or deck is also a fire division and destruction by fire of plastic pipes may cause inflow for liquid from tank, a metallic shut-off valve operable from above the bulkhead deck is to be fitted at the bulkhead or deck.

7.7.7 Application of Fire Protection Coatings

Fire protection coatings are to be applied on the joints, where necessary for meeting the required fire endurance criteria in 4-2-2/7.5.6, after performing hydrostatic pressure tests of the piping system (see 4-2-2/7.21). The fire protection coatings are to be applied in accordance with the manufacturer's recommendations using a procedure approved in each particular case.

7.9 Manufacturing of Plastic Pipes *(2007)*

The manufacturer is to have a quality system and be certified in accordance with 1-1-A3/5.3, 1-1-A3/5.5 of the ABS *Rules for Classification of Offshore Units and Structures (Part 1)* or ISO 9001. The quality system is to consist of elements necessary to ensure that pipes and component are produced with consistent and uniform mechanical and physical properties in accordance with recognized standards, including testing to demonstrate the compliance of plastic pipes, fittings and joints with 4-2-2/7.5.1 through 4-2-2/7.5.8 and 4-2-2/7.19, as applicable.

Where the manufacturer does not have a certified quality system in accordance with 1-1-A3/5.3, 1-1-A3/5.5 of the ABS *Rules for Classification of Offshore Units and Structures (Part 1)* or ISO 9001 (or equivalent), the tests in 4-2-2/7.5.1 through 4-2-2/7.5.8 and 4-2-2/7.19, as applicable, will be required using samples from each batch of pipes being supplied for use aboard the unit and are to be carried out in the presence of the Surveyor.

Each length of pipe is to be tested at the manufacturer's production facility to a hydrostatic pressure not less than 1.5 times the maximum allowable internal pressure of the pipe in 4-2-2/7.5.1. If the facility does not have a certified quality system in accordance with 1-1-A3/5.3, 1-1-A3/5.5 of the ABS *Rules for Classification of Offshore Units and Structures (Part 1)* or ISO 9001 (or equivalent), then the production testing must be witnessed by the Surveyor.

The manufacturer is to provide documentation certifying that all piping and piping components supplied are in compliance with the requirements of 4-2-2/7.

7.11 Plastic Pipe Bonding Procedure Qualification

7.11.1 Procedure Qualification Requirements

7.11.1(a) To qualify joint bonding procedures, the tests and examinations specified herein are to be successfully completed. The procedure for making bonds is to include the following:

i) Materials used

ii) Tools and fixtures

iii) Environmental requirements

iv) Joint preparation requirements

v) Cure temperature

vi) Dimensional requirements and tolerances

vii) Test acceptance criteria for the completed assembly

7.11.1(b) Any change in the bonding procedure which will affect the physical and mechanical properties of the joint will require the procedure to be re-qualified.

7.11.2 Procedure Qualification Testing

7.11.2(a) A test assembly is to be fabricated in accordance with the procedure to be qualified and it is to consist of at least one pipe-to-pipe joint and one pipe-to-fitting joint. When the test assembly has been cured, it is to be subjected to a hydrostatic test pressure at a safety factor of 2.5 times the design pressure of the test assembly for not less than one hour. No leakage or separation of joints is to be allowed. The test is to be conducted so that the joint is loaded in both longitudinal and circumferential direction.

7.11.2(b) Selection of pipes used for test assembly is to be in accordance with the following:

i) When the largest size to be joined is 200 mm (8 in.) nominal outside diameter or smaller, the test assembly is to be the largest pipe size to be joined.

ii) When the largest size to be joined is greater than 200 mm (8 in.) nominal outside diameter, the size of the test assembly is to be either 200 mm (8 in.) or 25% of the largest piping size to be joined, whichever is greater.

7.11.2(c) When conducting performance qualifications, each bonder and each bonding operator are to make up test assemblies, the size and number of which are to be as required above.

7.13 Tests by the Manufacturer – Fire Endurance Testing of Plastic Piping in the Dry Condition (For Level 1 and Level 2)

7.13.1 Test Method

7.13.1(a) The specimen is to be subjected to a furnace test with fast temperature increase similar to that likely to occur in a fully developed liquid hydrocarbon fire. The time/temperature is to be as follows:

Time	*Temperature*	
	°C	*°F*
At the end of 5 minutes	1945	1733
At the end of 10 minutes	1033	1891
At the end of 15 minutes	1071	1960
At the end of 30 minutes	1098	2008
At the end of 60 minutes	1100	2012

7.13.1(b) The accuracy of the furnace control is to be as follows:

i) During the first 10 minutes of the test, variation in the area under the curve of mean furnace temperature is to be within ±15% of the area under the standard curve.

ii) During the first 30 minutes of the test, variation in the area under the curve of mean furnace temperature is to be within ±10% of the area under the standard curve.

iii) For any period after the first 30 minutes of the test, variation in the area under the curve of mean furnace temperature is to be within ±5% of the area under the standard curve.

iv) At any time after the first 10 minutes of the test, the difference in the mean furnace temperature from the standard curve is to be within ±100°C (±180°F).

7.13.1(c) The locations where the temperatures are measured, the number of temperature measurements and the measurement techniques are to be approved by the Bureau.

7.13.2 Test Specimen

7.13.2(a) The test specimen is to be prepared with the joints and fittings intended for use in the proposed application.

7.13.2(b) The number of specimens is to be sufficient to test typical joints and fittings, including joints between non-metal and metal pipes and metal fittings to be used.

7.13.2(c) The ends of the specimen are to be closed. One of the ends is to allow pressurized nitrogen to be connected. The pipe ends and closures may be outside of the furnace.

7.13.2(d) The general orientation of the specimen is to be horizontal and is to be supported by one fixed support with the remaining supports allowing free movement. The free length between supports is not to be less than eight times the pipe diameter.

7.13.2(e) Most materials will require a thermal insulation to pass this test. The test procedure is to include the insulation and its covering.

7.13.2(f) If the insulation contains or is liable to absorb moisture, the specimen is not to be tested until the insulation has reached an air dry-condition defined as equilibrium with an ambient atmosphere of 50% relative humidity at 20 ± 5°C (68 ± 9°F). Accelerated conditioning is permissible, provided the method does not alter the properties of the component material. Special samples are to be used for moisture content determination and conditioned with the test specimen. These samples are to be so constructed as to represent the loss of water vapor from the specimen having similar thickness and exposed faces.

7.13.3 Test Condition

A nitrogen pressure inside the test specimen in to be maintained automatically at 0.7 ± 0.1 bar (0.7 ± 0.1 kgf/cm^2, 10 ± 1.5 psi) during the test. Means are to be provided to record the pressure inside of the pipe and the nitrogen flow into and out of the specimen in order to indicate leakage.

7.13.4 Acceptance Criteria

7.13.4(a) During the test, no nitrogen leakage from the sample is to occur.

7.13.4(b) After termination of the furnace test, the test specimen together with fire protective coating, if any, is to be allowed to cool in still air to ambient temperature and then tested to the maximum allowable pressure of the pipes, as defined in 4-2-2/7.5.1 and 4-2-2/7.5.2. The pressure is to be held for a minimum of 15 minutes without leakage. Where practicable, the hydrostatic test is to be conducted on bare pipe (i.e., coverings and insulation removed) so that any leakage will be apparent.

7.13.4(c) Alternative test methods and/or test procedures considered to be at least equivalent, including open pit testing method, may be accepted in cases where the pipes are too large for the test furnace.

7.15 Test by Manufacturer – Fire Endurance Testing of Water-Filled Plastic Piping (For Level 3)

7.15.1 Test Method

7.15.1(a) A propane multiple burner test with a fast temperature increase is to be used.

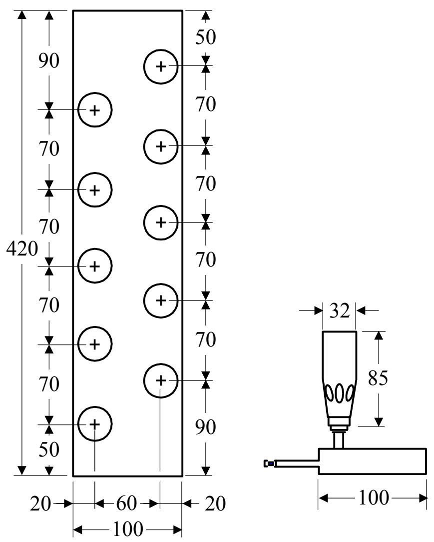
7.15.1(b) For piping up to and including 152 mm (6 in.) O.D., the fire source is to consist of two rows of five burners, as shown in 4-2-2/Figure 1. A constant heat flux averaging 113.6 kW/m^2 (36,000 BTU/hr-ft^2) ± 10% is to be maintained 12.5 + 1 cm (5 ± 0.4 in.) above the centerline of the burner array. This flux corresponds to a pre-mix flame of propane with a fuel flow rate of 5 kg/hr (11 lb/hr) for a total heat release of 65 kW (3700 BTU/min.). The gas consumption is to be measured with an accuracy of at least ± 3% in order to maintain a constant heat flux. Propane with a minimum purity of 95% is to be used.

7.15.1(c) For piping greater than 152 mm (6 in.) O.D., one additional row of burners is to be included for each 51 mm (2 in.) increase in pipe diameter. A constant heat flux averaging 113.6 kW/m^2 (36,000 BTU/hr-ft^2) ± 10% is to be maintained 12.5 + 1 cm (5 ± 0.4 in.) above the centerline of the burner array. This fuel flow is to be increased as required to maintain the designated heat flux.

7.15.1(d) The burners are to be type "Sievert No. 2942" or equivalent which produces an air mixed flame. The inner diameter of the burner heads is to be 29 mm (1.14 in.). See 4-2-2/Figure 1. The burner heads are to be mounted in the same plane and supplied with gas from a manifold. If necessary, each burner is to be equipped with a valve in order to adjust the flame height.

7.15.1(e) The height of the burner stand is also to be adjustable. It is to be mounted centrally below the test pipe with the rows of burners parallel to the pipe's axis. The distance between the burner heads and the pipe is to be maintained at 12.5 ± 1 cm (5 ± 0.4 in.) during the test. The free length of the pipe between its supports is to be 0.8 ± 0.05 m (31.5 ± 2 in.). See 4-2-2/Figure 2.

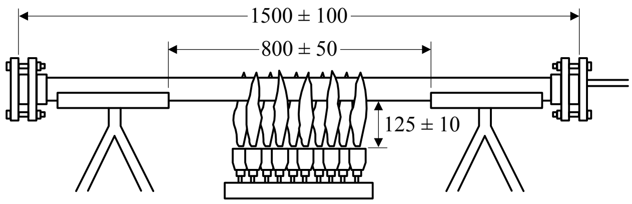
FIGURE 1
Fire Endurance Test Burner Assembly



a) Top View

b) Side View of one Burner

FIGURE 2
Fire Endurance Test Stand With Mounted Sample



7.15.2 Test Specimen

7.15.2(a) Each pipe is to have a length of approximately 1.5 m (5 ft).

7.15.2(b) The test pipe is to be prepared with permanent joints and fittings intended to be used. Only valves and straight joints versus elbows and bends are to be tested as the adhesive in the joint is the primary point of failure.

7.15.2(c) The number of pipe specimens is to be sufficient to test all typical joints and fittings.

7.15.2(d) The ends of each pipe specimen are to be closed. One of the ends is to allow pressurized water to be connected.

7.15.2(e) If the insulation contains or is liable to absorb moisture, the specimen is not to be tested until the insulation has reached an air dry-condition defined as equilibrium with an ambient atmosphere of 50% relative humidity at 20 ± 5°C (68 ± 9°F). Accelerated conditioning is permissible, provided the method does not alter the properties of the component material. Special samples are to be used for moisture content determination and conditioned with the test specimen. These samples are to be so constructed as to represent the loss of water vapor from the specimen having similar thickness and exposed faces.

7.15.2(f) The pipe samples are to rest freely in a horizontal position on two V-shaped supports. The friction between pipe and supports is to be minimized. The supports may consist of two stands, as shown in 4-2-2/Figure 2.

7.15.2(g) A relief valve is to be connected to one of the end closures of each specimen.

7.15.3 Test Conditions

7.15.3(a) The test is to be carried out in a sheltered test site in order to prevent any draft influencing the test.

7.15.3(b) Each pipe specimen is to be completely filled with dearated water to exclude air bubbles.

7.15.3(c) The water temperature is not to be less than 15°C (59°F) at the start and is to be measured continuously during the test. The water is to be stagnant and the pressure maintained at 3 ± 0.5 bar (3.1 ± 0.5 kgf/cm^2, 43.5 ± 7.25) during the test.

7.15.4 Acceptance Criteria

7.15.4(a) During the test, no leakage from the sample(s) is to occur, except that slight weeping through the pipe wall may be accepted.

7.15.4(b) After termination of the burner test, the test specimen together with fire protective coating, if any, is to be allowed to cool to ambient temperature and then tested to the maximum allowable pressure of the pipes, as defined in 4-2-2/7.5.1 and 4-2-2/7.5.2. The pressure is to be held for a minimum of 15 minutes without significant leakage [i.e., not exceeding 0.2 1/min. (0.05 gpm)]. Where practicable, the hydrostatic test is to be conducted on bare pipe (i.e., coverings and insulation removed) so that any leakage will be apparent.

7.17 Tests by Manufacturer – Flame Spread

7.17.1 Test Method

Flame spread of plastic piping is to be determined by IMO Resolution A.653(16) entitled "Recommendation on Improved Fire Test Procedures for Surface Flammability of Bulkhead, Ceiling, and Deck Finish Materials" with the following modifications.

7.17.1(a) Tests are to be made for each pipe material and size.

7.17.1(b) The test sample is to be fabricated by cutting pipes lengthwise into individual sections and then assembling the sections into a test sample as representative as possible of a flat surface. A test sample is to consist of at least two sections. The test sample is to be at least 800 ± 5 mm (31.5 ± 0.2 in.) long. All cuts are to be made normal to the pipe wall.

7.17.1(c) The number of sections that must be assembled together to form a test sample is to be that which corresponds to the nearest integral number of sections which makes up a test sample with an equivalent linearized surface width between 155 mm (6 in.) and 180 mm (7 in.). The surface width is defined as the measured sum of the outer circumference of the assembled pipe sections that are exposed to the flux from the radiant panel.

7.17.1(d) The assembled test sample is to have no gaps between individual sections.

7.17.1(e) The assembled test sample is to be constructed in such a way that the edges of two adjacent sections coincide with the centerline of the test holder.

7.17.1(f) The individual test sections are to be attached to the backing calcium silicate board using wire (No. 18 recommended) inserted at 50 mm (2 in.) intervals through the board and tightened by twisting at the back.

7.17.1(g) The individual pipe sections are to be mounted so that the highest point of the exposed surface is in the same plane as the exposed flat surface of a normal surface.

7.17.1(h) The space between the concave unexposed surface of the test sample and the surface of the calcium silicate backing board is to be left void.

7.17.1(i) The void space between the top of the exposed test surface and the bottom edge of the sample holder frame is to be filled with a high temperature insulating wool if the width the of the pipe segments extend under the side edges of the sample holding frame.

7.19 Testing By Manufacturer – General *(2007)*

Testing is to demonstrate the compliance of plastic pipes, fittings and joints for which approval, in accordance with 4-2-2/7, is requested. These tests are to be in compliance with the requirements of relevant standards as per 4-2-2/Table 3 and 4-2-2/Table 4.

TABLE 2
Fire Endurance Requirements Matrix

PIPING SYSTEMS		*LOCATION*							
		A	B	C	D	E	F	G	H
FLAMMABLE LIQUIDS									
1	Oil [flash point ≤ 60°C (140°F)]	NA	NA	0	NA	0	0	NA	L1 (2)
2	Fuel oil [flash point > 60°C (140°F)]	X	X	NA	0	0	0	L1	L1
3	Lubricating oil	X	X	NA	NA	NA	0	L1	L1
4	Hydraulic oil	X	X	0	0	0	0	L1	L1
SEA WATER (See Note 1)									
5	Bilge main and branches	L1	L1	NA	0	0	0	NA	L1
6	Fire main and water spray	L1	L1	NA	NA	0	0	X	L1
7	Foam system	L1	L1	NA	NA	NA	0	L1	L1
8	Sprinkler system	L1	L1	NA	NA	0	0	L3	L3
9	Ballast	L3	L3	0	0	0	0	L2	L2
10	Cooling water, essential services	L3	L3	NA	NA	0	0	NA	L2
11	Non-essential systems	0	0	NA	0	0	0	0	0
FRESH WATER									
12	Cooling water, essential services	L3	L3	NA	0	0	0	L3	L3
13	Condensate return	L3	L3	NA	NA	NA	0	0	0
14	Non-essential systems	0	0	NA	0	0	0	0	0
SANITARY/DRAINS/SCUPPERS									
15	Deck drains (internal)	L1 (3)	L1 (3)	NA	0	0	0	0	0
16	Sanitary drains (internal)	0	0	NA	0	0	0	0	0
17	Scuppers and discharges (overboard)	0 (1,5)	0 (1,5)	0	0	0	0	0 (1,5)	0
VENTS/SOUNDING									
18	Water tanks/dry spaces	0	0	0	0	0	0	0	0
19	Oil tanks [flash point > 60°C (140°F)]	X	X	X	0	0	0	X	X
20	Oil tanks [flash point ≤ 60°C (140°F)]	NA	NA	0	NA	0	0	NA	X
MISCELLANEOUS									
21	Control air	L1 (4)	L1 (4)	NA	0	0	0	L1 (4)	L1 (4)
22	Service air (non-essential)	0	0	NA	0	0	0	0	0
23	Brine	0	0	NA	NA	NA	0	0	0
24	Auxiliary low pressure steam (Pressure ≤ 7 bar (7 kgf/cm^2, 100 psi)	L2	L2	0	0	0	0	0 (6)	0 (6)

Locations

A Category A machinery spaces
B Other machinery spaces
C Oil tanks [flashpoint ≤ 60°C (140°F)]
D Fuel oil tanks [flashpoint > 60°C (140°F)]
E Ballast water tanks
F Cofferdams, void spaces, pipe tunnels and ducts
G Accommodation, service and control spaces
H Open decks

Abbreviations

L1 Fire endurance test in dry conditions, 60 minutes in accordance with 4-2-2/7.13
L2 Fire endurance test in dry conditions, 30 minutes, in accordance with 4-2-2/7.13
L3 Fire endurance test in wet conditions, 30 minutes, in accordance with 4-2-2/7.15
0 No fire endurance test required
NA Not applicable
X Metallic materials having a melting point greater than 925°C (1700°F).

TABLE 2 (continued)
Fire Endurance Requirements Matrix

Notes:

1 Where nonmetallic piping is used, remotely controlled valves are to be provided at the unit's side. These valves are to be controlled from outside of the space.

2 Remote closing valves are to be provided at the tanks.

3 For drains serving only the space concerned, "0" may replace "L1".

4 When controlling functions are not required by statutory requirements, "0" may replace "L1".

5 Scuppers serving open decks in positions 1 and 2, as defined in Regulation 13 of the International Convention on Load Lines, 1966, are to be "X" throughout unless fitted at the upper end with the means of closing capable of being operated from a position above the freeboard deck in order to prevent downflooding.

6 For essential services, such as fuel oil tank heating and whistle, "X" is to replace "0".

TABLE 3
Standards for Plastic Pipes – Typical Requirements for All Systems *(2007)*

	Test	*Typical Standard*	*Notes*
1	Internal pressure (1)	4-2-2/7.5.1 ASTM D 1599, ASTM D 2992 ISO 15493 or equivalent	Top, Middle, Bottom (of each pressure range) Tests are to be carried out on pipe spools made of different pipe sizes, fittings and pipe connections.
2	External pressure (1)	4-2-2/7.5.2 ISO 15493 or equivalent	As above, for straight pipes only.
3	Axial strength (1)	4-2-2/7.5.3	As above.
4	Load deformation	ASTM D 2412 or equivalent	Top, Middle, Bottom (of each pressure range)
5	Temperature limitations (1)	4-2-2/7.5.4 ISO 75 Method A GRP piping system: HDT test on each type of resin acc. to ISO 75 method A. Thermoplastic piping systems: ISO 75 Method AISO 306 Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST) VICAT test according to ISO 2507 Polyesters with an HDT below 80°C should not be used.	Each type of resin
6	Impact resistance (1)	4-2-2/7.5.5 ISO 9854: 1994, ISO 9653: 1991 ISO 15493 ASTM D 2444, or equivalent	Representative sample of each type of construction
7	Ageing	Manufacturer's standard ISO 9142:1990	Each type of construction
8	Fatigue	Manufacturer’s standard or service experience.	Each type of construction
9	Fluid absorption	ISO 8361:1991	
10	Material compatibility (2)	ASTM C581 Manufacturer’s standard	

Notes:

1 Where the manufacturer does not have a certified quality system, test to be witnessed by the Surveyor. See 4-2-2/7.9.

2 If applicable.

TABLE 4
Standards for Plastic Pipes – Additional Requirements Depending on Service and/or Location of Piping *(2007)*

	Test	*Typical Standard*	*Notes*
1	Fire endurance [1,2]	4-2-2/7.5.6	Representative samples of each type of construction and type of pipe connection.
2	Flame spread [1,2]	4-2-2/7.5.7	Representative samples of each type of construction.
3	Smoke generation [2]	IMO Fire Test Procedures Code	Representative samples of each type of construction.
4	Toxicity [2]	IMO Fire Test Procedures Code	Representative samples of each type of construction.
5	Electrical conductivity [1,2]	4-2-2/7.5.8 ASTM F1173-95 or ASTM D 257, NS 6126/ 11.2 or equivalent	Representative samples of each type of construction

Notes:

1 Where the manufacturer does not have a certified quality system, test to be witnessed by the Surveyor. See 4-2-2/7.9.

2 If applicable.

Note: Test items 1, 2 and 5 in 4-2-2/Table 4 are optional. However, if not carried out, the range of approved applications for the pipes will be limited accordingly (see 4-2-2/Table 2).

9 Valves

9.1 General *(1993)*

9.1.1 Standard Valves

All valves constructed and tested in accordance with a recognized standard are acceptable to the Bureau, subject to compliance with 4-2-2/9.5.

9.1.2 Non-Standard Valves

All other valves not certified by the manufacturer in accordance with a recognized standard are subject to special consideration, and drawings of such valves showing details of construction and materials are to be submitted for review, as well as basis for valve pressure rating, such as design calculations or appropriate burst test data.

9.3 Construction

All valves are to close with a right hand (clockwise) motion of the handwheel when facing the end of the stem and are to be either of the rising stem type or fitted with an indicator to show whether the valve is open or closed.

All valves of Group I piping systems having nominal diameters exceeding 50 mm (2 in.) are to have bolted, pressure seal or breech lock bonnets and fanged or welding ends. Welding ends are to be butt welding type, except that socket welding ends may be used for valves having nominal diameters of 80 mm (3 in.) or less, up to and including 39.2 bar (40.0 kgf/cm^2) pressure rating class (ANSI 600 Class), and for valves having nominal diameters of 65 mm (2.5 in.) or less, up to and including 98.1 bar (100 kgf/cm^2) pressure rating class (ANSI 1500 Class).

All cast iron valves are to have bolted bonnets or are to be of the union bonnet type. For cast iron valves of union bonnet type, the bonnet ring is to be of steel, bronze or malleable iron.

Stems, discs or disc faces, seats, and other wearing parts of valves are to be of corrosion-resistant materials suitable for intended service.

Valves are to be designed for the maximum pressure to which they will be subjected. The design pressure is to be at least 3.4 bar (3.5 kgf/cm^2, 50 psi), except that valves used in open systems, such as vent and drain lines, and valves mounted on atmospheric tanks which are not part of the tank suction or discharge piping (for example, level gauge and drain cocks and valves in inert gas and vapor emission control systems) may be designed for a pressure below 3.4 bar (3.5 kgf/cm^2, 50 psi), subject to the requirements of 4-2-2/9.1. Large fabricated ballast manifolds which connect lines exceeding 200 mm (8 in.) nominal pipe size may be specially considered when the maximum pressure to which they will be subjected does not exceed 1.7 bar (1.75 kgf/cm^2, 25 psi).

All valves for Group I piping systems and valves intended for use in steam or oil lines are to be constructed so that the stem is positively restrained from being screwed out of the body (bonnet). Plug cocks, butterfly valves and valves employing resilient material will be subject to special consideration. Valve operating systems for all valves which cannot be manually operated are to be submitted for approval.

9.5 Hydrostatic Test and Identification

All valves are to be subjected by the manufacturer to a hydrostatic test at a pressure equal to that stipulated by the American National Standards Institute or other recognized standard. They are to bear the trademark of the manufacturer legibly stamped or cast on the exterior of the valve and also the primary pressure rating at which the manufacturer guarantees the valve to meet the requirements of the standards.

11 Pipe Fittings

11.1 General *(1997)*

All fittings in Group I piping are to have flanged or welded ends in sizes over 89 mm O.D. (3 in. N.P.S). Screwed fittings may be used in Group I piping systems, provided the temperature does not exceed 496°C (925°F) and the pressure does not exceed the maximum pressure indicated below for the pipe size.

Pipe Size *mm O.D. (in. N.P.S.)*	*Maximum Pressure* *bar(kgf/cm^2, psi)*
above 89 (3)	not permitted in Group I piping service
above 60 (2) through 89 (3)	27.6 (28.10, 400)
above 33 (1) through 60 (2)	41.4 (42.20, 600)
above 27 (0.75) through 33 (1)	82.3 (84.4, 1200)
27 (0.75) and smaller	103 (105.5, 1500)

Flared, flareless and compression fittings may be used for tube sizes not exceeding 60 mm O.D. (2 in. N.P.S.) in Group I piping. In Group II piping, screwed fittings and flared, flareless and compression tube fittings will be accepted without size limitations. Flared fittings are to be used for flammable fluid systems, except that both flared and flareless fittings of the non-bite type may be used when the tubing system is of steel or nickel-copper or copper-nickel alloys. Only flared fittings are to be used when tubing for flammable fluid systems is of copper or copper-zinc alloys. See 4-2-6/3.7 for hydraulic systems.

11.3 Hydrostatic Test and Identification

All fittings are to be subjected by the manufacturer to a hydrostatic test at a pressure equal to that stipulated by the American National Standards Institute or other recognized standard. They are to bear the trademark of the manufacturer legibly stamped or cast on the exterior of the fitting and also the primary pressure rating at which the manufacturer guarantees the fitting to meet the requirements of the standards.

11.5 Nonstandard Fittings *(1993)*

Fittings which are not certified by the manufacturer to a recognized standard will be subject to special consideration. Plans showing details of construction, material and design calculations or test results are to be submitted for review.

11.7 Mechanical Joints *(2005)*

The installation of mechanical pipe joints, as covered by 4-2-2/11.1 and 4-2-2/11.5, is to be in accordance with the manufacturer's assembly instructions. Where special tools and gauges are required for installation of the joints, these are to be specified and supplied as necessary by the manufacturer. These special tools are to be kept onboard.

13 Welded Nonstandard Valves and Fittings *(1993)*

Nonstandard steel valves and fittings fabricated by means of fusion welding are to comply also with the requirements of Chapter 4 of the ABS *Rules for Materials and Welding (Part 2)*. However, after a manufacturer's procedure in the fabrication of equipment of this kind has been demonstrated by tests to the satisfaction of a Surveyor to the Bureau, subsequent tests on the product need not be witnessed, but the manufacturer's guarantee that the Rules are complied with will be accepted as for other valves and fittings which conform to standards of the American National Standards Institute or other recognized standards.

15 Flanges

15.1 General *(1996)*

Flanges are to be designed and fabricated in accordance with a recognized national or international standard. Slip-on flanges from flat plate may be substituted for hubbed slip-on flanges in Group II piping systems.

15.3 Group I Piping Flanges

In Group I piping, flanges may be attached to the pipes by any of the following methods appropriate for the material involved.

15.3.1 Steel Pipe

Over 60 mm O.D. (2 in. N.P.S.) steel pipes are to be expanded into steel flanges, or they may be screwed into the flanges and seal-welded. They may in all cases be attached by fusion welding in compliance with the requirements of 2-4-2/9 of the ABS *Rules for Materials and Welding (Part 2)*. Smaller pipes may be screwed without seal-welding, but in steam and oil lines are, in addition, to be expanded into the flanges in order to insure uniformly tight threads.

15.3.2 Nonferrous Pipe

In Group I, nonferrous pipes are to be brazed to composition or steel flanges, and in sizes of 60 mm O.D. (2 in. N.P.S.) and under, they may be screwed.

15.5 Group II Piping Flanges

Similar attachments are also to be used in Group II piping. However, modifications are permitted for welded flanges, as noted in 2-4-2/9.5 and 2-4-2/9.7 of the ABS *Rules for Materials and Welding (Part 2)*, and screwed flanges of suitable material may be used in all sizes.

17 Material of Valves and Fittings

17.1 General

The physical characteristics of such material are to be in accordance with the applicable requirements of Section 2-3-1 or such other appropriate material specification as may be approved in connection with a particular design for the stresses and temperatures to which they may be exposed. Manufacturers are to make physical tests of each melt and, upon request, are to submit the results of such tests to the Bureau.

17.3 Forged or Cast Steel

In any system, forged or cast steel may be used in the construction of valves and fittings for all pressures and temperatures. Consideration is to be given to the possibility of graphite formation in the following steels: Carbon steel above 425°C (800°F); carbon-molybdenum steel above 468°C (875°F); chrome-molybdenum steel (with chromium under 0.60%) above 524°C (975°F).

17.5 Cast Iron

For temperatures not exceeding 232°C (450°F), cast iron of the physical characteristics specified in Section 2-3-11 may be used in the construction of valves and fittings, except as noted in 4-2-1/9.11, 4-2-2/19.3, 4-2-2/21.5 and 4-2-5/3.9.

17.7 Nonferrous

Brass or bronze having the physical characteristics as specified in Section 2-3-1 may be used in the construction of valves and fittings intended for temperatures up to 208°C (406°F). For temperatures greater than 208°C (406°F), but not in excess of 288°C (550°F), high-temperature bronze is to be used and the chemical and physical characteristics are to be submitted for approval. Valves, fittings and flanges made of nonferrous material may be attached to nonferrous pipe by an approved soldering method. For pressures up to 6.9 bar (7 kgf/cm^2, 100 psi) and temperatures not exceeding 93°C (200°F), ordinary solder may be used, but for higher pressures and temperatures, the method and the quality of solder to be used will be subject to special consideration in each case.

17.9 Ductile (Nodular) Iron

Nodular-iron applications for valves and fittings will be specially considered where the temperature does not exceed 343°C (650°F).

19 Fluid Power Cylinders

19.1 Application

Hydraulic and pneumatic power cylinders are to be in accordance with the requirements of this Section. Cylinders forming a part of an independently manufactured and assembled unit that do not form part of unit’s piping system are not covered by this subsection.

19.3 Cylinders for Group I Piping Systems

19.3.1 Design *(1997)*

The design of hydraulic and pneumatic power cylinders is to meet the requirements of 4-4-1A1/1.7 and 4-4-1A1/3.1 (for nodular cast iron, use $y = 0.5$), 4-4-1A1/5 and 4-4-1A1/7 of the *Steel Vessel Rules,* as applicable, in association with *S,* as defined in this Subparagraph. Welding is to be in accordance with 2-4-2/1 of the ABS *Rules for Materials and Welding (Part 2).* The maximum allowable stress, *S,* is not to exceed the following:

U/A or Y/B

where

U = minimum specified tensile strength of material at room temperature

Y = minimum specified yield point or yield strength

A and *B* are as follows:

	Rolled or Forged Steel	*Case Steel*	*Nodular Cast Iron*
A	3.5	4	5
B	1.7	2	3

Alternatively, designs may be accepted on the basis of certified burst test reports. Steel cylinders of other than cast construction are to be designed for a bursting pressure not less than four times the maximum allowable working pressure. Cylinders of cast steel or ductile iron are to be designed for a bursting pressure not less than five times the maximum allowable working pressure. See 4-2-2/19.3.3 below.

19.3.2 Plans and Data to be Submitted

- Cylinder and head details
- Cylinder rod and piston details
- Thread standard and dimensions
- Welding details and dimensions
- Lug attachments
- Material specifications, including minimum tensile, yield and elongation properties
- Design pressure and temperatures (minimum and maximum)
- Test pressure

19.3.3 Material

The physical and chemical characteristics of materials entering into the construction of hydraulic and pneumatic power cylinders are to be in accordance with the applicable requirements of Section 2-3-1 of the ABS *Rules for Materials and Welding (Part 2)* or such other appropriate material specification as may be approved in connection with a particular design. Copies of certified mill test reports are to be made available to the Surveyor upon request. Ordinary cast iron or similar materials (elongation less than 12%) are not to be used for cylinders which may be subjected to shock loading.

19.3.4 Hydrostatic Tests

19.3.4(a) General. Cylinders are to be subjected to a hydrostatic test. This test need not be witnessed by the Surveyor.

19.3.4(b) Test Pressure. The test pressure supplied is to be not less than $1^1/_2$ times the maximum allowable working pressure for steel cylinders, and not less than twice the maximum allowable working pressure for cast iron and nodular iron cylinders.

19.5 Cylinders for Group II Piping Systems

Hydraulic and pneumatic power cylinders for use in Group II piping systems may be accepted on the basis of the manufacturer's data indicating pressure rating and suitability for the intended service.

21 Sea Inlets and Overboard Discharges

21.1 Installation *(2006)*

Piping connections bolted to the shell plating are to have the bolt heads countersunk on the outside and the bolts threaded through the plating. Where a reinforcing ring of sufficient thickness is riveted or welded to the inside of the shell, studs may be used.

Threaded connections outboard of the shell valves are not considered an acceptable method of connecting pipe to the shell.

21.3 Valve Connections to Shell

Pipe connections fitted between the shell and the valves are to be at least Extra Heavy (see 4-2-1/9.21) and as short as possible. Wafer-type valves are not to be used for any connections to the unit's shell unless specially approved.

21.5 Materials

All shell fittings and the valves required by 4-2-2/21.9 and 4-2-2/23 are to be of steel, bronze or other approved ductile material. Valves of ordinary cast iron or similar material are not acceptable. The use of nodular iron, also known as ductile iron or spheroidal-graphite iron, will be accepted, provided the material has an elongation not less than 12%. All pipes to which this subsection refers are to be of steel or other equivalent material, subject to special approval.

21.7 Shell Reinforcement

Overboard discharges are to have spigots extending through the shell plate. Boiler and evaporator blow-off overboard discharges are to have doubling plates or heavy inserts fitted. The spigot is to extend through the doubling and the shell and the external doubling plate, when fitted, but the spigot need not project beyond the outside surface of the unit.

21.9 Sea-Water Inlet and Discharge Valves *(2008)*

Positive closing valves are to be fitted at the shell in inlet and discharging piping. The controls are to be readily accessible and are to be provided with indicators showing whether the valves are open or closed. In order to be considered readily accessible, the controls, during normal operating conditions, are to be:

i) Located in a space normally entered without using tools,

ii) Clear of or protected from obstructions, moving equipment and hot surfaces that prevent operation or servicing, and

iii) Within operator's reach.

Materials readily rendered ineffective by heat are not to be used for connection to the shell where the failure of the material in the event of a fire would give rise to danger of flooding.

Power-operated valves are to meet the requirements in 4-2-1/9.19. Position indicating systems for sea-water inlet and discharge valves are to be independent of the valves' control systems. Additionally, sea-water valves necessary for the operation of propulsion machinery or generation of power required in 4-3-2/3.1 are to be designed to remain in the last ordered position upon loss of control power.

Valves for sea-water inlets and discharges are also to be in accordance with the following, as applicable.

21.9.1 Column-Stabilized Units

Sea-water inlets and discharges below the assigned load line are to be provided with valves which can be remotely operated from an accessible position outside of the space.

21.9.2 Self-Elevating and Surface-Type Units

Sea-water inlets and discharges in spaces below the assigned load line which are not intended to be normally manned are to be provided with valves which can be remotely operated from an accessible position outside of the space. If the valves are readily accessible, the spaces containing the inlets and discharges may be provided with bilge alarms in lieu of remote operation of the valves.

21.9.3 Self-Elevating Units

Mud pit discharges are to be provided with valves which can be operated from an accessible position. These valves are to be normally closed and a sign to this effect is to be posted near the operating position. Non-return valves need not be provided.

21.11 Sea Chests *(1996)*

The location of sea chests is to be such as to minimize the probability of blanking off the suction, and they are to be so arranged that the valves may be operated from the floors or gratings.

Sea chests are to be fitted with strainer plates at the shell. The strainers are to have a clear area of at least 1.5 times the area of the sea valves, and efficient means are to be provided for clearing the strainers.

23 Scuppers and Drains on Surface-Type and Self-Elevating Units

23.1 Discharges through the Shell *(2005)*

Discharges led through the shell either from spaces below the freeboard deck or from within superstructures and deckhouses on the freeboard deck, fitted with doors complying with the requirements of 3-2-11/5 of the *Steel Vessel Rules,* are to be fitted with efficient and accessible means for preventing water from passing inboard.

Normally, each separate discharge is to have one automatic non-return valve with a positive means of closing it from a position above the freeboard deck, or bulkhead deck, whichever is higher. Alternatively, one non-return valve and one positive closing valve controlled from above the freeboard deck may be accepted.

23.1.1

Where, however, the vertical distance from the load water-line to the inboard end of the discharge pipe exceeds $0.01L$, the discharge may have two automatic non-return valves without positive means of closing, provided that the inboard valves are always accessible for examination under service conditions. The inboard valve is to be above the deepest load waterline. If this is not practicable, then, provided a locally controlled stop valve is interposed between the two non-return valves, the inboard valve need not be fitted above the deepest load waterline.

23.1.2

Where that vertical distance from the summer load waterline to the inboard end of the discharge pipe exceeds 0.02*L*, a single automatic non-return valve without positive means of closing may be accepted provided it is located above the deepest load waterline. If this is impracticable, a locally operated positive closing valve may be provided below the single non-return valve in which case the non-return valve need not be located above the specified deepest load waterline. The means for operating the positive-action valve is to be readily accessible and provided with an indicator showing whether the valve is open or closed.

See 3-1-1/13 for definition of 'freeboard deck'.

3-1-1/3 of the *Steel Vessel Rules* and 3-1-1/3 of the *Barge Rules* define *L*.

23.1.3 *(2005)*

Where sanitary discharges and scuppers lead overboard through the shell in way of machinery spaces, the fitting to shell of a locally operated positive closing valve, together with a non-return valve inboard, will be acceptable

23.3 Scuppers and Discharges below the Freeboard Deck – Shell Penetration *(1996)*

Scuppers and discharge pipes originating at any level and penetrating the shell either more than 450 mm (17.5 in.) below the freeboard deck or less than 600 mm (23.5 in.) above the summer load waterline are to be provided with a non-return valve at the shell. This valve, unless required by 4-2-2/23.1, may be omitted if the piping has a wall thickness at least equal to the thickness of the shell plating or extra-heavy pipe (see 4-2-1/9.21), whichever is less.

23.5 Scuppers from Superstructures or Deckhouses

Scuppers leading from superstructures or deckhouse not fitted with doors complying with the requirements of Section 3-2-11/5 of the *Steel Vessel Rules* are to be led overboard.

27 Cooler Installations External to the Hull

27.1 General

The inlet and discharge connections of external cooler installations are to be in accordance with 4-2-2/21.1, 4-2-2/21.3, 4-2-2/21.5 and 4-2-2/21.9, except that wafer type valves will be acceptable.

27.3 Integral Keel Cooler Installations

The positive closing valves required by 4-2-2/27.1 need not be provided if the keel (skin) cooler installation is integral with the hull. To be considered integral with the hull, the installation is to be constructed such that channels are welded to the hull with the hull structure forming part of the channel. The channel material is to be at least of the same thickness and quality as that required for the hull, and the forward end of the cooler is to be faired to the hull with a slope of not greater than 4 to 1.

If positive closing valves are not required at the shell, all flexible hoses or joints are to be positioned above the deepest load waterline or be provided with an isolation valve.

27.5 Non-integral Keel Cooler Installations

Where non-integral keel coolers are used, if the shell penetrations are not fully welded, the penetration is to be encased in a watertight enclosure.

29 Penetrations through Watertight Boundaries

At the boundaries required to be maintained watertight for damage stability, valves or watertight closures may be required (see 3-3-1/9). Check valves and spring or gravity-actuated, non-return valves are not to be considered effective in preventing progressive flooding. Watertight closures or valves and their control and position-indicating systems are to be provided as follows:

29.1 Ventilating Systems

Non-watertight ducts passing through subdivision bulkheads and watertight ducts servicing more than one watertight compartment or which are within the extent of damage are to be provided with valves at the subdivision boundary. Valve operators are to be fitted with position indicators. Control of valves is to be from one of the following areas:

i) Ballast control room or other normally manned spaces.

ii) Readily accessible locations which are above the calculated immersion line in the damaged condition (see 3-3-1/1.3.).

29.3 Internal Drain System

29.3.1

Where drain systems are led to a separate, watertight compartment fitted with a bilge suction, positive closing valves are to be provided with position indicators. Control of these valves is to be from locations listed in 4-2-2/29.1.

29.3.2

Where the installation of a remote valve operator is impractical, drain lines may be fitted with quick-acting, self-closing valves at the boundary of the space which is equipped with a bilge suction.

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PART

4

CHAPTER 2 Pumps and Piping Systems

SECTION 3 Tank Vents and Overflows

1 Tank Vents and Overflows

1.1 General

Except for comparatively small compartments that are not fitted with a fixed means of drainage, vent pipes are to be fitted to all tanks, cofferdams, voids, tunnels and compartments which are not fitted with other ventilation arrangements.

In all units, the structural arrangement in double-bottom and other tanks is to be such as to permit the free passage of air and gases from all parts of the tanks to the vent pipes. Tanks having a comparatively small surface, such as fuel-oil settling tanks, need to be fitted with only one vent pipe, while tanks having a comparatively large surface are to be fitted with at least two vent pipes, one of which is to be located at the highest part of the tank. Vent pipes are to be arranged to provide adequate drainage under normal conditions.

All vent and overflow pipes on the open deck are to terminate by way of return bends.

1.3 Progressive Flooding Consideration *(1995)*

Tank vents and overflows are to be located giving due regard to stability and the extent of watertight integrity provided in the plans submitted in accordance with 4-2-1/3.1. They are to terminate above the extent of watertight integrity. Those terminating within the extent of weathertight integrity are to be fitted with automatic means of closure such as a ball check valve or equivalent.

The vent of a permanently filled compartment may terminate within the extent of watertight integrity. Automatic means of closures are not required for vents of such compartments.

For the purpose of positioning vent and overflow ends, damage to the space from which they emanate need not be considered.

Progressive flooding through tank vents and overflows, regardless of the means of closure, is to be considered when tank vents and overflows from intact spaces terminate within a damaged compartment or vice versa.

1.5 Height of Vent Pipes

Where air pipes extend above the freeboard or superstructure decks, the exposed parts of the pipes are to be of at least Standard thickness (see 4-2-1/9.21). The height from the deck to the point where water may have access below is to be at least 760 mm (30 in.) on the freeboard deck and 450 mm (17.5 in.). on the superstructure deck. Where these heights may interfere with the working of the unit, a lower height may be approved, provided that the closing arrangements and other circumstances justify a lower height.

See 4-2-3/1.3 for damage stability requirements.

1.7 Size

The diameter of each vent pipe is not to be less than 38 mm (1.5 in.) I.D. for fresh-water tanks, 51 mm (2 in.) I.D. for water-ballast tanks and 63 mm (2.5 in.) I.D. for oil tanks, unless specially approved otherwise. Where tanks are to be filled by pump pressure, the aggregate area of the vents in the tank is to be at least 125% of the effective area of the filling line, except that when overflows are fitted, the area of the overflow is to be at least 125% of the effective area of the filling line and the vents need not exceed the above minimum sizes. Notwithstanding the above, the pump capacity and pressure head are to be considered in the sizing of vents and overflows. When high capacity and/or high head pumps are used, calculations demonstrating the adequacy of the vent and overflows are to be submitted.

1.9 Termination of Vent Pipes *(2007)*

1.9.1 Termination on or Above Freeboard Deck

Vent pipes for all tanks, double bottoms and other compartments which extend to the shell of the unit are to be led above the freeboard deck. In addition, vents for ballast tanks and fuel oil tanks are to be led to the weather.

1.9.2 Termination in Machinery Spaces

Vents for other tanks not adjacent to the shell of the unit may terminate within the machinery space but are to be located so as to preclude the possibility of overflowing on electric equipment, engines or high temperature piping. For low flash point fuel oil, see 4-2-4/9.5.

1.9.3 Protection for Fuel Oil and Lubricating Oil Tanks

For self-propelled units, vent pipes for fuel oil service tanks, fuel oil settling tanks and lubricating oil tanks which directly serve the engines are to be located and arranged and/or suitably protected from mechanical damage in order to minimize the possibility of being broken and allowing ingress of seawater splashes or rain water into the above-mentioned oil tanks.

1.9.4 Fuel Oil Tanks Vent Outlets

Vent outlets from fuel oil tanks are to be fitted with corrosion-resistant flame screens having clear area through the mesh of not less than the required area of the vent pipe and are to be located where the possibility of ignition of gases issuing from the vent outlets is remote. Either a single screen of corrosion-resistant wire of at least 12 by 12 meshes per lineal cm (30 by 30 mesh per lineal inch), or two screens of at least 8 by 8 meshes per lineal cm (20 by 20 mesh per lineal inch) spaced not less than 13 mm (0.5 inch) nor more than 38 mm (1.5 inch) apart are acceptable.

See also 4-2-3/15.3 for progressive flooding considerations.

Note: Mesh count is defined as a number of openings in a lineal cm (inch) counted from the center of any wire to the center of a parallel wire.

1.11 Overflow Pipes *(1998)*

Overflow pipes discharging through the unit's side are to be located as far above the deepest load line as practicable and are to be provided with non-return valves located on the unit's side. Where the overflow does not extend above the freeboard deck, there is to be provided in addition an efficient and accessible means for preventing water from passing inboard. Such means may consist of another non-return valve located in an accessible position above the deepest load line. Where it is impracticable to locate the inner valve in an accessible position, one non-return valve with positive means for closing from an accessible position above the freeboard or bulkhead deck will be acceptable, provided there are suitable arrangements to insure the valve not being closed by unauthorized persons and provided a notice is posted in a conspicuous place at the operating station to the effect that the valve is never to be closed, except as may be required in an emergency.

Overflow pipes where provided from combustible and flammable liquid tanks are to be led to an overflow tank of adequate capacity or to a storage tank having space reserved for overflow purposes. An alarm device is to be provided to give warning when the liquid reaches a predetermined level in the overflow tank. If a sight flow glass is also provided in the overflow pipe, then such sight glasses are to be fitted only in vertical sections of overflow pipes and be in readily visible positions.

3 Sounding Arrangements

3.1 General

All tanks, except as noted below, are to be provided with separate sounding pipes or with approved tank-level indicating apparatus. Where a tank-level indicating system is used, a supplementary manual means of sounding is to be provided, where practicable, for tanks which are not always accessible.

In general, void compartments adjacent to the sea or to tanks containing liquids, and void compartments through which piping carrying liquids pass are to be fitted with separate sounding pipes, approved tank liquid level indicating apparatus, or be fitted with means to determine if the void tanks contain liquids. Voids as defined above which do not comply with this requirement are to be accounted for in the unit's stability analysis. See 3-3-1/1.3.3.

3.3 Sounding Pipes *(1993)*

Sounding pipes are not to be less than 38 mm (1.5 in.) inside diameter. Where a sounding pipe exceeds 20 m (65.6 ft) in length, the internal diameter is to be at least 50 mm (2 in.). They are to be led as straight as possible from the lowest part of the tank or compartment to the bulkhead deck or to a position which is always accessible. If sounding pipes terminate below the freeboard deck, they are to be provided with means for closing in the following manner.

3.3.1 Oil Tanks

For oil tanks, with quick-acting, self-closing gate valves.

3.3.2 Other Tanks

For tanks other than oil tanks, with gate valves or a screw cap secured to the pipe with a chain.

Provision is to be made to prevent injuring the unit's plating by the striking of the sounding rod. In general, sounding pipes are not to pass through bilge wells, but if this is not practicable, the pipe is to be at least Extra Heavy in the bilge well. (See 4-2-1/9.21). Sounding pipes for combustible or flammable fluids are not to terminate in accommodation spaces.

3.3.3 Ignition of Spillage

17.3.3(a) Fuel Oil Tanks. Sounding pipes for fuel oil tanks are not to terminate in any space where the risk of ignition of spillage may exist. In particular, they shall not terminate in machinery paces or in close proximity to internal combustion engines, generators, major electric equipment or surfaces with temperatures in excess of 220°C (428°F) in other spaces. Where it is impracticable to do otherwise, sounding pipes from fuel oil tanks may terminate in machinery spaces, provided the following are met:

i) The sounding pipes terminate in locations remote from ignition hazards or effective precautions such as shielding are taken to prevent fuel oil spillage from coming into contact with a source of ignition;

ii) The terminations of sounding pipes are fitted with quick-acting, self-closing gate valves and with a small-diameter self-closing test cock or equivalent located below the gate valve for the purpose of ascertaining that fuel oil is not present before the gate valve is opened. Provisions are to be made so as to prevent spillage of fuel oil through the test cock from creating an ignition hazard.

iii) *(2005)* An oil level gauge is provided. However, short sounding pipes may be used for tanks other than double bottom tanks without the additional closed level gauge, provided an overflow system is fitted, see 4-2-3/1.11.

3.3.3(b) Lubricating Oil Tanks (2005). Sounding pipes from lubricating oil tanks may terminate in machinery spaces provided that the following are met:

i) The sounding pipes are to terminate in locations remote from the ignition hazards, or effective precautions, such as shielding, are taken to prevent oil spillage from coming into contact with a source of ignition.

ii) The termination of sounding pipes is fitted with a quick-acting self-closing gate valve. Alternatively, for lubricating oil tanks that cannot be filled by a pump, the sounding pipes may be fitted with an appropriate means of closure such as a shut-off valve or a screw cap attached by chain to the pipe.

3.5 Gauge Glasses

Tanks may be fitted with suitable gauge glasses, provided the gauge glasses are fitted with a valve at each end and adequately protected from mechanical damage.

Tanks containing flammable or combustible fluids are to be fitted with gauge glasses of the flat glass type having approved self-closing valves at each end. For hydraulic oil tanks located in spaces other than Category A machinery spaces, cylindrical gauge glasses with approved self-closing valves at each end will be acceptable, provided such spaces do not contain internal combustion engines, generators, major electrical equipment or piping having a surface temperature in excess of 220°C (428°F).

Tanks integral with the shell which are located below the deepest load waterline may be fitted with gauge glasses, provided they are of the flat glass type having approved self-closing valves at each end.

See 5-1-1/3.7.2(6) for the definition of Category A machinery spaces.

3.7 Level Indicating Device *(2005)*

Where a level-indicating device or system is provided for determining the level in a tank containing flammable or combustible liquid, failure of the device/system is not to result in the release of the content of the tank through the device. Penetrations for level switches may be used below the tank top provided they are contained in a steel enclosure or other enclosures not being capable of being destroyed by fire. If an overflow is not fitted, means are also to be provided to prevent overfilling of the tank in the event of malfunctioning of the indicating device/system.

PART

4

CHAPTER 2 Pumps and Piping Systems

SECTION 4 Bilge and Ballast Systems and Tanks

1 General Arrangement of Bilge and Ballast Systems for Surface-Type Units

1.1 General

A satisfactory pumping plant is to be provided in all units capable of pumping from and draining any compartment when the unit is on an even keel and either upright or listed 5 degrees. For this purpose, wing suctions will often be necessary, except in narrow compartments at the ends of the unit. Arrangements are to be made whereby water in the compartment will drain to the suction pipes. Efficient means are to be provided for draining water from all tank tops and other watertight flats. Peak tanks, chain lockers and decks over peak tanks may be drained by ejectors or hand pumps. See also 3-2-4/17.3 of the *Steel Vessel Rules*. For cases where a suction line is led through the forepeak bulkhead, see 4-2-1/9.11.

1.3 Number of Bilge Pumps

At least two power-driven bilge pumps are to be provided, one of which may be attached to the propulsion unit.

1.5 Independent Bilge Suctions

One of the independent power pumps is to be fitted with a suction led directly from the main machinery-space bilge to the suction valve chest of the pump so arranged that it can be operated independently of the bilge system. The size of this line is to be such that the pump will deliver its full capacity. If watertight bulkheads separate the main machinery space into compartments, such a direct suction is to be fitted to each compartment unless the pumps available for bilge service are distributed throughout these compartments, in which case, at least one pump in each such compartment is to be fitted with a direct suction in its compartment.

1.7 Direct Bilge Suctions

In addition to the independent bilge suction in 4-2-4/1.5, the following arrangements are required for ship-type units 55 m (180 ft) or more in length.

1.7.1 Steam-engine Installation

For steam-engine installations, the main circulating pumps are to be fitted with a direct bilge suction for the main machinery space and the diameter of such a suction is to be at least two-thirds the diameter of the main injection. Where the main circulating pump is not suitable for this purpose, a direct bilge suction is to be provided in accordance with 4-2-4/1.7.2 below. The selected pump is to be an independent power driven pump.

1.7.2 Internal-combustion-engine Installation

For internal-combustion-engine installations, a direct bilge suction for the engine room is to be provided from the largest suitable pump in the engine room, except a required bilge pump. The area of the direct suction pipe is to be equal to the full suction inlet of the pump selected. A suitable overboard discharge line is to be provided and the means of control of the direct bilge suction is to be readily accessible and so located as to provide rapid operation.

1.7.3 Valve Arrangement

The direct bilge suctions are to be fitted with suitable non-return valves.

3 General Arrangement of Bilge Systems for Column-Stabilized Units and Self-Elevating Units

3.1 Permanent Systems

Except as indicated below, all compartments are to have a permanently installed bilge or drainage system. Compartments below the bulkhead deck containing essential equipment for operation and safety of the unit are to be capable of being pumped out by at least two power-driven bilge pumps or equivalent. For column stabilized units, the bilge system in each pump room is to be operable from the central ballast control station.

3.3 Void Compartments

In general, void compartments adjacent to the sea or to tanks containing liquids, and void compartments through which piping conveying liquids pass, are to be drained by permanently installed bilge or drainage systems or by portable means. If portable pumps are used, two are to be provided and both pumps and arrangements for pumping are to be readily accessible. Void compartments as defined above which are not provided with bilge or drainage systems complying with the above are to be accounted for in the units stability analysis. See 3-3-1/1.3.3 and 4-2-2/29.3.

3.5 Chain Lockers

Chain lockers are to be drained by permanently installed bilge or drainage systems or by portable means. Means are to be provided for removal of mud and debris.

3.7 Bilge Alarm

Propulsion rooms and pump rooms in lower hulls of column-stabilized units are to be provided with two independent systems of high bilge water level detection, giving an audible and visual alarm at the central ballast control station.

5 Bilge Piping (All Units)

5.1 General

The arrangement of the bilge pumping system is to be such as to prevent the possibility of water or oil passing into the machinery spaces, or from one compartment to another, whether from the sea, water ballast or oil tanks. The bilge mains are to have separate control valves at the pumps.

5.3 Installation

Bilge pipes passing through compartments intended for the carriage of oil are to be of either steel or wrought iron. Where bilge pipes pass through deep tanks, means are to be provided to prevent the flooding of other spaces in the event of a pipe breaking or joint leaking in the tanks. Such means may consist of an oiltight or watertight tunnel, or making the lines of Extra-Heavy steel pipe (see 4-2-1/9.21) properly installed to take care of expansion and having all joints within the tank welded or extra-heavy flanged joints. The number of flanged joints is to be kept to a minimum. When a tunnel is not employed and the line runs through a deep tank, bilge pipes are to have non-return valves fitted at the open ends.

5.5 Manifolds, Cocks and Valves *(1996)*

All manifolds, cocks and manually operated valves in connection with the bilge pumping arrangement are to be in positions which are accessible at all times under ordinary circumstances. Where such valves are located in normally unmanned spaces below the assigned load line and which are not provided with high bilge water level alarms, then the valves are to be operable from outside such spaces.

All valves in the machinery space controlling the bilge suctions from the various compartments are to be of the stop-check type. If valves are fitted in the open ends of bilge pipes, they are to be of the non-return type.

Remote control of bilge valves is to be clearly marked at the control station and means are to be provided to indicate whether the valves are open or closed.

5.7 Common-main-type Bilge Systems

Where permitted, this type of system is to have the fore-and-aft piping installed inboard of the assumed penetration zone, as defined in 3-3-1/7. The control valves required in the branches from the bilge main are to be accessible at all times and are to be of the stop-check type with an approved type of remote operator. Remote operators may be located in a manned machinery space, or from an accessible position above the freeboard deck, or from underdeck walkways. Remote operators may be of the hydraulic, pneumatic or reach-rod type.

5.9 Strainers

Bilge lines in machinery spaces other than emergency suctions are to be fitted with strainers easily accessible from the floor plates and are to have straight tail pipes to the bilges. The ends of bilge lines in other compartments are to be fitted with suitable strainers having an open area of not less than three times the area of the suction pipe. In addition, strainers are to be fitted in accessible positions between the bilge manifolds and the pumps.

5.11 Gravity Drains

Gravity drains that penetrate the main machinery space watertight bulkheads below the freeboard deck and terminate within the main machinery space are to be fitted with a valve operable from above the freeboard deck or with quick-acting, self-closing valves. The valve should preferably be located in the main machinery space. When gravity drains from other spaces are terminated in cargo holds, the cargo hold bilge well is to be fitted with a high level alarm. Gravity drains which terminate in spaces which are protected by fixed gas extinguishing systems are to be fitted with means to prevent the escape of extinguishing medium.

5.13 Bilge Suctions from Hazardous Areas

Hazardous and non-hazardous areas are to be provided with separate drainage or pumping arrangements.

5.15 Exceptions

The bilge arrangements of units intended for restricted or special services will be specially considered in each case.

7 Bilge Pumps (All Units)

7.1 General *(2007)*

Sanitary, ballast and general-service pumps may be accepted as independent power bilge pumps, provided they are of the required capacity and are fitted with stop valves so that when a pump is used for one service, the other services can be isolated. Where centrifugal pumps are installed, suitable means for priming are to be provided.

7.3 Arrangement and Capacity

Each bilge pump is to be capable of giving a speed of water through the bilge main, required by 4-2-3/9.1 or 4-2-3/9.3, as applicable, of not less than 2 m (6.6 ft) per second. The pump capacity, Q, in this case may be determined from the following equation.

$$Q = 5.66d^2/10^3 \text{ m}^3\text{/hr} \qquad Q = 16.1d^2 \text{ gpm}$$

where

d = diameter of main-bilge-line suction, mm (in.), required by 4-2-4/9.

When more than two pumps are connected to the bilge system, their arrangement and aggregate capacity are not to be less effective.

9 Size of Bilge Suctions

9.1 Surface-Type Units

The least internal diameter of bilge suction pipes is to be that of the nearest commercial size within 6 mm (0.25 in.) of the diameter determined by the following equations.

9.1.1 Main Line

For the diameter of main-bilge-line suctions and direct bilge suctions to the pumps:

$$d = 25 + 1.68\sqrt{L(B + D)} \text{ mm} \qquad d = 1 + \sqrt{L(B + D)/2500} \text{ in.}$$

9.1.2 Branch Lines

For the equivalent diameter of the combined branch suctions to a compartment:

$$d = 25 + 2.16\sqrt{c(B + D)} \text{ mm} \qquad d = 1 + \sqrt{c(B + D)/1500} \text{ in.}$$

where

d	=	internal diameter of pipe, in mm (in.)
L	=	length of unit, in m (ft)
B	=	breadth of unit, in m (ft)
D	=	molded depth to bulkhead or freeboard deck, in m (ft), as defined in 3-1-1/23.
c	=	length of compartment, in m (ft)

L and *B* are defined in Section 3-1-1 of the *Steel Vessel Rules* for ship-type units and Section 3-1-1 of the *Barge Rules* for barge-type units.

9.1.3 Main Line Reductions

In units where engine room bilge pumps are fitted primarily for drainage within the engine room, *L* may be reduced by the combined length of the tanks. In such cases, the cross sectional area of the bilge main is not to be less than twice the required cross sectional area of the engine room branch lines.

9.1.4 Size Limits

No main suction piping is to be less than 63 mm (2.5 in.) internal diameter. No branch piping need be more than 100 mm (4 in.) I.D., nor is it to be less than 51 mm (2 in.) I.D. in diameter, except that for drainage of small pockets or spaces 38 mm (1.5 in.) I.D. pipe may be used.

9.3 Column-Stabilized Units and Self-Elevating Units

9.3.1 Main Line

The cross sectional area of the bilge main is not to be less than the combined areas of the two largest required branch suctions. Additionally, the cross sectional area of the bilge main for self-elevating drilling units is not to be less than that required by 4-2-4/9.1.1 for surface-type units.

9.3.2 Branch Lines

The size of branch suctions and drains from each compartment is not to be less than that determined from the following equation:

$$d = [2.15\sqrt{A} + 25] \text{ mm} \qquad d = [\sqrt{A/1500} + 1] \text{ in.}$$

where

d	=	internal diameter of the branch suction to the nearest 5 mm (0.20 in.)
A	=	wetted surface in m^2 (ft^2) of

i) Single compartment drained by the branch suction, excluding stiffening members, when the compartment is half-filled.

ii) The two largest compartments, excluding stiffening members, when the compartments are half-filled where multiple compartments are drained together.

9.3.3 Size Limits

The internal diameter of any bilge line is not to be less than 50 mm (2 in.).

11 Ballast Piping (All Units)

11.1 General

The arrangement of the ballast pumping system is to be such as to prevent the possibility of water or oil passing into the machinery spaces, or from one compartment to another, whether from the sea, water ballast or oil tanks. The ballast mains are to have separate control valves at the pumps.

11.3 Installation

Ballast pipes passing through compartments intended for the carriage of oil are to be either steel or wrought iron. Where ballast pipes pass through deep tanks, means are to be provided to prevent the flooding of other spaces in the event of a pipe breaking or joint leaking in the tanks.

Such means may consist of an oiltight or watertight tunnel, or making the lines of Extra-Heavy steel pipe (see 4-2-1/9.21) properly installed to take care of expansion and having all joints within the tank welded or extra-heavy flanged joints. The number of flanged joints is to be kept to a minimum.

11.5 Controls for Ballast Tank Valves

Ballast tank valves are to be arranged so that they will remain closed at all times, except when ballasting. For this purpose, manual screw thread operated valves or positive holding arrangements for butterfly type valves or other approved arrangement will be accepted. Where installed, remote controlled valves are to be either arranged so that they will close and remain closed upon loss of control power or arranged so they will remain in their last position and are provided with a readily accessible manual means of closing in case of loss of power to the valve control system. Remote control of ballast valves is to be clearly marked at the control station and means are to be provided to indicate whether the valve is open or closed.

11.7 Exceptions

The ballast arrangements of units intended for restricted or special services will be specially considered in each case.

13 Ballasting Systems for Column-Stabilized Units

13.1 General

The ballast system is to be designed and arranged such that the system can take suction from and deballast any ballast tank under normal operating and transit conditions. The system is to be capable of restoring the unit to a normal operating or transit draft and a level trim condition, when subject separately to each of the following:

i) The assumed damaged conditions as specified in 3-3-1/1.3.2(a) with any one pump inoperable.

ii) The flooding specified in 3-3-1/1.3.2(b).

In addition, the system is to be capable of raising the unit, starting from a level trim condition at deepest normal operating draft, either a distance of 4.6 m (15 ft) or to the severe storm draft, whichever distance is greater, within three hours (calculations are to be submitted). The ballasting procedure is to be submitted for information and is to be provided to the unit's operating personnel.

13.3 Manifolds

Ballast suctions are to be led from readily accessible manifolds unless independent pumps are provided for each tank. Ballast systems are to be arranged to prevent the inadvertent transfer of ballast water from one quadrant to any other quadrant of the unit.

13.5 Pumps

13.5.1 Number

In general, at least two independent ballast pumps are to be capable of taking suction on each ballast tank. In the case of units with two lower hulls, each hull is to be provided with at least two independently driven ballast pumps. Units with more than two lower hulls or of unusual configuration will be subject to special consideration.

13.5.2 Pump Performance *(2002)*

At least two pumps are to be capable of effectively emptying each intact tank at maximum normal operating draft when the unit is subject to the assumed damage conditions specified in 3-3-1/1.3.2. [*Note:* Loss of a pump(s) due to flooding of a pump room is to be considered in meeting this requirement.] Each of the pumps utilized in meeting the above requirement is to have adequate head/capacity characteristics and available net positive suction head (NPSHa) to operate at the angles of heel and trim associated with the conditions specified in 3-3-1/1.3.2 at a capacity of not less than 50% of the capacity required from that pump to meet the criteria of 4-2-4/13.1.

Pump data and calculations substantiating compliance with this requirement are to be submitted. The use of submersible pumps will be subject to special consideration.

13.7 Ballast Control Features *(1995)*

13.7.1 Centralized Control Station *(1995)*

13.7.1(a) Location. A centralized control station is to be provided. It is to be located above the worst damage waterline and in a space clear of the assumed extent of damage specified in 3-3-1/7.3, protected from weather and readily accessible when the unit is subjected to the severe storm and damage, as defined in 3-3-1/1.3.1 and 3-3-1/1.3.2.

13.7.1(b) Controls and Indications. The central ballast control station is to be fitted with the following control and indicating systems.

i) Ballast pump control system

ii) Ballast pump status indicating system

iii) Ballast valve control system

iv) Ballast valve position indicating system

v) Draft indicating system

vi) Tank level indicating system

vii) Heel and trim indicators

viii) Electric power availability system (main and emergency)

ix) Ballast control hydraulic or pneumatic pressure indicating system, where applicable.

13.7.1(c) Communication. A means of communication, which is independent of the drilling unit's service electrical system, is to be provided between the central ballast control station and those spaces containing the local controls for ballast pumps and associated ballast valves.

13.7.1(d) Back-up Station Back-up station is not required but if fitted, it is to comply with the requirements in 4-2-4/13.7.1(a) and 4-2-4/13.7.1(c), except that the back-up station need not be located above the worst damaged waterline.

13.7.2 Independent Local Control *(1995)*

All ballast pumps and valves are to be fitted with independent local control operable in the event of failure of the remote control from the central ballast control station. These independent local controls need not be power operated. The independent local controls for each ballast pump and its associated valves are to be from the same location. For communication, see 4-2-4/13.7.1(c).

13.7.3 Safety Features *(1995)*

13.7.3(a) Independency

i) *All Systems.* The systems listed in 4-2-4/13.7.1(b) are to function independently of one another or have sufficient redundancy so that a failure in one system does not jeopardize the operation of any of the other systems.

ii) *Pump/Valve Control Systems.* The ballast pump and ballast valve control systems are to be arranged such that loss of any one component will not cause loss of operation of the other pumps or valves. This requirement will not apply to those parts of a control system dedicated to a single ballast valve nor will it apply to manifolds serving exclusively those dedicated systems.

13.7.3(b) Dual Power Source. For those systems listed in 4-3-2/5.3ix), the source of any electrical power is to comply with the requirements in 4-3-2/5.3. Where the power source is pneumatic or hydraulic, there are to be at least two power units designed to function at the inclination angles in 4-3-2/5.5.1.

13.7.3(c) Disconnects. Means are to be provided at the central ballast control station to isolate or disconnect each ballast pump and ballast valve control system from its source of electrical, pneumatic or hydraulic power.

13.7.3(d) Electronic Systems. Where microprocessor, computer-operated or multiplex type systems form part of the control system, they are to have back-up capability for continued operation upon loss of any single major component.

13.7.3(e) Valve Controls. The ballast valve control system is to be designed and arranged so that there is not continuing transfer of ballast upon loss of power. See also 4-2-4/13.3. Ballast tank valves are to close automatically upon loss of power. They are to remain closed upon reactivation of control power until they are intentionally opened.

13.7.4 Valve Position Indicating Systems *(1995)*

A means to indicate whether a valve is open or closed is to be provided at each location from which the valve may be controlled. The indicators are to rely on movement of the valve spindle.

13.7.5 Draft Indicating System *(1995)*

The draft indicating system is to indicate the draft at each corner of the unit.

13.7.6 Tank Level Indicating System *(1995)*

The tank level indicating system is to indicate the liquid levels in all ballast tanks and in other tanks, such as fuel oil, fresh water, drilling water or liquid storage tanks, the filling of which could affect the stability of the unit. Tank level sensors are not to be located in the tank suction lines.

A secondary means of determining levels in ballast tanks, which may be a sounding pipe, is also to be provided.

PART

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CHAPTER 2 Pumps and Piping Systems

SECTION 5 Fuel Oil Systems and Tanks

1 Fuel Oil Piping System – General

1.1 Arrangement *(1994)*

1.1.1 Tanks

As far as practicable, fuel-oil tanks are to be part of the structure and located outside of machinery spaces of Category A. Where fuel-oil tanks, other than double bottom tanks, are necessarily located adjacent to or within machinery spaces of Category A, at least one of their vertical sides is to be contiguous to the machinery space boundaries, and preferably have a common boundary with the double bottom tanks, and the area of the tank boundary common with the machinery spaces is to be kept to a minimum. Where such tanks are situated within the boundaries of machinery spaces of Category A, they are not to contain fuel oil having a flashpoint of 60°C (140°F) or less. In general, the use of free-standing fuel oil tanks is to be avoided. Where permitted, they are to be placed in an oil-tight spill tray of ample size with adequate means of drainage, in accordance with 4-2-1/9.29.1.

1.1.2 Spillage

No fuel oil tank is to be situated where spillage or leakage therefrom can constitute a hazard by falling on heated surfaces. Precautions are to be taken to prevent any oil that may escape under pressure from any pump, filter or heater from coming into contact with heated surfaces.

1.1.3 Sounding Arrangements

See 4-2-3/3, as applicable.

1.1.4 Service and Settling Tanks *(2004)*

For a self-propelled drilling unit, the vent pipes for fuel oil service and settling tanks which directly serve the engines are to be located and arranged and/or suitably protected from mechanical damage in order to minimize the possibility of being broken and allowing ingress of seawater splashes or rain water into the above-mentioned oil tanks. At least two fuel oil service tanks are to be provided, and the capacity, with one service tank unavailable, is to be sufficient for at least eight hours operation of the propulsion plant at maximum continuous rating and the generator plant (excluding emergency generator) at the normal sea load.

Where the propulsion plant and auxiliary machinery are supplied by different service tanks, or where more than one type of fuel is used onboard the unit, the number and capacity of the fuel oil service tanks is to be sufficient such that the propulsion plant, including all auxiliary machinery vital for propulsion, and the generator plant have both a main fuel oil supply and a back-up fuel oil supply. The capacity of the tanks, with one service tank unavailable, is to be sufficient to provide the machinery it serves with enough fuel oil for at least eight hours operation, as required above.

Alternatives equivalent to the above arrangements will be considered.

A service tank is a fuel tank which contains only fuel of a quality ready for use, that is, fuel of a grade and quality that meets the specification required by the equipment manufacturer. A service tank is to be declared as such and is not to be used for any other purpose.

1.3 Piping, Valves and Fittings

Fuel oil pipes, valves and fittings are to be of steel or other approved materials.

1.5 Oil Heating Arrangements *(1994)*

1.5.1 Oil Heaters

Where steam heaters or heaters using other heating media are provided in fuel oil systems they are to be fitted with a temperature control and either a high temperature alarm or a low flow alarm, except where the maximum temperature of the heating medium does not exceed 220°C (428°F).

Where electric heaters are fitted, they are to be arranged to de-energize automatically when the oil level falls to a predetermined level to ensure that the heating elements are permanently submerged during operation. In addition, a safety temperature switch with a manual reset independent from the automatic control sensor is to be provided to cut off the electric power supply in order to avoid a surface temperature in excess of 220°C (428°F).

1.5.2 Tanks

Unless specially approved otherwise, fuel oil in storage tanks is not to be heated to temperatures within 10°C (18°F) below the flash point of the fuel oil.

Where heating arrangements are provided, the control and alarm requirements of 4-2-5/1.5.1 are applicable.

1.7 Fuel Oil Purifiers *(1997)*

Where fuel oil purifiers for heated oil are installed, the arrangement is to be in accordance with 5-3-1/11.

3 Fuel-oil Transfer and Filling

3.1 General

The fuel-oil pumping arrangements are to be distinct from the other pumping systems as far as practicable, and the means provided for preventing dangerous interconnection in service are to be thoroughly effective.

3.3 Heating Coils

When heating coils are fitted, and oil leakage into the returns could contaminate the boiler feed water, provision is to be made to detect this leakage by running the returns from the heating coils to an inspection tank or other approved oil detector before being led to the boiler feed system.

3.5 Pipes in Oil Tanks

Oil pipes and other pipes, where passing through oil tanks, are to be of steel, except that other materials may be considered where it is demonstrated that the material is suitable for the intended service. All packing is to be of a composition not affected by oil.

3.7 Control Valves or Cocks

Valves or cocks controlling the various suctions are to be located close to the bulkhead where the suctions enter the machinery spaces and, wherever practicable, directly over the gutterway in way of deep and settling tanks. Pumps, strainers, etc., requiring occasional examination are to have drip pans.

3.9 Valves on Oil Tanks *(2004)*

Where pipe lines emanate from fuel oil tanks at such a level that they will be subjected to a static head of oil from the tank, they are to be fitted with positive closing valves located at the tank. Where the fuel oil piping passes through adjacent tanks, the valve required above may be located where the pipe run exits the adjacent tank(s) provided the piping in the adjacent tanks is Extra-Heavy and has all welded connections. However, if the adjacent tank is a fuel oil tank, the pipe run within the fuel oil tank is to be at least Standard thickness.

If the valves are installed on the outside of the tank, they are not to be of cast iron. The use of nodular iron, also known as ductile iron or spheroidal-graphite iron, will be accepted, provided the material has an elongation not less than 12%. Arrangements are to be provided for closing them at the valve and for tanks having a capacity of 500 liters (132 U.S. gal.) or greater, from a readily accessible and safe location outside of the compartment in which the valve is located. If the positive closing valve required above is situated in a shaft tunnel or pipe tunnel or similar space, arrangements for closing may be effected by means of an additional valve on the pipe or pipes outside of the tunnel or similar space. If such an additional valve is fitted in the machinery space it is to be operated from a position outside of this space. Where independent filling lines are fitted, they are to enter at or near the top of the tank, but if this would be impracticable, they are to be fitted with non-return valves at the tank. Also see 5-3-1/9.5.

The valves required above may be remotely operated by reach rods or by electric, hydraulic or pneumatic means. The source of power to operate these valves is to be located outside of the space in which the valves are located. The positioning of the valve by either local or remote means is not to interfere with the ability of the other means to close the valve. This remote means of closure is to override all other means of valve control.

On self-propelled or dynamically-positioned units, the use of an electric, hydraulic or pneumatic system to keep the valve directly in the open position is not acceptable. Materials readily rendered in effective by heat are not to be used in the construction of the valves or the closure mechanism within the space unless adequately protected to ensure effective closure facility in the event of fire. If electric cables are utilized, they are to be fire-resistant, meeting the requirements of IEC 60331. See 4-3-4/13.

Hydraulic systems are to be in accordance with 4-2-6/3 for both Class I and II piping systems. For a pneumatic system, the air supply may be from a source from within the space, provided a separate receiver complying with the following is located outside of the space.

i) Sufficient capacity to close all connected valves twice

ii) Fitted with low air pressure alarm

iii) Air supply line is fitted with a non-return valve adjacent to the receiver

5 Fuel-oil Service System for Boilers

Where boilers are located in machinery spaces, they are to be fitted with guard plates and drip pans in way of furnaces. Boilers installed for the purpose of providing power for auxiliaries are to have at least two means of feeding and two fuel-oil service pumps. The construction of all boilers is to comply with the requirements of Section 4-4-1 and Appendix 4-4-1A1 of the *Steel Vessel Rules*.

7 Fuel-oil Service System for Internal Combustion Engines

7.1 Fuel-oil Pumps and Oil Heaters

7.1.1 Transfer Pumps

Two fuel-oil transfer pumps are to be provided and one of them is to be independent of the main engine.

7.1.2 Booster Pumps

A standby fuel-oil booster pump is to be provided for main engines having independently driven booster pumps. For main engines having attached booster pumps, a complete pump may be carried as a spare in lieu of the standby pump.

7.1.3 Heaters

When fuel-oil heaters are required for main engine operation, at least two heaters of approximately equal size are to be installed. The combined capacity of the heaters is to be not less than that required to supply the main engine(s) at full power.

7.3 Oil Tanks and Drains for Fuel Oil Systems *(1994)*

Drain tanks for waste oil, fuel oil overflows, drains from fuel and lube oil drip pans, and fuel injection piping, etc. are to be fitted with air and sounding pipes. Non-return valves are to be fitted in drain lines entering the drain tanks, except where backflow would not present a hazard. Suitable means are to be provided for pumping out these drain tanks.

Oil tanks not forming a part of the unit's structure, where permitted by 4-2-5/1.1.1, are to have suitable drip pans with adequate means of drainage, in accordance with 4-2-1/9.29.1.

7.5 Fuel-oil Pressure Piping

Pipes from booster pumps to injection systems are to be at least Standard seamless steel (see 4-2-1/9.21). Pipes conveying heated oil are to be at least Standard seamless or electric resistance welded steel. ERW pipe is to be straight seam and fabricated with no filler metal (e.g., ABS Grade 2 or 3 ERW). Valves and fittings may be screwed in sizes up to and including 60 mm O.D. (2 in. N.P.S.), but screwed unions are not to be used on pressure lines in sizes 33 mm O.D. (1 in. N.P.S.) and over. Valves are to be so constructed as to permit packing under pressure.

7.7 Fuel-oil Injection System *(1994)*

7.7.1 General

Strainers are to be provided in the fuel-oil injection-pump suction line. For main propulsion engines, the arrangement is to be such that the strainers may be cleaned without interrupting the fuel supply to the engine. For auxiliary engines, the arrangement is to be such that the strainers may be cleaned without undue interruption of power necessary for propulsion. Multiple auxiliary engines, each fitted with a separate strainer and arranged such that changeover to a standby unit can be accomplished without loss of propulsion capability, will be acceptable for this purpose.

Where strainers are fitted in parallel to enable cleaning without disrupting the oil supply, means are to be provided to minimize the possibility of a strainer under pressure being opened inadvertently. Strainers are to be provided with suitable means for venting when being put in operation and being depressurized before being opened. Valves or cocks with drain pipes led to a safe location are to be used for this purpose. Strainers are to be so located that in the event of leakage, oil cannot be sprayed onto the exhaust manifold or surfaces with temperatures in excess of 220°C (428°F).

Cut-out valves are to be located at the service tanks and be so arranged as to be operable from the engine-room floor plates and, where considered necessary, from outside the engine compartment. See also 4-2-5/3.9. The injection line is to be of seamless drain pipe and fittings are to be extra heavy. The material used may be either steel or nonferrous, as approved in connection with the design.

7.7.2 Piping Between Injection Pump and Injectors *(2005)*

7.7.2(a) Injection piping. All external high pressure fuel delivery lines between the high-pressure fuel pumps and fuel injectors are to be protected with a jacketed piping system capable of containing fuel from a high-pressure line failure. A jacketed pipe incorporates an outer pipe into which the high-pressure fuel pipe is placed, forming a permanent assembly. Metallic hose of an approved type may be accepted as the outer pipe, where outer piping flexibility is required for the manufacturing process of the permanent assembly. The jacketed piping system is to include means for collection of leakages and arrangements are to be provided for an alarm to be given of a fuel line failure.

7.7.2(b) Fuel oil return piping. When the peak to peak pressure pulsation in the fuel oil return piping from the injectors exceeds 20 bar (20.5 kgf/cm^2, 285 psi), jacketing of the return pipes is also required.

7.9 Piping Between Booster Pump and Injection Pumps *(2005)*

Spray shields are to be fitted around flanged joints, flanged bonnets and any other flanged or threaded connections in fuel oil piping systems under pressure exceeding 1.8 bar (1.84 kgf/cm^2, 26 psi) which are located above or near units of high temperature, including boilers, steam pipes, exhaust manifolds, silencers or other equipment required to be insulated by 5-3-1/15), and to avoid, as far as practicable, oil spray or oil leakage into machinery air intakes or other sources of ignition. The number of joints in such piping systems is to be kept to a minimum.

9 Low Flash Point Fuels *(1994)*

9.1 General

Fuel oils with a flash point of 60°C (140°F) closed cup or below may be accepted for the following:

9.1.1

Units classed for restrictive service within areas having a climate ensuring that ambient temperatures of spaces where such fuel oil is stored will not rise within 10°C (18°F) below its flash point may use fuel oil with flash point of 60°C (140°F) or below, but not less than 43°C (110°F).

9.1.2

Installations complying with the ABS *Guide for Burning Crude Oil and Slops in Main and Auxiliary Boilers,* regarding the use of crude oil as fuel.

9.1.3

For emergency generators, fuel oil with a flash point of not less than 43°C (110°F) may be used. See 4-3-2/5.5.2i).

9.3 Fuel Heating

For oil heating arrangements, see 4-2-5/1.5.2.

9.5 Fuel-tank Vents

Vent pipes are to extend at least 1 m (3 ft) above the operating deck unless otherwise required by damage stability considerations or the International Convention on Load Lines.

PART

4

CHAPTER 2 Pumps and Piping Systems

SECTION 6 Other Piping Systems and Tanks

1 Lubricating-oil Systems

1.1 General *(1998)*

The lubricating-oil piping is to be entirely separated from other piping systems. In addition, the requirements of 4-2-5/1.1.2, 4-2-5/1.3, and 4-2-5/1.5 are applicable.

The requirements in 4-2-5/3.9 are also applicable for lubricating-oil tanks. However, arrangements for remotely closing the valve from a position outside of the compartment need not be provided if inadvertent valve closure could result in damage to the running machinery due to lack of lubricating-oil. Where the machinery is arranged for automatic shutdown upon loss of lubricating-oil, the valve required by 4-2-5/3.9i) is to be provided with means to close it from a readily accessible and safe location outside of the compartment in which the valve is located.

For ship-type units, the lubricating systems are to be so arranged that they will function satisfactorily under the conditions specified in 4-1-1/7.

1.3 Sight Flow Glasses

Sight flow glasses may be used in lubricating systems provided they are fire-resistant.

1.5 Turbines and Reduction Gears

For turbines and their reduction gears, see 4-6-6/9.7.1 and 4-6-6/9.3.1 of the *Steel Vessel Rules*.

1.7 Internal Combustion Engines and Reduction Gears

Lubricating-oil systems for internal-combustion engines and their reduction gears are to be in accordance with the following.

1.7.1 Lubricating-oil Pumps *(1993)*

In cases where forced lubrication is used for propulsion engines and reduction gears, one independently driven stand-by pump is to be provided in addition to the necessary pumps for normal operation. Two separate means are to be provided for water circulation where oil coolers are fitted (see 4-2-6/11.7). Where the size and design of an engine is such that lubrication before starting is not necessary and an attached pump is normally used, an independently driven stand-by pump is not required if a complete duplicate of the attached pump is carried as a spare. The above requirements are applicable to diesel propulsion engines and for reduction gears associated with single diesel propulsion engines with a maximum operating speed above

400 RPM driving a single shaft (single and multiple screw). For reduction gears associated with diesel propulsion engines with a maximum operating speed of 400 RPM and below and reduction gears associated with multiple diesel engines driving a single shaft (single and multiple screw), see 4-6-5/5.3.1 of the *Steel Vessel Rules*.

1.7.2 Filters *(1998)*

Oil filters are to be provided. In the case of main propulsion engines which are equipped with full-flow-type filters, the arrangements are to be such that the filters may be cleaned without interrupting the oil supply. For auxiliary engines, the arrangement is to be such that the filters may be cleaned without undue interruption of power necessary for propulsion. Multiple auxiliary engines, each fitted with a separate filter and arranged such that change over to a standby unit can be accomplished without loss of propulsion capability, will be acceptable for this purpose. The arrangement of the valving is to be such as to avoid release of debris into the lubricating-oil system upon activation of the relieving mechanism.

Where filters are fitted in parallel to enable cleaning without disrupting the oil supply, means are to be provided to minimize the possibility of a filter under pressure being opened inadvertently. Filters are to be provided with suitable means for venting when being put in operation and being depressurized before being opened. Valves and cocks with drain pipes led to a safe location are to be used for this purpose. Filters are to be so arranged as to prevent, in the event of leakage, spraying of oil onto the exhaust manifold and surfaces with temperatures in excess of 220°C (428°F).

1.7.3 Low-oil-pressure Alarm *(1993)*

An alarm device with audible and visual signals for failure of the lubricating-oil system is to be fitted.

1.7.4 Drain Pipes *(1997)*

Lubricating oil drain pipes from the engine sump to the drain tank are to be submerged at their outlet ends.

No interconnection is to be made between the drain pipes from the crankcases of two or more engines.

1.9 Electrical Machinery

For electrical machinery, see also 4-3-3/3.3, 4-3-3/3.5.1 and 4-3-4/3.15.

3 Hydraulic Systems

3.1 General

The arrangements for Group I hydraulic piping systems are to be in accordance with the requirements of this section, except that hydraulic systems which form part of a unit which is independently manufactured and assembled and which does not form part of the unit's piping system (such as a crane) are not covered by this Section. Plans showing clearly the arrangements and details are to be submitted for review. The requirements for fuel oil tanks contained in 4-2-5/1.1.2 and 4-2-5/1.3 are also applicable for tanks containing hydraulic fluid.

3.3 Valves

3.3.1 General

In general, valves are to comply with the requirements of 4-2-2/9 and 4-2-2/17.

3.3.2 Relief Valves

Relief valves are to be provided for the protection of the hydraulic system. Each relief valve is to be capable of relieving not less than full pump flow with a maximum pressure rise of not more than 10% of the relief valve setting.

3.5 Piping

Piping is to meet the requirements of 4-2-1/5 and 4-2-2/5, except that mill tests need not be witnessed by the Surveyor. In such cases, mill certificates are to be provided.

3.7 Pipe Fittings

Fittings and flanges are to meet the requirements of 4-2-2/11 and 4-2-2/15, except as follows.

3.7.1 Non-standard Fittings

Fittings which are not constructed to a recognized standard will be subject to special consideration. Plans showing details of construction, material and design calculations or test results are to be submitted for review.

3.7.2 Split Flanges *(2004)*

Split flanges are not to be used in steering gear systems and certified thruster systems for propulsion or station keeping service. The use of split flanges for all other applications will be specially considered.

3.7.3 Straight Thread O Ring Connections

Straight thread O ring type connections may be used for connections to equipment such as pumps, valves, cylinders, accumulators, gauges and hoses. Such connections are not to be used for joining sections of pipe.

3.7.4 Tapered Threaded Connections

Tapered threaded connections up to and including 89 mm O.D. (3 in. N.P.S.) may be used without limitation for connections to equipment such as pumps, valves, cylinders, accumulators, gauges and hoses.

Such connections are not to be used for joining sections of pipe, except where permitted by 4-2-2/11.1.

3.9 Hose

Hose assemblies are to be in accordance with 4-2-1/9.25.

3.11 Accumulators

Accumulators are to meet the requirements of Section 4-4-1 and Appendix 4-4-1A1 of the *Steel Vessel Rules*. Each accumulator which may be isolated is to be protected by suitable relief valves. Where a gas charging system is used, a relief valve is to be provided on the gas side of the accumulator.

3.13 Fluid Power Cylinders

Fluid power cylinders are to meet the requirements of 4-2-2/19.

3.15 Design Pressure

The pressure used for determining the strength and design of piping and components is not to be less than the relief valve setting.

3.17 Segregation of High Pressure Hydraulic Units *(1995)*

Hydraulic units with working pressures above 15.5 bar (15.8 kgf/cm^2, 225 psi) installed within machinery spaces are to be placed in separate room or rooms or shielded as necessary to prevent any oil or oil mist that may escape under pressure from coming into contact with surfaces with temperatures in excess of 220°C (428°F), electrical equipment or other sources of ignition. For the purposes of this requirement, a hydraulic unit includes the power pack and all components of the hydraulic piping system.

5 Fixed Oxygen-Acetylene Installations *(2003)*

5.1 Application *(2005)*

Provisions of 4-2-6/5.3 apply to fixed oxygen-acetylene installations that have two or more cylinders of oxygen and acetylene, respectively. Spare cylinders of gases need not be counted for this purpose. Provisions of 4-2-6/5.5 and 4-2-6/5.7, as applicable, are to be complied with for fixed installations regardless of the number of cylinders.

5.3 Gas Storage

5.3.1 Storage of Gas Cylinders

15.3.1(a) Storage room. The gas cylinders are to be stored in rooms dedicated for this purpose only. A separate room is to be provided for each gas. The rooms are to be on or above the upper-most continuous deck and are to be constructed of steel. Access to the rooms is to be from the open deck and the door is to open outwards. The boundaries between the rooms and other enclosed spaces are to be gastight. Suitable drainage of the storage room is to be provided.

15.3.1(b) Open area. Where no storage room is provided, the gas cylinders may be placed in an open storage area. In such cases, they are to be provided with weather protection (particularly from heavy seas and heat) and effectively protected from mechanical damage. Suitable drainage of the open storage area is to be provided.

15.3.1(c) Piping passing through storage room or area. Piping systems containing flammable fluids are not to run through the storage room or open storage area

5.3.2 Ventilation of Storage Room

Gas cylinder storage rooms are to be fitted with ventilation systems capable of providing at least six air changes per hour based on the gross volume of the room. The ventilation system is to be independent of ventilation systems of other spaces. The space within 3 m (10 ft) from the power ventilation exhaust or 1 m (3 ft) from the natural ventilation exhaust is to be considered a hazardous area. The fan is to be of the non-sparking construction. See 4-3-3/9.7. Small storage spaces provided with sufficiently large openings for natural ventilation need not be fitted with mechanical ventilation.

5.3.3 Electrical Installation in Storage Room *(2008)*

Electrical equipment installed within the storage room, including the ventilation fan motor, is to be of the certified safe type. Electrical equipment installed within the storage room may be any of the types indicated in 4-3-3/9.1.2(b) and is to be IEC Publication 60079 group IIC class T2.

5.5 Piping System Components

5.5.1 Pipe and Fittings

5.5.1(a) General. In general, pipes, pipe fittings, pipe joints and valves are to be in accordance with the provisions of Section 4-2-2 for Class I piping systems, except as modified below.

5.5.1(b) Piping materials. Materials for acetylene on the high-pressure side between the cylinders and the regulator are to be steel. Copper or copper alloys containing more than 65% copper are not to be used in acetylene piping (high or low pressure). Materials for oxygen on the high-pressure side are to be steel or copper. Materials for both acetylene and oxygen on the high-pressure side are preferably to be corrosion resistant. All pipes, both high- and low-pressure sides, are to be seamless.

5.5.1(c) Design pressure (2006). Pipes, pipe fittings and valves on the oxygen high-pressure side are to be designed for not less than 207 bar (211 kgf/cm^2, 3000 psi). Pipes used on the low-pressure side are to be at least of standard wall thickness.

5.5.1(d) Pipe joints. All pipe joints outside of the storage room or open storage area are to be welded.

5.5.2 Pressure Relief Devices

Pressure relief devices are to be provided in the gas piping if the maximum design pressure of the piping system can be exceeded. These devices are to be set to discharge at not more than the maximum design pressure of the piping system to a location in the weather remote from sources of vapor ignition or openings to spaces or tanks. The area within 3 m (10 ft) of the pressure relief device discharge outlet is to be regarded as a hazardous area. The pressure relief devices may be either a relief valve or a rupture disc.

5.5.3 System Arrangements

Where two or more gas cylinders are connected to a manifold, high pressure piping between each gas cylinder and the manifold is to be fitted with a non-return valve. The piping is not to run through unventilated spaces or accommodation spaces. Outlet stations are to be fitted with shut-off valves. Outlet stations are to be provided with suitable protective devices to prevent back flow of gas and the passage of flame into the supply lines.

5.5.4 Gas Cylinders

Gas cylinders are to be designed, constructed and certified in accordance with the provisions of 4-4-1/1.11.4 of the *Steel Vessel Rules*. Each cylinder is to be fitted with a suitable pressure relief device such as a fusible plug or a rupture disc.

The area within 3 m (10 ft) of the pressure relief device discharge outlet is to be regarded as a hazardous area.

7 Fuel Storage for Helicopter Facilities

7.1 General *(2007)*

Fixed fuel storage and transfer facilities are to comply with the following:

7.1.1 Isolation

Fuel storage and transfer facilities are to be remote or suitably isolated from areas which contain a source of vapor ignition and are not to be located on landing areas. The storage and transfer area is to be permanently marked as an area where smoking and open flames are not permitted.

7.1.2 Hazardous Areas *(2008)*

The requirements for hazardous areas are applicable for fuel with a flash point at or below 60°C (140°F) close cup test. Open spaces within 3 m (10 ft) of the refueling equipment and within 3 m (10 ft) of the storage tank vent outlets are to be regarded as hazardous areas. The first 1.5 m (5 ft) is to be regarded a Zone 1 hazardous area and the second 1.5 m (5 ft) is to be regarded a Zone 2 hazardous area.

Enclosed spaces containing refueling equipment or storage tank vents are to be regarded as Zone 1 hazardous areas. See 4-3-3/9 for acceptable certified safe equipment and is to be IEC Publication 60079 group IIA class T3. Enclosed spaces are to meet the following provisions.

7.1.2(a) Ventilation Capacity. The enclosed space is to be provided with an effective power ventilation system sufficient to provide at least six air changes per hour.

7.1.2(b) Exhaust Ventilation Duct and Fan. The exhaust duct is to be regarded as a Zone 1 hazardous area and the outlet from any exhaust duct is to be sited in a safe location, having regard to other possible sources of ignition. See 4-1-3/3.3ii) and 4-1-3/3.5vii). Exhaust fans are to be of non-sparking construction complying with 4-3-3/9.7.

7.1.2(c) Dewatering System. Where a gravity drain system is fitted, the system is to comply with the provisions of 4-2-2/23. Where a bilge pumping system is fitted, the system is to comply with the provisions of 4-2-3/1 through 4-2-3/7 as applicable.

7.1.3 Fuel Storage Tank Construction

Fixed fuel storage tanks are to be of approved metal construction. Special attention is to be given to the design, mounting, securing arrangement and electrical bonding of the storage tank and the fuel transfer system.

7.1.4 Fuel Storage Tank Vents

Tank vents are to be sized in accordance with 4-2-3/1.7, API Standard 2000, "Venting Atmospheric and Low-Pressure Storage Tanks", or other approved criteria. Vent outlets are to be located such that vapors will disperse freely.

7.1.5 Fuel Storage Tank Valves

Storage tank outlet valves are to be provided with a means of remote closure in the event of fire. Means are also to be provided for remote shutdown of the fuel transfer unit.

7.3 Spill Containment

To contain spillage and retain fire extinguishing agents, a coaming at least 150 mm (6 in.) in height is to be provided. The coaming is to surround the fuel storage area, which consists of the fuel tank, associated piping and any pumping unit adjacent to the storage tank. Where the pumping unit is remote from the tank, a separate coaming around the unit is to be provided. A coaming will be required only around the fuel pumping unit where the installation is such that the fuel storage tank is cantilevered from the platform and arranged to be jettisoned.

Drainage is to be provided for the area enclosed by the coaming complying with the following:

7.3.1

The area within the coaming is to be sloped toward the drain line.

7.3.2

Drainage from the area within the coaming is to be led through a valve designed for selective output (e.g., three-way valve) either to a holding tank complying with 4-6-4/7.1.2 and 4-6-4/7.1.3 or directly overboard. No other valves may be fitted in the drain line.

7.3.3

The drain line cross sectional area is to be at least twice that of the fuel storage tank outlet connection.

Coamings not provided with drainage arrangements in accordance with the above are to be sized to contain the full volume of the fuel storage tank plus 150 mm (6 in.) of foam.

9 Starting-air Systems

9.1 Design and Construction *(2006)*

The design and construction of all air containers and piping systems are to be in accordance with the applicable requirements of Section 4-4-1 and Appendix 4-4-1A1 of the *Steel Vessel Rules* and the following. The containers are to be so installed as to make the drain connections effective under extreme conditions of trim. Compressed-air systems are to be fitted with relief valves and each container which can be isolated from a relief valve is to be provided with its own safety valves or equivalent. Connections are also to be provided for cleaning the air container and pipelines. All discharge pipes from starting air compressors are to be led directly to the starting air receivers, and all starting pipes from the air receivers to main or auxiliary engines are to be entirely separate from the compressor discharge piping system.

9.3 Starting-air Capacity *(1996)*

Units having internal combustion engines arranged for air starting are to be provided with at least two starting-air containers of approximately equal size. The total capacity of the starting-air containers is to be sufficient to provide, without recharging the containers, at least the number of consecutive starts stated below. If other compressed air systems, such as control air, are supplied from starting-air containers, the aggregate capacity of the containers is to be sufficient for continued operation of these systems after the air necessary for the required number of starts has been used.

9.3.1 Diesel Propulsion *(1996)*

The minimum number of consecutive starts (total) required to be provided from the starting-air containers is to be based upon the arrangement of the engines and shafting systems as indicated in the following table.

	Single Screw Unit		*Multiple Screw Unit*	
	One engine coupled to shaft directly or through reduction gear	*Two or more engines coupled to shaft through clutch and reduction gear*	*One engine coupled to each shaft directly or through reduction gear*	*Two or more engines coupled to each shaft through clutch and reduction gear*
Reversible Engines	12	16	16	16
Non-reversible Engines	16	18	18	18

For arrangements of engines and shafting systems which differ from those indicated in the table, the capacity of the starting-air containers will be specially considered based on an equivalent number of starts.

9.3.2 Diesel-electric Propulsion *(2006)*

The minimum number of consecutive starts required to be provided from the starting-air containers is to be determined from the following equation.

$$S = 6 + G(G - 1)$$

where

S = total number of consecutive starts

G = number of engines necessary to maintain sufficient electrical load to permit vessel transit at full seagoing power and maneuvering. The value of G need not exceed 3.

9.5 Protective Devices for Starting-air Mains

In order to protect starting-air mains against explosions arising from improper functioning of starting valves, an isolation non-return valve or equivalent is to be installed at the starting-air supply connection to each engine. Where engine bores exceed 230 mm (9 in.), a bursting disc or flame arrester is to be fitted in way of the starting valve of each cylinder for direct reversing engines having a main starting manifold or at the supply inlet to the starting-air manifold for non-reversing engines.

11 Cooling-water Systems for Internal Combustion Engines

11.1 General

Means are to be provided to ascertain the temperature of the circulating water at the return from each engine and to indicate that the proper circulation is being maintained. Drain cocks are to be provided at the lowest point of all jackets. For relief valves, see 4-2-1/9.15.

11.3 Sea Suctions

At least two independent sea suctions are to be provided for supplying water to the engine jackets or to the heat exchangers.

11.5 Strainers

Where sea water is used for direct cooling of the engine, unless other equivalent arrangement is specially approved by the Bureau, suitable strainers are to be fitted between the sea valves and the pump suctions and are to be either of the duplex type or otherwise so arranged that they can be cleaned without interrupting the cooling-water supply. This applies also to the emergency circulating water to the engine.

11.7 Circulating Water Pumps *(1993)*

There are to be at least two means for supplying cooling water to main and auxiliary engines, compressors, coolers, reduction gears, etc. One of these means is to be independently driven and may consist of a connection from a suitable pump of adequate size normally used for other purposes, such as a general service pump, or in the case of fresh-water circulation, one of the unit's fresh-water pumps. Where, due to the design of the engine, the connection of an independent pump is impracticable, the independently driven stand-by pump will not be required if a complete duplicate of the attached pump is carried as a spare. Multiple auxiliary engine installations utilizing attached pumps need not be provided with spare pumps.

13 Exhaust System

13.1 Exhaust Lines

The exhaust pipes are to be water-jacketed or effectively insulated. Exhaust pipes of several engines are not to be connected together, but are to be run separately to the atmosphere unless arranged to prevent the return of gases to an idle engine. Exhaust lines which are led overboard near the waterline are to be protected against the possibility of water finding its way inboard. Boiler uptakes and engine-exhaust lines are not to be connected, except when specially approved, as in cases where the boilers are arranged to utilize the waste heat from the engines.

13.3 Exhaust Gas Temperature

Propulsion engines with bores exceeding 200 mm (8 in.) are to be fitted with a means to display the exhaust gas temperature of each cylinder.

15 Valves in Atomizing Lines

Where air or steam is used to atomize well bore fluids prior to flaring, a non-return valve is to be fitted in the line. This valve is to be part of the permanently installed piping, readily accessible and as close as possible to the burner boom. Alternative arrangements shown to provide an equivalent level of safety will be considered.

17 Helicopter Deck Drainage Arrangements *(1992)*

Helicopter decks are to be arranged and provided with means to prevent collection of liquids and to prevent liquids from spreading to or falling on other parts of the unit.

19 Boilers and Associated Piping

Boilers and their associated steam, exhaust and feed systems are to be in accordance with the applicable requirements of Part 4, Chapters 4 and 6 of the *Steel Vessel Rules*.

21 Steering Gear Piping

Piping systems associated with steering gear systems are to be in accordance with Section 4-3-4 of the *Steel Vessel Rules*.

23 Gas Turbine Piping

Piping systems associated with gas turbines are to be in accordance with 4-2-3/9 of the *Steel Vessel Rules*.

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PART

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CHAPTER 3 Electrical Installations

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PART

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CHAPTER 3 Electrical Installations

SECTION 1 General

1 Applications

Electrical apparatus and wiring systems are to be constructed and installed in accordance with the requirements of this Section.

3 Definitions

The following definitions apply for the purpose of this Section.

3.1 Earthed Distribution System

A system in which one pole of a single phase system or the neutral point of a three phase system is earthed but the earthing connection does not normally carry current.

3.3 Essential Services *(2004)*

Essential services are those considered necessary for:

- Continuous operation to maintain propulsion and steering (primary essential services);
- Non-continuous operation to maintain propulsion and steering and a minimum level of safety for the drilling unit's navigation and systems (secondary essential services); and
- Emergency services as described in 4-3-2/5.3 (each service is either primary essential or secondary essential depending upon its nature); and
- Other special characteristics (e.g., special services) of the drilling unit whose loss or failure would create a potential danger to the unit (secondary essential services).

Examples of primary essential services and secondary essential services are as listed in 4-3-1/Table 4 and 4-3-1/Table 5, respectively.

3.5 Explosion-proof (Flameproof) Equipment

Explosion-proof equipment is equipment:

i) Having an enclosure capable of:

  - withstanding an explosion within it of a specified flammable gas or vapor, and
  - preventing the ignition of the specified flammable gas or vapor in the atmosphere surrounding the enclosure by sparks, flashes or explosions of the gas or vapor within, and

ii) Operates at such an external temperature that a surrounding flammable atmosphere will not be ignited.

Where explosion-proof equipment is required by these Rules, equipment certified as being flameproof as defined in IEC Publication 60079 or other recognized standard may be accepted.

3.7 Hazardous Area (Hazardous Location)

An area where flammable or explosive vapor, gas, or dust, or explosives may normally be expected to accumulate.

3.9 Hull-return System

A system in which insulated conductors are provided for connection to one pole or phase of the supply, the hull of the drilling unit or other permanently earthed structure being used for effecting connections to the other pole or phase.

3.11 Intrinsically safe

A circuit or part of a circuit is intrinsically safe when any spark or any thermal effect produced in the test conditions prescribed in a recognized standard (such as IEC 60079-11) is incapable of causing ignition of the prescribed explosive gas atmosphere.

3.11.1 Category "ia"

Apparatus which is incapable of causing ignition in normal operation, or with a single fault, or with any combination of two faults applied, with the following safety factors:

In normal operation:	1.5
With one fault:	1.5
With two faults:	1.0

Above safety factors are applied to the current, voltage or their combination, as specified in 10.4.1 of IEC 60079-11.

3.13 Increased Safety

Type of protection applied to electrical apparatus that does not produce arcs or sparks in normal service, in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arc and sparks. See IEC 60079-7.

3.15 Non-Periodic Duty Rating

A rating at which the machine is operated continuously or intermittently with varying the load and speed within the permissible operating range. The load and speed variations include the overloads applied frequently, which may greatly exceed the full load rating of the machine.

3.17 Non-sparking Fan

A fan consisting of a combination of impeller and housing which are unlikely to produce sparks by static electricity or by entry of foreign objects in both normal and abnormal conditions. See also 4-3-3/9.7.

3.19 Periodic Duty Rating

A rating at which the machine is operated repeatedly on cycle of sequential loading with starting, electric braking, no-load running, rest and de-energized periods, where applicable. The time for the duration of operating cycle (duty cycle) is to be 10 minutes and the ratio (i.e., cyclic duration factor) between the period of loading (including starting and electric braking) and the duty cycle is to be one of the values of 15%, 25%, 40% or 60%.

3.21 Portable Apparatus

Portable apparatus is any apparatus served by a flexible cord.

3.23 Pressurized Equipment *(1997)*

Equipment having an enclosure in which positive pressure is maintained to prevent against the ingress of external atmosphere and complying with the requirements in 4-3-3/9.3.3.

3.25 Semi-enclosed Space

A space limited by decks and/or bulkheads in such a manner that the natural conditions of ventilation in the space are notably different from those obtained on open deck.

3.27 Separate Circuit

A circuit which is independently protected by a circuit protection device at the final subcircuit and is dedicated to a single load.

3.29 Short Circuit

A short circuit is an abnormal connection through a negligible impedance, whether made accidentally or intentionally, between two points of different potential in a circuit.

3.31 Short-time Rating

A rating at which the machine is operated for a limited period which is less than that required to reach the steady temperature condition, followed by a rest and de-energized period of sufficient duration to re-establish the machine temperature within 2°C (3.6°F) of the coolant.

5 Plans and Data to Be Submitted

See 4-3-2/1, 4-3-3/1, 4-3-4/1 and 4-3-5/3.3.

7 Standard Distribution System

The following are recognized as standard systems of distribution. Distribution systems differing from these will be specially considered.

- Two-wire direct current
- Three-wire direct current
- Two-wire single-phase alternating current
- Three-wire three-phase alternating current*
- Four-wire three-phase alternating current

* Three-wire single-phase AC may be used in conjunction with this system for lighting.

9 Voltage and Frequency Variations *(2008)*

Electrical appliances supplied from the main or emergency systems, are to be so designed and manufactured that they are capable of being operated satisfactorily under the normally occurring variations in voltage and frequency. Unless otherwise stated in national or international standards, the variations from the rated value may be taken from 4-3-1/Table 1. Any special system, such as electronic circuits, which cannot operate satisfactorily within the limit shown in 4-3-1/Table 1, is not to be supplied directly from the system but by alternative means, such as through a stabilized supply.

For generators, see 4-3-4/3.17.1, 4-3-4/3.19.1, and 4-3-4/3.21.2.

11 Materials

All electrical equipment is to be constructed of durable and flame-retardant materials. Materials are to be resistant to corrosion, moisture, high and low temperatures, and are to have other qualities necessary to prevent deterioration in the ambient conditions that the equipment may be expected to encounter.

12 Grounding Arrangements

Where not obtained through normal construction, arrangements are to be provided to effectively ground metal structures of derricks, masts and helicopter decks. See also 4-2-6/7.1.2 for fuel storage for helicopter facilities. Grounding arrangements are also to be provided for tending vessels.

13 Insulation Material

For the purpose of these requirements, insulating material is designated as follows.

13.1 Class A Insulation

Materials or combinations of materials such as cotton, silk and paper when suitably impregnated or coated or when immersed in a dielectric liquid such as oil. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 105°C (221°F).

13.3 Class B Insulation

Materials or combinations of materials such as mica, glass fiber, etc., with suitable bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 130°C (266°F).

13.5 Class E Insulation

Materials or combinations of materials which, by experience or accepted tests, can be shown to be capable of operation at 120°C (248°F) (materials possessing a degree of thermal stability allowing them to be operated at a temperature 15°C (27°F) higher than Class A materials).

13.7 Class F Insulation

Materials or combinations of materials such as mica, glass fiber, etc., with suitable bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 155°C (311°F).

13.9 Class H Insulation

Materials or combinations of materials such as silicone elastomer, mica, glass fiber, etc., with suitable bonding substances such as appropriate silicone resins. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 180°C (356°F).

13.11 Insulation for Temperature Above 180°C (356°F)

Materials or combinations of materials which by experience or accepted tests can be shown to be capable of satisfactory operation at temperature over 180°C (356°F) will also be considered. Supporting background experience or report of tests conducted in accordance with a recognized standard ascertaining their suitability for the intended application and temperature operation are to be submitted for review.

15 Degree of Protection for Enclosure

The designation to indicate the degree of protection consists of the characteristic letters IP followed by two numerals (the "characteristic numerals") indicating conformity with conditions stated in 4-3-1/Table 2 and 4-3-1/Table 3. The test and inspection for determining the degree of protection may be carried out in accordance with IEC Publication 60529 by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from the Bureau. Type of enclosure required for protection of equipment is to be suitable for the intended location. See 4-3-3/3.1.1 for selection of protective enclosure for electrical equipment based on location condition. Equipment in compliance with recognized national standards will also be considered.

17 Temperature Ratings

17.1 General

In the following requirements, an ambient temperature of 40°C (104°F) has been assumed for locations outside of boiler and engine rooms while 45°C (113°F) has been assumed as the ambient temperature for the latter spaces. However, electric rotating machines in boiler and engine rooms are to be rated for an ambient temperature of 50°C (122°F). Where the ambient temperature is in excess of these values, the equipment's total rated temperature is not to be exceeded. Where equipment has been rated on ambient temperatures less than those contemplated, consideration will be given to the use of such equipment, provided the total temperature for which the equipment is rated will not be exceeded.

17.3 Reduced Ambient Temperature *(2005)*

17.3.1 Environmentally Controlled Spaces

Where electrical equipment is installed within environmentally-controlled spaces, the ambient temperature for which the equipment is to be rated may be reduced from 45°C and maintained at a value not less than 35°C, provided:

i) The equipment is not to be used for emergency services.

ii) Temperature control is achieved by at least two independent cooling systems so arranged that in the event of loss of one cooling system for any reason, the remaining system(s) is capable of satisfactorily maintaining the design temperature. The cooling equipment is to be rated for a 45°C ambient temperature.

iii) The equipment is to be able to initially start to work safely at a 45°C ambient temperature until such a time that the lesser ambient temperature may be achieved.

iv) Audible and visual alarms are provided, at a continually-manned control station, to indicate any malfunction of the cooling systems.

17.3.2 Rating of Cables

In accepting a lesser ambient temperature than 45°C, it is to be ensured that electrical cables for their entire length are adequately rated for the maximum ambient temperature to which they are exposed along their length.

17.3.3 Ambient Temperature Control Equipment

The equipment used for cooling and maintaining the lesser ambient temperature is to be classified as a secondary essential service, in accordance with 4-3-1/3.3, and the capability of cooling is to be witnessed by the Surveyor at sea trial.

19 Clearances and Creepage Distances

The distances between live parts of different potential and between live parts and the case or other earthed metal, whether across surfaces or in air, are to be adequate for working voltage, having regard to the nature of the insulating material and the conditions of service. See 4-3-5/1.1.4 and 4-3-4/7.11.6 for additional requirements for switchboard and high voltage systems.

21 Service Trial

21.1 Electrical Installation for Drilling Unit Main Services

All auxiliary apparatus is to be tried under working conditions. Each generator is to be run for a time sufficient to show satisfactory operation, and parallel operation with all possible combinations is to be demonstrated. Each auxiliary motor necessary to the operation of the drilling unit is to be run for a time sufficient to show satisfactory performance at such load as can readily be obtained. All main switches and circuit breakers are to be operated, but not necessarily at full load. The operation of the lighting system, heaters, etc., is to be demonstrated satisfactorily. The entire installation is to operate to the satisfaction of the Surveyor and the drop in voltage on any part of the installation is not to exceed 6%. See 4-3-3/5.1.3.

21.3 Communication Facilities

Satisfactory operation of the interior communications system required by 4-3-2/15 is to be demonstrated to the Surveyor during sea trials. Particular attention is to be given to demonstrating that the voice communication systems required by 4-3-2/15 provide the capability of carrying on a conversation while the drilling unit is being navigated.

TABLE 1
Voltage and Frequency Variations [See 4-3-1/9] *(2008)*

Voltage and Frequency Variations for AC Distribution Systems		
Quantity in Operation	*Permanent Variation*	*Transient Variation (Recovery Time)*
Frequency	±5%	±10% (5 s)
Voltage	+6%, –10%	±20% (1.5 s)

Voltage Variations for DC Distribution Systems (such as systems supplied by DC generators or rectifiers)	
Parameters	*Variations*
Voltage tolerance (continuous)	±10%
Voltage cyclic variation deviation	5%
Voltage ripple (AC r.m.s over steady DC voltage)	10%

Voltage Variations for Battery Systems	
Type of System	*Variations*
Components connected to the battery during charging (see Note)	+30%, –25%
Components not connected to the battery during charging	+20%, –25%

Note: Different voltage variations as determined by the charging/discharging characteristics, including the ripple voltage from the charging device, may be considered.

TABLE 2
Degree of Protection – Indicated by the First Characteristic Numeral [See 4-3-1/15]

Degree of Protection		
First Characteristic Numeral	*Short Description*	*Definition*
0	Non-protected	No special protection
1	Protected against solid objects greater than 50 mm (2 in.)	A large surfacing of the body, such as a hand (but no protection against deliberate access). Solid object exceeding 50 mm (2 in.) in diameter.
2	Protected against solid objects greater than 12 mm (0.5 in.)	Fingers or similar objects not exceeding 80 mm (3.15 in.) in length. Solid objects exceeding 12 mm (0.5 in.) in diameter.
3	Protected against solid objects greater than 2.5 mm (0.1 in.)	Tools, wires, etc., of diameter or thickness greater than 2.5 mm (0.1 in.). Solid objects exceeding 2.5 mm (0.1 in.) in diameter.
4	Protected against solid objects greater than 1 mm (0.04 in.)	Wires or strips of thickness greater than 1 mm (0.04 in.). Solid objects exceeding 1 mm (0.04 in.) in diameter.
5	Dust protected	Ingress of dust is not totally prevented, but dust does not enter in sufficient quantity to interfere with satisfactory operation of the equipment.
6	Dust-tight	No ingress of dust

TABLE 2 (continued)
Degree of Protection – Indicated by the First Characteristic Numeral [See 4-3-1/15]

[Designation]

The degree of protection is designated as shown in the following examples:

When it is required to indicate the degree of protection by only one characteristic numeral which shows either degree of protection against foreign bodies and electrical shock or against liquid, the omitted numeral is to be replaced by the letter X.

Examples:

1 IP56 The first characteristic numeral of "5".

The second characteristic numeral of "6".

2 IPX5 Degree of protection against only liquid.

3 IP2X Degree of protection against foreign bodies and electrical shock.

TABLE 3
Degree of Protection – Indicated by the Second Characteristic Numeral [See 4-3-1/15]

Degree of Protection		
Second Characteristic Numeral	*Short Description*	*Definition*
0	Non-protected	No special protection
1	Protected against dripping water	Dripping water (vertically falling drops) is to have no harmful effect.
2	Protected against dripping water when tilted up to 15 deg.	Vertically dripping water is to have no harmful effect when the enclosure is tilted at any angle up to 15 deg. from its normal position.
3	Protected against spraying water	Water falling as spray at an angle up to 60 deg. from the vertical is to have no harmful effect.
4	Protected against splashing water	Water splashed against the enclosure from any direction is to have no harmful effect.
5	Protected against water jets	Water projected by a nozzle against the enclosure from any direction is to have no harmful effect.
6	Protected against heavy seas	Water from heavy seas or water projected in powerful jets is not to enter the enclosure in harmful quantities.
7	Protected against the effects of immersion	Ingress of water in a harmful quantity is not to be possible when the enclosure is immersed in water under defined conditions of pressure and time.
8	Protected against submersion	The equipment is suitable for continuous submersion in water under conditions which are to be specified by the manufacturer. *Note:* Normally, this will mean that the equipment is hermetically sealed. However, with certain types of equipment, it can mean that water can enter but only in such a manner that it produces no harmful effects.

See Designation and examples in 4-3-1/Table 2.

TABLE 4
Primary Essential Services *(2004)*

(a)	Steering gears
(b)	Pumps for controllable pitch propellers
(c)	Scavenging air blower, fuel oil supply pumps, fuel valve cooling pumps, lubricating oil pumps and cooling water pumps for main and auxiliary engines and turbines necessary for propulsion
(d)	Ventilation necessary to maintain propulsion
(e)	Forced draft fans, feed water pumps, water circulating pumps, vacuum pumps and condensate pumps for steam plants on steam turbine drilling units, and also for auxiliary boilers where steam is used for equipment supplying primary essential services
(f)	Oil burning installations for steam plants on steam turbine drilling units and for auxiliary boilers where steam is used for equipment supplying primary essential services
(g)	Azimuth thrusters which are the sole means for propulsion/steering with lubricating oil pumps, cooling water pumps, etc.
(h)	Electrical equipment for electric propulsion plant with lubricating oil pumps and cooling water pumps
(i)	Electric generators and associated power sources supplying primary essential equipment
(j)	Hydraulic pumps supplying primary essential equipment
(k)	Viscosity control equipment for heavy fuel oil
(l)	Control, monitoring and safety devices/systems of equipment for primary essential services.

TABLE 5
Secondary Essential Services *(2004)*

(a)	Windlass
(b)	Fuel oil transfer pumps and fuel oil treatment equipment
(c)	Lubrication oil transfer pumps and lubrication oil treatment equipment
(d)	Pre-heaters for heavy fuel oil
(e)	Starting air and control air compressors
(f)	Bilge, ballast and heeling pumps
(g)	Fire pumps and other fire extinguishing medium pumps
(h)	Ventilating fans for engine and boiler rooms
(i)	Services considered necessary to maintain dangerous spaces in a safe condition
(j)	Navigation lights, aids and signals
(k)	Internal communication equipment required by 4-3-2/15
(l)	Fire and gas detection and alarm system
(m)	Lighting system
(n)	Electrical equipment for watertight and fire-tight closing appliances
(o)	Electric generators and associated power sources supplying secondary essential equipment
(p)	Hydraulic pumps supplying secondary essential equipment
(q)	Control, monitoring and safety devices/systems of equipment for secondary essential services
(r)	Blow-out preventer control systems
(s)	Well control systems
(t)	Dynamic positioning systems
(u)	Inerting systems
(v)	Ventilation systems necessary to maintain a safe atmosphere
(w)	Elevating (jacking) systems
(x)	Ballast control systems (on column stabilized units)
(y)	*(2005)* Ambient temperature control equipment required by 4-3-1/17.3

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PART

4

CHAPTER 3 Electrical Installations

SECTION 2 Drilling Unit Systems

1 Plans and Data to be Submitted

1.1 Wiring

1.1.1 Systems

One line diagrams for the following electrical systems are to be submitted for review.

- Power Supply and Distribution
- Lighting including Navigation Light
- Internal Communication
- General Emergency Alarm
- Fire Detection and Alarm
- Steering Gear Control (for self-propelled drilling unit)
- Intrinsically-safe Equipment
- Emergency Generator Starting

1.1.2 Data for Wiring Systems

The one line diagrams are to show the circuit designation, type and size of cables, cable grouping and banking, trip setting and rating of the circuit protection devices, the location of electrical equipment accompanied by list of components, complete feeder list, rated load current for each branch circuit, and voltage drop for longest run of each size cable. The one line diagram for power supply and distribution systems is to indicate the following component details.

- Generator: kW rating, voltage, rated current, frequency, number of phases, power factor
- Batteries: type, voltage, capacity, conductor protection (when required)
- Motors: kW rating, remote stops (when required)
- Transformers: kVA rating, rated voltage and current on primary and secondary side, connection method

The one line diagram for power supply and distribution systems is also to include a list of sequential start of motors and equipment having emergency tripping or preferential tripping features.

1.3 Short-circuit Data

In order to establish that the protective devices on the main and emergency switchboards have sufficient short-circuit breaking and making capacities, data are to be submitted giving the maximum calculated short-circuit current in symmetrical r.m.s. and asymmetrical peak values available at the main bus bars together with the maximum allowable breaking and making capacities of the protective device. Similar calculations are to be made at other points in the distribution system where necessary to determine the adequacy of the interrupting capacities of protective devices.

1.5 Protective Device Coordination

A protective device coordination study is be submitted for review. This protective device coordination study is to consist of an organized time-current study of all protective devices in series from the utilization equipment to the source for all circuit protection devices having different setting or time-current characteristics for long-time delay tripping, short-time delay tripping and instantaneous tripping, where applicable. Where an overcurrent relay is provided in series and adjacent to the circuit protection device, the operating and time-current characteristics of the relay are to be considered for coordination. See 4-3-2/9.1.5.

1.7 Load Analysis *(2002)*

An electric-plant load analysis is to be submitted for review. The electric-plant (including high voltage drilling unit main service transformers or converters, where applicable per 4-3-2/7.1.6) load analysis is to cover all operating conditions of the drilling unit, including normal seagoing (if applicable) and emergency operations.

3 Drilling Unit Main Service Source of Power

3.1 Power Supply by Generators

3.1.1 Number of Generators

Units are to be provided with at least two main generator sets with combined capacity sufficient to maintain the unit in normal operations (including the drilling mode) and habitable conditions to include at least adequate services for cooking, heating, domestic refrigeration, mechanical ventilation, sanitary and fresh water.

3.1.2 Capacity of Generators *(2004)*

In addition to 4-3-2/3.1.1, the capacity of the generator sets is to be sufficient to maintain the drilling unit in normal operational and habitable conditions, excluding drilling equipment, with any one main generator in reserve. The capacity of main generators is to be determined without recourse to the emergency source of power. See 4-3-2/5 for emergency power source requirements. Also, for self-propelled drilling units, the generating sets are to be such that with any one generator or its primary source of power out of operation, the remaining generating sets are capable of providing the electrical services necessary to start the main propulsion plant from a dead ship condition, as defined in 4-1-1/10.3, within thirty minutes of the blackout. See also 4-3-2/3.1.4.

3.1.3 Multiple Generators

For drilling units having multiple generating sets providing power for both propulsion and auxiliary services, the propulsion loads considered for normal operation need only include those necessary to propel the unit at 3.6 m/s (7 kn) or one-half the design speed in calm water, whichever is the lesser. See 4-3-5/3.17.4 to 4-3-5/3.17.6 for details of propulsion generator.

3.1.4 Starting from "Dead Ship" Condition *(2004)*

In restoring the propulsion from a dead ship condition (see 4-1-1/10.3) for self propelled drilling units, no stored energy for starting the propulsion plant, the main source of electrical power and other essential auxiliaries is to be assumed available. It is assumed that means are available to start the emergency generator at all times.

The emergency source of electrical power may be used to restore the propulsion, provided its capability either alone or combined with that of any other source of electrical power is sufficient to provide at the same time those services required to be supplied by 4-3-2/5.3ii) through 4-3-2/5.3iii).

The emergency generator and other means needed to restore the propulsion are to have a capacity such that the necessary propulsion starting energy is available within 30 minutes of blackout, as defined in 4-1-1/10.1. Emergency generator stored starting energy is not to be directly used for starting the propulsion plant, the main source of electrical power and/or other essential auxiliaries (emergency generator excluded).

See also 4-3-2/3.1.2 above.

3.1.5 Fuel Capacity for Generator Prime Mover

For self-propelled drilling units where the fuel for any drilling unit's main service generator prime mover differs from the fuel for the main propulsion plant, adequate fuel capacity for that drilling unit's service generator prime mover with adequate margins is to be provided for the longest anticipated run of the drilling unit between fueling ports.

3.1.6 System Arrangement *(2004)*

3.1.6(a) General. For self-propelled drilling units where the main source of electrical power is necessary for propulsion and steering and the safety of the drilling unit, the system is to be so arranged that the electrical supply to equipment necessary for these services is maintained or is capable of being restored in the case of loss of any one of the generators in service in accordance with the provision in 4-3-2/3.1.6(b) or 4-3-2/3.1.6(c).

Load shedding of nonessential services, and where necessary, secondary essential services (see 4-3-1/3.3) or other arrangements, as may be necessary, are to be provided to protect the generators against the sustained overload. For main bus bar subdivision, see 4-3-4/7.15.2.

3.1.6(b) Single Generator Operation. Where the electrical power is normally supplied by a single generator, provision is to be made upon loss of power for automatic starting and connecting to the main switchboard of a stand-by generator(s) of sufficient capacity with automatic restarting of the essential auxiliaries in sequential operation, if necessary, to permit propulsion and steering and to ensure the safety of the drilling unit. Starting and connection to the main switchboard of the standby generator is to be preferably within 30 seconds after loss of the electrical power supply but in no case in more than 45 seconds.

3.1.6(c) Multiple Generator Operation. Where the electrical power is normally supplied by more than one generator set simultaneously in parallel operation, the system is to be so arranged that in the event of the loss of any one of the generators in service, the electrical supply to equipment necessary for propulsion and steering and to ensure the safety of the drilling unit will be maintained by the remaining generator(s) in service. See also 4-3-2/3.1.3.

3.3 Generator Driven by Propulsion Unit *(2004)*

3.3.1 Constant Speed Drive

A generator driven by a main propulsion unit (shaft generator) capable of operating continuously at a constant speed, e.g., a system where the drilling unit speed and direction are controlled only by varying propeller pitch, may be considered to be one of the generators required by 4-3-2/3.1.1, provided that the arrangements stated in *i)* to *iii)* below are complied with:

i) The generator and the generating systems are capable of maintaining the voltage and frequency variation within the limits specified in 4-3-4/3.21.2 and 4-3-1/Table 1 under all weather conditions during sailing or maneuvering and also while the drilling unit is stopped.

ii) The rated capacity of the generator and the generating systems is safeguarded during all operations given under *i),* and is such that the services required by 4-3-2/3.1.2 can be maintained upon loss of any generator in service.

iii) An arrangement is made for starting a standby generator and connecting it to the switchboard, in accordance with 4-3-2/3.1.6.

3.3.2 Variable Speed Drive

Shaft generator installations not capable of operating continuously at a constant speed may be used for normal operational and habitable conditions of the drilling unit, provided that the arrangements stated in *i)* to *v)* below are complied with. This type of generator will not be counted as one of the generators required by 4-3-2/3.1.2.

i) In addition to this type of generator, generators of sufficient and adequate rating are provided, which constitute the main source of electrical power required by 4-3-2/3.1.2.

ii) When the frequency variations at the main bus bar exceed the following limits due to the speed variation of the propulsion machinery which drives the generator, arrangements are made to comply with 4-3-2/3.1.6.

- Permanent frequency variation: ± 5.5%
- Transient frequency variation: ± 11% (5 sec)

iii) The generators and the generating systems are capable of maintaining the voltage and frequency variation within the limits specified in 4-3-4/3.21.2 and 4-3-1/Table 1.

iv) Where load-shedding arrangements are provided, they are fitted in accordance with 4-3-2/9.3.3.

v) Where the propulsion machinery is capable of being operated from the navigation bridge, means are provided or procedures are in place to ensure that power supply to essential services is maintained during maneuvering conditions in order to avoid a blackout situation.

3.5 Sizing of AC Generator

In selecting the capacity of an alternating-current generating plant, particular attention is to be given to the starting current of motors forming part of the system. Under normal operating conditions of the drilling unit with one generator held in reserve as a standby, the remaining generator sets operating in parallel and initially carrying the minimum load necessary for operating the drilling unit are to have sufficient capacity with respect to the largest idle motor on the drilling unit so that the motor can be started and the voltage drop occasioned by its starting current will not cause any already running motor to stall or control equipment to drop out.

5 Emergency Source of Power

5.1 General

5.1.1 Basic Requirement

A self-contained emergency source of electrical power – together with its associated power transformer, if any, transitional source of emergency power, emergency switchboard, emergency lighting switchboard, and the fuel oil tank for emergency generator prime mover – is to be installed in a non-hazardous space and is to be located above the worst damage waterline (see 3-3-1/1.3.2), aft of the collision bulkhead, if any, and in a space which is not within the assumed extent of damage defined in 3-3-1/7. Its location is to be readily accessible from the open deck. The arrangement is to be such as to insure that a fire, flooding or other failure in a space containing the main source of electrical power, or in any space containing internal combustion machinery for propulsion, any oil-fired or oil-fuel unit, or internal combustion machinery with an aggregate total power of 375 kW (500 hp) or more, will not interfere with the supply or distribution of emergency power.

5.1.2 Boundary

Where the "boundaries" of spaces containing the emergency sources of electrical power, associated power transformer, transitional source of emergency power, emergency switchboard, emergency lighting switchboard, and the fuel oil tank for emergency generator prime mover are contiguous to boundaries of internal combustion machinery for propulsion, an oil-fired, or oil-fuel unit, or internal combustion machinery with an aggregate total power of 375 kW (500 hp) or more, the contiguous boundaries are to be in compliance with Section 3-4-1.

5.1.3 Alternate Arrangements

Where the main source of electrical power is located in two or more spaces which have their own systems, including power distribution and control systems, completely independent of the systems in other spaces and such that a fire or other casualty in any other of the spaces will not affect the power distribution from the others, or to the services required in 4-3-2/5.3, the requirements for self-contained emergency source of power may be considered satisfied without an additional emergency source of electrical power, provided that:

i) There are at least two generating sets meeting the inclination design requirements of 4-3-2/5.5.1;

ii) Each set is of sufficient capacity to meet the requirements of 4-3-2/5.3;

iii) The generating sets are located in each of at least two spaces;

iv) The arrangements required by 4-3-2/5.1.3 in each such space are equivalent to those required by 4-3-2/5.5.2, 4-3-2/5.9 and 4-3-2/5.15 so that a source of electrical power is available at all times for the services required by 4-3-2/5.3; and

v) The location of each of the spaces referred to in 4-3-2/5.1.3iii) is in compliance with 4-3-2/5.1.1 and the boundaries meet the requirements of 4-3-2/5.1.2, except that contiguous boundaries should consist of an "A-60" bulkhead and a cofferdam, or a steel bulkhead insulated to class "A-60" on both sides.

5.3 Emergency Power Supply

The electrical power available is to be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously, and for equipment which can be shown as not being required in actual service to draw their rated loads. In the latter case, supporting details are to be submitted. Having regard to starting currents and the transitory nature of certain loads, the emergency source of electrical power is to be capable of supplying simultaneously for at least 18 hours (unless otherwise stated) the following services, if they depend upon an electrical source for their operation.

i) *(1999)* Navigation lights, other lights and sound signals required by the International Regulations for the Prevention of Collisions at Sea in force.

ii) Emergency lighting:

- At every embarkation station on deck, their launching appliances and the area of water into which they are to be launched;
- In all service and accommodation alleyways, stairways and exits, personnel elevators and shafts;
- In the machinery spaces and main generating stations, including their control positions.
- In all control stations (including drilling stations), machinery control rooms, and at each main and emergency switchboard;
- At all stowage positions for firemen's outfits;
- For self-propelled drilling units, at the steering gear.
- At the sprinkler pump, if any, at one of the fire pumps, if dependent upon emergency generator for its source of power, at the bilge pump, if any, and at the starting positions of their motors; and
- *(1999)* On helicopter landing deck perimeter.

iii) General alarm and internal communication systems required in an emergency.

iv) *(1999)* Required fire and gas detection and alarm systems.

v) Fire extinguishing systems.

vi) Permanently installed diving equipment necessary for safe conduct of diving operations, if dependent on the drilling unit's electrical power.

vii) Abandonment systems dependent on electric power, including lighting for embarkation stations.

viii) Electric blow-out preventer control systems.

ix) *On column-stabilized units:* Ballast valve control system, ballast valve position indicating system, draft level indicating system and tank level indicating system.

x) *On column stabilized units:* The largest single ballast pump required by 4-2-4/13.5.1. See also 4-3-2/5.11.

xi) Alarms required in 4-3-2/17.5 and 4-3-2/17.7.

xii) *For self-propelled drilling units:* Steering gear (for a period of at least 10 minutes of continuous operation, see 4-3-2/11.5).

xiii) Unless an independent temporary source of stored energy is provided, operation (but not necessarily all of them simultaneously) for at least half an hour of watertight doors referred to in 3-3-1/9.3, including their controls and indicators.

xiv) *(1999)* For a period of four days, any signaling lights or sound signals which may be required for marking of offshore structures.

xv) *(2005)* For a period of 30 minutes, free-fall lifeboat secondary launching appliance, if the secondary launching appliance is not dependent on gravity, stored mechanical power or other manual means.

The emergency generator may be used exceptionally and for short periods to supply non-emergency loads, provided arrangements are made to disconnect automatically non-emergency circuits from the emergency switchboard when there is a failure of the main source of power.

If the emergency generator is used to meet requirements for dead ship (blackout) start-up (see 4-1-1/11), it is to be sized to simultaneously supply power for emergency lighting, internal communications and fire detection and alarm systems, in addition to the power needed for the dead ship (blackout) start-up.

5.5 Emergency Sources

5.5.1 General

The emergency source of electrical power may be either a generator or an accumulator battery in accordance with 4-3-2/5.5.2 or 4-3-2/5.5.3. The emergency generator and its prime mover and any emergency accumulator battery are to be designed to function at full rated power when upright and when inclined up to a maximum angle of heel in the intact and damaged condition, as determined in accordance with Section 3-3-1. In no case need the equipment be designed to operate when inclined more than:

- 25° in any direction on a column-stabilized unit;
- 15° in any direction on a self-elevating unit, and
- 22.5° about the longitudinal axis and/or when inclined 10° about the transverse axis on a surface unit.

5.5.2 Generator

Where the emergency source of electrical power is a generator, it is to be:

i) Driven by a prime mover with an independent supply of fuel having a flashpoint (closed cup test) of not less than 43°C (110°F), and

ii) Started automatically upon failure of the main source of electrical power supply and connected automatically to the emergency switchboard—then, those services referred to in 4-3-2/5.7 are to be connected automatically to the emergency generator as quickly as is safe and practicable subject to a maximum of 45 seconds, or

Provided with a transitional source of emergency electrical power as specified in 4-3-2/5.7 unless an emergency generator is provided capable both of supplying the services referred to in 4-3-2/5.7 of being automatically started and supplying the required load as quickly as is safe and practicable subject to a maximum of 45 seconds, and

iii) An adequate fuel capacity for the emergency generator prime mover is to be provided.

5.5.3 Accumulator Battery

Where the emergency source of electrical power is an accumulator battery, it is to be capable of:

i) Carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage,

ii) Automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and

iii) Immediately supplying at least those services specified in 4-3-2/5.7.

5.5.4 Emergency Generator for Non-emergency Services *(2008)*

Provided that suitable measures are taken for safeguarding independent emergency operations under all circumstances, the emergency generator may be used, exceptionally, and for short periods, to supply non-emergency circuits during the blackout situation (see 4-1-1/10.1), dead ship condition (see 4-1-1/10.3), and routine use for testing (see 4-3-2/5.13). The generator is to be safeguarded against overload by automatically shedding such non-emergency services so that supply to the required emergency loads is always available. See also 4-3-2/5.9.5.

5.7 Transitional Source of Power

The transitional source of emergency electrical power, where required by 4-3-2/5.5.2ii), is to consist of an accumulator battery which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage, and be of sufficient capacity and is to be so arranged as to supply automatically in the event of failure of either the main or the emergency source of electrical power for half an hour at least the following services if they depend upon an electrical source for their operation:

i) The lighting required by 4-3-2/5.3ii). For this transitional phase, the required emergency electric lighting, in respect of the machinery space and accommodation and service spaces, may be provided by permanently fixed, individual, automatically charged, relay operated accumulator lamps; and

ii) All services required by 4-3-2/5.3iii) and 4-3-2/5.3iv) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

iii) Electric blow-out preventer control systems.

5.9 Emergency Switchboard

5.9.1 General

The emergency switchboard is to be installed as near as is practicable to the emergency source of electrical power.

5.9.2 Emergency Switchboard for Generator

Where the emergency source of electrical power is a generator, the emergency switchboard is to be located in the same space unless the operation of the emergency switchboard would thereby be impaired.

5.9.3 Accumulator Battery

No accumulator battery fitted in accordance with 4-3-2/5.5.3 or 4-3-2/5.7 is to be installed in the same space as the emergency switchboard. An indicator is to be mounted on the main switchboard or in the machinery control room to indicate when these batteries are being discharged.

5.9.4 Interconnector Feeder Between Emergency and Main Switchboards

The emergency switchboard is to be supplied during normal operation from the main switchboard by an interconnector feeder which is to be protected at the main switchboard against overload and short circuit. The interconnector feeder is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power. Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard against short circuit. In addition, the circuit protection device at the emergency switchboard on the interconnector feeder is to trip to prevent overloading of the emergency generator.

5.9.5 Disconnection of Non-emergency Circuits

For ready availability of the emergency source of electrical power, arrangements are to be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard so that electrical power is to be automatically available to the emergency circuits.

5.11 Ballast Pumps

On column-stabilized units, it is to be possible to supply each ballast pump required by 4-2-4/13.5.1 from the emergency source of power. The arrangement is to be such that one of the pumps is connected directly to the main switchboard and the other pump is connected directly to the emergency switchboard. For systems utilizing independent pumps in each tank, all pumps are to be capable of being supplied from an emergency source of power. When sizing the emergency source of power in accordance with 4-3-2/5.3, the largest ballast pump capable of being supplied from this source is to be assumed to be operating simultaneously with the loads specified in 4-3-2/5.3, allowing for suitable load and diversity factors.

5.13 Arrangements for Periodic Testing

Provision is to be made to enable the periodic testing of the complete emergency system, and is to include the testing of automatic starting arrangements.

5.15 Starting Arrangements for Emergency Generator Sets

5.15.1 Cold Conditions

Emergency generating sets are to be capable of being readily started in their cold condition at a temperature of 0°C (32°F). If this is impracticable or if lower temperatures are likely to be encountered, heating arrangements are to be provided for ready starting of the generating sets.

5.15.2 Number of Starts

Each emergency generator that is arranged to be automatically started is to be equipped with approved starting devices with a stored energy capability of at least three consecutive starts. Unless a second independent means of starting is provided, the source of stored energy is to be protected to preclude critical depletion by automatic starting system, i.e., the automatic starting system is only allowable for consumption of the stored energy source to a level that would still provide the capability for starting the emergency generator upon intervention by personnel. In addition, a second source of energy is to be provided for an additional three starts within 30 minutes unless manual starting can be demonstrated to be effective to the Surveyor.

5.15.3 Charging of Stored Energy

The stored energy is to be maintained at all times, as follows:

5.15.3(a) Electrical and hydraulic starting systems are to be maintained from the emergency switchboard;

5.15.3(b) Compressed air starting systems may be maintained by the main or auxiliary compressed air receivers through a suitable non-return valve or by an emergency air compressor which, if electrically driven, is supplied from the emergency switchboard;

5.15.3(c) All of these starting, charging and energy storing devices are to be located in the emergency generator space. These devices are not to be used for any purpose other than the operation of the emergency generating set. This does not preclude the supply to the air receiver of the emergency generating set from the main or auxiliary compressed air system through the non-return valve fitted in the emergency generator space.

5.15.4 Manual Starting

Where automatic starting is not required, manual (hand) starting is permissible, such as manual cranking, inertia starters, manually charged hydraulic accumulators or power charge cartridges, where they can be demonstrated as being effective to the Surveyor.

When manual (hand) starting is not practicable, the requirements of 4-3-2/5.15.2 and 4-3-2/5.15.3 are to be complied with, except that starting may be manually initiated.

5.17 Alarms and Safeguards for Emergency Diesel Engines *(2006)*

5.17.1 Information to be Submitted

Information demonstrating compliance with these requirements is to be submitted for review. The information is to include instructions to test the alarm and safety systems.

5.17.2 Alarms and Safeguards

5.17.2(a) Alarms and safeguards are to be fitted in accordance with 4-3-2/Table 1.

5.17.2(b) The safety and alarm systems are to be designed to 'fail safe'. The characteristics of the 'fail safe' operation are to be evaluated on the basis not only of the system and its associated machinery, but also the complete installation, as well as the drilling unit.

5.17.2(c) Regardless of the engine output, if shutdowns additional to those specified in 4-3-2/Table 1 are provided, except for the overspeed shutdown, they are to be automatically overridden when the engine is in automatic or remote control mode.

5.17.2(d) The alarm system is to function in accordance with 4-9-1/9.3 and 4-9.1/9.7 of the *Steel Vessel Rules*, with additional requirements that grouped alarms are to be arranged on the bridge. For drilling units that are not self-propelled, the grouped alarms are to be arranged at an emergency control station (see 4-4-1/27).

5.17.2(e) In addition to the fuel oil control from outside the space, a local means of engine shutdown is to be provided.

5.17.2(f) Local indications of at least those parameters listed in 4-3-2/Table 1 are to be provided within the same space as the diesel engines and are to remain operational in the event of failure of the alarm and safety systems.

TABLE 1
Alarms and Safeguards for Emergency Diesel Engines
[See 4-3-2/5.17] *(2006)*

Systems	*Monitored Parameters*		*A*	*Auto Shut Down*	*Notes [A = Alarm; x = apply]*
Fuel oil	A1	Leakage from pressure pipes	x		
Lubricating oil	B1	Temperature – high	x		For engines having a power of 220 kW or more.
	B2	Lubricating oil pressure – low	x		
	B3	Oil mist concentration in crankcase – high	x		For engines having a power of more than 2250 kW (3000 hp) or having a cylinder bore of more than 300 mm (11.8 in.).
Cooling medium	C1	Pressure or flow – low	x		For engines having a power of 220 kW or more.
	C2	Temperature – high	x		
Engine	D1	Overspeed activated	x	x	For engines having a power of 220 kW or more.

5.19 Requirements by the Governmental Authority

Attention is directed to the requirements of the governmental authority of the country whose flag the drilling unit flies for the emergency services and the accumulator batteries required in various types of drilling units.

7 Distribution System

7.1 Drilling Unit Main Service Distribution System

7.1.1 General

Current-carrying parts with potential to earth are to be protected against accidental contact.

For recognized standard distribution systems, see 4-3-1/7. Separate feeders are to be provided for essential and emergency services.

7.1.2 Method of Distribution

The output of the drilling unit's service generators may be supplied to the current consumers by way of either branch system, meshed network system or ring main system. The cables of a ring-main or other looped circuit (e.g., interconnecting section boards in a continuous circuit) are to be formed of conductors having sufficient current-carrying and short-circuit capacity for any possible load and supply configuration.

7.1.3 Through-feed Arrangements

The size of feeder conductors is to be uniform for the total length, but may be reduced beyond any intermediate section board and distribution board, provided that the reduced size section of the feeder is protected by an overload device.

7.1.4 Motor Control Center *(2006)*

Feeder cables from the main switchboard or any section board to the motor control centers are to have a continuous current-carrying capacity not less than 100% of the sum of the nameplate ratings of all the motors supplied. Feeder cables of lesser current capacity are permitted, where the design is such that connected consumers are not operated simultaneously, under any operating mode.

7.1.5 Motor Branch Circuit

A separate circuit is to be provided for each fixed motor having a full-load current rating of 6 amperes or more and the conductors are to have a carrying capacity of not less than 100% of the motor full-load current rating. No branch circuit is to have conductors less than 1.5 mm^2 wire. Circuit-disconnecting devices are to be provided for each motor branch circuit and are to be in accordance with 4-3-3/3.13.2 and 4-3-4/7.17.2.

7.1.6 Power Supply Through Transformers and Converters

7.1.6(a) Continuity of Supply (2004). Where transformers and/or converters form a part of the drilling unit's main service electrical system supplying essential services and services necessary for minimum comfortable conditions of habitability, the number and capacity of the transformers and/or converters are to be such that with any one transformer or converter or any one single phase of a transformer out of service, the remaining transformers and/or converters or remaining phases of the transformer are capable of supplying power to these loads under normal seagoing conditions.

7.1.6(b) Arrangements (2002). Each required transformer is to be located as a separate unit with separate enclosure or equivalent, and is to be served by separate circuits on the primary and secondary sides. Each of the secondary circuits is to be provided with a multipole isolating switch. This multipole isolating switch is not to be installed on the transformer casing or its vicinity (in so far as practicable) in order to preclude its damage by fire or other incident at the transformer. A circuit breaker provided in the secondary circuit in accordance with 4-3-2/9.15.1 will be acceptable in lieu of the multipole isolating switch.

7.1.6(c) Transformers and Converters for Battery Charger (2004). Where batteries connected to a single battery charger are the sole means of supplying DC power to equipment for essential services, as defined in 4-3-1/3.3, failure of the single battery charger under normal operating conditions should not result in total loss of these services once the batteries are depleted. In order to ensure continuity of the power supply to such equipment, one of the following arrangements is to be provided:

i) Duplicate battery chargers; or

ii) A single battery charger and a transformer/rectifier (or switching converter) which is independent of the battery charger, provided with a change-over switch; or

iii) Duplicate transformer/rectifier (or switching converter) units within a single battery charger, provided with a change-over switch.

The above requirements are not applicable for the following:

- The equipment for the essential services, which contains a single transformer/ rectifier with a single AC power supply feeder to such equipment.
- The services which are not used continuously, such as battery chargers for engine starting batteries, etc.

7.1.7 Heating Appliances

Each heater is to be connected to a separate final subcircuit. However, a group of up to 10 heaters whose total current does not exceed 16A may be connected to a single final subcircuit.

7.3 Hull Return System

7.3.1 General

The hull return system is not to be used for power, heating or lighting, except that the following systems may be used:

i) Impressed current cathodic protective systems;

ii) Limited and locally earthed systems, provided that any possible resulting current does not flow directly through any hazardous areas; or

iii) Insulation level monitoring devices, provided the circulation current does not exceed 30 mA under all possible conditions.

Current-carrying parts with potential to earth are to be protected against accidental contact.

7.3.2 Final Subcircuits and Earth Wires

Where the hull return system is used, all final subcircuits (i.e., all circuits fitted after the last protective device) are to consist of two insulated wires, the hull return being achieved by connecting to the hull one of the busbars of the distribution board from which they originate. The earth wires are to be in accessible locations to permit their ready examination and to enable their disconnection for testing of insulation.

7.5 Earthed Distribution Systems

System earthing is to be effected by means independent of any earthing arrangements of the non-current-carrying parts. Means of disconnection is to be provided in the neutral earthing connection of each generator so that the generator may be disconnected for maintenance. In distribution systems with neutral earthed or for generators intended to be run with neutrals interconnected, the machines are to be designed to avoid circulating currents exceeding the prescribed value. Transformer neutral is not to be earthed unless all corresponding generator neutrals are disconnected from the system (e.g., during shore supply). See 4-3-3/7.5.2.

7.7 External or Shore Power Supply Connection

7.7.1 General

Where arrangements are made for the supply of electricity from a source on shore or other external source, a termination point is to be provided on the drilling unit for the reception of the flexible cable from the external source. Fixed cables of adequate rating are to be provided between the termination point and the main or emergency switchboard. Means for disconnecting the external or shore power supply are to be provided at the receiving switchboard. See 4-3-2/9.11 for the protection of external or shore power supply circuit.

7.7.2 Earthing Terminal

An earth terminal is to be provided for connecting the hull to an external earth.

7.7.3 Indicators

The external connection supply or shore connection is to be provided with a pilot lamp and a voltmeter (and frequency meter for AC) at main or emergency switchboard to show energized status of the cable.

7.7.4 Polarity or Phase Sequence

Means are to be provided for checking the polarity (for DC) or the phase sequence (for three-phase AC) of the incoming supply in relation to the drilling unit’s system.

7.7.5 Information Plate

An information plate is to be provided at or near the connection box giving full information on the system of supply and the nominal voltage (and frequency if AC) of the drilling unit’s system and the recommended procedure for carrying out the connection.

7.7.6 Securing of Trailing Cable

Provision is to be made for securing the trailing cable to a framework to absorb stress on the electrical terminals by catenary tension of the cable.

7.9 Harmonics *(2006)*

The total harmonic distortion (THD) in the voltage waveform in the distribution systems is not to exceed 5% and any single order harmonics not to exceed 3%. Other higher values may be accepted provided the distribution equipment and consumers are designed to operate at the higher limits.

9 Circuit Protection System

9.1 System Design

9.1.1 General *(1998)*

Electrical installations are to be protected against accidental overload and short circuit, except

i) As permitted by 4-3-2/11.3,

ii) Where it is impracticable to do so, such as engine starting battery circuit, and

iii) Where by design, the installation is incapable of developing overload, in which case it may be protected against short circuit only.

The protection is to be by automatic protective devices for:

i) Continued supply to remaining essential circuits in the event of a fault, and

ii) Minimizing the possibility of damage to the system and fire.

Three-phase, three-wire alternating current circuits are to be protected by a triple-pole circuit breaker with three overload trips or by a triple-pole switch with a fuse in each phase. All branch circuits are to be protected at distribution boards only and any reduction in conductor sizes is to be protected. Dual-voltage systems having an earthed neutral are not to have fuses in the neutral conductor, but a circuit breaker which simultaneously opens all conductors may be installed when desired. In no case is the dual-voltage system to extend beyond the last distribution board.

9.1.2 Protection Against Short-circuit

9.1.2(a) Protective Devices. Protection against short-circuit is to be provided for each non-earthed conductor by means of circuit breakers or fuses.

9.1.2(b) Rated Short-circuit Breaking Capacity. The rated short-circuit breaking capacity of every protective device is not to be less than the maximum available fault current at that point. For alternating current (AC), the rated short-circuit breaking capacity is not to be less than the root mean square (r.m.s.) value of the AC component of the prospective short-circuit current at the point of application. The circuit breaker is to be able to break any current having an AC component not exceeding its rated breaking capacity, whatever the inherent direct current (DC) component may be at the beginning of the interruption.

9.1.2(c) Rated Short-circuit Making Capacity. The rated short-circuit making capacity of every switching device is to be adequate for maximum peak value of the prospective short-circuit current at the point of installation. The circuit breaker is to be able to make the current corresponding to its making capacity without opening within a time corresponding to the maximum time delay required.

9.1.3 Protection Against Overload

9.1.3(a) Circuit Breakers. Circuit breakers or other mechanical switching devices for overload protection are to have a tripping characteristic (overload-trip time) adequate for the overload capacity of all elements in the system to be protected and for any discrimination requirements.

9.1.3(b) Fuses. The fuse of greater than 320 amperes is not to be used for overload protection.

9.1.3(c) Rating (2005). Fuse ratings and rating (or settings, if adjustable) of time-delay trip elements of circuit breakers are not to exceed the rated current capacity of the conductor to be protected as listed in 4-3-4/Table 10, except as otherwise permitted for generator, motor and transformer circuit protection in 4-3-2/9.3, 4-3-2/9.13 and 4-3-2/9.15. If the standard ratings or settings of overload devices do not correspond to the rating or the setting allowed for conductors, the next higher standard rating or setting may be used, provided it does not exceed 150% of the allowable current carrying capacity of the conductor, where permitted by the Standard to which the feeder cables have been constructed. Except as otherwise permitted for motor and transformer branch-circuit protection, adjustable-trip circuit breakers of the time-delay or instantaneous type are to be set to operate at not more than 150% of the rated capacity of the conductor to be protected.

9.1.3(d) Indication. The rating or setting of the overload protective device for each circuit is to be permanently indicated at the location of the protective device.

9.1.4 Cascade System (Back-up Protection)

9.1.4(a) General. Where a circuit breaker does not have a short circuit breaking and/or making capacity at least equal to the maximum prospective short-circuit current at the point where it is installed, it is to be backed-up by fuse or by a circuit breaker on the generator side, having at least the necessary short-circuit rating for the available fault at the point of application. The upstream circuit breaker or fuse is to be specifically approved for back-up combinations with the downstream circuit breaker and maximum fault rating for the combinations is to be provided. Cascading arrangements exclude generator circuit breakers.

9.1.4(b) Application. Downstream circuit breakers having short circuit ratings less than the short circuit current available at the point of application will be specially considered for non-essential circuits and for essential circuits where automatic transfer to a duplicate circuit is utilized. The same fuse or circuit breaker may back-up more than one circuit breaker when essential services are not involved.

9.1.5 Coordinated Tripping

Coordinated tripping is to be provided between generator, bus tie, bus feeder and feeder protective devices. See also 4-3-2/9.3.2 and 4-3-2/9.7.1. Except for cascade system (backup protection) in 4-3-2/9.1.4, the coordinated tripping is also to be provided between feeder and branch-circuit protective devices for essential services. Continuity of service to essential circuits under short-circuit conditions is to be achieved by discrimination of the protective devices as follows:

9.1.5(a) The tripping characteristics of protective devices in series are to be coordinated.

9.1.5(b) Only the protective device nearest to the fault is to open the circuit, except for cascade system (back-up protection) as specified in 4-3-2/9.1.4(a).

9.1.5(c) The protective devices are to be capable of carrying, without opening, a current not less than the short-circuit current at the point of application for a time corresponding to the opening of the breaker, increased by the time delay required for discrimination.

9.3 Protection for Generators

9.3.1 General

Generators of less than 25 kW not arranged for parallel operation may be protected by fuses. Any generators arranged for parallel operation and all generators of 25 kW and over are to be protected by a trip-free circuit breaker whose trip settings are not to exceed the thermal withstand capacity of the generator. The long-time over-current protection is not to exceed 15% above either the full-load rating of continuous-rated machines or the overload rating of special-rated machines. The shutting down of the prime mover is to cause the tripping of the drilling unit main service generator circuit breaker.

9.3.2 Trip Setting for Coordination

The instantaneous and short-time overcurrent trips of the generators are to be set at the lowest values of current and time which will coordinate with the trip settings of feeder circuit breakers. See also 4-3-2/9.1.5, 4-3-2/9.5.1, and 4-3-2/9.5.2(a).

9.3.3 Load Shedding Arrangements *(2004)*

9.3.3(a) Provision for Load Shedding Arrangements. In order to safeguard continuity of the electrical power supply, automatic load-shedding arrangements or other equivalent arrangements are to be provided:

i) Where only one generating set is normally used to supply power for propulsion and steering of the drilling unit, and a possibility exists that due to the switching on of additional loads, whether manually or automatically initiated, the total load exceeds the rated generator capacity of the running generator, or

ii) Where electrical power is normally supplied by more than one generator set simultaneously in parallel operation for propulsion and steering of the drilling unit, upon the failure of one of the parallel running generators, the total connected load exceeds the total capacity of the remaining generator(s).

9.3.3(b) Services not Allowed for Shedding. Automatic load-shedding arrangements or other equivalent arrangements are not to automatically disconnect the following services. See 4-3-1/3.3 for the definition of essential services.

i) Primary essential services that, when disconnected, will cause immediate disruption to propulsion and maneuvering of the drilling unit,

ii) Emergency services as listed in 4-3-2/5.3, and

iii) Secondary essential services that, when disconnected, will:

- Cause immediate disruption of systems required for safety and navigation of the drilling unit, such as:
  - Lighting systems,
  - Navigation lights, aids and signals,
  - Internal communication systems required by 4-3-2/15, etc.
- Prevent services necessary for safety from being immediately reconnected when the power supply is restored to its normal operating conditions, such as:
  - Fire pumps, and other fire extinguishing medium pumps,
  - Bilge pumps,
  - Ventilation fans for engine and boiler rooms.

9.3.4 Emergency Generator

The emergency generator is also to comply with 4-3-2/9.1, 4-3-2/9.3, 4-3-2/9.5 and 4-3-2/9.7, where applicable. See also 4-3-2/5.9.

9.5 Protection for Alternating-current (AC) Generators

9.5.1 Short-time Delay Trip *(2008)*

Short-time delay trip are to be provided with circuit breakers for AC generator. For generators with a capacity of less than 200 kW having prime movers such as diesel engines which operate independently of the electrical system, consideration will be given to omission of short-time delay trips if instantaneous and long time delay trips are provided.

Short-time delay trips are to be provided with circuit breakers for AC generators. See also 4-3-2/9.3.2. The current setting of the short time delay trip is to be less than the steady state short circuit current of the generator.

For generators with a capacity of less than 200 kW having prime movers such as diesel engines or gas turbines which operate independently of the electrical system, consideration may be given to omission of short-time delay trips, if instantaneous trips and long time overcurrent protection (see 4-3-2/9.3.1) are provided. When the short time delay trips are omitted, the thermal withstand capacity of the generator is to be greater than the steady state short-circuit current of the generator, until activation of the tripping system.

9.5.2 Parallel Operation

Where AC generators are arranged for parallel operation with other AC generators, the following protective devices are to be provided.

9.5.2(a) Instantaneous Trip (2008). Instantaneous trips are to be installed and set in excess of the maximum short-circuit contribution of the individual generator where three or more generators are arranged for parallel operation. See also 4-3-2/9.3.2.

9.5.2(b) Reverse Power Protection (2006). A time-delayed reverse active power protection or other devices which provide adequate protection is to be provided. The setting of protective devices is to be in the range of 8% to 15% of the rated power for diesel engines. A setting of less than 8% of the rated power of diesel engines may be allowed with a suitable time delay recommended by the diesel engine manufacturer. A fall of 50% in the applied voltage is not to render the reverse power protection inoperative, although it may alter the setting to open the breaker within the above range.

9.5.2(c) Undervoltoge Protection. Means are to be provided to prevent the generator circuit breaker from closing if the generator is not generating, and to open the same when the generator voltage collapses.

In the case of an undervoltage release provided for this purpose, the operation is to be instantaneous when preventing closure of the breaker, but is to be delayed for discrimination purposes when tripping a breaker.

9.7 Protection for Direct Current (DC) Generators

9.7.1 Instantaneous Trip

DC generator circuit breakers are to be provided with an instantaneous trip set below the generator maximum short-circuit current and are to coordinate with the trip settings of feeder circuit breakers supplied by the generator.

9.7.2 Parallel Operation

9.7.2(a) Reverse Current Protection. DC generators arranged for parallel operation with other DC generators or with an accumulator battery are to be provided with instantaneous or short-time delayed reverse current protection. The setting of the protection devices is to be within the power range specified by 4-3-2/9.5.2(b). When the equalizer connection is provided, the reverse current device is to be connected on the pole opposite to the equalizer connection where the series compound winding for the generator is connected. Reverse current protection is to be adequate to deal effectively with reverse current conditions emanating from the distribution system (e.g., electric driven cargo winches).

9.7.2(b) Generator Ammeter Shunts. Generator ammeter shunts are to be so located that the ammeters indicate total generator current.

9.7.2(c) Undervoltage Protection. Requirements for AC generator in 4-3-2/9.5.2(c) are also applicable to DC generator.

9.9 Protection for Accumulator Batteries

Accumulator (storage) batteries, other than engine starting batteries, are to be protected against overload and short circuits by devices placed as near as practicable to the batteries but outside of the battery rooms, lockers or boxes, except that the emergency batteries supplying essential services are to have short circuit protection only. Fuses may be used for the protection of emergency lighting storage batteries instead of circuit breakers up to and including 320 amperes rating. The charging equipment, except converters, for all batteries with a voltage more than 20% of the line voltage is to be provided with reverse current protection.

9.11 Protection for External or Shore Power Supply

9.11.1 General

Where arrangements are made for the supply of electricity from a source on shore or other external source, permanently fixed cables from the external supply or shore connection box to the main or emergency switchboard are to be protected by fuses or circuit breakers located at the connection box.

9.11.2 Interlocking Arrangement

Where the generator is not arranged for parallel operation with the external or shore power supply, an interlocking arrangement is to be provided for the circuit breakers or disconnecting devices between generator and the external or shore power supply in order to safeguard from connecting unlike power sources to the same bus.

9.13 Protection for Motor Branch Circuits

9.13.1 General

Trip elements of circuit breaker for starting and for short-circuit protection are to be in accordance with 4-3-2/9.13.2 or 4-3-2/9.13.3, except that circuit breakers having only instantaneous trips may be provided as part of the motor control center. Where circuit breakers having only instantaneous trips are provided, the motor running protective device is to open all conductors, and the motor controller is to be capable of opening the circuit without damage to itself resulting from a current up to the setting of the circuit breaker. Circuit-disconnecting devices are to be provided for each motor branch circuit and are to be in accordance with 4-3-3/3.13.2 and 4-3-4/7.17.2.

9.13.2 Direct-current Motor Branch Circuits

The maximum fuse rating or the setting of the time-delay trip element is to be 150% of the full-load rating of the motor served. If that rating or setting is not available, the next higher available rating or setting may be used.

9.13.3 Alternating-current Motor Branch Circuits

The maximum fuse rating or setting of the trip element is to be the value stated below. If that rating or setting is not available, the next higher available rating or setting may be used.

Type of Motor	*Rating or Setting in % Motor Full-load Current*
Squirrel-cage and Synchronous Full-voltage, Reactor or Resistor-starting	250
Autotransformer Starting	200
Wound Rotor	150

When fuses are used to protect polyphase motor circuits, it is to be arranged to protect against single-phasing.

The setting of magnetic instantaneous trips for short-circuit protection only is to exceed the transient current inrush of the motor, and is to be the standard value nearest to, but not less than, 10 times full-load motor current.

9.13.4 Motor Running Protection

Running protection is to be provided for all motors having a power rating exceeding 0.5 kW, except that such protection is not to be provided for steering motors (see 4-3-2/11.3). The running protection is to be set between 100% and 125% of the motor rated current.

9.13.5 Undervoltage Protection and Undervoltage Release *(2004)*

Undervoltage protection is to be provided for motors having power rating exceeding 0.5 kW to prevent undesired restarting after a stoppage due to a voltage low or failure condition.

Undervoltage release is to be provided on controllers for essential and emergency services where the automatic restart after a restoration of the normal voltage is not hazardous. The use of controllers of the undervoltage release type is to be limited to avoid excessive starting current when a group of motors with undervoltage release controllers are restarted automatically upon restoration of the normal voltage, unless a sequential starting is provided to limit excessive starting current.

9.13.6 Jacking Gear Motors

For group installations of jacking gear motors, see the special arrangements permitted in 4-1-3/7.

9.15 Protection for Transformer Circuits

9.15.1 Setting of Overcurrent Device

Each power and lighting transformer feeder is to be protected by an overcurrent device rated or set at a value not more than 125% of rated primary current. When a transformer is provided with an overcurrent device in the secondary circuit rated or set at not more than 125% of rated secondary current, the feeder overcurrent device may be rated or set at a value less than 250% of the rated primary current.

9.15.2 Parallel Operation *(2006)*

When the transformers are arranged for parallel operation, means are to be provided to disconnect the transformer from the secondary circuit. Where power can be fed into secondary windings, short-circuit protection (i.e., short-time delay trips) is to be provided in the secondary connections. In addition, when the disconnecting device in primary side of the transformer is opened due to any reason (e.g., the short-circuit protection, overload protection, or manual operation for opening), the disconnecting device in the secondary side of the transformer is to be arranged to open the circuit automatically.

9.17 Protection for Meters, Pilot Lamps and Control Circuits

Indicating and measuring devices are to be protected by means of fuses or current limiting devices. For devices such as voltage regulators where interruption of the circuit may have serious consequences, fuses are not to be used. If fuses are not used, means are to be provided to prevent fire in an unprotected part of the installation. Fuses are to be placed as near as possible to the tapping from the supply.

11 Systems for Steering Gear Installed in Self-propelled Units

11.1 Power Supply Feeder

Each electric or electrohydraulic steering gear is to be served by at least two exclusive circuits fed directly from the main switchboard. However, one of the circuits may be supplied through the emergency switchboard. An auxiliary electric or electrohydraulic steering gear associated with a main electric or electrohydraulic steering gear may be connected to one of the circuits supplying this main steering gear. The circuits supplying an electric or electrohydraulic steering gear are to have adequate rating for supplying all motors, control systems and instrumentation which are normally connected to them and operated simultaneously. The circuits are to be separated throughout their length as widely as is practicable.

11.3 Protection for Steering Gear Motor Circuit

11.3.1 Short Circuit Protection *(1997)*

Each steering gear feeder is to be provided with short-circuit protection which is to be located at the main or emergency switchboard. Long-term overcurrent protection is not to be provided for steering gear motors.

11.3.1(a) Direct Current (DC) Motors. For DC motors, the feeder circuit breaker is to be set to trip instantaneously at not less than 300% and not more than 375% of the rated full-load current of the steering-gear motor, except that the feeder circuit breaker on the emergency switchboard may be set to trip at not less than 200%.

11.3.1(b) Alternating Current (AC) Motors. For AC motors, the protection against excess current, including starting current, if provided, is to be for not less than twice the full load current of the motor or circuit so protected, and is to be arranged to permit the passage of the appropriate starting currents.

11.3.1(c) Fuses as Motor-feeder Protection. The use of fuses instead of circuit breakers for steering gear motor feeder short circuit protection is not permitted.

11.3.2 Undervoltage Release

Power unit motor controllers and other automatic motor controllers are to be fitted with undervoltage release.

11.5 Emergency Power Supply

Where the rudder stock is required by 3-2-14/7.1 of the *Steel Vessel Rules* to be over 230 mm (9 in.) diameter using $K_s = 1.0$ in way of the tiller, excluding strengthening for navigation in ice, an alternative power supply, sufficient at least to supply the steering gear power unit and also its associated control system and rudder angle indicator, is to be provided automatically within 45 seconds either from the emergency source of electrical power or from an independent source of power located in the steering gear compartment. The steering gear power unit under alternative power supply is to be capable of moving the rudder from 15 degrees on one side to 15 degrees on the other side in not more than 60 seconds with the drilling unit at the line draft while running at one half the maximum speed ahead or 7 knots, whichever is the greater. This independent source of power is to be used only for this purpose. The capacity is to be sufficient for at least 10 minutes of continuous operation.

11.7 Controls, Instrumentation, and Alarms

See 4-3-4/5.7, 4-3-4/13, 4-3-4/15 and 4-3-4/17 of the *Steel Vessel Rules*.

13 Lighting and Navigation Light Systems

13.1 Lighting System

13.1.1 Main Lighting System

A main electric lighting system is to provide illumination throughout those parts of the drilling unit normally accessible to and used by crew. It is to be supplied from the main source of electrical power.

13.1.2 System Arrangement

13.1.2(a) Main Lighting System. The arrangement of the main electric lighting system is to be such that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, if any, the main switchboard and the main lighting switchboard will not render the emergency electric lighting system required by 4-3-2/5.3ii) inoperative.

13.1.2(b) Emergency Lighting System. The arrangement of the emergency electric lighting system is to be such that a fire or other casualty in spaces containing the emergency source of electrical power, associated transforming equipment, if any, the emergency switchboard and the emergency lighting switchboard will not render the main electric lighting system required by 4-3-2/13.1.1 inoperative.

13.1.3 Lighting Circuits

13.1.3(a) Machinery Space and Accommodation Space (2006). In spaces such as:

- Public spaces;
- Category A machinery spaces;
- Galleys;
- Corridors;
- Stairways leading to boat-decks, including stair towers and escape trunks;

there is to be more than one final subcircuit for lighting, one of which may be supplied from the emergency switchboard, in such a way that failure of any one circuit does not leave these spaces in darkness.

13.1.4 Protection for Lighting Circuits

Lighting circuits are to be protected against overload and short circuit. Overload protective devices are to be rated or set at not more than 30 amperes. The connected load is not to exceed the lesser of the rated current carrying capacity of the conductor or 80% of the overload protective device rating or setting. The control switches are to be rated for the load controlled.

13.3 Navigation Light System

13.3.1 Feeders

The masthead, side and stern lights are to be separately connected to a distribution board reserved for navigation light, placed in an accessible position on the bridge, and is connected directly or through transformers to the main or emergency switchboard. These lights are to be fitted with duplicate lamps or other dual light sources and are to be controlled by an indicator panel. Provision is to be made on the bridge for the navigation lights to be transferred to an alternative supply. See 4-3-2/5.3i) for power supply.

13.3.2 Navigation Light Indicator

Each navigation light as listed in 4-3-2/13.3.1 is to be provided with an indicator panel which automatically gives audible and/or visual warning in the event of extinction of the light. If an audible device is used, it is to be connected to a separate source of supply, for example, a primary or accumulator (storage) battery. If a visual signal is used which is connected in series with the navigation light, means are to be provided to prevent the extinction of the navigation light due to failure of the visual signal. A means for disconnection of each navigation light circuit is to be provided at the indicator panel.

13.3.3 Protection *(1998)*

Each navigation light, as listed in 4-3-2/13.3.1, is to be protected by a fuse or circuit breaker in each insulated pole.

Similarly, the navigation light indicator panel is to be provided with a fused-feeder disconnect double-pole switch or double-pole circuit breaker which may be fitted on the distribution board or the indicator panel. The rating of the fuses or circuit breaker setting is to be at least twice that of the largest branch fuse or the circuit breaker setting and greater than the maximum panel load.

15 Interior Communication Systems for Self-propelled Units

15.1 Navigation Bridge

15.1.1 General

At least two independent means are to be provided for communicating orders from the navigation bridge to the position in the machinery space or in the control room from which the speed and direction of thrust of the propellers are normally controlled. Appropriate means of communication are to be provided to any other positions from which the main propulsion machinery may be controlled. See 4-3-2/5.3iii) for power supply.

15.1.2 Engine Order Telegraph

One of the communicating means between navigation bridge and the main propulsion control position is to be an engine room telegraph which provides visual indication of the orders and responses both in the machinery space and on the navigation bridge. Final subcircuit for power supply to this system is to be independent of other electrical systems and control, monitoring and alarm systems. See 4-3-2/5.3iii) for power supply. Communication network and power supply circuit for this may be combined with the engine order telegraph system specified in 4-3-2/15.3.

15.3 Main Propulsion Control Stations

A common talking means of voice communication and calling or engine order telegraph repeater is to be provided between the main propulsion control station and local control positions for main propulsion engines and controllable pitch propellers. Voice communication systems are to provide the capability of carrying on a conversation while the drilling unit is being navigated. Final subcircuit for power supply to these are to be independent of the other electrical system and the control, monitoring and alarm systems. Communication network and power supply circuit for the voice communication system may be combined with the system required in 4-3-2/15.5.

15.5 Voice Communications

15.5.1 Propulsion and Steering Control Stations

A common talking means of voice communication and calling is to be provided between the navigation bridge, main propulsion control station and the steering gear compartment so that the simultaneous talking among these spaces is possible at all times and the calling to these spaces is always possible even if the line is busy.

15.5.2 Communication in Case of an Emergency *(2007)*

Means of voice communication is to be available for transfer of information between all locations where action may be necessary in case of an emergency. Such locations include the emergency control stations required by 5-3-1/7, machinery spaces, SCR rooms and all locations vital to the safety of the unit. Simultaneous talking among these locations is to be possible at all times and the calling to these locations is always to be possible even if the line is busy.

15.5.3 Elevator

Where an elevator is installed, a telephone is to be permanently installed in all cars and connected to a continuously manned area. The telephone may be sound powered, battery operated or electrically powered from the emergency source of power.

15.5.4 Independence of Power Supply Circuit

Final subcircuit for power supply to these voice communication systems is to be independent of other electrical systems and control, monitoring and alarm systems. See 4-3-2/5.3iii) for power supply.

15.7 Emergency and Interior-communication Switchboard

Emergency and interior-communication switchboards, when fitted, are to comply with the applicable parts of 4-3-4/7, and attention is directed to the requirements of the governmental authority whose flag the drilling unit flies.

15.9 Public Address System *(2007)*

The public address system is to comply with subparagraphs 4-3-2/15.9.1 through 4-3-2/15.9.3 as follows:

15.9.1 System Requirements

The system is to be a loud speaker installation enabling the broadcast of messages which are clearly audible in all parts of the unit. The system is to provide for the broadcast of messages from the navigation bridge, emergency control stations (see 4-4-1/27) and other strategic points with an override function so that all emergency messages may be broadcast if any loudspeaker in the locations concerned has been turned off, its volume has been turned down or the public address system is in use for other purposes.

15.9.2 Minimum Sound Levels

With the drilling unit underway or in normal operating conditions, the minimum sound levels for broadcasting emergency announcements are to be:

i) In interior locations, 75 dB (A) and at least 20 dB (A) above the speech interference level.

ii) In exterior locations, 80 dB (A) and at least 15 dB (A) above the speech interference level.

15.9.3 Emergency Source of Power

The system is to be connected to the emergency source of power.

15.9.4 Public Address System Combined with General Alarm System *(2006)*

Where a single system serves for both public address and general emergency alarm functions, the system is to be arranged so that a single failure is not to cause the loss of both systems and is to minimize the effect of a single failure. The major system components, such as power supply unit, amplifier, alarm tone generator, etc., are to be duplicated. The coverage provided by the arrangement of the system loops and speakers is to be such that after a single failure, the announcements and alarms are still audible in all spaces. Duplication of system loops and speakers in each room or space is not required provided the announcements and alarms are still audible in all spaces.

17 Manually Operated Alarms

17.1 General Emergency Alarm Systems

17.1.1 General *(1999)*

A general alarm system complying with requirements of 4-3-2/17.1.2 is to be provided to summon crew to muster stations and initiate actions included in the muster list. The system is to be supplemented by instructions over a public address system meeting the requirements of 4-3-2/15.9. Any entertainment sound system is to be automatically turned off when the general emergency alarm is activated.

17.1.2 System Requirements *(1999)*

The general emergency alarm system is to be capable of sounding the general emergency alarm signal, fire alarm signal and abandon unit signal on a electrically operated bell or klaxon or other equivalent warning system, which is to be powered from the drilling unit's main supply and the emergency source of electrical power required by 4-3-2/5. The system is to be capable of operation from the navigation bridge, emergency control stations (see 5-3-1/7) and from other strategic points. The system is to be clearly audible in all parts of the unit. The alarm is to continue to function after it has been triggered until it is manually turned off or is temporarily interrupted by a message on the public address system. Self-propelled drilling units are to be capable of sounding the general emergency alarm on the drilling unit's whistle, but which need only be capable of operation from the navigation bridge.

17.1.2(a) The minimum sound levels for the emergency alarm tone in interior spaces are to be 80 dB and at least 10 dB (A) above ambient noise levels existing during normal equipment operation in moderate weather. In cabins without a loud speaker installation, an electrical alarm transducer is to be installed.

17.1.2(b) The sound levels at the sleeping position in cabins and in cabin bathrooms are to be at least 75 dB (A) and at least 10 dB (A) above ambient noise levels.

Note: Refer to the Code on Alarms and Indicators adopted by IMO Resolution A.830(19).

17.3 Engineers' Alarm *(2006)*

An engineers' alarm operable from the main propulsion control station or at the maneuvering platform, as appropriate, is to be provided. It is to be audible in each engineer's cabin and its sound pressure level is to comply with 4-3-2/17.1.2. See 4-3-2/5.3iii) for power supply.

17.5 Refrigerated Space Alarm

Fan and diffuser rooms serving subfreezing compartments are to be provided with a device capable of activating an audible and visual alarm in a manned control center and operable from within the latter space for the protection of personnel. See 4-3-2/5.3xi) for power supply.

17.7 Elevator

A device which will activate an audible and visual alarm in a manned control center is to be provided in all cars. Such alarm system is to be independent of power and control systems of the elevator. See 4-3-2/5.3xi) for power supply.

19 Fire Protection and Fire Detection Systems

19.1 Emergency Stop

19.1.1 Ventilation System

19.1.1(a) General. All electrical ventilation systems are to be provided with means for stopping the motors in case of fire or other emergency. These requirements do not apply to closed recirculating systems within a single space. See also 5-3-1/9.

19.1.1(b) Machinery Space Ventilation. The main machinery-space ventilation is to be provided with means for stopping the ventilation fans, which is to be located in the passageway leading to, but outside of the space, or in the fire-fighting station, if provided.

19.1.1(c) Ventilation Other Than Machinery Space. A control station for all other ventilation systems is to be located in the fire-control room or navigation bridge, or in an accessible position leading to, but outside of the space ventilated.

19.1.2 Fuel Oil Units

See 4-2-5/1.5 and 5-3-1/9.3 for emergency tripping and emergency stop for fuel oil units.

19.3 Fire Detection and Alarm System

See 4-2-5/1.1.

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PART

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CHAPTER 3 Electrical Installations

SECTION 3 Drilling Unit Installation

1 Plans and Data to be Submitted

1.1 Booklet of Standard Details

A booklet of the standard wiring practices and details, including such items as cable supports, earthing details, bulkhead and deck penetrations, cable joints and sealing, cable splicing, watertight and explosion-proof connections to equipment, earthing and bonding connections, etc., as applicable, is to be submitted. Where cable penetration methods for A- or B-class decks or bulkheads are shown, an evidence of approval by an Administration signatory to 1974 SOLAS as amended is also to be submitted.

1.3 Arrangement of Electrical Equipment

A general arrangement plan showing the location of at least the following electrical equipment is to be submitted for review.

- Generator, Essential Motor, and Transformer
- Battery
- Switchboard, Battery Charger, and Motor Controller
- Emergency Lighting Fixture
- General Emergency Alarm Device and Alarm Actuator
- Detector, Manual Call Point and Alarm Panel for Fire
- Detection and Alarm System
- Certified-safe Type Equipment

Where cable splices or cable junction boxes are provided, locations of the splices and cable junction boxes together with the information of their services are also to be submitted for review.

1.5 Electrical Equipment in Hazardous Areas

A plan showing hazardous areas is to be submitted for review together with the following:

- A list of intended electrical equipment in the indicated hazardous areas, including a description of the equipment, applicable degree of protection and ratings. See 5-2-5/1.1.
- For intrinsically-safe systems, also wiring plans, installation instructions with any restrictions imposed by the certification agency.
- Detail of installation for echo sounder, speed log and impressed current cathodic protection system where located in these areas.

When the selection of the equipment has been finalized, a list identifying all equipment in the hazardous areas, their degree of protection, rating, manufacturer's name, model number and evidence of certification is to be submitted. An approved copy of this list/booklet is to be maintained onboard for future reference. See 6-2-4/11.1 and 4-3-3/9.1.

1.7 Emergency Shutdown Procedures

Details of the emergency shutdown procedures for electrical equipment as referred to in 5-3-1/7. See also 4-3-5/7.1.

1.9 Maintenance Schedule of Batteries *(2008)*

Maintenance schedule of batteries for essential and emergency services. See 4-3-3/3.7.5.

3 Equipment Installation and Arrangement

3.1 General Consideration

3.1.1 Equipment Location *(2006)*

3.1.1(a) General. Electrical equipment is to be so placed or protected as to minimize the probability of mechanical injury or damage from the accumulation of dust, oil vapors, steam or dripping liquids. Equipment liable to generate arc is to be ventilated or placed in a compartment ventilated to avoid accumulation of flammable gases, acid fumes and oil vapors. See 4-3-3/Table 1 for required degree of protection for various locations.

3.1.1(b) Equipment in Areas Protected by Local Fixed Pressure Water-spraying or Local Water-mist Fire Extinguishing System in Machinery Spaces. Unless it is essential for safety or operational purposes, electrical and electronic equipment is not to be located within areas protected by Local Fixed Pressure Water-spraying or Water-mist Fire Extinguishing System and in adjacent areas where water may extend. The electrical and electronic equipment located within areas protected by Local Fixed Pressure Water-spraying or Water-mist Fire Extinguishing System and those within adjacent areas exposed to direct spray are to have a degree of protection not less than IP44. See 4-3-3/Figure 1.

Electrical and electronic equipment within adjacent areas not exposed to direct spray may have a lower degree of protection provided evidence of suitability for use in these areas is submitted taking into account the design and equipment layout, e.g., position of inlet ventilation openings, filters, baffles, etc., to prevent or restrict the ingress of water mist/spray into the equipment. The cooling airflow for the equipment is to be assured.

Note:

Additional precautions may be required to be taken with respect to:

a. Tracking as the result of water entering the equipment

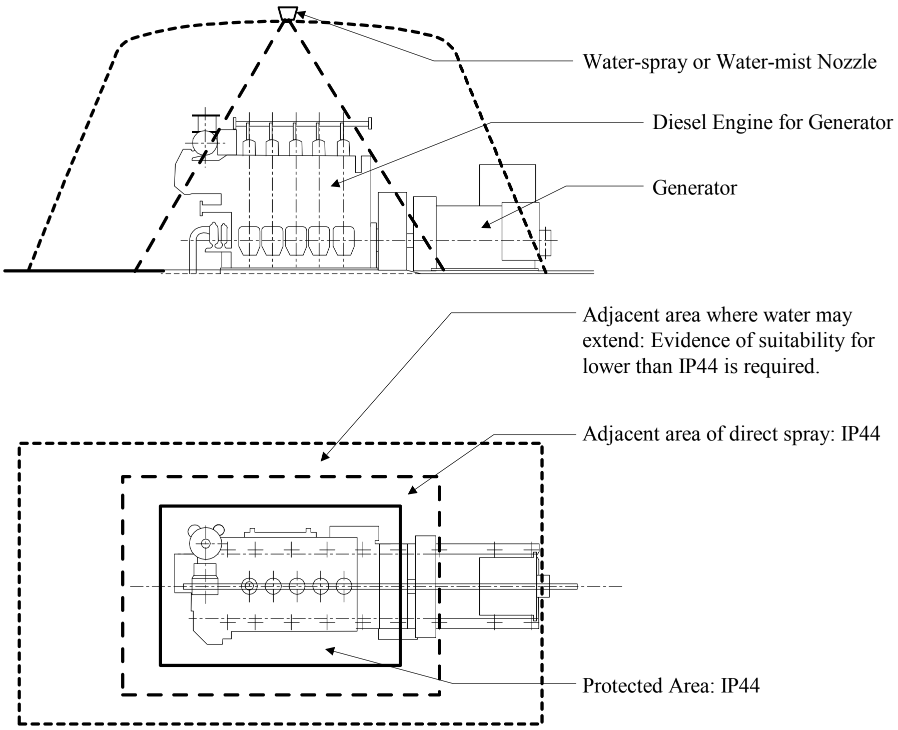
b. Potential damage as the result of residual salts from sea water systems

c. High voltage installations

d. Personnel protection against electric shock

Equipment may require maintenance after being subjected to water mist/spray.

FIGURE 1
Example of Protected Area, Adjacent Area of Direct Spray and Adjacent Area where Water May Extend *(2006)*



3.1.2 Protection from Bilge Water

All generators, motors and electric couplings are to be so arranged that they cannot be damaged by bilge water; and, if necessary, a watertight coaming is to be provided to form a well around the base of such equipment with provision for removing water from the well.

3.1.3 Accessibility

The design and arrangement of electrical apparatus is to provide accessibility to parts requiring inspection or adjustment. Armature and field coils, rotors and revolving fields are to be removable and where air ducts are used, there are to be means of access.

3.3 Generators

In general, all generators on ship-type drilling units are to be located with their shafts in a fore-and-aft direction on the drilling unit and are to operate satisfactorily in accordance with the inclination requirements of 4-1-1/7. Where it is not practicable to mount the generators with the armature shafts in the fore-and-aft direction, their lubrication will require special consideration. Provision is to be made to prevent oil or oil vapor from passing into the machine windings.

3.5 Drilling Unit Main Service Motors

3.5.1 General

Motors for use in the machinery space above the floor plate or spaces where subject to mechanical injury, or dripping of oil or water are to have an enclosure of at least IP22 protection in accordance with 4-3-3/Table 1. However, where they are protected by drip covers, they may have an enclosure of a lower protection grade than IP22. The motors having a protection enclosure of IP22 or lower are to be installed at a location high enough to avoid bilge water. Motors below the level of the floor plates are to have an enclosure of at least IP44 protection. Where motors intended for service at sea are not mounted with the rotor shafts in the fore-and-aft direction, the type of bearing and lubrication will require special consideration.

3.5.2 Pump Motors

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

3.5.3 Motors on Weather Decks

Motors for use on weather decks are to have an enclosure of at least IP56 protection or are to be enclosed in watertight housings.

3.5.4 Motors Below Decks

Motors below decks are to be installed at a location as dry as practicable and away from steam, water, and oil piping.

3.7 Accumulator Batteries

3.7.1 General

The following requirements are applicable to permanently installed power, control and monitoring storage batteries of acid or alkaline types. Batteries are to be so arranged that the trays are accessible and provided with not less than 254 mm (10 in.) headroom. Where a relief valve is provided for discharging excessive gas due to overcharge, arrangements are to be made for releasing the gas to the weather deck away from any source of ignition.

3.7.2 Battery Installation and Arrangements *(2008)*

3.7.2(a) Large Batteries. Large storage batteries, those connected to a charging device with an output of more than 2 kW, are to be installed in a room assigned to the battery only, but may be installed in a deck locker if such a room is not available. No electrical equipment is to be installed in the battery rooms unless essential for the operational purposes and certified safe for battery room atmosphere. Electrical equipment installed in battery rooms may be any of the types indicated in 4-3-3/9.1.2(b) and is to be IEC Publication 60079 group IIC class T1.

3.7.2(b) Moderate-size Batteries. Batteries of moderate size, those connected to a charging device with a power output of 0.2 kW up to and including 2 kW, may be installed in the battery room or may be installed in battery lockers or deck boxes in the emergency generator room, machinery space or other suitable location. Cranking batteries are to be located as closely as possible to the engine or engines served.

3.7.2(c) Small Batteries. Small batteries are to be installed in a battery box and may be located as desired, except they are not to be located in sleeping quarters unless hermetically sealed.

3.7.2(d) Low-hydrogen-emission Battery Installations. A low-hydrogen-emission battery installation with a battery charger having a charging rate of a large or moderate battery size installation may be treated as a moderate or small battery installation, respectively, if the following are met:

i) Calculations under the worst case charging conditions are submitted that demonstrate that the low-hydrogen-emission battery installation does not emit more hydrogen under similar charging conditions than a bank of standard lead acid batteries supplied by a 2 kW charger for a moderate battery installation or 0.2 kW charger for a small battery installation, and *ii)* A warning notice is placed to notify maintenance personnel that additional batteries are not to be installed, and batteries are only to be replaced by other batteries of the same or lower hydrogen emission rate.

3.7.2(e) Battery Trays. Trays for batteries are to be chocked with wood strips or equivalent to prevent movement and each tray is to be fitted with nonabsorbent insulating supports on the bottom and with similar spacer blocks at the sides or with equivalent provision to secure air-circulation space all around each tray.

3.7.2(f) Identification of Battery Types. Lead-acid batteries and alkaline batteries, when placed in the same battery compartment, are to be effectively identified as to type and segregated.

3.7.3 Ventilation

3.7.3(a) Battery Rooms. Battery rooms are to be ventilated to avoid accumulation of flammable gas. Natural ventilation may be employed if ducts are run directly from the top of the battery room to the open air above.

If natural ventilation is impractical, mechanical exhaust ventilation is to be provided with fan intake at the top of the room. Fans are to be of non-sparking construction in accordance with 4-3-3/9.7 and capable of completely changing the air in the battery room in not more than two minutes. Alternatively, a lesser ventilation rate may be considered, provided that satisfactory calculations are submitted substantiating that adequate ventilation is available to maintain the flammable gases within the battery room to a level below the lower explosive limit (L.E.L.) at the maximum battery charging current. Where the ventilation rate is based on low hydrogen emission type batteries, a warning notice to this effect is to be provided in a visible place in the battery room. Openings for air inlet are to be provided near the floor.

3.7.3(b) Battery Lockers. Battery lockers are to be ventilated, if practicable, similarly to battery rooms by a duct led from the top of the locker to the open air or to an exhaust ventilation duct. Louvers or equivalent are to be provided near the bottom for entrance of air.

3.7.3(c) Deck Boxes. Deck boxes are to be provided with a duct from the top of the box, terminating in a goose neck, mushroom head or equivalent to prevent entrance of water. Holes for air inlet are to be provided on at least two opposite sides of the box. The entire deck box, including openings for ventilation, is to be weathertight to prevent entrance of spray or rain.

3.7.3(d) Small Battery Boxes. Boxes for small batteries require no ventilation other than openings near the top to permit escape of gas.

3.7.4 Protection from Corrosion

The interiors of battery rooms, including the structural parts and shelves therein, as well as ventilation inlets and outlets are to be painted with corrosion-resistant paint. Shelves in battery rooms or lockers for acid batteries are to have a watertight lining of sheet lead not less than 1.6 mm ($^1/_{16}$ in.) on all sides. For alkaline batteries, the shelves are to be similarly lined with steel not less than 0.8 mm ($^1/_{32}$ in.) thick. Alternatively, a battery room may be fitted with a watertight lead pan, steel for alkaline batteries, over the entire deck, carried up not less than 152 mm (6 in.) on all sides. Deck boxes are to be lined in accordance with the above alternative method. Boxes for small batteries are to be lined to a depth of 76 mm (3 in.) consistent with the methods described above.

3.7.5 Maintenance of Batteries *(2008)*

3.7.5(a) Maintenance Schedule of Batteries. Where batteries are fitted for use for essential and emergency services, a maintenance schedule of such batteries is to be provided and maintained.

The schedule is to include all batteries used for essential and emergency services, including system batteries installed in battery rooms, battery lockers and deck boxes as well as batteries installed within vendor supplied equipment. Examples of batteries included with equipment are:

- Computer equipment and programmable logic controllers (PLC) use in computer based systems and programmable electronic systems, when used for essential or emergency services.
- Radiocommunication equipment, such as the equipment required by the IMO MODU Code, Chapter 11.

The schedule is to be submitted for review and is to include at least the following information regarding the batteries.

- Type and manufacturer's type designation.
- Voltage and ampere-hour rating.
- Location.
- Equipment and/or system(s) served.
- Maintenance/replacement cycle dates.
- Date(s) of last maintenance and/or replacement.
- For replacement batteries in storage, the date of manufacture and shelf life (See Note below)

Note: Shelf life is the duration of storage under specified conditions at the end of which a battery retains the ability to give a specified performance.

3.7.5(b) Procedure of Maintenance. Procedures are to be put in place to show that, where batteries are replaced, they are to be of an equivalent performance type. Details of the schedule, procedures, and the maintenance records are to be included in the drilling unit's maintenance system and integrated into the drilling unit's operational maintenance routine, as appropriate, which are to be verified by the Surveyor.

3.7.6 Replacement of Batteries *(2008)*

Where a vented type battery (See Note 1) replaces a valve-regulated, sealed type battery (See Note 2), the requirements in 4-3-3/3.7.2 and 4-3-3/3.7.3 are to be complied with on the basis of the charging capacity.

Notes:

1 A vented battery is one in which the cells have a cover provided with an opening through which products of electrolysis and evaporation are allowed to escape freely from the cells to atmosphere.

2 A valve-regulated battery is one in which cells are closed but have an arrangement (valve) which allows the escape of gas if the internal pressure exceeds a predetermined value.

3.9 Switchboard

Switchboards are to be so arranged as to give easy access, as may be needed, to apparatus and equipment without danger to personnel. Switchboards are to be located in a dry place so as to provide a clear working space of at least 914 mm (36 in.) at the front of the switchboard and a clearance of at least 610 mm (24 in.) at the rear, which may be reduced to 457 mm (18 in.) in way of stiffeners or frames, except that for switchboards which are enclosed at the rear and are fully serviceable from the front, clearance at the rear will not be required unless necessary for cooling. Switchboards are to be secured to a solid foundation. They are to be self-supported or are to be braced to the bulkhead or the deck above. In case the last method is used, means of bracing is to be flexible to allow deflection of the deck without buckling the assembly structure.

3.11 Distribution Boards

3.11.1 Location and Protection *(2004)*

Distribution boards are to be located in accessible positions. Distribution boards may be located behind panels/linings within accommodation spaces, including stairway enclosures, without the need to categorize the space to a fire integrity standard, provided no provision is made for storage. Distribution boards are to have approved noncombustible non-hygroscopic enclosures. Metal enclosures and all exposed metal parts in nonmetallic enclosures are to be earthed to the drilling unit's structure. All cases are to be of adequate mechanical strength.

3.11.2 Switchboard-type Distribution Boards

Distribution boards of the switchboard type, unless installed in machinery spaces or in compartments assigned exclusively to electric equipment and accessible only to authorized personnel, are to be completely enclosed or protected against accidental contact and unauthorized operation.

3.11.3 Safety-type Panels *(1998)*

If the method of operation demands the handling of switches by persons unfamiliar with electrical equipment, the distribution board is to be of the safety type. This type of distribution board is to be used for controlling branch lighting circuits. Dead front type panels are to be used where voltage to earth is in excess of 50 volts DC or 50 volts AC r.m.s. between conductors.

3.13 Motor Controllers and Control Centers

3.13.1 Location and Installation

Motor control centers are to be located in a dry place. Clear working space is to be provided around motor control centers to enable doors to be fully opened and equipment removed for maintenance and replacement. Motor control centers are to be secured to a solid foundation, be self-supported or be braced to the bulkhead.

3.13.2 Disconnecting Arrangements

3.13.2(a) Device. Means are to be provided for disconnecting the motor and controller from all supply conductors, except that a manually operated switch or circuit breaker may serve as both controller and disconnecting means (see 4-3-4/7.17.2).

3.13.2(b) Location (1998). The disconnecting device may be in the same enclosure with the controller or may be in a separate enclosure, and is to be externally operated. Except for remotely controlled fire extinguishing purpose motors, the branch-circuit switch or circuit breaker on the power-distribution board or switchboard may serve as the disconnect device if in the same compartment with the controller.

3.13.2(c) Locking Means (1998). If the disconnecting device is not within sight of both motor and controller, or if it is more than 15.25 m (50 ft) from either, it is to be arranged for locking in the open position. For remotely controlled fire extinguishing purpose motors, the locking means are to be provided at the feeder circuit breaker for such motors.

3.13.2(d) Identification Plate. The disconnect switch, if not adjacent to the controller, is to be provided with an identification plate.

3.13.2(e) Open and Close Indications. The disconnect device is to indicate by a position of the handle, or otherwise, whether it is open or closed.

3.13.3 Indicating-light Circuits

Where indicating-light circuits are employed, their potential is to be limited to 150 volts if the opening of the foregoing disconnecting devices does not de-energize the indicating circuit.

3.15 Resistors for Control Apparatus

The resistor is to be protected against corrosion, either by rust-proofing or embedding in a protective material. Resistors are to be located in well-ventilated compartments and are to be mounted with ample clearances, about 305 mm (12 in.) to prevent excessive heating of an adjacent drilling unit's structure or dangerous overheating of unprotected combustible material. The arrangement of the electrical equipment and wiring located within these spaces is to be such as to prevent their exposure to ambient temperatures in excess of that for which they have been designed.

3.17 Lighting Fixtures

Lighting fixtures are to be so arranged as to prevent temperature rises which could damage the cables and wiring, and to prevent surrounding material from becoming excessively hot.

3.19 Heating Equipment

Electric radiators, if used, are to be fixed in position and be so constructed as to reduce fire risks to a minimum. Electric radiators of the exposed-element type are not to be used.

3.21 Magnetic Compasses

Precautions are to be taken in connection with apparatus and wiring in the vicinity of the magnetic compass to prevent disturbance of the needle from external magnetic fields.

3.23 Portable Equipment and Outlets

Portable equipment are not to be used in hazardous areas nor are portable lights to be used for berth lights in accommodations.

3.25 Receptacles and Plugs of Different Ratings

Receptacles and plugs of different electrical ratings are not to be interchangeable. In cases where it is necessary to use 230 volts portable equipment, the receptacles for their attachment are to be of a type which will not permit attaching 115 volts equipment.

3.27 Installation Requirements for Recovery from Dead Ship Condition *(2005)*

Means are to be provided to ensure that machinery for self propelled drilling units can be brought into operation from the dead ship condition without external aid. See 4-1-1/11.

Where the emergency source of power is an emergency generator which complies with 4-3-2/5.15 and 4-3-2/3.1.4, this emergency generator may be used for restoring operation of the main propulsion plant, boilers and auxiliary machinery.

Where there is no emergency generator installed, the arrangements for bringing main and auxiliary machinery into operation are to be such that the initial charge of starting air or initial electrical power and any power supplies for engine operation can be developed onboard the drilling unit without external aid. If for this purpose an emergency air compressor or an electric generator is required, these units are to be powered by a hand-starting oil engine or a hand-operated compressor.

The arrangements for bringing the main and auxiliary machinery into operation are to have a capacity such that the starting energy and any power supplies for propulsion engine operation are available within 30 minutes of a black out condition.

3.29 Services Required to be Operable Under a Fire Condition *(2008)*

For the purpose of 4-3-3/5.17.2, services required to be operable under a fire condition include, but not limited thereto, are the following:

i) Fire and general alarm system

ii) Fire extinguishing system including fire extinguishing medium release alarms

iii) Emergency Fire Pump

iv) Fire detection system

v) Control and power systems for all power operated fire doors and their status indicating systems

vi) Control and power systems for all power operated watertight doors and their status indicating systems

vii) Emergency lighting

viii) Public address system

ix) Remote emergency stop/shutdown arrangement for systems which may support the propagation of fire and/or explosion

3.31 High Fire Risk Areas *(2008)*

For the purpose of 4-3-3/5.17, the examples of the high fire risk areas are the following:

i) Machinery spaces as defined by 5-1-1/3.7.2(6) and (7)

ii) Spaces containing fuel treatment equipment and other highly flammable substances

iii) Galley and pantries containing cooking appliances

iv) Laundry containing drying equipment

5 Cable Installation

5.1 General Considerations

5.1.1 Continuity of Cabling

Electric cables are to be installed in continuous lengths between terminations at equipment or in cable junction boxes. See 4-3-3/5.33. However, approved splices will be permitted at interfaces of new construction modules, when necessary to extend existing circuits for a drilling unit undergoing repair or alteration, and in certain cases to provide for cables of exceptional length (See 4-3-3/5.29).

5.1.2 Choice of Cables

The rated operating temperature of the insulating material is to be at least 10°C (18°F) higher than the maximum ambient temperature likely to exist, or to be produced, in the space where the cable is installed.

5.1.3 Cable Voltage Drop for New Installation

The cross-sectional area of conductors are to be so determined that the drop in voltage from the main or emergency switchboard bus-bars to any and every point of the installation when the conductors are carrying the maximum current under normal steady conditions of service, will not exceed 6% of the nominal voltage. For supplies from batteries with a voltage not exceeding 55 V, this figure may be increased to 10%.

The above values are applicable under normal steady conditions. Under special conditions of short duration, such as motor starting, higher voltage drops may be accepted, provided the installation is capable of withstanding the effects of these higher voltage drops.

5.1.4 Restricted Location of Cabling

Cables and wiring are to be installed and supported in such a manner as to avoid chafing or other damage. Cables are to be located with a view to avoiding, as far as practicable, spaces where excessive heat and gases may be encountered; also, spaces where they may be exposed to damage, such as exposed sides of deckhouses. Cables are not to be installed in the bilge area unless protected from bilge water.

5.1.5 Means of Drainage from Cable Enclosures

Where cables are installed in a cable draw box and horizontal pipes or the equivalent is used for cable protection, means of drainage are to be provided.

5.1.6 High Voltage Cables

Cables serving systems above 1 kV are not to be bunched with cables serving systems of 1 kV and below.

5.1.7 Paint on Cables *(2006)*

Where paint or any other coating is systematically and intentionally applied on the electric cables, it is to be established that the mechanical and fire performance properties of the cable are not adversely affected.

In this regard:

i) Fire retardant property is to be confirmed to be in compliance with 4-3-4/13.1.2.

ii) It is to be confirmed that the paint and the solvent used will not cause damages to the cable sheath (e.g., cracking).

Overspray on cables or painted exterior cables are not subject to the requirements of this section.

5.1.8 Cable Installation above High Voltage Switchgear and Control-Gear *(2006)*

Where a pressure relief flap is provided for high voltage switchgear and high voltage control-gear, the cables are not to be installed near and above this equipment in order to prevent the damage of cables from the flare/flame released from the relief flap upon occurrence of short circuit in this equipment.

5.3 Insulation Resistance for New Installation

Each power and each light circuit is to have an insulation resistance between conductors and between each conductor and earth of not less than the following values.

Up to 5 amperes load	2 megohms
10 amperes load	1 megohm
25 amperes load	400,000 ohms
50 amperes load	250,000 ohms
100 amperes load	100,000 ohms
200 amperes load	50,000 ohms
Over 200 amperes load	25,000 ohms

If the above values are not obtained, any or all appliances connected to the circuit may be disconnected for this test.

5.5 Protection for Electric-magnetic Induction

5.5.1 Multiple Conductor Cables

All phase conductors of alternating-current cables are to be contained within the same sheath in order to avoid overheating due to induction by use of multiple conductor cables.

5.5.2 Single Conductor Cables *(1999)*

AC installations are to be carried out, as far as possible, in twin or multi-conductor cables. However, when it is necessary to use single conductor cables in circuits rated in excess of 20 A, the following arrangements are to be complied with:

5.5.2(a) Cables are supported on non-fragile insulators;

5.5.2(b) There are to be no magnetic materials between cables of a group; and

5.5.2(c) (1999) Where single conductor cables are run in bunches, each group of cables is to comprise 360 electrical degrees. To this end, in three-phase circuits, single conductor cable runs of 30 m (100 ft) or longer and having a cross-sectional area of 185 mm^2 (365,005 circ. Mils) or more are to be transposed throughout the length at intervals not exceeding 15 m (50 ft) in order to equalize to some degree the impedance of the three phase circuits. Alternatively, such cables may be installed in trefoil formation. See 4-3-4/13.1.5 for armor.

5.5.3 Non-shielded Signal Cables

Except for fiber optic cables, non-shielded signal cables for automation and control systems essential for the safe operation of the drilling unit which may be affected by electromagnetic interference are not to be run in the same bunch with power or lighting cables.

5.7 Joints and Sealing

Cables not having a moisture-resistant insulation are to be sealed against the admission of moisture by methods such as taping in combination with insulating compound or sealing devices. Cables are to be installed in such a manner that stresses on the cable are not transmitted to the conductors. Terminations and joints in all conductors are to be so made as to retain the original electrical, flame retarding and, where necessary, fire resisting properties of the cable. Terminal boxes are to be secured in place and the moisture-resistant jacket is to extend through the cable clamp. Enclosures for outlets, switches and similar fittings are to be flame- and moisture-resistant and of adequate mechanical strength and rigidity to protect the contents and to prevent distortion under all likely conditions of service. See also 4-3-3/5.17.1 and 4-3-3/5.29.

5.9 Support and Bending

5.9.1 Support and Fixing *(1999)*

Where cables are fixed by means of clips, saddles or straps, they are to have a surface area so large and shaped such that the cables remain tight without their coverings being damaged. Metal clips may be screwed directly to deck or bulkhead, except on watertight bulkheads.

5.9.1(a) The distances between supports are to be suitably chosen according to the type of cable and the probability of vibration, and are not to exceed 400 mm (16 in.). For a horizontal cable run where the cables are laid on cable supports in the form of tray plates, separate support brackets or hanger ladders, the spacing between the fixing points may be up to 900 mm (36 in.), provided that there are supports with maximum spacing as specified above. This exemption does not apply to cable runs along weather decks when the cable run is arranged so that the cables can be subjected to forces by water washing over the deck.

Note: When designing a cable support system for single-core cables, consideration is also to be given to the effects of electrodynamic forces developing on the occurrence of a short-circuit.

The above-given distances between cable supports are not necessarily adequate for these cables. Further, other recognized standards for cable support and fixing will be considered.

5.9.1(b) The supports and the corresponding accessories are to be robust and are to be of corrosion-resistant material or suitably treated before erection to resist corrosion.

5.9.1(c) Cable clips or straps made from an approved material other than metal (such as polyamide, PVC) may be used.

5.9.1(d) When cables are fixed by means of clips or straps referred to in 4-3-3/5.9.1(c) above and these cables are not laid on top of horizontal cable trays or cable supports, suitable metal cable clips or saddles are to be added at regular distances not exceeding 2 m (6.5 ft) in order to prevent the release of cables during a fire. This also applies to the fixing of nonmetallic conduits or pipes.

Note: Item 4-3-3/5.9.1(e) does not necessarily apply in the case of cable runs with only one or a few cables with small diameters for the connection of a lighting fitting, alarm transducer, etc.

5.9.1(e) (2004) Non-metallic clips, saddles or straps, are to be flame retardant in accordance with IEC Publication 60092-101.

5.9.2 Bending Radius

For bending radius requirements, see 4-3-3/Table 2.

5.9.3 Plastic Cable Trays and Protective Casings *(2004)*

5.9.3(a) Installations (2008). Cable trays and protective casings made of plastic materials are to be supplemented by metallic fixing and straps such that, in the event of a fire, they and the cables affixed are prevented from falling and causing an injury to personnel and/or an obstruction to any escape route. See 4-3-3/5.9.1(d). Cable trays and protective casings made of plastic materials are to be flame retardant (see Appendix 4-8-4A1 of the *Steel Vessel Rules*). Where plastic cable trays and protective casings are used on open deck, they are additionally to be protected against UV light by such as anti-UV coating or equivalent.

Note: "Plastic" means both thermoplastic and thermosetting plastic materials with or without reinforcement, such as PVC and fiber reinforced plastics (FRP). "Protective casing" means a closed cover in the form of a pipe or other closed ducts of non-circular shape.

5.9.3(b) Safe Working Load (2008). The load on the cable trays and protective casings is to be within the Safe Working Load (SWL). The support spacing is to be not greater than the manufacturer's recommendation nor in excess of the spacing at the SWL test (see Appendix 4-8-4A1 of the *Steel Vessel Rules*). In general, the spacing is not to exceed 2 meters.

Note: The selection and spacing of cable tray and protective casing supports are to take into account:

- Dimensions of the cable trays and the protective casings;
- Mechanical and physical properties of their material;
- Mass of the cable trays/protective casings;
- Loads due to weight of cables, external forces, thrust forces and vibrations;
- Maximum accelerations to which the system may be subjected;
- Combination of loads.

5.9.3(c) Cable occupation ratio in protective casing. The sum of the total cross-sectional area of all cables on the basis of their external diameter is not to exceed 40% of the internal cross-sectional area of the protective casing. This does not apply to a single cable in a protective casing.

5.9.3(d) Hazardous areas (2008). Cable trays and protective casings passing through hazardous areas are to be electrically conductive (see Appendix 4-8-4A1 of the *Steel Vessel Rules*).

5.9.3(e) Type Testing (2008). Cable trays and protective casings made of plastic materials are to be type tested in accordance with Appendix 4-8-4A1 of the *Steel Vessel Rules*. Alternate test procedures for impact resistance test, safe working load test, flame retardant test, smoke and toxicity tests and/or resistivity test from an international or national standard may be considered instead of the test specified in Appendix 4-8-4A1 of the *Steel Vessel Rules*. The type test reports are to be submitted for review.

5.11 Cable Run in Bunches

5.11.1 Reduction of Current Rating

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 reduction factor is to be applied to the current rating obtained from 4-3-4/Table 10.

Number of Cables in One Bunch	*Reduction Factor*
One to six	1.00
Seven to twelve	0.85

Bunches of more than twelve cables will be subject to special consideration based on the type and service of the various cables in the bunch.

5.11.2 Clearance and Segregation

A clearance is to be maintained between any two cable bunches of at least the diameter of the largest cable in either bunch. Otherwise, for the purpose of determining the number of cables in the bunch, the total number of cables on both sides of the clearance will be used.

5.11.3 Cable of Lower Conductor Temperature

The current rating of each cable in a bunch is to be determined based on the lowest conductor temperature rating of any cable in the bunch.

5.13 Deck and Bulkhead Penetrations

Where cables pass through watertight, firetight or smoke-tight bulkheads or decks, the penetrations are to 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. Additionally, each such stuffing tube, transit device or pourable material is to be of a character so as not to damage the cable physically or through chemical action or through heat build-up. When cables pass through non-watertight bulkheads where the bearing surface is less than 6.4 mm (0.25 in.), the holes are to be fitted with bushings having rounded edges and a bearing surface for the cable of at least 6.4 mm (0.25 in.) in length. Where cables pass through deck beams or similar structural parts, all burrs are to be removed in way of the holes and care is to be taken to eliminate sharp edges. Where cable conduit pipe or equivalent is carried through decks or bulkheads, arrangements are to be made to maintain the integrity of the water or gas tightness of the structure. Cables are not to pass through a collision bulkhead.

5.15 Mechanical Protection

5.15.1 Metallic Armor

Electric cables installed in locations liable to damage during normal operation of the drilling unit are to be provided with braided metallic armor and otherwise suitably protected from mechanical injury as appropriate for the location.

5.15.2 Conduit Pipe or Structural Shapes

Where cables are installed in locations in way of hatches, tank tops, open decks subject to seas, and where passing through decks, they are to be protected by substantial metal shields, structural shapes, pipe or other equivalent means. All such coverings are to be of sufficient strength to provide effective protection to the cables. When expansion bends are fitted, they are to be accessible for maintenance. Where cables are installed in metal piping or in a metal conduit system, such piping and systems are to be earthed and are to be mechanically and electrically continuous across all joints.

5.17 Emergency and Essential Feeders

5.17.1 Location *(2008)*

As far as practicable, cables and wiring for emergency and essential services, including those listed in 4-3-3/3.29, are not to pass through high fire risk areas (see 4-3-3/3.31).

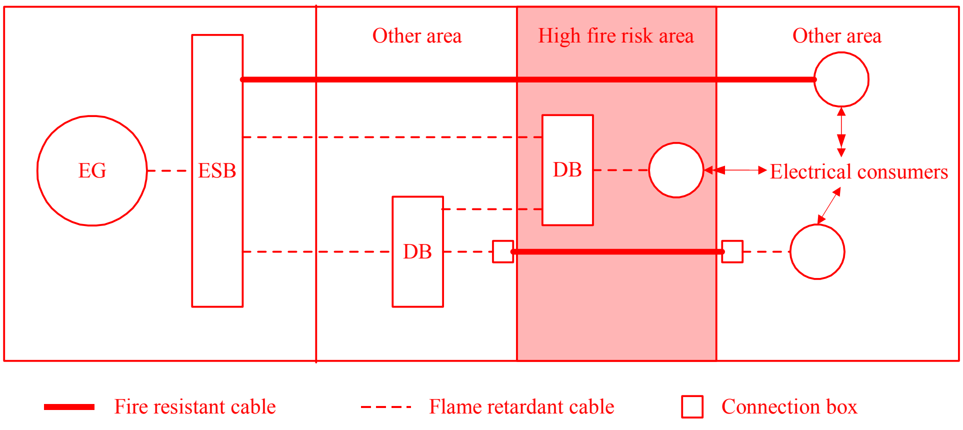
These cables and wiring are also to be run in such a manner as to preclude their being rendered unserviceable by heating of the bulkheads that may be caused by a fire in an adjacent space.

5.17.2 Services Necessary Under a Fire Condition *(2008)*

Where cables for services required to be operable under a fire condition (see 4-3-3/3.29) including their power supplies pass through high fire risk areas (see 4-3-3/3.31) other than those which they serve, they are to be so arranged that a fire in any of these areas does not affect the operation of the service in any other area. This may be achieved by any of the following measures:

5.17.2(a) Fire resistant cables in accordance with 4-3-4/13.1.3 are installed and run continuous to keep the fire integrity within the high fire risk area. See 4-3-3/Figure 2.

FIGURE 2
Cables within High Fire Risk Areas *(2008)*



5.17.2(b) At least two loops/radial distributions run as widely apart as is practicable and so arranged that in the event of damage by fire at least one of the loops/radial distributions remains operational.

5.17.2(c) Cables used in systems that are self monitoring, fail safe or duplicated with cable runs separated as widely as practicable, may be exempted.

5.17.3 Requirements by the Governmental Authority

Attention is directed to the requirements of the governmental authority of the country whose flag the drilling unit flies, for the installation of emergency circuits required in various types of drilling units.

5.19 Mineral Insulated Cables

At all points where mineral-insulated, metal-sheathed cable terminates, an approved seal is to be provided immediately after stripping to prevent entrance of moisture into the mineral insulation. In addition, the conductors extending beyond the sheath are to be insulated with an approved insulating material. When mineral-insulated cable is connected to boxes or equipment, the fittings are to be approved for the conditions of service. The connections are to be in accordance with the manufacturer's installation recommendation.

5.21 Fiber Optic Cables

The installation of fiber optic cables is to be in accordance with the manufacturer's recommendations to prevent sharp bends where the fiber optic cables enter the equipment enclosure. Consideration is to be given to the use of angled stuffing tubes. The cables are to be installed so as to avoid abrading, crushing, twisting, kinking or pulling around sharp edges.

5.23 Battery Room

Where cables enter battery rooms, the holes are to be bushed as required for watertight bulkheads in 4-3-3/5.13. All connections within battery rooms are to be resistant to the electrolyte. Cables are to be sealed to resist the entrance of electrolyte by spray or creepage. The size of the connecting cable is to be based on current-carrying capacities given in 4-3-4/Table 10 and the starting rate of charge or maximum discharge rate, whichever is the greater, is to be taken into consideration in determining the cable size.

5.25 Paneling and Dome Fixtures

Cables may be installed behind paneling, provided all connections are accessible and the location of concealed connection boxes is indicated. Where a cable strip molding is used for cable installation on the incombustible paneling, it is to be of incombustible material. Dome fixtures are to be installed so that they are vented or they are to be fitted with fire-resistant material in such a manner as to protect the insulated wiring leading to the lamps and any exposed woodwork from excessive temperature.

5.27 Sheathing and Structural Insulation

Cables may be installed behind sheathing, but they are not to be installed behind nor imbedded in structural insulation. They are to pass through such insulation at right angles and are to be protected by a continuous pipe with a stuffing tube at one end. For deck penetrations, this stuffing tube is to be at the upper end of the pipe and for bulkhead penetrations, it is to be on the uninsulated side of the bulkhead. For refrigerated-space insulation, the pipe is to be of phenolic or similar heat-insulating material joined to the bulkhead stuffing tube, or a section of such material is to be inserted between the bulkhead stuffing tube and the metallic pipe.

5.29 Splicing of Electrical Cables

5.29.1 Basis of Approval

Replacement insulation is to be fire resistant and is to be equivalent in electrical and thermal properties to the original insulation. The replacement jacket is to be at least equivalent to the original impervious sheath and is to assure a watertight splice. Splices are to be made using an approved splice kit which contains the following:

- Connector of correct size and number
- Replacement insulation
- Replacement jacket
- Instructions for use

In addition, prior to approval of a splicing kit, it will be required that completed splices be tested for fire resistance, watertightness, dielectric strength, etc. to the satisfaction of the Surveyor. This requirement may be modified for splice kits which have had such tests conducted and reported on by an independent agency acceptable to the Bureau.

5.29.2 Installation

All splices are to be made after the cable is in place and are to be accessible for inspection. The conductor splice is to be made using a pressure type butt connector by use of a one-cycle compression tool. See 4-3-3/9.1.3 for splices in hazardous area.

5.29.3 Protection

Splices may be located in protected enclosures or in open wireways. Armored cables having splices will not be required to have the armor replaced, provided that the remaining armor has been earthed in compliance with 4-3-3/7.9 or provided the armor is made electrically continuous. Splices are to be so located such that stresses (as from the weight of the cable) are not carried by the splice.

5.31 Splicing of Fiber Optic Cables

Splicing of fiber optic cables is to be made by means of approved mechanical or fusion methods.

5.33 Cable Junction Box

Except for propulsion cables, junction boxes may be used in the installation of electric cables aboard the drilling unit, provided the plans required by 4-3-3/1.3 for junction boxes are submitted and the following requirements are complied with:

5.33.1

The design and construction of the junction boxes are to comply with 4-3-4/11.7, as well as 4-3-3/5.33ii). below.

5.33.2

The junction boxes are to be suitable for the environment in which they are installed (i.e., explosion-proof in hazardous areas, watertight or weathertight on deck, etc.).

5.33.3 *(1998)*

Separate* junction boxes are to be used for feeders and circuits of each of the following rated voltage levels:

* A physical barrier may be used in lieu of two separate junction boxes for circuits having rated voltage levels corresponding to those in either 4-3-3/5.33.3(a) or 4-3-3/5.33.3(b).

5.33.3(a) Rated voltage levels not exceeding those specified in 4-3-3/7.1i)

5.33.3(b) Rated voltage levels exceeding those in 4-3-3/5.33.3(a), up to and including 1 kV. A physical barrier is to be used within the junction box to separate distribution systems of different rated voltages, such as 480 V, 600 V and 750 V.

5.33.3(c) Rated voltage levels exceeding 1 kV. Separate junction boxes are to be used for each of the rated voltage levels exceeding 1 kV.

Each junction box and the compartment in the junction box separated by a physical barrier are to be appropriately identified as regards the rated voltage of the feeders and circuits it contains.

5.33.4

The junction boxes for emergency feeders and circuits are to be separate from those used for normal drilling unit main service feeders and circuits.

5.33.5

Cables are to be supported, as necessary, within junction boxes so as not to put stress (as from the weight of the cable) on the cable contact mountings. The connections are to be provided with locking type connections.

In addition to the above, the applicable requirements in 4-3-3/5 and 4-3-4/13 regarding cable installation and application details are to be complied with.

7 Earthing

7.1 General

Exposed metal parts of electrical machines or equipment which are not intended to be live but which are liable under fault conditions to become live are to be earthed unless the machines or equipment are:

i) *(1998)* Supplied at a voltage not exceeding 50 volts DC or 50 volts AC r.m.s. between conductors; auto-transformers are not to be used for the purpose of achieving this voltage; or

ii) Supplied at a voltage not exceeding 250 V AC r.m.s. By safety isolating transformers supplying only one consuming device; or

iii) Constructed in accordance with the principle of double insulation.

7.3 Permanent Equipment

The metal frames or cases of all permanently installed generators, motors, controllers, instruments and similar equipment are to be permanently earthed through a metallic contact with the drilling unit's structure. Alternatively, they are to be connected to the hull by a separate conductor in accordance with 4-3-3/7.5. Where outlets, switches and similar fittings are of nonmetallic construction, all exposed metal parts are to be earthed.

7.5 Connections

7.5.1 General

All earthing conductors are to be of copper or other corrosion-resistant material and are to be protected against damage. The nominal cross-sectional area of every copper earthing conductor is to be not less than that required by 4-3-3/Table 3.

7.5.2 Earthed Distribution System

Earthing conductors in an earthed distribution system are to comply with 4-3-3/7.5.1, except that the earthing conductor in line C4 of 4-3-3/Table 3 is to be $A/2$.

7.5.3 Connection to Hull Structure.

All connections of an earth-continuity conductor or earthing lead to the drilling unit's structure are to be made in accessible positions and are to be secured by a screw of brass or other corrosion-resistant material having a cross-sectional area equivalent to the earth-continuity conductor or earthing lead, but not less than 4 mm (0.16 in.) in diameter. The earth connection screw is to be used for this purpose only. See 4-2-1/9.27 for control of static electricity.

7.7 Portable Cords *(1998)*

Receptacle outlets operating at 50 volts DC or 50 volts AC r.m.s. or more are to have an earthing pole.

7.9 Cable Metallic Covering

All metal sheaths, armor of cable and mineral-insulated, metal-sheathed cable are to be electrically continuous and are to be earthed to the metal hull at each end of the run, except that final subcircuits may be earthed at the supply end only. All metallic coverings of power and lighting cables passing through hazardous area or connected to equipment in such an area are to be earthed at least at each end.

9 Equipment and Installation in Hazardous Area

9.1 General Consideration

9.1.1 General *(2006)*

Electrical equipment and wiring are not to be installed in a hazardous area unless essential for operational purposes. Hazardous areas are defined in Section 4-3-6. For certified safe-type equipment, see 4-3-3/9.3.

Fans used for the ventilation of the hazardous areas are to be of non-sparking construction in accordance with 4-6-3/11.7.

9.1.2 Electrical Equipment

The following equipment and cables are acceptable for installation in hazardous locations:

9.1.2(a) Zone 0 Areas. Only certified intrinsically-safe circuits or equipment and associated wiring are permitted in Zone 0 areas.

9.1.2(b) Zone 1 Areas. Equipment and cables permitted in Zone 1 areas are to be:

i) Certified intrinsically-safe circuits or equipment and associated wiring

ii) Certified flameproof (explosion proof) equipment

iii) Certified increased safety equipment; for increased safety motors, consideration is to be given to the protection against overcurrent

iv) Pressurized enclosure type equipment (see 4-3-3/9.3.3).

v) Permanently installed cables with:

- metallic armor, or
- of mineral-insulated, metallic-sheathed type, or
- installed in metallic conduit with explosion-proof gas-tight fittings, or

vi) Flexible cables, where necessary, provided they are of heavy duty type.

9.1.2(c) Zone 2 Areas. Equipment and cables permitted in Zone 2 areas are to be:

i) All equipment approved for Zone 1 areas

ii) The following equipment, provided the operating temperature does not exceed 315°C (600°F) and provided any brushes, switching mechanisms or similar arc-producing devices are approved for Zone 1 areas:

iii) Enclosed squirrel-cage induction motors

iv) Fixed lighting fixtures protected from mechanical damage *v)* Transformers, solenoids or impedance coils in general purpose enclosures

vi) Cables with moisture-resistant jacket (impervious-sheathed) and protected from mechanical damage.

9.1.3 Cables Installation *(2006)*

Cables in hazardous areas are to be armored or mineral-insulated metal-sheathed where required by 4-3-3/9.1.2, except for cables of intrinsically safe circuits subject to the requirements of 4-3-3/5.15. Where cables pass through hazardous area boundaries, they are to be run through gastight fittings. No splices are allowed in hazardous areas, except in intrinsically-safe circuits. Where it is necessary to join cables in hazardous areas (e.g., flexible cable connections to non-flexible cables), the joints are to be made in approved junction boxes.

9.1.4 Lighting Circuits *(2002)*

All switches and protective devices for lighting fixtures in hazardous areas are to interrupt all poles or phases and are to be located in a non-hazardous area. However, a switch may be located in a hazardous area if the switch is of a certified-safe type for the hazardous location in which it is to be installed. On solidly grounded distribution systems, the switches need not open the grounded conductor. The switches and protective devices for lighting fixtures are to be suitably labeled for identification purposes.

9.1.5 Permanent Warning Plates

Permanent warning plates are to be installed in the vicinity of hazardous areas in which electrical equipment is installed, such as pump room, to advise personnel carrying out maintenance, repair or surveys of availability of the booklet/list of equipment in hazardous areas referenced in 4-3-3/1.5, if required for their use.

9.3 Certified-safe Type and Pressurized Equipment and Systems

9.3.1 Installation Approval

Electrical equipment in hazardous areas is to be of a type suitable for such locations. Where permitted by the Rules, electrical equipment of certified-safe type will be approved for installation, provided such equipment has been type-tested and certified by a competent independent testing laboratory as suitable for hazardous areas and provided that there is no departure in the production equipment from the design so tested and approved.

9.3.2 Intrinsically-safe System

9.3.2(a) Separation. Intrinsically-safe systems are to be completely separated and independent of all other electric systems. Intrinsically-safe cables are to have shielded conductors or to be installed a minimum of 50 mm (2 in.) from other electric cables and are not to occupy an enclosure (such as a junction box or terminal cabinet) with non-intrinsically-safe circuits.

9.3.2(b) Physical Barrier. When intrinsically-safe components are located by necessity within enclosures that contain non-intrinsically-safe systems, such as control consoles and motor starters, such components are to be effectively isolated in a sub-compartment by physical barriers having a cover or panel secured by bolts, locks, allen screws or other approved methods. The physical barrier is not intended to apply to the source of power for the intrinsically-safe circuit interface.

9.3.2(c) Nameplate. The sub-compartment is to have an identifying nameplate indicating that the equipment within is intrinsically safe and that unauthorized modification or repairs are prohibited.

9.3.2(d) Replacement. Unless specifically approved, replacement equipment for intrinsically-safe circuits is to be identical to the original equipment.

9.3.3 Pressurized Equipment *(1997)*

Pressurized equipment is to consist of separately ventilated enclosures supplied with positive-pressure ventilation from a closed-loop system or from a source outside of the hazardous areas, and provision is to be made such that the equipment cannot be energized until the enclosure has been purged with a minimum of ten air changes and required pressure is obtained. Ventilating pipes are to have a minimum wall thickness of 3 mm (0.12 in. or 11 gauge). In the case of loss of pressurization, power is to be automatically removed from the equipment, unless this would result in a condition more hazardous than that created by failure to de-energize the equipment. In this case, in lieu of removal of power, an audible and visual alarm is to be provided at a normally manned control station.

Pressurized equipment in compliance with IEC Publication 60079-2, NFPA 496 or other recognized standard will also be acceptable.

9.5 Paint Stores

9.5.1 General

Electrical equipment in paint stores and in ventilation ducts serving such spaces as permitted in 4-3-3/9.1 is to comply with the requirements for group IIB class T3 in IEC Publication 79.

The following type of equipment will be acceptable for such spaces:

i) Intrinsically-safe defined by 4-3-1/3.11

ii) Explosion-proof defined by 4-3-1/3.5

iii) *(1997)* Pressurized defined by 4-3-1/3.23

iv) Increased safety defined by 4-3-1/3.13

v) Other equipment with special protection, recognized as safe for use in explosive gas atmospheres by a national or other appropriate authority

9.5.2 Open Area Near Ventilation Openings

In the areas on open deck within 1 m (3.3 ft) of ventilation inlet or within 1 m (3.3 ft) (if natural) or 3 m (10 ft) (if mechanical) of exhaust outlet, the installation of electrical equipment and cables is to be in accordance with 4-3-3/9.1.

9.5.3 Enclosed Access Spaces

The enclosed spaces giving access to the paint store may be considered as non-hazardous, provided that:

i) The door to the paint store is gastight with self-closing devices without holding back arrangements.

ii) The paint store is provided with an acceptable, independent, natural ventilation system ventilated from a safe area, and

iii) Warning notices are fitted adjacent to the paint store entrance stating that the store contains flammable liquids.

9.7 Non-sparking Fans

9.7.1 Design Criteria

9.7.1(a) Air Gap. The air gap between the impeller and the casing is to be not less than 10% of the shaft diameter in way of the impeller bearing, but not less than 2 mm (0.08 in.). It need not be more than 13 mm (0.5 in.).

9.7.1(b) Protection Screen. Protection screens of not more than 13 mm (0.5 in.) square mesh are to be fitted in the inlet and outlet of ventilation openings on the open deck to prevent the entrance of objects into the fan casing.

9.7.2 Materials

9.7.2(a) Impeller and its Housing. Except as indicated in 4-3-3/9.7.2(c) below, the impeller and the housing in way of the impeller are to be made of alloys which are recognized as being spark proof by appropriate test.

9.7.2(b) Electrostatic Charges. Electrostatic charges both in the rotating body and the casing are to be prevented by the use of antistatic materials. Furthermore, the installation onboard of the ventilation units is to be such as to ensure the safe bonding to the hull of the units themselves.

9.7.2(c) Acceptable Combination of Materials. Tests referred to in 4-3-3/9.7.2(a) above are not required for fans having the following combinations:

i) Impellers and/or housings of nonmetallic material, due regard being paid to the elimination of static electricity;

ii) Impellers and housings of nonferrous materials;

iii) Impellers of aluminum alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness of nonferrous materials is fitted in way of the impeller;

iv) Any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm (0.5 in.) tip design clearance.

9.7.2(d) Unacceptable Combination of Materials. The following impellers and housings are considered as sparking-producing and are not permitted:

i) Impellers of an aluminum alloy or magnesium alloy and a ferrous housing, regardless of tip clearance;

ii) Housing made of an aluminum alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance;

iii) Any combination of ferrous impeller and housing with less than 13 mm (0.5 in.) design tip clearance.

9.7.3 Type Test *(2007)*

Type tests on the finished product are to be carried out using an acceptable national or international standard. Such type test reports are to be made available when requested by the Surveyor.

TABLE 1
Minimum Degree of Protection [See 4-3-3/3.1.1] *(2006)*

Example of Location	*Condition of Location*	*Switchboards, distribution boards, motor control centers & controllers (See 4-3-3/3.9 to 4-3-3/3.13)*	*Generators (See 4-3-3/3.3)*	*Motors (See 4-3-3/3.5)*	*Transformers, Converters*	*Lighting fixtures (See 4-3-3/3.17)*	*Heating appliances (See 4-3-3/3.19)*	*Accessories* (2)
Dry accommodation space	Danger of touching live parts only	IP20	-	IP20	IP20	IP20	IP20	IP20
Dry control rooms (4) *(1999)*		IP20	-	IP20	IP20	IP20	IP20	IP20
Control rooms *(1999)*	Danger of dripping liquid and/or moderate mechanical damage	IP22	-	IP22	IP22	IP22	IP22	IP22
Machinery spaces above floor plates (5)		IP22	IP22	IP22	IP22	IP22	IP22	IP44
Steering gear rooms		IP22	IP22	IP22	IP22	IP22	IP22	IP44
Refrigerating machinery rooms		IP22	-	IP22	IP22	IP22	IP22	IP44
Emergency machinery rooms		IP22	IP22	IP22	IP22	IP22	IP22	IP44
General store rooms		IP22	IP22	IP22	IP22	IP22	IP22	IP22
Pantries		IP22	-	IP22	IP22	IP22	IP22	IP44
Provision rooms		IP22	-	IP22	IP22	IP22	IP22	IP22
Bathrooms & Showers	Increased danger of liquid and/or mechanical damage	-	-	-	-	IP34	IP44	IP55
Machinery spaces below floor plates		-	-	IP44	-	IP34	IP44	IP55 (3)
Closed fuel oil or lubricating oil separator rooms		IP44	-	IP44	-	IP34	IP44	IP55 (3)
Ballast pump rooms	Increased danger of liquid and/or mechanical damage	IP44	-	IP44	IP44	IP34	IP44	IP55
Refrigerated rooms		-	-	IP44	-	IP34	IP44	IP55
Galleys and Laundries		IP44	-	IP44	IP44	IP34	IP44	IP44
Open decks	Exposure to heavy seas	IP56	-	IP56	-	IP55	IP56	IP56
Bilge wells	Exposure to submersion	-	-	-	-	IPX8	-	IPX8

Notes

1 Empty spaces shown with "–" indicate installation of electrical equipment is not recommended.

2 "Accessory" includes switches, detectors, junction boxes, etc. Accessories which are acceptable for use in hazardous areas are limited by the condition of the areas. Specific requirements are given in the Rules. See 4-3-3/3.23.

3 Socket outlets are not to be installed in machinery spaces below the floor plates, enclosed fuel and lubricating oil separator rooms or spaces requiring certified safe type equipment.

4 *(1999)* For the purpose of this Table, the wheelhouse may be categorized as a "dry control room", and consequently, the installation of IP20 equipment would suffice therein, provided that: (a) the equipment is located as to preclude being exposed to steam, or dripping/spraying liquids emanating from pipe flanges, valves, ventilation ducts and outlets, etc., installed in its vicinity, and (b) the equipment is placed to preclude the possibility of being exposed to sea or rain.

5 *(2006)* See 4-3-3/3.1.1(b) where the equipment is located within areas protected by local fixed pressure waterspraying or water-mist fire extinguishing system and its adjacent areas.

TABLE 2
Minimum Bending Radii of Cables [See 4-3-3/5.9.2] *(1999)*

Cable construction		*Over all diameter, D*	*Minimum internal bending radius*
Insulation	*Outer covering*		
Thermoplastic or thermosetting with circular copper conductor	Unarmored or unbraided	$D \leq 25$ mm (1 in.)	4*D*
		$D > 25$ mm	6*D*
	Metal braid screened or armored	Any	6*D*
	Metal wire or metal-tape armored or metal-sheathed	Any	6*D*
	Composite polyester/metal laminate tape screened units or collective tape screening	Any	8*D*
Thermoplastic or thermosetting with shaped copper conductor	Any	Any	8*D*
Mineral	Hard metal-sheathed	Any	6*D*

TABLE 3
Size of Earth-continuity Conductors and Earthing Connections [See 4-3-3/7.5] *(2003)*

Type of Earthing Connection		*Cross-sectional Area, A, of Associated Current Carrying Conductor*	*Minimum Cross-sectional Area of Copper Earthing Connection*
Earth-continuity conductor in flexible cable or flexible cord	A1	$A \leq 16$ mm^2	A
	A2	16 mm^2 $< A \leq 32$ mm^2	16 mm^2
	A3	$A > 32$ mm^2	$A/2$
Earth-continuity conductor incorporated in fixed cable	For cables having an insulated earth-continuity conductor		
	B1a	$A \leq 1.5$ mm^2	1.5 mm^2
	B1b	1.5 mm^2 $< A \leq 16$ mm^2	A
	B1c	16 mm^2 $< A \leq 32$ mm^2	16 mm^2
	B1d	$A > 32$ mm^2	$A/2$
	For cables with bare earth wire in direct contact with the lead sheath		
	B2a	$A \leq 2.5$ mm^2	1 mm^2
	B2b	2.5 mm^2 $< A \leq 6$ mm^2	1.5 mm^2
Separate fixed earthing conductor	C1a	$A \leq 3$ mm^2	Stranded earthing connection: 1.5 mm^2 for $A \leq 1.5$ mm^2; A for $A > 1.5$ mm^2
	C1b		Unstranded earthing connection: 3 mm^2
	C2	3 mm^2 $< A \leq 6$ mm^2	3 mm^2
	C3	6 mm^2 $< A \leq 125$ mm^2	$A/2$
	C4	$A > 125$ mm^2	64 mm^2 (see Note (1))

Notes:

1 For earthed distribution systems, the size of earthing conductor is not to be less than $A/2$.

2 Conversion Table for mm^2 to circular mils:

mm^2	*circ. mils*		*mm^2*	*circ. mils*		*mm^2*	*circ. mils*		*mm^2*	*circ. mils*
1	1,973		2.5	4,933		6	11,841		70	138,147
1.5	2,960		4	7,894		16	31,576		120	236,823

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PART

4

CHAPTER 3 Electrical Installations

SECTION 4 Machinery and Equipment

1 Plans and Data to Be Submitted

1.1 Generators and Motors of 100 kW and Over

Drawings showing assembly, seating arrangements, terminal arrangements, shafts, coupling, coupling bolts, stator and rotor details are to be submitted for review together with data for complete rating, class of insulation, designed ambient temperature, temperature rise, weights and speeds for rotating parts. Plans to be submitted for generator prime movers are given in 4-2-4/1.5, 4-2-1/1.9 and 4-2-1/Appendix 1 of the *Steel Vessel Rules*, as applicable. See also 4-1-1/3 and Section 4-1-2 of these Rules.

1.3 Generators and Motors Below 100 kW

Complete rating, class of insulation and degree of enclosure.

1.5 Switchboards, Distribution Boards, etc. for Essential or Emergency Services

For switchboards, distribution boards, battery chargers, motor control centers, controllers for essential services or emergency services, drawings showing arrangements and details, front view, and installation arrangements are to be submitted for review together with data for protective device rating and setting, type of internal wiring, and size and rated current carrying capacity (together with short-circuit current data) of bus bars and internal wiring for power circuit. In addition, a schematic or logic diagram with a written description giving the sequence of events and system operating procedures for electrical power supply management on switchboards, and sequential or automatic changeover of the motors are also to be submitted for review. For equipment intended solely for drilling operations, see 4-1-1/3.

3 Rotating Machines

3.1 General

3.1.1 Applications

All rotating electrical machines of 100 kW and over are to be constructed and tested in accordance with the following requirements to the satisfaction of the Surveyor. All rotating electrical machines below 100 kW are to be constructed and equipped in accordance with good commercial practice, and will be accepted, subject to a satisfactory performance test conducted to the satisfaction of the Surveyor after installation. For rotating machines intended solely for drilling operations, see 4-1-1/3 and Section 4-1-2.

3.1.2 Certification on Basis of an Approved Quality Assurance Program

See 4-1-1/5.

3.1.3 References

3.1.3(a) Inclination. For the requirements covering inclination for design condition, see 4-1-1/7.

3.1.3(b) Insulation Material. For the requirements covering insulation material, see 4-3-1/13.

3.1.3(c) Capacity of Generators. For requirements covering main generator capacity, see 4-3-2/3.1.2 and 4-3-2/3.5. For requirements covering emergency generator capacity, see 4-3-2/5.3.

3.1.3(d) Power Supply by Generators. For requirements covering power supply by main or emergency generator, see 4-3-2/3.1 and 4-3-2/5.5.2, respectively.

3.1.3(e) Protection for Generator Circuits. For requirements covering protection for generator, see 4-3-2/9.3, 4-3-2/9.5 and 4-3-2/9.7.

3.1.3(f) Protection for Motor Circuits. For requirements covering protection for motor branch circuit, see 4-3-2/9.13.

3.1.3(g) Installation. For requirements covering installation, see 4-3-3/3.3 for generators and 4-3-3/3.5 for motors.

3.1.3(h) Protection Enclosures and its Selection. For requirements covering degree of the protection and the selection of equipment, see 4-3-1/15 and 4-3-3/3.1, respectively.

3.3 Testing and Inspection

3.3.1 Applications

3.3.1(a) Machines of 100 kW and Over. With the exception of rotating machines intended solely for drilling operations (see 4-1-2/1), all rotating machines of 100 kW and over are to be tested in accordance with 4-3-4/Table 1 in the presence of and inspected by the Surveyor, preferably at the plant of the manufacturer.

3.3.1(b) Machines Below 100 kW. For machines of less than 100 kW, the tests may be carried out by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from the Bureau.

3.3.2 Special Testing Arrangements

In cases where all of the required tests are not carried out at the plant of the manufacturer, the Surveyor is to be notified and arrangements are to be made so that the remaining tests will be witnessed.

3.5 Insulation Resistance Measurement

The resistance is to be measured before the commencement of the testing and after completion of the testing for all circuits. Circuits or groups of circuits of different voltages above earth are to be tested separately. This test is to be made with at least 500 volts DC, and the insulation resistance in megohms of the circuits while at their operating temperatures is to be normally at least equal to:

$$\frac{\text{Rated Voltage of the Machine}}{(\text{Rating in kVA}/100)+1000}$$

The minimum insulation resistance of the fields of machines separately excited with voltage less than the rated voltage of the machine is to be of the order of one-half to one megohm.

3.7 Overload and Overcurrent Capability *(1997)*

3.7.1 AC Generators *(2003)*

AC generators are to be capable of withstanding a current equal to 1.5 times the rated current for not less than 30 seconds. The test may be performed in conjunction with the short circuit testing, provided the electrical input energy to the machine is not less than that required for the above overload capability.

3.7.2 AC Motors

3.7.2(a) Overcurrent Capacity. (2003) Three-phase motors, except for commutator motors, having rated outputs not exceeding 315 kW and rated voltages not exceeding 1 kV are to be capable of withstanding a current equal to 1.5 times the rated current for not less than two minutes. For three-phase and single phase motors having rated outputs above 315 kW, the overcurrent capacity is to be in accordance with the manufacturer's specification. The test may be performed at a reduced speed.

3.7.2(b) Overload Capacity. Three-phase induction motors are to be capable of withstanding for 15 seconds, without stalling or abrupt change in s`peed, an excess torque of 60% of their rated torque, the voltage and frequency being maintained at their rated values.

3.7.2(c) Overload Capacity for Synchronous Motors. Three-phase synchronous motors are to be capable of withstanding an excess torque, as specified below, for 15 seconds without falling out of synchronism, the excitation being maintained at the value corresponding to the rated load.

Synchronous (wound rotor) induction motors:	35% excess torque
Synchronous (cylindrical rotor) motors:	35% excess torque
Synchronous (salient pole) motors:	50% excess torque

When automatic excitation is used, the limit of torque values is to be the same as with the excitation equipment operating under normal conditions.

3.9 Dielectric Strength of Insulation

3.9.1 Application

The dielectric test voltage is to be successively applied between each electric circuit and all other electric circuits and metal parts earthed and for direct-current (DC) rotating machines between brush rings of opposite polarity. Interconnected polyphase windings are to be considered as one circuit. All windings, except that under test, are to be connected to earth.

3.9.2 Standard Voltage Test *(2003)*

The insulation of all rotating machines is to be tested with the parts completely assembled and not with the individual parts. The dielectric strength of the insulation is to be tested by the continuous application for 60 seconds of an alternating voltage having a frequency of 25 to 60 Hz and voltage in 4-3-4/Table 2. The requirements in 4-3-4/Table 2 apply to those machines other than high voltage systems covered by 4-3-5/1.11.1(f).

3.9.3 Direct Current Test

A standard voltage test using a direct current source equal to 1.7 times the required alternating-current voltage will be acceptable.

3.11 Temperature Ratings

3.11.1 Temperature Rises

3.11.1(a) Continuous Rating Machines. After the machine has been run continuously under a rated load until steady temperature condition has been reached, the temperature rises are not to exceed those given in 4-3-4/Table 3.

3.11.1(b) Short-time Rating Machines. After the machine has been run at a rated load during the rated time, followed by a rest and de-energized period of sufficient duration to re-establish the machine temperatures within 2°C (3.6°F) of the coolant, the temperature rises are not to exceed those given in 4-3-4/Table 3. At the beginning of the temperature measurement, the temperature of the machine is to be within 5°C (8°F) of the temperature of the coolant.

3.11.1(c) Periodic Duty Rating Machines. The machine has been run at a rated load for the designed load cycle to be applied and continued until obtaining the practically identical temperature cycle. At the middle of the period causing the greatest heating in the last cycle of the operation, the temperature rises are not to exceed those given in 4-3-4/Table 3.

3.11.1(d) Non-periodic Duty Rating Machines. After the machine has been run continuously or intermittently under the designed variations of the load and speed within the permissible operating range until reaching the steady temperature condition, the temperature rises are not to exceed those given in 4-3-4/Table 3.

3.11.1(e) Insulation Material Above 180°C (356°F). Temperature rises for insulation materials above 180°C (356°F) will be considered in accordance with 4-3-1/13.11.

3.11.2 Ambient Temperature *(2007)*

These final temperatures are based on an ambient temperature of 50°C (122°F), for machines located within boiler and engine rooms in accordance with 4-3-1/17. Where provision is made for ensuring the ambient temperature of the space being maintained at 40°C (104°F) or less, as by air cooling or by locating the machine outside of the boiler and engine rooms, the temperature rises of the windings may be 5°C (9°F) higher. The ambient temperature is to be taken in at least two places within 1.83 m (6 ft) of the machine under test and by thermometers having their bulbs immersed in oil contained in an open cup.

3.13 Construction and Assemblies

3.13.1 Enclosure, Frame and Pedestals

Magnet frames and pedestals may be separate but are to be secured to a common foundation.

3.13.2 Shafts and Couplings

Rotating shaft, hollow shaft and coupling flange with bolts are to comply with 4-2-4/5.3, 4-3-2/5.3 and 4-3-5/5.7.3 of the *Steel Vessel Rules*. Plans to be submitted are given in 4-2-4/1.5 and 4-2-1/1.9 of the *Steel Vessel Rules*.

3.13.3 Circulating Currents

Means are to be provided to prevent circulating currents from passing between the journals and the bearings where the design and arrangement of the machine is such that damaging current may be expected. Where such protection is required, a warning plate is to be provided in a visible place cautioning against the removal of such protection.

3.13.4 Rotating Exciters

Rotating exciters are to conform to all applicable requirements for generators.

3.13.5 Insulation of Windings

Armature and field coils are to be treated to resist oil and water.

3.13.6 Protection Against Cooling Water

Where water cooling is used, the cooler is to be so arranged to avoid entry of water into the machine, whether through leakage or from condensation in the heat exchanger.

3.13.7 Moisture-condensation Prevention

When the weight of the rotating machine, excluding the shaft, is over 455 kg (1000 lb), it is to be provided with means to prevent moisture condensation in the machine when idle. Where steam-heating coils are installed for this purpose, there are to be no pipe joints inside of the casings. See item 7 in 4-3-4/Table 7 for space heater pilot lamp for alternating-current generators.

3.13.8 Terminal Arrangements

Terminals are to be provided at an accessible position and protected against mechanical damage and accidental contact for earthing, short-circuit or touching. Terminal leads are to be secured to the frame and the designation of each terminal lead are to be clearly marked. The ends of terminal leads are to be fitted with connectors. Cable glands or similar are to be provided where cable penetrations may compromise the protection property of terminal enclosures.

3.13.9 Nameplates

Nameplates of corrosion-resistant material are to be provided in an accessible position of the machine and are to indicate at least the information as listed in 4-3-4/Table 4.

3.15 Lubrication

Rotating machines are to have continuous lubrication at all running speeds and all normal working bearing temperatures, with the unit's inclinations specified in 4-1-1/7. Unless otherwise approved, where forced lubrication is employed, the machines are to be provided with means to shut down their prime movers automatically upon failure of the lubricating system. Each self-lubricating sleeve bearing is to be fitted with an inspection lid and means for visual indication of oil level or an oil gauge.

3.17 Turbines for Generators

Gas-turbine prime mover driving generators are to meet the applicable requirements in Section 4-2-3 of the *Steel Vessel Rules s* and in addition are to comply with the following requirements. For rotating machines intended solely for drilling operations, see 4-1-1/3 and Section 4-1-2 of these Rules.

3.17.1 Operating Governor *(2004)*

An effective operating governor is to be fitted on prime movers driving main or emergency electric generators and is to be capable of automatically maintaining speed within the following limits. Special consideration will be given when an installation requires different characteristics.

3.17.1(a) Transient Frequency Variations. The transient frequency variations in the electrical network, when running at the indicated loads below, are to be within ±10% of the rated frequency when:

i) Running at full load (equal to rated output) of the generator and the maximum electrical step load is suddenly thrown off:

In the case when a step load equivalent to the rated output of a generator is thrown off, a transient frequency variation in excess of 10% of the rated frequency may be acceptable, provided the overspeed protective device fitted in addition to the governor, as required by 4-3-4/3.17.2, is not activated.

ii) Running at no load and 50% of the full load of the generator is suddenly thrown on followed by the remaining 50% load after an interval sufficient to restore the frequency to steady state.

In all instances, the frequency is to return to within ±1% of the final steady state condition in no more than five seconds.

3.17.1(b) Frequency Variations in Steady State. The permanent frequency variation is to be within ±5% of the rated frequency at any load between no load and full load.

3.17.1(c) Emergency Generator Prime Movers. For gas turbines driving emergency generators, the requirements of 4-3-4/3.17.1(a) and 4-3-4/3.17.1(b) are to be met. However, for the purpose of 4-3-4/3.17.1(a)ii), where the sum of all loads that can be automatically connected is larger than 50% of the full load of the emergency generator, the sum of these loads is to be used as the first applied load.

3.17.2 Overspeed Governor

In addition to the normal operating governor, an overspeed governor is to be fitted which will trip the turbine throttle when the rated speed is exceeded by more than 15%. Provision is to be made for hand tripping. See 4-3-4/3.15 for pressure-lubricated machines.

3.17.3 Power Output of Gas Turbines

To satisfy the requirements of 4-3-2/3.1, the required power output of gas turbine prime movers for drilling unit main service generator sets is to be based on the maximum expected inlet air temperature.

3.19 Diesel Engines for Generators

Diesel-engine prime movers are to meet the applicable requirements in Section 4-2-1 of the *Steel Vessel Rules* and, in addition, are to comply with the following requirements. For rotating machines intended solely for drilling operations, see 4-1-1/3 and Section 4-1-2 of these Rules.

3.19.1 Operating Governor *(2004)*

An effective operating governor is to be fitted on prime movers driving main or emergency electric generators and is to be capable of automatically maintaining the speed within the following limits. Special consideration will be given when an installation requires different characteristics.

3.19.1(a) Transient Frequency Variations. The transient frequency variations in the electrical network, when running at the indicated loads below, are to be within ±10% of the rated frequency when:

i) Running at full load (equal to rated output) of the generator and the maximum electrical step load is suddenly thrown off,

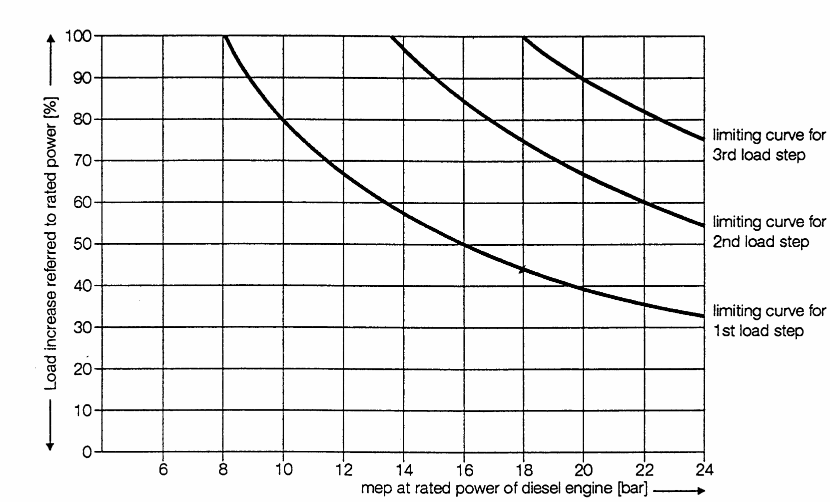
In the case when a step load equivalent to the rated output of a generator is thrown off, a transient frequency variation in excess of 10% of the rated frequency may be acceptable, provided the overspeed protective device, fitted in addition to the governor, as required by 4-3-4/3.19.2, is not activated.

ii) Running at no load and 50% of the full load of the generator is suddenly thrown on followed by the remaining 50% load after an interval sufficient to restore the frequency to steady state.

In all instances, the frequency is to return to within ±1% of the final steady state condition in no more than five seconds.

iii) Where the electrical power system is fitted with a power management system and sequential starting arrangements, the application of loads in multiple steps of less than 50% of rated load in 4-3-4/3.19.1(a)ii) above may be permitted, provided it is in accordance with 4-3-4/Figure 1. The details of the power management system and sequential starting arrangements are to be submitted and its satisfactory operation is to be demonstrated to the Surveyor.

FIGURE 1
Limiting Curves for Loading 4-stroke Diesel Engines Step-by-step from No-load to Rated Power as Function of the Brake Mean Effective Pressure



3.19.1(b) Frequency Variations in Steady State. The permanent frequency variation is to be within ±5% of the rated frequency at all loads between no load and full load.

3.19.1(c) Emergency Generator Prime Movers. For prime movers driving emergency generators, the requirements of 4-3-4/3.19.1(a) and 4-3-4/3.19.1(b) above are to be met. However, for the purpose of 4-3-4/3.19.1(a)ii), where the sum of all loads that can be automatically connected is larger than 50% of the full load of the emergency generator, the sum of these loads is to be used as the first applied load.

3.19.2 Overspeed Governor

In addition to the normal operating governor, each auxiliary diesel engine having a maximum continuous output of 220 kW and over is to be fitted with a separate overspeed device so adjusted that the speed cannot exceed the maximum rated speed by more than 15%. Provision is to be made for hand tripping. See 4-3-4/3.15 for pressure-lubricated machines.

3.21 Alternating-current (AC) Generators *(1997)*

3.21.1 Control and Excitation of Generators

Excitation current for generators is to be provided by attached rotating exciters or by static exciters deriving their source of power from the machine being excited.

3.21.2 Voltage Regulation

3.21.2(a) Voltage Regulators. A separate regulator is to be supplied for each AC generator. When it is intended that two or more generators will be operated in parallel, reactive-droop compensating means are to be provided to divide the reactive power properly between the generators.

3.21.2(b) Variation from Rated Voltage - Steady Conditions. Each AC generator for drilling unit main service driven by its prime mover having governor characteristics complying with 4-3-4/3.17.1 or 4-3-4/3.19.1 is to be provided with an excitation system capable of maintaining the voltage under steady conditions within plus or minus 2.5% of the rated voltage for all loads between zero and rated load at rated power factor. These limits may be increased to plus or minus 3.5% for emergency sets.

3.21.2(c) Variation from rated voltage – Transient Conditions. Momentary voltage variations are to be within the range of minus 15% to plus 20% of the rated voltage, and the voltage is to be restored to within plus or minus 3% of the rated voltage in not more than 1.5 seconds when:

- A load equal to the starting current of the largest motor or a group of motors, but in any case, at least 60% of the rated current of the generator, and power factor of 0.4 lagging or less, is suddenly thrown on with the generator running at no load; and
- A load equal to the above is suddenly thrown off.

Consideration can be given to performing the test required by 4-3-4/Table 1, Item 4 according to precise information concerning the maximum values of the sudden loads instead of the values indicated above, provided precise information is available. The precise information concerning the maximum values of the sudden loads is to be based on the power management system arrangements and starting arrangements provided for the electrical system.

3.21.2(d) Short Circuit Conditions. Under steady-state short-circuit conditions, the generator together with its excitation system is to be capable of maintaining a steady-state short-circuit current of not less than three times its rated full load current for a period of two seconds or of such magnitude and duration as required to properly actuate the associated electrical protective devices.

3.21.3 Parallel Operation

For AC generating sets operating in parallel, the following requirements are to be complied with. See also 4-3-2/9.5.2 for protection of AC generators in parallel operation.

3.21.3(a) Reactive Load Sharing. The reactive loads of the individual generating sets are not to differ from their proportionate share of the combined reactive load by more than 10% of the rated reactive output of the largest generator, or 25% of the rated reactive output of the smallest generator, whichever is the less.

3.21.3(b) Load Sharing. For any load between 20% and 100% of the sum of the rated output (aggregate output) of all generators, the load on any generator is not to differ more than 15% of the rated output in kilowatt of the largest generator or 25% of the rated output in kilowatt of the individual generator in question, whichever is the less, from its proportionate share of the combined load for any steady state condition. The starting point for the determination of the foregoing load-distribution requirements is to be at 75% of the aggregate output with each generator carrying its proportionate share.

3.21.3(c) Facilities for Load Adjustment. Facilities are to be provided to adjust the governor sufficiently fine to permit an adjustment of load not exceeding 5% of the aggregate output at normal frequency.

3.21.4 Temperature Detectors

AC generators rated above 500 kW are to be provided with means for obtaining the temperatures of the stationary windings. A minimum of one embedded temperature detector per phase is to be provided for this purpose on the hot end of the machine. The temperatures are to be indicated in an accessible position, preferably the generator control panel. See item 14 in 4-3-4/Table 7 for the temperature indicators for AC generators.

3.23 Direct-current (DC) Generators

3.23.1 Control and Excitation of Generators

3.23.1(a) Field Regulations. Means are to be provided at the switchboard to enable the voltage of each generator to be adjusted separately. This equipment is to be capable of adjusting the voltage of the DC generator to within 0.5% of the rated voltage at all loads between no-load and full-load.

3.23.1(b) Polarity of Series Windings. The series windings of each generator for two wire DC system are to be connected to the negative terminal of each machine.

3.23.1(c) Equalizer Connections. See 4-3-4/7.15.3.

3.23.2 Voltage Regulation

3.23.2(a) Shunt or Stabilized Shunt-wound Generator. When the voltage has been set at full-load to its rated value, the removal of the load is not to cause a permanent increase of the voltage greater than 15% of the rated voltage. When the voltage has been set either at full-load or at no-load, the voltage obtained at any value of the load is not to exceed the no-load voltage.

3.23.2(b) Compound-wound Generator. Compound-wound generators are to be so designed in relation to the governing characteristics of prime mover that with the generator at full-load operating temperature and starting at 20% load with voltage within 1% of rated voltage, it gives at full-load a voltage within 1.5% of rated voltage. The average of ascending and descending voltage regulation curves between 20% load and full-load is not to vary more than 3% from rated voltage.

3.23.2(c) Automatic Voltage Regulators. Drilling unit main service generators which are of the shunt type are to be provided with automatic voltage regulators. However, if the load fluctuation does not interfere with the operation of essential auxiliaries, shunt-wound generators without voltage regulators or stabilized shunt-wound machines may be used. An automatic voltage regulator will not be required for the drilling unit main service generators of approximately flat-compounded type. Automatic voltage regulators are to be provided for all service generators driven by variable speed engines used also for propulsion purposes, whether these generators are of the shunt, stabilized shunt or compound-wound type.

3.23.3 Parallel Operation

For DC generating sets operating in parallel, the following requirements are to be complied with. See also 4-3-2/9.7.2 for protection of DC generators in parallel operation.

3.23.3(a) Stability. The generating sets are to be stable in operation at all loads from no-load to full-load.

3.23.3(b) Load Sharing. For any load between 20% and 100% of the sum of the rated output (aggregate output) of all generators, the load on any generator is not to differ more than 12% of the rated output in kilowatt of the largest generator or 25% of the rated output in kilowatt of the individual generator in question, whichever is the less, from its proportionate share of the combined load for any steady state condition. The starting point for the determination of the foregoing load-distribution requirements is to be at 75% of the aggregate output with each generator carrying its proportionate share.

3.23.3(c) Tripping of Circuit Breaker. DC generators which operate in parallel are to be provided with a switch which will trip the generator circuit breaker upon functioning of the overspeed device.

5 Accumulator Batteries

5.1 General

5.1.1 Application

All accumulator batteries for engine starting, essential or emergency services are to be constructed and installed in accordance with the following requirements. Accumulator batteries for services other than the above are to be constructed and equipped in accordance with good commercial practice. All accumulator batteries will be accepted subject to a satisfactory performance test conducted after installation to the satisfaction of the Surveyor.

5.1.2 Sealed Type Batteries

Where arrangements are made for releasing gas through a relief valve following an overcharge condition, calculations demonstrating compliance with the criteria in 4-3-3/3.7.3 under the expected rate of hydrogen generation are to be submitted together with the details of installation and mechanical ventilation arrangements.

5.1.3 References

5.1.3(a) Emergency Services. For requirements covering emergency services and transitional source of power, see 4-3-2/5.5.3 and 4-3-2/5.7, respectively.

5.1.3(b) Protection of Batteries For requirements covering protection of batteries, see 4-3-2/9.9.

5.1.3(c) Battery Installation. For requirements covering battery installation, ventilation of the battery location and protection from corrosion, see 4-3-3/3.7.

5.1.3(d) Cable Installation. For requirements covering cable installation in the battery room, see 4-3-3/5.23.

5.3 Construction and Assembly

5.3.1 Cells and Filling Plugs

The cells are to be so constructed as to prevent spilling of electrolyte due to an inclination of 40 degrees from normal. The filling plugs are to be so constructed as to prevent spilling of electrolyte due to the unit's movements, such as rolling and pitching.

5.3.2 Crates and Trays

The cells are to be grouped in crates or trays of rigid construction equipped with handles to facilitate handling. For protection from corrosion, see 4-3-3/3.7.4. The mass of crates or trays are not to exceed 100 kg (220.5 lb).

5.3.3 Nameplate

Nameplates of corrosion-resistant material are to be provided in an accessible position of each crate or tray and are to indicate at least the information as listed in 4-3-4/Table 4.

5.5 Engine-starting Battery

Battery systems for engine-starting purposes may be of the one-wire type and the earth lead is to be carried to the engine frame. See also 4-8-2/11.11 of the *Steel Vessel Rules* and 4-3-2/5.15 of this Chapter for main engine starting and the starting arrangement of the emergency generator, respectively.

7 Switchboards, Distribution Boards, Chargers, and Controllers

7.1 General

7.1.1 Applications

Switchboards are to provide adequate control of the generation and distribution of electric power. The following equipment are to be constructed and tested in accordance with the following requirements to the satisfaction of the Surveyor.

- Switchboards and motor controllers for essential and emergency services or for RMC certification,
- Motor control centers whose total connected motor rating is 100 kW or more, regardless of their services, and
- Battery chargers and discharging boards for emergency or transitional source of power.

Switchboard, distribution board, charger, and controllers not covered by the above paragraph are to be constructed and equipped in accordance with good commercial practice, and will be accepted subject to a satisfactory performance test conducted after installation to the satisfaction of the Surveyor.

7.1.2 References

7.1.2(a) Inclination. For requirements covering inclination for design condition, see 4-1-1/7.

7.1.2(b) Emergency Switchboard. For requirements covering emergency switchboard, see 4-3-2/5.9.

7.1.2(c) Circuit Breakers. For requirements covering generator circuit breakers, see 4-3-4/11.1.

7.1.2(d) Feeder Protection. For requirements covering feeder protection, see 4-3-2/9.3 to 4-3-2/9.17, 4-3-2/11.3, 4-3-2/13.1.4 and 4-3-2/13.3.3.

7.1.2(e) Hull Return and Earthed Distribution System. For requirements covering hull return system and earthed distribution system, see 4-3-2/7.3 and 4-3-2/7.5, respectively.

7.1.2(f) Earthing. For requirements covering earthing connections, see 4-3-3/7.

7.1.2(g) Installation. For requirements covering installation, see 4-3-3/3.9 for switchboard, 4-3-3/3.11 for distribution boards, and 4-3-3/3.13 for motor controllers and control centers.

7.1.2(h) Protection Enclosures and its Selection. For requirements covering degree of the protection and the selection of equipment, see 4-3-1/15 and 4-3-3/3.1, respectively.

7.3 Testing and Inspection

7.3.1 Applications

7.3.1(a) For Essential or Emergency Services. All Switchboards and motor controllers intended for essential services or emergency services are to be tested in the presence of and inspected by the Surveyor, preferably at the plant of the manufacturer. For distribution boards, the tests may be carried out by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from the Bureau.

7.3.1(b) For Nonessential or Non-emergency Services. For switchboards, distribution boards and motor controllers of other than essential or emergency services, the tests may be carried out by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from the Bureau.

7.3.1(c) Motor Control Centers. All motor control centers whose total connected motor rating is 100 kW or more, regardless of their services, are to be tested in the presence of and inspected by the Surveyor, preferably at the plant of the manufacturer.

7.3.1(d) Battery Charger Units, Uninterruptible Power System (UPS) Units, and Distribution Boards (2008). Battery charger units of 25 kW and over, uninterruptible power system (UPS) units of 50 KVA and over, and distribution boards [associated with the charging or discharging of the battery system or uninterruptible power system (UPS)] are used for essential services (see 4-3-1/3.3), emergency source of power (see 4-3-2/5), and transitional source of power (see 4-3-2/5.7), are to be tested in the presence of and inspected by the Surveyor, preferably at the plant of the manufacturer. For all other battery charger units, uninterruptible power system (UPS) units, and distribution boards, the tests may be carried out by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from the Bureau.

7.3.1(e) Test Items. Tests are to be carried out in accordance with the requirements in 4-3-4/Table 5.

7.3.2 Special Testing Arrangements

In cases where all of the required tests are not carried out at the plant of the manufacturer, the Surveyor is to be notified and arrangements are to be made so that the remaining tests may be witnessed.

7.5 Insulation Resistance Measurement

The insulation resistance between current-carrying parts (connected together for the purpose of this test) and earth and between current-carrying parts of opposite polarity is to be measured at a DC voltage of not less than 500 volts before and after the dielectric strength tests. The insulation resistance measurement after the dielectric strength tests is to be carried out before components which have been disconnected for the dielectric tests are reconnected, and the insulation resistance is not to be less than 1 megohm.

7.7 Dielectric Strength of Insulation *(1997)*

The dielectric strength of the insulation is to be tested for 60 seconds by an alternating voltage applied in accordance with 4-3-4/Table 5 between:

i) All live parts and the interconnected exposed conductive parts, and

ii) Each phase and all other phases connected for this test to the interconnected exposed conductive parts of the unit.

The test voltage at the moment of application is not to exceed 50% of the values given in 4-3-4/Table 5. It is to be increased steadily within a few seconds to the required test voltage and maintained for 60 seconds. Test voltage is to have a sinusoidal waveform and a frequency between 45 Hz and 60 Hz.

7.7.1 Production-line Apparatus

Standard apparatus produced in large quantities for which the standard test voltage is 2500 volts or less may be tested for one second with a test voltage 20% higher than the one-minute test voltage.

7.7.2 Devices with Low Insulation Strength

Certain devices such as potential transformers having inherently lower insulation strength are to be disconnected during the test.

7.9 Construction and Assembly

7.9.1 Enclosures and Assemblies

Enclosures and assemblies are to be constructed of steel or other suitable, incombustible, moisture-resistant materials and reinforced as necessary to withstand the mechanical, electrical (magnetic) and thermal stresses likely to be encountered in service, and are to be protected against corrosion. No wood is to be used, except for hardwood for nonconducting hand rails. Insulating materials are to be flame-retardant and moisture-resistant. The supporting framework is to be of rigid construction.

7.9.2 Dead Front

The dead-front type is to be used. Live-front type is not acceptable, regardless of the voltage ratings.

7.9.3 Mechanical Strength

All levers, handles, hand wheels, interlocks and their connecting links, shafts and bearings for the operation of switches and contactors are to be of such proportions that they will not be broken or distorted by manual operation.

7.9.4 Mechanical Protection *(2004)*

The sides and the rear and, where necessary, the front of switchboards are to be suitably guarded. Exposed live parts having voltages to earth exceeding a voltage of 55 volts DC or 55 volts AC r.m.s. between conductors are not to be installed on the front of such switchboards. Unless the switchboard is installed on an electrically insulated floor, non-conducting mats or gratings are to be provided at the front and rear of the switchboard. Where the floor on which the switchboard is installed is of electrically insulated construction, the insulation level of the floor to the earth is to be at least 50 MΩ. A notice plate is to be posted at the entrance to the switchboard room or on the switchboard front panel to state that the floor in the room is of electrically insulated construction. Drip covers are to be provided over switchboards when subject to damage by leaks or falling objects.

7.11 Bus Bars, Wiring and Contacts

7.11.1 Design

Copper bar is to be used for main and generator bus in the switchboard. Other materials and combination of materials will be specially considered. Generator bus bars are to be designed on a basis of maximum generator rating. All other bus bars and bus-bar connections are to be designed for at least 75% of the combined full-load rated currents of all apparatus they supply, except that when they supply one unit or any group of units in continuous operation, they are to be designed for full load.

7.11.2 Operating Temperature of Bus Bars

Bus bars are to be proportioned to avoid temperature which will affect the normal operation of electrical devices mounted on the board.

7.11.3 Short Circuit Rating

Circuit breakers and bus bars are to be mounted, braced and located so as to withstand the thermal effects and mechanical forces resulting from the maximum prospective short circuit current. Switchboard instruments, controls, etc., are to be located with respect to circuit breakers so as to minimize the thermal effects due to short circuit currents.

7.11.4 Internal Wiring

Instrument and control wiring is to be of the stranded type and is to have heat-resisting and flame-retarding insulation. Wiring from hinged panels is to be of the extra-flexible type.

7.11.5 Arrangement

7.11.5(a) Accessibility. The arrangement of bus bars and wiring on the back is to be such that all lugs are readily accessible.

7.11.5(b) Locking of Connections (2004). All nuts and connections are to be fitted with locking devices to prevent loosening due to vibration. Bolted bus bar connections are to be suitably treated (e.g., silver plating) to avoid deterioration of electrical conductivity over time.

7.11.5(c) Soldered Connections. Soldered connections are not to be used for connecting or terminating any wire or cable of nominal cross-sectional area of greater than 2.5 mm^2 (4,933 circ. mils). Soldered connections, where used, are to have a solder contact length at least 1.5 times the diameter of the conductor.

7.11.6 Clearances and Creepage Distances

Bare main bus bars, but not including the conductors between the main bus bars and the supply side of outgoing units, are to have minimum clearances (in air) and creepage distances (across surfaces) in accordance with 4-3-4/Table 6.

7.11.7 Terminals

Terminals or terminal rows for systems of different voltage are to be clearly separated from each other and the rated voltage is to be clearly marked. Each terminal is to have a nameplate indicating the circuit designation or circuit number.

7.13 Control and Protective Devices

7.13.1 Circuit-disconnecting Devices

7.13.1(a) Systems Exceeding 55 Volts. Distribution boards, chargers or controllers for distribution to motors, appliances, and lighting or other branch circuits are to be fitted with multipole circuit breakers or a multipole switch-fuse combination in each unearthed conductor.

7.13.1(b) Systems of 55 Volts and Less. For distribution boards, chargers or controllers where voltage to earth or between poles does not exceed 55 volts DC or 55 volts AC r.m.s., the fuses may be provided without switches.

7.13.1(c) Disconnect Device. The rating of the disconnecting device is to be coordinated with the voltage and current requirements of the load. The disconnect device is to indicate by position of the handle, or otherwise, whether it is open or closed.

7.13.2 Arrangement of Equipment

7.13.2(a) Air Circuit Breakers. Air circuit breaker contacts are to be kept at least 305 mm (12 in.) from the drilling unit's structure unless insulation barriers are installed.

7.13.2(b) Voltage Regulators. Voltage regulator elements are to be provided with enclosing cases to protect them from damage.

7.13.2(c) Equipment Operated in High Temperature. Where rheostats or other devices that may operate at high temperatures are mounted on the switchboard, they are to be naturally ventilated and so located or isolated by barriers as to prevent excessive temperature of adjacent devices. When this cannot be accomplished, the rheostat or other device is to be mounted separately from the switchboard.

7.13.2(d) Accessibility to Fuses. All fuses, except for instrument and control circuits, are to be mounted on or be accessible from the front of the switchboard.

7.13.2(e) Protective Device for Instrumentation. All wiring on the boards for instrumentation is to be protected by fuses or current limiting devices. See 4-3-2/9.17.

7.13.2(f) Wearing Parts. All wearing parts are to be accessible for inspection and readily renewable.

7.13.3 Markings

Identification plates are to be provided for each piece of apparatus to indicate clearly its service. Identification plates for feeders and branch circuits are to include the circuit designation and the rating of the fuse or circuit-breaker trip setting required by the circuit.

7.15 Switchboards

In addition to 4-3-4/7.1 to 4-3-4/7.13, as applicable, the switchboards for essential or emergency services are to comply with the following requirements.

7.15.1 Handrails

Insulated handrail or insulated handles are to be provided on the front of the switchboard. Similarly, where access to the rear is required, insulated handrail or insulated handles are also to be fitted on the rear of the switchboard.

7.15.2 Main Bus Bar Subdivision *(1998)*

Where the main source of electrical power is necessary for propulsion of the drilling unit, the main bus bar is to be subdivided into at least two parts which is to be normally connected by circuit breaker or other approved means. As far as practicable, the connection of generating sets and any other duplicated equipment is to be equally divided between the parts.

7.15.3 Equalizer Circuit for Direct-current (DC) Generators

7.15.3(a) Equalizer Main Circuit. The current rating of the equalizer main circuit for direct-current (DC) generators is not to be less than half of the rated full-load current of the generator.

7.15.3(b) Equalizer Bus Bars. The current rating of the equalizer bus bars is not to be less than half of the rated full-load current of the largest generator in the group.

7.15.4 Equipment and Instrumentation *(2005)*

Equipment and instrumentation are to be provided in accordance with 4-3-4/Table 7. They are to be suitable for starting, stopping, synchronizing and paralleling each generator set from the main switchboard. They may be mounted on the centralized control console, if the main switchboard is located in the centralized control station.

7.17 Motor Controllers and Control Centers

In addition to 4-3-4/7.1 to 4-3-4/7.13 as applicable, the motor controllers and control centers for essential or emergency services are to comply with the following requirements.

7.17.1 Enclosures and Assemblies

The following materials are acceptable for the enclosures.

- Cast metal, other than die-cast metal, at least 3 mm ($^1/_8$ in.) thick at every point.
- Nonmetallic materials which have ample strength, are noncombustible and nonabsorptive, (e.g., laminated phenolic material).
- Sheet metal of adequate strength.

Motor control centers are to be constructed so that they are secured to a solid foundation, be self-supported or be braced to the bulkhead.

7.17.2 Disconnect Switches and Circuit Breakers *(1999)*

Means are to be provided for the disconnection of the full load from all live poles of supply of every motor at 0.5 kW or above and its controlgear. Where the controlgear is mounted on or adjacent to a main or auxiliary distribution switchboard, a disconnecting switch in the switchboard may be used for this purpose. Otherwise, a disconnecting switch within the controlgear enclosure or a separate enclosed disconnecting switch is to be provided. Disconnect switches and circuit breakers are to be operated without opening the enclosures in which they are installed.

7.17.3 Auto-starters

Alternating-current (AC) motor manual auto-starters with self-contained auto-transformers are to be provided with switches of the quick-make-and-break type, and the starter is to be arranged so that it will be impossible to throw to the running position without having first thrown to the starting position. Switches are to be preferably of the contactor or air-break-type.

7.19 Battery Systems and Uninterruptible Power Systems (UPS) *(2008)*

In addition to 4-3-4/7.1 to 4-3-4/7.13, as applicable, equipment for essential, emergency, and transitional sources of power services are to comply with the following requirements. Such equipment would include the battery charger unit, uninterruptible power system (UPS) unit, and the distribution boards associated with the charging or discharging of the battery system or uninterruptible power system (UPS).

7.19.1 Definitions *(2008)*

Uninterruptible Power System (UPS) – A combination of converters, switches and energy storage means, for example batteries, constituting a power system for maintaining continuity of load power in case of input power failure.

Off-line UPS unit – A UPS unit where under normal operation the output load is powered from the bypass line (raw mains) and only transferred to the inverter if the bypass supply fails or goes outside preset limits. This transition will invariably result in a brief (typically 2 to 10 ms) break in the load supply.

Line interactive UPS unit – An off-line UPS unit where the bypass line switch to stored energy power when the input power goes outside the preset voltage and frequency limits.

On-line UPS unit – A UPS unit where under normal operation the output load is powered from the inverter, and will therefore continue to operate without break in the event of the supply input failing or going outside preset limits.

DC UPS unit – A UPS unit where the output is in DC (direct current).

7.19.2 Battery Charging Rate *(2008)*

Except when a different charging rate is necessary and is specified for a particular application, the charging facilities are to be such that the completely discharged battery can be recharged to 80% capacity in not more than 10 hours. See also 4-8-3/7.19.6(c).

7.19.3 Discharge Protection *(2008)*

An acceptable means, such as reverse current protection, is to be provided for preventing a failed component in the battery charger unit or uninterruptible power system (UPS) unit from discharging the battery.

7.19.4 Design and Construction *(2008)*

7.19.4(a) Construction. Battery charger units and uninterruptible power system (UPS) units are to be constructed in accordance with the IEC 62040 Series, or an acceptable and relevant national or international standard.

7.19.4(b) Operation. The operation of the UPS is not to depend upon external services.

7.19.4(c) Type. The type of UPS unit employed, whether off-line, line interactive or on-line, is to be appropriate to the power supply requirements of the connected load equipment.

7.19.4(d) Continuity of Supply. An external bypass is to be provided to account for a failure within the uninterruptible power system (UPS). For battery charger units and DC UPS units, see 4-3-2/7.1.6(c).

7.19.4(e) Monitoring and Alarming. The battery charger unit or uninterruptible power system (UPS) unit is to be monitored and audible and visual alarm is to be given in a normally attended location for the following.

- Power supply failure (voltage and frequency) to the connected load
- Earth fault,
- Operation of battery protective device,
- When the battery is being discharged, and
- When the bypass is in operation for on-line UPS units. When changeover occurs, for battery charger units and DC UPS units required to comply with 4-3-2/7.1.6(c).

7.19.5 Location *(2008)*

7.19.5(a) Location. The UPS unit is to be suitably located for use in an emergency. The UPS unit is to be located as near as practical to the equipment being supplied, provided the arrangements comply with all other Rules, such as 4-3-3/3.7, 4-3-3/3.9, 4-3-3/3.11, and 4-3-3/3.13 for location of electrical equipment.

7.19.5(b) Ventilation. UPS units utilizing valve regulated sealed batteries may be located in compartments with normal electrical equipment, provided the ventilation arrangements are in accordance with the requirements of 4-3-3/3.7. Since valve regulated sealed batteries are considered low-hydrogen-emission batteries, calculations are to be submitted in accordance with 43-3/3.7.2(d) to establish the gas emission performance of the valve regulated batteries compared to the standard lead acid batteries. Arrangements are to be provided to allow any possible gas emission to be led to the weather, unless the gas emission performance of the valve regulated batteries does not exceed that of standard lead acid batteries connected to a charging device of 0.2 kW.

7.19.5(c) Battery Installation. For battery installation arrangements, see 4-3-3/3.7.

7.19.6 Performance *(2008)*

7.19.6(a) Duration. The output power is to be maintained for the duration required for the connected equipment as stated in 4-3-2/5.3 for emergency services and 4-3-2/5.7 of transitional source of power, as applicable.

7.19.6(b) Battery Capacity. No additional circuits are to be connected to the battery charger unit or UPS unit without verification that the batteries have adequate capacity. The battery capacity is, at all times, to be capable of supplying the designated loads for the time specified in 4-3-4/7.19.6(a).

7.19.6(c) Recharging. On restoration of the input power, the rating of the charging facilities are to be sufficient to recharge the batteries while maintaining the output supply to the load equipment. See also 4-3-4/7.19.2.

7.19.7 Testing and Survey *(2008)*

7.19.7(a) Surveys. Equipment units are to be surveyed during manufacturing and testing in accordance with 4-3-4/7.3.1.

7.19.7(b) Testing. Appropriate testing is to be carried out to demonstrate that the battery charger units and uninterruptible power system (UPS) units are suitable for the intended environment. This is expected to include as a minimum the following tests:

- Functionality, including operation of alarms;
- Temperature rise;
- Ventilation rate;
- Battery capacity

7.19.7(c) Test upon power input failure. Where the supply is to be maintained without a break following a power input failure, this is to be verified after installation by practical test.

9 Transformers

9.1 General

9.1.1 Applications *(2004)*

All transformers which serve for essential or emergency electrical supply are to be constructed, tested, and installed in accordance with the following requirements. Transformers other than the above services, auto-transformers for starting motors or isolation transformers are to be constructed and equipped in accordance with good commercial practice. All transformers are to be of the dry and air cooled type. The use of liquid immersed type transformers will be subject to special consideration. Transformers other than for essential or emergency services will be accepted, subject to a satisfactory performance test conducted after installation to the satisfaction of the Surveyor.

9.1.2 References

9.1.2(a) Power Supply Arrangement. For requirements covering arrangement of power supply through transformers to drilling unit main service systems, see 4-3-2/7.1.6.

9.1.2(b) Protection. For requirements covering protection of transformers, see 4-3-2/9.15.

9.1.2(c) Protection Enclosures and its Selection. For requirements covering selection of the protection enclosures for location conditions, see 4-3-3/3.1.1.

9.1.3 Forced Cooling Arrangement (Air or Liquid) *(1997)*

Where forced cooling medium is used to preclude the transformer from exceeding temperatures outside of its rated range, monitoring and alarm means are to be provided and arranged so that an alarm activates when pre-set temperature conditions are exceeded. Manual or automatic arrangements are to be made to reduce the transformer load to a level corresponding to the cooling available.

9.3 Temperature Rise

The design temperature rise of insulated windings based on an ambient temperature of 40°C (104°F) is not to exceed the values listed in 4-3-4/Table 8. If the ambient temperature exceeds 40°C (104°F), the transformer is to be derated so that the total temperature based on the above temperature rises is not exceeded. Temperatures are to be taken by the resistance method of temperature determination. Temperature rises for insulation material above 180°C (356°F) will be considered in accordance with 4-3-1/13.11.

9.5 Construction and Assembly

9.5.1 Windings

All transformer windings are to be treated to resist moisture, sea atmosphere and oil vapors.

9.5.2 Terminals

Terminals are to be provided in an accessible position. The circuit designation is to be clearly marked on each terminal connection. The terminals are to be so spaced or shielded that they can not be accidentally earthed, short-circuited or touched.

9.5.3 Nameplate

Nameplates of corrosion-resistant material are to be provided in an accessible position of the transformer and are to indicate at least the information as listed in 4-3-4/Table 4.

9.5.4 Prevention of the Accumulation of Moisture *(2002)*

Transformers of 10 kVA/phase and over are to be provided with effective means to prevent accumulation of moisture and condensation within the transformer enclosure where the transformer is disconnected from the switchboard during standby (cold standby). Where it is arranged that the transformer is retained in an energized condition throughout a period of standby (hot standby), the exciting current to the primary winding may be considered as a means to meet the above purpose. In case of hot standby, a warning plate is to be posted at or near the disconnecting device for the primary side feeder to the transformer.

9.7 Testing *(1999)*

For single-phase transformers rated 1 kVA and above or three-phase transformers rate 5 kVA and above intended for essential or emergency services, the following tests are to be carried out by the transformer's manufacturer in accordance with a recognized standard whose certificate of test is to be submitted for review upon request.

i) Measurement of winding resistance, voltage ratio, impedance voltage, short circuit impedance, insulation resistance, load loss, no load loss and excitation current, phase relation and polarity.

ii) Dielectric strength.

iii) Temperature rise (required for one transformer of each size and type). See 4-3-4/9.3.

11 Other Electric and Electronics Devices

11.1 Circuit Breakers

11.1.1 General

Circuit breakers are to be constructed and tested to comply with IEC Publication 60947-1 or other recognized standard. The tests may be carried out by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from the Bureau. Circuit breakers of the thermal type are to be calibrated for an ambient-air temperature as provided in 4-3-1/17.

Note: Where thermal-type breakers are mounted within enclosures, it is pointed out that the temperature within the enclosure may exceed the designated ambient-air temperature.

11.1.2 Mechanical Property

Arc-rupturing and main contacts of all open frame circuit breakers are to be self-cleaning.

11.1.3 Isolation

The electrical system is to be arranged so that portions may be isolated to remove circuit breakers while maintaining services necessary for propulsion and safety of the unit, or circuit breakers are to be mounted or arranged in such a manner that the breaker may be removed from the front without disconnecting the copper or cable connections or without de-energizing the supply to the breaker.

11.3 Fuses

Fuses are to be constructed and tested to comply with IEC Publication 269 or other recognized standard. The tests may be carried out by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from the Bureau. All components of the fuse are to be resistant to heat, mechanical stresses and corrosive influences which may occur in normal use.

11.5 Semiconductor Converters

11.5.1 General

The requirements in this subsection are applicable to static converters for essential and emergency services using semiconductor rectifying elements such as diodes, reverse blocking triodes, thyristors, etc. The tests may be carried out by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from the Bureau. All semiconductor converters will be accepted subject to a satisfactory performance test conducted after installation to the satisfaction of the Surveyor.

11.5.2 Cooling Arrangements

Semiconductor converters are preferably to be of a dry and air cooled type. Where semiconductor converters are of a liquid-immersed type, a liquid over-temperature alarm and gas overpressure protection devices are to be provided. If provision is made for breathing, a dehydrator is to be provided. Where arrangement for the forced cooling is provided, the circuit is to be designed that power cannot be applied to, or retained, on converter stacks unless effective cooling is maintained.

11.5.3 Accessibility

Semiconductor converter stacks or semiconductor components are to be mounted in such a manner that they can be removed from equipment without dismantling the complete unit.

11.5.4 Nameplate

A nameplate or identification is to be provided on the semiconductor converter and is to indicate at least the information as listed in 4-3-4/Table 4.

11.7 Cable Junction Boxes

11.7.1 General

The design and construction of the junction boxes are to be in compliance with 4-3-4/11.7.2 or other recognized standard. The tests may be carried out by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from the Bureau.

11.7.2 Design and Construction

Live parts are to be mounted on durable flame-retardant, moisture-resistant material of permanently high dielectric strength and high resistance. The live parts are to be so arranged by suitable spacing or shielding with flame-retardant insulating material that short-circuit cannot readily occur between conductors of different polarity or between conductors and earthed metal. Junction boxes are to be made of flame-retardant material and are to be clearly identified, defining their function and voltage.

13 Cables and Wires

13.1 Cable Construction

13.1.1 General *(2008)*

Electric cables are to have conductors, insulation and moisture-resistant jackets in accordance with IEC Publication 60092-350, 60092-351, 60092-352, 60092-353, 60092-354, 60092-359, 60092-373, 60092-374, 60092-375, 60092-376 or IEEE Std. 45. Other recognized marine standards will also be considered. The tests may be carried out by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from the Bureau. Network cables are to comply with a recognized industry standard. Conductors are to be of copper and stranded in all sizes. Conductors are not to be less than the following in cross-sectional size:

- 1.0 mm^2 (1,973.5 circ. mils) for power and lighting,
- 0.5 mm^2 (986.8 circ. mils) for control cables,
- 0.5 mm^2 (986.8 circ. mils) for essential or emergency signaling and communications cables, except for those assembled by the equipment manufacturer, and
- 0.35 mm^2 (690.8 circ. mils) for telephone cables for nonessential communication services, except for those assembled by the equipment manufacturer.

See 4-3-4/Table 10 for current carrying capacity for insulated copper wires and cables.

13.1.2 Flame Retardant Property

13.1.2(a) Standards. All electric cables are to be at least of a flame-retardant type complying with the following:

i) *(1999)* Depending on the intended installation, cables constructed to IEC Publication 60092 standards are to comply with the flammability criteria of IEC Publication 60332-3, category A/F or A/F/R, or

ii) Cables constructed to IEEE Std. 45 are to comply with the flammability criteria of that standard, or

iii) Cables constructed to another recognized marine standard, where specially approved, are to comply with the flammability criteria of IEEE Std. 45 or other acceptable standards.

Consideration will be given to the special types of cables, such as radio frequency cable, which do not comply with the above requirements.

13.1.2(b) Alternative Arrangement (2005). Flame retardant marine cables, including network cables, which have not passed the above-mentioned bunched cable flammability criteria may be considered, provided that the cable is treated with approved flame-retardant material or the installation is provided with approved fire stop arrangements. Special consideration may be given to the flame retardancy of special types of cables, such as radio frequency cables. When specifically approved, bus duct may be used in lieu of cable.

13.1.3 Fire Resistant Property *(2008)*

When electric cables are required to be fire-resistant, they are to comply with the requirements of IEC Standard 60331-31 for cables greater than 20 mm overall in diameter, otherwise they are to comply with the IEC Standard 60331-21 for cable diameters 20 mm or less. For special cables, requirements in the following standards may be used:

- IEC Standard 60331-23: Procedures and requirements – Electric data cables
- IEC Standard 60331-25: Procedures and requirements – Optical fiber cables

Cables complying with alternative national standards suitable for use in a marine environment may be considered. Fire resistant type cables are to be easily distinguishable. See also 4-3-3/3.29 and 4-3-3-/5.17.

13.1.4 Insulation Material

All electrical cables for power, lighting, communication, control and electronic circuits are to have insulation suitable for a conductor temperature of not less than 60°C (140°F). See 4-3-4/Table 9 for types of cable insulation.

13.1.5 Armor for Single-conductor Cables

The armor is to be nonmagnetic for single-conductor alternating-current cables.

13.1.6 Fiber Optic Cables

Fiber optic cables are to be constructed and tested to a recognized fiber optic cable construction standard acceptable to the Bureau. The requirements of flame retardancy for the electrical cables is applicable to the fiber optic cables. The construction of the fiber optic cable which may pass through or enter a hazardous area is to be such that escape of gases to a safe area is not possible through the cable.

13.3 Portable and Flexing Electric Cables

Unless otherwise required in the Rules, cables for portable equipment and cables subject to flexing service need not be armored.

13.5 Mineral-insulated, Metal-sheathed Cable

Mineral-insulated cable provided with approved fittings for terminating and connecting to boxes, outlets and other equipment may be used for any service up to 600 volts and may be used for feeders and branch circuits in both exposed and concealed work, in dry or wet locations. The moisture-resisting jacket (sheath) of mineral-insulated, metal-sheathed cable exposed to corrosive conditions is to be made of or protected by materials suitable for those conditions.

TABLE 1
Factory Testing Schedule for Generators and Motors ≥ 100 kW (135 hp) [See 4-3-4/3.3.1(a)] *(2003)*

	Tests	*AC generators*		*AC motors*		*DC machines*	
		Type test [(1)]	*Routine test* [(2)]	*Type test* [(1)]	*Routine test* [(2)]	*Type test* [(1)]	*Routine test* [(2)]
1	Visual inspection	x	x	x	x	x	x
2	Insulation resistance measurement	x	x	x	x	x	x
3	Winding resistance measurement.	x	x	x	x	x	x
4	*(2003)* Verification of voltage regulation system.	x	x[(3)]				
5	Rated load test and temperature rise measurement.	x		x		x	
6	*(2003)* Overload/over-current test.	x	x[(4)]	x	x[(4)]	x	x[(4)]
7	Verification of steady short circuit condition. [(5)]	x					
8	*(2003)* Over-speed test.	x	x	x[(6)]	x[(6)]	x[(6)]	x[(6)]
9	Dielectric strength test.	x	x	x	x	x	x
10	Running balance test. [(7)]	x	x	x	x	x	x
11	Verification of degree of protection.	x		x		x	
12	Bearing check after test.	x	x	x	x	x	x
13	Air gap measurement.	x	x			x	x
14	Commutation check.					x	

Notes

1 Type tests apply to prototype machines or to at least the first of a batch of machines.

2 *(2003)* Machines to be routine tested are to have reference to the machine of the same type that has passed a type test. Reports of routine tested machines are to contain manufacturers' serial numbers of the type tested machines and the test results.

3 *(2003)* Only functional test of voltage regulator system.

4 *(2003)* Applicable only to generators and motors ≥ 100 kW (135 hp) for essential services.

5 *(2003)* Verification at steady short circuit condition applies to synchronous generators only.

6 *(2003)* Where so specified and agreed upon between purchaser and manufacturer. Not required for squirrel cage motors.

7 Static balance (machine rated 500 rpm or less) or dynamic balance (over 500 rpm) will be accepted in lieu of the specified test on machines to be close-coupled to engines and supplied without shaft and/or bearings, or with incomplete set of bearings.

TABLE 2
Dielectric Strength Test for Rotating Machines [See 4-3-4/3.9]

Item		*Machine or Part*	*Test Voltage (AC r.m.s.)*
1		Insulated windings of rotated machines having rated output less than 1 kVA, and of rated voltage less than 100 V with the exception of those in items 4 to 8.	500 V + twice the rated voltage.
2		Insulated windings of rotating machines having rated output less than 10,000 kVA with the exception of those in items 1 and 4 to 8 (See Note 2).	1,000 V + twice the rated voltage with minimum of 1,500 V (See Note 1).
3		*(1999)* Insulated windings of rotating machines having rated output 10,000 kVA or more, and of rated voltage (see Note 1) up to 24,000 V with the exception of those in items 4 to 8 (see Note 2*)*.	1,000 V + twice the rated voltage.
4		Separately-excited field windings of DC machines.	1,000 V + twice the maximum rated circuit voltage with minimum of 1,500 V (See Note 1).
5		Field windings of synchronous generators and synchronous motors.	
	a)	Field windings of synchronous generators	Ten times the rated excitation voltage with a minimum of 1,500 V and a maximum of 3,500 V.
	b)	When the machine is intended to be started with the field winding short-circuited or connected across a resistance of value less than ten times the resistance of winding.	Ten times the rated excitation voltage with a minimum of 1,500 V and a maximum of 3,500 V.
	c)	When the machine will be started either with: – the field winding connected across resistance or more than ten times the field winding resistance, or – the field windings on open circuit or without a field dividing switch.	1,000 V + twice the maximum value of the voltage with a minimum of 1,500 V – between the terminals of the field winding, or – between the terminals of any section for a sectionalized field winding, which will be occurred under the specified starting conditions (see Note 3).
6		Secondary (usually rotor) windings of induction motors or synchronous induction motors if not permanently short-circuited (e.g., if intended for rheostatic starting)	
	a)	For non-reversing motors or motors reversible from standstill only.	1,000 V + twice the open-circuit standstill voltage as measured between slip-rings or secondary terminals with rated voltage applied to the primary windings.
	b)	For motors to be reversed or braked by reversing the primary supply while the motor is running.	1,000 V + four times the open-circuit standstill secondary voltage as defined in item 6.a. above.
7		Exciters (except as listed below) *Exception 1*—Exciters of synchronous motors (including synchronous induction motors) if connected to earth or disconnected from the field winding during starting *Exception 2*—Separately excited field windings of exciters (see Item 4 above).	As for windings to which they are connected. 1,000 V + twice the rated exciter voltage with a minimum of 1,500 V.
8		Assembled group of machines and apparatus.	A repetition of the tests in items 1 to 7 above is to be avoided if possible. But, if a test on an assembled group of several pieces of new apparatus, each one is made, the test voltage to be applied to such assembled group is to be 80% of the lowest test voltage appropriate for any part of the group (see Note 4).

Notes:

1 For two-phase windings having one terminal in common, the rated voltage for the purpose of calculating the test voltage is to be taken as 1.4 times the voltage of each separate phase.

2 High-voltage tests on machines having graded insulation is to be subject to special consideration.

3 The voltage, which is occurred between the terminals of field windings or sections thereof under the specified starting conditions, may be measured at any convenient reduced supply voltage. The voltage so measured is to be increased in the ratio of the specified starting supply voltage to the test supply voltage.

4 For windings of one or more machines connected together electrically, the voltage to be considered is the maximum voltage that occurs in relation to earth.

TABLE 3
Limits of Temperature Rise for Air-Cooled Rotating Machines
[See 4-3-4/3.11.1] *(2007)*

Ambient Temperature = 50°C [(1)]

Item No.		*Part of Machine*	*Temperature Measuring Method*	*Limit of Temperature Rise, °C for Class of Insulation*				
				A	*E*	*B*	*F*	*H*
1	a)	AC windings of machines having rated output of 5,000 kW (or kVA) or more	Resistance	50	—	70	90	115
			Embedded temp. detector	55	—	75	95	120
	b)	AC windings of machines having rated output above 200 kW (or kVA) but less than 5,000 kW (or kVA)	Resistance	50	65	70	95	115
			Embedded temp. detector.	55	—	80	100	120
	c)	AC windings of machines having rated outputs of 200 kW (or kVA) or less [(2)]	Resistance	50	65	70	95	115
2		Windings of armatures having commutators	Thermometer	40	55	60	75	95
			Resistance	50	65	70	95	115
3		Field windings of AC and DC machines having DC excitation, other than those in item 4	Thermometer	40	55	60	75	95
			Resistance	50	65	70	95	115
4	a)	Field winding of synchronous machines with cylindrical rotors having DC excitation winding embedded in slots, except synchronous induction motors	Resistance	—	—	80	100	125
	b)	Stationary field windings of AC machines having more than one layer	Thermometer	40	55	60	75	95
			Resistance	50	65	70	95	115
			Embedded temp. detector.	—	—	80	100	125
	c)	Low resistance field winding of AC and DC machines and compensating windings of DC machines having more than one layer	Thermometer	50	65	70	90	115
			Resistance	50	65	70	90	115
	d)	Single-layer windings of AC and DC machines with exposed bare or varnished metal surfaces and single layer compensating windings of DC machines [(3)]	Thermometer	55	70	80	100	125
			Resistance	55	70	80	100	125
5		Permanently short-circuited windings	The temperature rise of any parts is not to be detrimental to the insulating of that part or to any other part adjacent to it.					
6		Magnetic cores and all structural components, whether or not in direct contact with insulation (excluding bearings)						
7		Commutators, slip-rings and their brushes and brushing	The temperature rise of any parts is not to be detrimental to the insulating of that part or to any other part adjacent to it. Additionally, the temperature is not to exceed that at which the combination of brush grade and commutator/slip-ring materials can handle the current over the entire operating range.					

Notes

1 The limit of temperature rise in the above Table is based on an ambient temperature of 50°C in accordance with IEC Publication 60092-101. For rotating machines based on a 45°C ambient, the temperature rises may be increased by 5°C. (See 4-3-4/3.11.2).

2 With application of the superposition test method to windings of machines rated 200 kW (or kVA) or less with insulation classes A, E, B or F, the limits of temperature rise given for the resistance method may be increased by 5°C.

3 Also includes multiple layer windings provided that the under layers are each in contact with the circulating coolant.

TABLE 4 Nameplates

a. Rotating Machines [See 4-3-4/3.13.9]

The manufacturer's name
The manufacturer's serial number (or identification mark)
The year of manufacture
Type of Machine (Generator or motor, etc.)
Degree of protection enclosures (by IP code)
Class of rating or duty type
The rated output
The rated voltage
The rated current and type of current (AC or DC)
The rated speed (r.p.m.) or speed range
The class of insulation or permissible temperature rise
The ambient temperature

Number of phase (for AC machines)
The rated frequency (for AC machines)
Power factor (for AC machines)
Type of winding (for DC machines)

Exciter voltage (for synchronous machines or DC machines with separate excitation)
Exciter current at rating (for synchronous machines or DC machines with separate excitation)
Open-circuit voltage between slip-rings and the slip-ring current for rated conditions (for wounded-rotor induction machines)

b. Accumulator Battery [See 4-3-4/5.3.3]

The manufacturer's name
The type designation
The rated voltage
The ampere-hour rating at a specific rate of discharge
The specific gravity of the electrolyte
(in the case of a lead-acid battery, the specific gravity when the battery is fully charged).

c. Transformer [See 4-3-4/9.5.3]

The manufacturer's name
The manufacturer's serial number (or identification mark)
The year of manufacture
The number of phases
The rated power
The rated frequency
The rated voltage in primary and secondary sides
The rated current in primary and secondary sides
The class of insulation or permissible temperature rise
The ambient temperature

d. Semiconductor Converter [See 4-3-4/11.5.4]

The manufacturer's name
The identification number of the equipment

TABLE 5
Factory Testing Schedule for Switchboards, Chargers, Motor Control Centers, and Controllers [See 4-3-4/7.3.1]

1 Insulation resistance measurements in accordance with 4-3-4/7.5.

2 Dielectric strength test in accordance with 4-3-4/7.7 and the Table below.

3 *(1998)* Protective device tripping test, such as overcurrent tripping, emergency tripping, preferential tripping, etc.

4 Inspection of the assembly, including inspection of wiring and, if necessary, electrical operation test.

Standard Test Voltage for Dielectric Strength Test

Rated Insulation Voltage	*Dielectric Test Voltage AC r.m.s.*
Up to and including 12 V	2250 V
over 12 V to 60 V inclusive	2500 V
over 60 V to 300 V inclusive	2000 V
over 300 V to 690 V inclusive	2500 V
over 690 V to 800 V inclusive	3000 V
over 800 V to 1000 V inclusive	3500 V
over 1000 V to 1500 V inclusive*	3500 V
Note: *For Direct-current (DC) only	

TABLE 6
Clearance and Creepage Distance for Switchboards, Distribution Boards, Chargers, Motor Control Centers and Controllers (1) [See 4-3-4/7.11.6]

Rated insulation voltage (V)	*Minimum clearances mm (in.)*	*Minimum creepage distances mm (in.)*
Up to 250	15 ($^{19}/_{32}$)	20 ($^{25}/_{32}$)
From 251 to 660	20 ($^{25}/_{32}$)	30 (1$^{3}/_{16}$)
Above 660 (2)	25 (1)	35 (1$^{3}/_{8}$)

Notes:

1 The values in this table apply to clearances and creepage distances between live parts as well as between live parts and exposed conductive parts, including earthing.

2 For 1 kV to 15 kV systems, see 4-3-5/1.1.4.

TABLE 7
Equipment and Instrumentation for Switchboard [See 4-3-4/7.15.4]

Instrumentation and Equipment		*Alternating-current (AC) Switchboard*	*Direct-current (DC) Switchboard*
1.	Pilot Lamp	A pilot lamp for each generator connected between generator and circuit breaker. See Note 3.	A pilot lamp for each generator connected between generator and circuit breaker.
2.	Generator Disconnect	A generator switch or disconnecting links in series with the generator circuit breaker which is to disconnect completely all leads of the generator and the circuit breaker from the buses, except the earth lead. See Note 1.	A generator switch, or disconnecting links, in series with the circuit breaker which will open positive, negative, neutral and equalizer leads, except that for 3-wire generators, equalizer poles may be provided on the circuit breaker. For 3-wire generators, the circuit breakers are to protect against a short circuit on the equalizer buses. See Note 1.
3.	Field Rheostat	A field rheostat for each generator and each exciter. See Note 2.	A field rheostat for each generator. See Note 2.
4.	Insulation Monitor and Alarm	A means for continuously monitoring the electrical insulation level to earth, and an audible or visual alarm for abnormally low insulation values. See Note 3.	A means for continuously monitoring the electrical insulation level to earth, and an audible or visual alarm for abnormally low insulation values. For 3-wire generators, see 4-3-5/5.3. See Note 3.
5.	Ammeter	An ammeter for each generator with a selector switch to read the current of each phase. See Note 3.	An ammeter for each 2-wire generator. For each 3-wire generator, an ammeter for each positive and negative lead and a center-zero ammeter in the earth connection at the generator switchboard. Ammeters are to be so located in the circuit as to indicate total generator current.
6.	Voltmeter	A voltmeter for each generator, with a selector switch to each phase of the generator and to one phase of the bus. See Note 3.	A voltmeter for each generator with voltmeter switch for connecting the voltmeter to indicate generator voltage and bus voltage. For each 3-wire generator, a voltmeter with voltmeter switch for connecting the voltmeter to indicate generator voltage, positive to negative, positive to neutral, and neutral to negative. Where permanent provisions for shore connections are fitted, one voltmeter switch to provide also for reading shore-connection voltage, positive to negative.
7.	Space Heater Pilot Lamp	Where electric heaters are provided for generators, a heater pilot lamp is to be fitted for each generator.	Where electric heaters are provided for generators, a heater pilot lamp is to be fitted for each generator.
8.	Synchroscope or Lamps	A synchroscope or synchronizing lamps with selector switch for paralleling in any combination. See Note 3.	Not applicable.
9.	Prime mover Speed Control	Control for prime mover speed for paralleling. See Note 3.	Not applicable.
10.	Wattmeter	Where generators are arranged for parallel operation, an indicating wattmeter is to be fitted for each generator. See Note 3.	Not applicable.
11.	Frequency Meter	A frequency meter with selector switch to connect to any generator. See Note 3.	Not applicable.
12.	Field Switch	A double-pole field switch with discharge clips and resistor for each generator. See Note 2.	Not applicable.
13.	Voltage Regulator	A voltage regulator. See Note 3.	Not applicable.
14.	Stator Winding Temperature Indicator *(1997)*	For alternating current generator above 500 kW, a stator winding temperature indicator is to be fitted for each generator control panel. See Notes 3 and 4.	For direct current propulsion generator above 500 kW, an interpole winding temperature indicator is to be fitted for each generator control panel. See Notes 3 and 4.

Notes:

1 The switch or links may be omitted when draw-out or plug-in mounted generator breakers are furnished.

2 For generators with variable voltage exciters or rotary amplifier exciters, each controlled by voltage-regulator unit acting on the exciter field, the field switch, the discharge resistor and generator field rheostat may be omitted.

3 *(2005)* Where units have centralized control systems in accordance with Part 4, Chapter 9 of the ABS *Steel Vessel Rules* and the generators can be paralleled from the centralized control station, and the switchboard is located in the centralized control station, this equipment may be mounted on the control console. See 4-3-4/7.15.4.

4 *(1997)* For high voltage systems, see also 4-3-5/1.11.1(c).

TABLE 8
Temperature Rise for Transformers [1,2] [See 4-3-4/9.3]

Insulation Class	*Copper Temperature Rise by Resistance*	*Hottest Spot Temperature Rise*
Class A	55°C (99°F)	65°C (117°F)
Class B	80°C (144°F)	110°C (198°F)
Class F	115°C (207°F)	145°C (261°F)
Class H	150°C (270°F)	180°C (324°F)

Notes:

1 Metallic parts in contact with or adjacent to insulation are not to attain a temperature in excess of that allowed for the hottest-spot copper temperature adjacent to that insulation.

2 Temperature rises are based on an ambient temperature of 40°C. See 4-3-4/9.3.

TABLE 9
Types of Cable Insulation [See 4-3-4/13.1.4]

Insulation Type Designation	*Insulation Materials*	*Maximum Conductor Temperature*
V60, PVC/A	Polyvinyl Chloride – General purpose	60°C (140°F)*
V75, PVC *(1997)*	Polyvinyl Chloride – Heat resisting *(1997)*	75°C (167°F) *
R85, XLPE	Cross-linked Polyethylene	85°C (185°F) *
E85, EPR	Ethylene Propylene Rubber	85°C (185°F) *
M95	Mineral (MI)	95°C (203°F)*
S95	Silicone Rubber	95°C (203°F) *

* A maximum conductor temperature of 250°C (482°F) is permissible for special applications and standard end fittings may be used, provided the temperature does not exceed 85°C (185°F) at the end of fittings. However, when the temperature at the end of the fittings is higher than 85°C (185°F), special consideration will be given to an appropriate end fitting.

TABLE 10
Maximum Current Carrying Capacity for Insulated Copper Wires and Cables [See 4-3-4/13.1.1] *(1997)*

Values in amperes
45°C (113°F) Ambient
750 V and Less (AC or DC)

Conductor Size		*1/C TYPE*				*2/C TYPE*				*3-4/C TYPE*			
mm^2	*10^3 circ mils*	*V60 PVC/A 60°C (140°F)*	*V75, Heat Resist. PVC 75°C (167°F)*	*R85, XLPE, E85, 85°C (185°F)*	*M95, S95 95°C (203°F)*	*V60 PVC/A 60°C (140°F)*	*V75, Heat Resist. PVC 75°C (167°F)*	*R85, XLPE, E85, 85°C (185°F)*	*M95, S95 95°C (203°F)*	*V60 PVC/A 60°C (140°F)*	*V75, Heat Resist. PVC 75°C (167°F)*	*R85, XLPE, E85, 85°C (185°F)*	*M95, S95 95°C (203°F)*
625			755	894	1006		642	760	855		529	626	704
600			736	872	981		626	741	834		515	610	687
	1000		662	784	882		563	666	750		463	549	617
500			656	778	875		558	661	744		459	545	613
	950		641	760	854		545	646	726		449	532	598
	900		620	734	826		527	624	702		434	514	578
	850		598	709	797		508	603	677		419	496	558
	800		576	682	767		490	580	652		403	477	540
400			571	677	761		485	575	647		400	474	533
	750		553	655	737		470	557	626		387	459	516
	700		529	628	706		450	534	600		370	440	494
	650		506	599	674		430	509	573		354	419	472
	600		481	570	641		409	485	545		337	399	449
300		335	477	565	636	285	405	480	541	235	334	396	445
	550		455	540	607		387	459	516		319	378	425
	500		429	509	572		365	433	486		300	356	400
240		290	415	492	553	247	353	418	470	203	291	344	387
	450		402	476	536		342	405	456		281	333	375
	400		373	442	498		317	376	423		261	309	349
185		250	353	418	470	213	300	355	400	175	247	293	329
	350		343	407	458		292	346	389		240	285	321
	300		312	370	416		265	315	354		218	259	291
150		220	309	367	412	187	263	312	350	154	216	257	288
	250		278	330	371		236	281	315		195	231	260
120		190	269	319	359	162	229	271	305	133	188	223	251
	212		251	297	335		213	252	285		176	208	235
95		165	232	276	310	140	197	235	264	116	162	193	217
	168		217	257	289		184	218	246		152	180	202
70		135	192	228	256	115	163	194	218	95	134	160	179
	133		188	222	250		160	189	213		132	155	175
	106		163	193	217		139	164	184		114	135	152
50		105	156	184	208	89	133	156	177	74	109	129	146
	83.7		140	166	187		119	141	159		98	116	131
35		87	125	148	166	74	106	126	141	61	88	104	116
	66.4		121	144	162		103	122	138		85	101	113
	52.6		105	124	140		89	105	119		74	87	98
25		71	101	120	135	60	86	102	115	50	71	84	95
	41.7		91	108	121		77	92	103		64	76	85

TABLE 10 (continued)
Maximum Current Carrying Capacity for Insulated Copper Wires and Cables [See 4-3-4/13.1.1] *(1997)*

	33.1		79	93	105		67	79	89		55	65	74
16		54	76	91	102	46	65	77	87	38	53	64	71
	26.3		68	81	91		58	69	77		48	57	64
	20.8		59	70	78		50	60	66		41	49	55
10		40	57	67	76	34	48	57	65	28	40	47	53
	16.5		51	60	68		43	51	58		36	42	48
6		29	41	49	55	25	35	42	47	20	29	34	39
	10.4		38	45	51		32	38	43		27	32	36
4		22	32	38	43	19	27	32	37	15	22	27	30
	6.53		28	34	38		24	29	32		20	24	27
2.5		17	24	28	32	14	20	24	27	12	17	20	22
	4.11		21	25	32		18	21	27		15	18	22
1.5		12	17	21	26	10	14	18	22	8	12	15	18
1.25			15	18	23		13	15	20		11	13	16
1.0		8	13	16	20	7	11	14	17	6	9	11	14

Notes:

1 The values given above have been calculated for an ambient of 45°C (113°F) and assume that a conductor temperature equal to the maximum rated temperature of the insulation is reached and maintained continuously in the case of a group of four cables bunched together and laid in free air.

2 The current rating values given in 4-3-4/Table 10 (and those derived therefrom) may be considered applicable, without correction factors, for cables double-banked on cable trays, in cable conduits or cable pipes, except as noted in Note 3.

3 For bunched cables, see 4-3-3/5.11.1.

4 These current ratings are applicable for both armored and unarmored cables.

5 If ambient temperature differs from 45°C (113°F), the values in 4-3-4/Table 10 are to be multiplied by the following factors.

Maximum Conductor Temperature	*Ambient Correction Factor*					
	40°C (104°F)	*50°C (122°F)*	*55°C (131°F)*	*60°C (140°F)*	*65°C (149°F)*	*70°C (158°F)*
60°C (140°F)	1.15	0.82	—	—	—	—
75°C (167°F)	1.08	0.91	0.82	0.71	0.58	—
80°C (176°F)	1.07	0.93	0.85	0.76	0.65	0.53
85°C (185°F)	1.06	0.94	0.87	0.79	0.71	0.61
95°C (203°F)	1.05	0.95	0.89	0.84	0.77	0.71

6 Where the number of conductors in a cable exceeds four, as in control cables, the maximum current carrying capacity of each conductor is to be reduced as in the following table:

No. of Conductors	*% of 3–4/C TYPE Values in 4-3-4/Table 10*
5–6	80
7–24	70
25–42	60
43 and above	50

7 When a mineral-insulated cable is installed in such a location that its copper sheath is liable to be touched when in service, the current rating is to be multiplied by the correction factor 0.80 in order that the sheath temperature does not exceed 70°C (158°F).

8 Cables being accepted based on approved alternate standard may have current carrying capacity of that standard, provided the cables are in full compliance with that standard.

PART

4

CHAPTER 3 Electrical Installations

SECTION 5 Specialized Installations

1 High Voltage Systems

1.1 General

1.1.1 Application *(2003)*

The following requirements in this Subsection are applicable to AC systems with nominal voltage (phase to phase) exceeding 1 kV. Unless stated otherwise, high voltage equipment and systems are to comply with the other parts in Part 4, Chapter 3 for low voltage equipment and systems, as well.

1.1.2 Standard Voltages *(2003)*

The nominal standard voltage is not to exceed 15 kV. A higher voltage may be considered for special applications.

1.1.3 Air Clearance and Creepage Distance

1.1.3(a) Air Clearance. (2003) Phase-to-phase air clearances and phase-to-earth air clearances between non-insulated parts are to be not less than the minimum as specified below.

Nominal Voltage in kV	*Minimum air clearance in mm (in.)*
3–3.3	55 (2.2)
6–6.6	90 (3.6)
10–11	120 (4.8)
15	160 (6.3)

Where intermediate values of nominal voltages are accepted, the next higher air clearance is to be observed. In the case of smaller distances, an appropriate voltage impulse test is to be applied.

1.1.3(b) Creepage Distance. Creepage distances between live parts and between live parts and earthed metal parts are to be adequate for the nominal voltage of the system, due regard being paid to the comparative tracking index of insulating materials under moist conditions according to the IEC Publication 60112 and to the transient over-voltage developed by switching and fault conditions.

1.3 System Design

1.3.1 Selective Coordination

Selective coordination is to be in accordance with 4-3-2/9.1.5, regardless of the system neutral earthing arrangement.

1.3.2 Earthed Neutral Systems

1.3.2(a) Neutral Earthing (2003). The current in the earth fault condition is to be not in excess of full load current of the largest generator on the switchboard or relevant switchboard section and in no case less than three times the minimum current required for operation of any device in the earth fault condition.

At least one source neutral to ground connection is to be available whenever the system is in the energized mode.

1.3.2(b) Equipment (2003). Electrical equipment in directly earthed neutral or other neutral earthed systems is to be able to withstand the current due to a single phase fault against earth for a period necessary to trip the protection device.

1.3.3 Neutral Disconnection

Each generator neutral is to be provided with means for disconnection.

1.3.4 Hull Connection of Earthing Impedance *(2003)*

All earthing impedances are to be connected to the hull. The connection to the hull is to be so arranged that any circulating currents in the earth connections will not interfere with radio, radar, communication and control equipment circuits. In systems with neutral earthed, connection of the neutral to the hull is to be provided for each generator switchboard section.

1.3.5 Earth Fault Detection *(2003)*

An earth fault is to be indicated by visual and audible means. In low impedance or direct earthed systems, provision is to be made to automatically disconnect the faulty circuits. In high impedance earthed systems where outgoing feeders will not be isolated in case of an earth fault, the insulation of the equipment is to be designed for the phase to phase voltage.

1.3.6 Number and Capacity of Transformers *(2002)*

The number and capacity of transformers is to be sufficient under seagoing conditions with any three-phase transformer or any one transformer of three single phase transformer bank out of service to carry those electrical loads for essential service and for minimum comfortable conditions of habitability. For this purpose and for the purpose of immediate continuity of supply, the provision of a single-phase transformer carried onboard as a spare for a three phase transformer bank or V-V connection by two remaining single-phase transformers is not acceptable.

1.5 Circuit Breakers and Switches – Auxiliary Circuit Power Supply Systems for Operating Energy *(2004)*

1.5.1 Source and Capacity of Power Supply

Where electrical energy or mechanical energy is required for the operation of circuit breakers and switches, a means of storing such energy is to be provided with a capacity at least sufficient for two on/off operation cycles of all of the components. However, the tripping due to overload or short-circuit, and under-voltage is to be independent of any stored electrical energy sources. This does not preclude the use of stored energy for shunt tripping, provided alarms are activated upon loss of continuity in the release circuits and power supply failures. The stored energy may be supplied from within the circuit in which the circuit breakers or switches are located.

1.5.2 Number of External Sources of Stored Energy

Where the stored energy is supplied from a source external to the circuit, such supply is to be from at least two sources so arranged that a failure or loss of one source will not cause the loss of more than one set of generators and/or essential services. Where it will be necessary to have the source of supply available for dead ship startup, the source of supply is to be provided from the emergency source of electrical power

1.7 Circuit Protection

1.7.1 Protection of Generator *(2003)*

Protection against phase-to-phase fault in the cables connecting the generators to the switchboard and against interwinding faults within the generator is to be provided. This is to trip the generator circuit breaker and automatically de-excite the generator. In distribution systems with a low-impedance earthed neutral, phase to earth faults are to be likewise treated.

1.7.2 Protection of Power Transformers *(2003)*

Power transformers are to be provided with overload and short circuit protection. Each high-voltage transformer intended to supply power to the low-voltage drilling unit main service switchboard is to be protected in accordance with 4-3-2/9.15. In addition, the following means for protecting the transformers or the electric distribution system are to be provided:

1.7.2(a) Coordinated Trips of Protective Devices (2002). Discriminative tripping is to be provided for the following. See 4-3-2/9.1.5.

i) Between the primary side protective device of the transformer and the feeder protective devices on the low-voltage drilling unit main service switchboard, or

ii) Between the secondary side protective device of the transformer, if fitted, and the feeder protective devices on the low-voltage drilling unit main service switchboard.

1.7.2(b) Load Shedding Arrangement (2002). Where the power is supplied through a single set of three-phase transformers to a low-voltage drilling unit main service switchboard, automatic load shedding arrangements are to be provided when the total load connected to the low voltage drilling unit main service switchboard exceeds the rated capacity of the transformer. See 4-3-2/1.7 and 4-3-2/9.3.3.

1.7.2(c) Protection from Electrical Disturbance (2002). Means or arrangements are to be provided for protecting the transformers from voltage transients generated within the system due to circuit conditions, such as high-frequency current interruption and current suppression (chopping) as the result of switching, vacuum cartridge circuit breaker operation, or thyrister-switching.

An analysis or data for the estimated voltage transients is to be submitted to show that the insulation of the transformer is capable of withstanding the estimated voltage transients. See 4-3-5/1.11.3(b).

1.7.2(d) Detection of Phase-to-Phase Internal Faults (2002). For three-phase transformers of 100 kVA or more, means for detecting a phase-to-phase internal fault are to be provided. The detection of the phase-to-phase internal fault is to activate an alarm at the manned control station or to automatically disconnect the transformer from the high-voltage power distribution network.

1.7.2(e) Protection from Earth-Faults (2002). Where a Y-neutral of three-phase transformer windings is earthed, means for detecting an earth-fault are to be provided. The detection of the earth fault is to activate an alarm at the manned control station or to automatically disconnect the transformer from the high-voltage power distribution network.

1.7.2(f) Transformers Arranged in Parallel (2002). When transformers are connected in parallel, tripping of the protective devices at the primary side is to automatically trip the switch or protective devices connected at the secondary side.

1.7.3 Voltage Transformers for Control and Instrumentation *(2003)*

Voltage transformers are to be provided with overload and short circuit protection on the secondary side.

1.7.4 Fuses *(2003)*

Fuses are not to be used for overload protection.

1.7.5 Over Voltage Protection *(2003)*

Lower voltage systems supplied through transformers from high voltage systems are to be protected against overvoltages. This may be achieved by:

i) Direct earthing of the lower voltage system,

ii) Appropriate neutral voltage limiters, or

iii) Earthed screen between primary and secondary winding of transformers

1.9 Equipment Installation and Arrangement

1.9.1 Degree of Protection

The degree of equipment protection is to be in accordance with 4-3-3/Table 1.

1.9.2 Protective Arrangements

1.9.2(a) Interlocking Arrangements. Where high-voltage equipment is not contained in an enclosure, but a room forms the enclosure of the equipment, the access doors are to be so interlocked that they cannot be opened until the supply is isolated and the equipment earthed down.

1.9.2(b) Warning Plate. At the entrance of such spaces, a suitable marking is to be placed which indicates danger of high-voltage and the maximum voltage inside of the space. For high-voltage electrical equipment installed outside of these spaces, a similar marking is to be provided.

1.9.3 Cables

1.9.3(a) Runs of Cables (2003). In accommodation spaces, high voltage cables are to be run in enclosed cable transit systems.

1.9.3(b) Segregation (2003). High voltage cables of different voltage ratings are not to be installed in the same cable bunch, duct, pipe or box. Where high voltage cables of different voltage ratings are installed on the same cable tray, the air clearance between cables is not to be less than the minimum air clearance for the higher voltage side in 4-3-5/1.1.3(a). However, high voltage cables are not to be installed on the same cable tray for the cables operating at the nominal system voltage of 1 kV or less.

Higher voltage equipment is not to be combined with lower voltage equipment in the same enclosure unless segregation or other suitable measures are taken to ensure safe access to lower voltage equipment

1.9.3(c) Installation Arrangements (2003). High voltage cables are to be installed on cable trays or equivalent when they are provided with a continuous metallic sheath or armor which is effectively bonded to earth. Otherwise, they are to be installed for their entire length in metallic casings effectively bonded to earth.

1.9.3(d) Termination and Splices (2003). Terminations in all conductors of high voltage cables are to be, as far as practicable, effectively covered with suitable insulating material. In terminal boxes, if conductors are not insulated, phases are to be separated from earth and from each other by substantial barriers of suitable insulating materials. High voltage cables of the radial field type, i.e., having a conductive layer to control the electric field within the insulation, are to have terminations which provide electric stress control.

Terminations are to be of a type compatible with the insulation and jacket material of the cable and are to be provided with means to ground all metallic shielding components (i.e., tapes, wires etc).

1.9.3(e) Marking. High voltage cables are to be readily identifiable by suitable marking.

1.9.3(f) Test after Installation (2003). A voltage withstand test is to be carried out on each completed cable and its accessories before a new high voltage installation, including additions to an existing installation, is put into service.

The test is to be carried out after an insulation resistance test.

When a DC voltage withstand test is carried out, the voltage is to be not less than:

$1.6(2.5U_o + 2\text{ kV})$ for cables of rated voltage (U_o) up to and including 3.6 kV, or

$4.2U_o$ for higher rated voltages

where U_o is the rated power frequency voltage between conductor and earth or metallic screen, for which the cable is designed.

The test voltage is to be maintained for a minimum of 15 minutes.

After completion of the test, the conductors are to be connected to earth for a sufficient period in order to remove any trapped electric charge.

An insulation resistance test is then repeated.

Alternatively, an AC voltage withstand test may be carried out upon advice from the high voltage cable manufacturer at a voltage not less than the normal operating voltage of the cable, and it is to be maintained for a minimum of 24 hours.

Note: Tests in accordance with IEC Publication 60502 will also be considered adequate.

1.11 Machinery and Equipment

1.11.1 Rotating Machines

1.11.1(a) Protection. Rotating machines are to have a degree of protection of at least IP23; for terminal box, IP44; and for motors accessible to unqualified personnel, IP43.

1.11.1(b) Windings (2003). Generator stator windings are to have all phase ends brought out for the installation of the differential protection.

1.11.1(c) Temperature Detectors. Rotating machines are to be provided with temperature detectors in their stator windings to actuate a visual and audible alarm in a normally attended position whenever the temperature exceeds the permissible limit. If embedded temperature detectors are used, means are to be provided to protect the circuit against over-voltage.

1.11.1(d) (2004) No text.

1.11.1(e) Space Heater. Effective means are to be provided to prevent the accumulation of moisture and condensation within the machines when they are idle.

1.11.1(f) Tests (2003). In addition to the tests normally required for rotating machinery, a high frequency, high voltage test, in accordance with IEC Publication 60034-15, is to be carried out on the individual coils in order to demonstrate a satisfactory withstand level of the inter-turn insulation to steep fronted switching surges.

1.11.2 Switchgear and Control-gear Assemblies

Switchgear and control gear assemblies are to be constructed according to the IEC Publication 60298 and the following additional requirements:

1.11.2(a) Protection (2003). Switchgear, control-gear assemblies and static converters are to have a degree of protection of at least IP32. For those installed in a space accessible to unqualified personnel, the protection is to be increased to IP4X, where "X" is dependent on the liquid condition in the location in which the equipment is to be installed (see 4-3-1/Table 3).

1.11.2(b) Mechanical Construction (2003). Switchgear is to be of metal-enclosed type in accordance with IEC Publication 60298 or of the insulation-enclosed type in accordance with IEC Publication 60466.

1.11.2(c) Configuration (2003). The main bus bars are to be subdivided into at least two independent parts which are to be connected by at least one circuit breaker or other approved means, each part being supplied by at least one generator. The connection of generating sets and any other required duplicated equipment is to be divided, as far as possible, equally between the parts.

1.11.2(d) Clearance and Creepage Distances. For clearance and creepage distances, see 4-3-5/1.1.3.

1.11.2(e) Locking Facilities. Withdrawable circuit breakers and switches are to be provided with mechanical locking facilities in both service and disconnected positions. For maintenance purposes, key locking of withdrawable circuit breakers, switches and fixed disconnectors is to be possible. Withdrawable circuit breakers, when in the service position, are to have no relative motion between fixed and moving parts.

1.11.2(f) Shutters. The fixed contacts of withdrawable circuit breakers and switches are to be so arranged that in the withdrawn position, the live contacts of the bus bars are automatically covered.

1.11.2(g) Earthing and Short-circuiting Facilities (2003). For maintenance purposes, an adequate number of earthing and short circuiting facilities is to be provided to enable equipment and cables to be earthed or short-circuited to earth before being worked upon.

1.11.2(h) Tests (2003). A power frequency voltage test is to be carried out on high voltage switchgear and control-gear assemblies. The test procedure and voltages are to be in accordance with IEC Publication 60298.

1.11.3 Transformers *(2002)*

1.11.3(a) Application (2008). Provisions of 4-3-5/1.11.3 are applicable to power transformers for essential services. See also 4-3-4/9. Items 4-3-5/1.11.3(c) and 4-3-5/1.11.3(d) are applicable to transformers of the dry type only. These requirements are not applicable to transformers intended for the following services:

- Instrument transformers.
- Transformers for static converters.
- Starting transformers.

Dry type transformers are to comply with the applicable Parts of the IEC 60076 Series. Liquid filled transformers are to comply with the applicable Parts of the IEC 60076 Series. Oil immersed transformers are to be provided with the following alarms and protections:

- Liquid level (Low) – alarm
- Liquid temperature (High) – alarm
- Liquid level (Low) – trip or load reduction

- Liquid temperature (High) – trip or load reduction
- Gas pressure relay (High) – trip

1.11.3(b) Plans (2002). In addition to the details required in 4-3-4/9, the applicable standard of construction and the rated withstanding voltage of the insulation are also to be submitted for review.

1.11.3(c) Enclosure (2003). Transformers are to have a degree of protection of at least IP23. However, when installed in spaces accessible to unqualified personnel, the degree of protection is to be increased to IP4X, where "X" is dependent on the liquid condition in the location in which the equipment is to be installed (see 4-3-1/Table 3). For transformers not contained in enclosures, see 4-3-5/1.9.1.

1.11.3(d) Space Heater (2002). Effective means to prevent accumulation of moisture and condensation within the transformers (when de-energized) is to be provided.

1.11.3(e) Testing (2002). Three-phase transformers or three-phase bank transformers of 100 kVA and above are to be tested in the presence of the Surveyor. The test items are to be in accordance with the standard applicable to the transformer. The tests are also to be carried out in the presence of the Surveyor for each individual transformer. Transformers of less than 100 kVA will be accepted subject to a satisfactory performance test conducted after installation to the satisfaction of the Surveyor.

Specific requirements are applicable for the following tests:

i) In the dielectric strength test, the short duration power frequency withstand voltage to be applied is to follow the standard applicable to the transformer but not less than the estimated voltage transient generated within the system. If the short duration power frequency withstand voltage is not specified in the applicable standard, IEC 60076-3 is to be referred to. For the voltage transient, see 4-3-5/1.7.2(c).

ii) The induced over-voltage withstand test (layer test) is also to be carried out in accordance with the standard applicable to the transformers in the presence of the Surveyor. This test is intended to verify the power-frequency withstand strength along the winding under test and between its phase (strength between turns and between layers in the windings). If the induced over-voltage withstand test is not specified in the applicable standard, IEC 60076-3 is to be referred to.

1.11.3(f) Nameplate. (2002) In addition to the requirements in 4-3-4/Table 4c, the following information is also to be indicated on the nameplate:

- Applicable standard
- Short duration power frequency withstand voltage for verification of insulation level of each winding

1.11.4 Cables *(2003)*

1.11.4(a) Standards. Cables are to be constructed to IEC Publication 60092-353, 60092-354, or other equivalent recognized standard. See also 4-3-4/13.1.

3 Electric Propulsion System

3.1 General *(2007)*

3.1.1 Application

The following requirements in this sub-section are applicable to the electric propulsion system. The electric propulsion system complying with any other recognized standard will be considered. Unless stated otherwise, electric propulsion equipment and systems are to comply with the applicable requirements in other parts of Part 4, Chapter 3, as well.

3.1.2 Plans and Data to be Submitted

In addition to the plans and data to be submitted in accordance with 4-3-2/1, 4-3-3/1, and 4-3-4/1, the following plans and data are to be submitted for review.

- One line diagrams of propulsion control system for power supply, circuit protection, alarm, monitoring, safety and emergency shutdown systems, including list of alarm and monitoring points.
- Plans showing the location of propulsion controls and its monitoring stations.
- Arrangements and details of the propulsion control console or panel including schematic diagram of the system therein.
- Arrangements and details of electric coupling.
- Arrangements and details of the semiconductor converters enclosure for propulsion system including data for semiconductor converter, cooling system with its interlocking arrangement.

3.3 System Design *(2007)*

3.3.1 General

For the purposes of the electric propulsion system requirements, an integrated electric propulsion system is a system where a common set of generators supply power to the vessel service loads as well as the propulsion loads.

3.3.2 Generating Capacity

For vessels with an integrated electric propulsion system, under normal sea-going conditions, when one generator is out of service, the remaining generator capacity is to be sufficient to carry all of the loads for vessel services (essential services, normal services and for minimum comfortable conditions of habitability) and the propulsion loads to provide for a speed of not less than 7 knots or one half of the design speed, whichever is the lesser.

3.3.3 Power Management System

For vessels with an integrated electric propulsion system, a power management system is to be provided. The power management system is to be designed to control load sharing between generators, prevent blackouts, maintain power to the essential service loads and maintain power to the propulsion loads.

The system is to account for the following operating scenarios.

- All generators in operation, then the loss of one generator
- When at least one generator is not in operation and there is an increase in the propulsion loads, or a loss of one of the generators, that would result in the need to start a generator that was not in operation.

Further, the system is to prevent overloading the generators, by reducing the propulsion load or load shedding of non essential loads. In general, the system is to limit power to the propulsion loads to maintain power to the vessel's essential service loads. However, the system is to shed non essential loads to maintain power to the propulsion loads.

An audible and visible alarm is to be installed at each propulsion control location and is to be activated when the system is limiting the propulsion power in order to maintain power to the other essential service loads.

3.3.4 Regenerative Power

For systems where regenerative power may be developed through the semiconductor converters, the regenerative power is not to cause disturbances in the system voltage and frequency which exceeds the limits of 4-3-1/9. See also 4-3-5/3.17.4(a) and 4-3-5/3.17.4(e).

3.3.5 Harmonics

A harmonic distortion calculation is to be submitted for review for all vessels with electric propulsion. The calculation is to indicate that the harmonic distortion levels at all locations throughout the power distribution system (main generation switchboard, downstream power distribution switchboards, etc.) are within the limits of 4-3-2/7.9. The harmonic distortion levels at dedicated propulsion buses are also to be within the limits of 4-3-2/7.9, otherwise documentation from the manufacturer is to be submitted indicating that the equipment is designed for operation at a higher level of distortion.

3.5 Propulsion Power Supply Systems

3.5.1 Propulsion Generators

3.5.1(a) Power Supply. The power for the propulsion equipment may be derived from a single generator. If a drilling unit main service generator is also used for propulsion purposes other than for boosting the propulsion power, such generator and power supply circuits to propulsion systems are also to comply with the applicable requirements in this subsection. See also 4-3-2/3.1.4.

3.5.1(b) Single System. If a propulsion system contains only one generator and one motor and cannot be connected to another propulsion system, more than one exciter set is to be provided for each machine. However, this is not necessary for self-exited generators or for multi-propeller propulsion units where any additional exciter set may be common for the drilling unit.

3.5.1(c) Multiple Systems. Systems having two or more propulsion generators, two or more semiconductor converters, or two or more motors on one propeller shaft are to be so arranged that any unit may be taken out of service and disconnected electrically without preventing the operation of the remaining units.

3.5.1(d) Excitation Systems. Arrangements for electric propulsion generators are to be such that propulsion can be maintained in case of failure of an excitation system or failure of a power supply for an excitation system. Propulsion may be at reduced power under such conditions where two or more propulsion generators are installed, provided such reduced power is sufficient to provide for a speed of not less than 7 knots or $^1/_2$ of the design speed, whichever is the lesser.

3.5.1(e) Features for Other Services. If the propulsion generator is used for purposes other than for propulsion, such as dredging, cargo oil pumps and other special services, overload protection in the auxiliary circuit and means for making voltage adjustments are to be provided at the control board. When propulsion alternating-current generators are used for other services for operation in port, the port excitation control is to be provided with a device that is to operate just below normal idling speed of the generator to remove excitation automatically.

3.5.2 Propulsion Excitation

3.5.2(a) Excitation Circuits. Every exciter set is to be supplied by a separate feeder. Excitation circuits are not to be fitted with overload circuit-interrupting devices, except those intended to function in connection with the protection for the propulsion generator. In such cases, the field circuit breaker is to be provided with a discharge resistor, unless a permanent discharge resistor is provided.

3.5.2(b) Field Circuits. Field circuits are to be provided with means for suppressing voltage rise when a field switch is opened. Where fuses are used for excitation circuit protection, it is essential that they do not interrupt the field discharge resistor circuit upon rupturing.

3.5.2(c) Drilling Unit's Service Generator Connection. Where the excitation supply is obtained from the drilling unit's service generators, the connection is to be made to the generator side of the generator circuit breaker with the excitation supply passing through the overload current device of the breaker.

3.5.3 Semiconductor Converters *(1999)*

Semiconductor converter circuits are to be able to withstand the transient overcurrents to which the system is subject during maneuvering.

3.5.3(a) Where semiconductor converters are connected in parallel, the current for each semiconductor is to be equally distributed as far as practicable. If several elements are connected in parallel and a separate fan is fitted for each parallel branch, arrangements are to be made for disconnecting the circuit for which ventilation is not available.

3.5.3(b) Where semiconductor converters are in series, the voltage between the semiconductor devices are to be equally distributed as far as practicable.

3.5.3(c) In case of failure of the cooling system, an alarm is to be given or the current is to be reduced automatically.

3.7 Circuit Protection

3.7.1 Setting

Overcurrent protective devices, if any, in the main circuits are to be set sufficiently high so as not to operate on overcurrents caused by maneuvering or normal operation in heavy seas or in floating broken ice.

3.7.2 Direct-current (DC) Propulsion Circuits

3.7.2(a) Circuit Protection. Direct-current propulsion circuits are not to have fuses. Each circuit is to be protected by overload relays to open the field circuits or by remote-controlled main-circuit interrupting devices. Provision is to be made for closing circuit breakers promptly after opening.

3.7.2(b) Protection for Reversal of the Rotation. Where separately driven DC generators are connected electrically in series, means shall be provided to prevent reversal of the rotation of a generator upon failure of the driving power of its prime mover.

3.7.3 Excitation Circuits

An overload protection is not to be provided for opening of the excitation circuit.

3.7.4 Reduction of Magnetic Fluxes

Means are to be provided for selective tripping or rapid reduction of the magnetic fluxes of the generators and motors so that overcurrents do not reach values which may endanger the plant.

3.7.5 Semiconductor Converters

3.7.5(a) Overvoltage Protection. Means are to be provided to prevent excessive overvoltages in a supply system to which converters are connected. Visual and audible alarms are to be provided at the control station for tripping of the protective fuses for these devices.

3.7.5(b) Overcurrent Protection. Arrangements are to be made so that the permissible current of semiconductor elements cannot be exceeded during normal operation.

3.7.5(c) Short-circuit Protection. Fuses are to be provided for protection of short-circuit of semiconductor converters. Visual and audible alarms are to be provided at the control station for tripping of these semiconductor protective fuses. In case of blown fuse, the respective part of the plants is to be taken out of operation.

3.7.5(d) Filter Circuits. Fuses are to be provided for filter circuits. Visual and audible alarms are to be provided at the control station for tripping of the fuse.

3.7.6 Direct-current (DC) Propulsion Motors Supplied by Semiconductor Converters *(2008)*

The protection features of the semiconductor converters are to be arranged to avoid a damaging flashover in the DC propulsion motor. A possible cause of a damaging flashover would be removal of the field current. The protection features of the semiconductor converters are to take into account the increase in armature current created by the removal of the field current, due to accidental loss of the field, or activation of a protection feature intended to protect the field.

To verify compliance with the above, the maximum time-current characteristics that can be commutated by the motor as well as the time-current characteristics of the protective features of the semiconductor converters are to be submitted for review. To avoid a damaging flashover, the maximum time-current characteristics of the motor is to be provided by the motor manufacturer and is to be used by the semiconductor converter manufacturer to determine the appropriate set points for the protection features of the semiconductor converters.

3.9 Protection for Earth Leakage

3.9.1 Main Propulsion Circuits

Means for earth leakage detection are to be provided for the main propulsion circuit and be arranged to operate an alarm upon the occurrence of an earth fault. When the fault current flowing is liable to cause damage, arrangements for opening the main propulsion circuit are also to be provided.

3.9.2 Excitation Circuits

Means are to be provided for earth leakage detection in excitation circuits of propulsion machines but may be omitted in circuits of brushless excitation systems and of machines rated up to 500 kW.

3.9.3 Alternating-current (AC) Systems

Alternating-current propulsion circuits are to be provided with an earthing detector alarm or indicator. If the neutral is earthed for this purpose, it is to be through an arrangement which will limit the current at full-rated voltage so that it will not exceed approximately 20 amperes upon a fault to earth in the propulsion system. An unbalance relay is to be provided which is to open the generator and motorfield circuits upon the occurrence of an appreciable unbalanced fault.

3.9.4 Direct-current (DC) Systems

The earthing detector may consist of a voltmeter or lights. Provision is to be made for protection against severe overloads, excessive currents and electrical faults likely to result in damage to the plant. Protective equipment is to be capable of being so set as not to operate on the overloads or overcurrents experienced in a heavy seaway or when maneuvering.

3.11 Electric Propulsion Control

3.11.1 General

Failure of a control signal is not to cause an excessive increase in propeller speed. The reference value transmitters in the control stations and the control equipment are to be so designed that any defect in the desired value transmitters or in the cables between the control station and the propulsion system will not cause a substantial increase in the propeller speed.

3.11.2 Automatic and Remote Control Systems

Where two or more control stations are provided outside of the engine room, or where automatic control of the propulsion machinery is provided, Part 4, Chapter 9 of the *Steel Vessel Rules*, as applicable, are to be complied with. See 4-9-1/3 of the *Steel Vessel Rules* for propulsion class symbols.

3.11.3 Testing and Inspection

Controls for electric propulsion equipment are to be inspected when finished and dielectric strength tests and insulation resistance measurements made on the various circuits in the presence of the Surveyor, preferably at the plant of manufacture. The satisfactory tripping and operation of all relays, contactors and the various safety devices are also to be demonstrated.

3.11.4 Initiation of Control

The control of the propulsion system can be activated only when the delegated control lever is in zero position and the system is ready for operation.

3.11.5 Emergency Stop

Each control station shall have an emergency stop device which is independent of the control lever.

3.11.6 Prime Mover Control

Where required by the system of control, means are to be provided at the control assembly for controlling the prime mover speed and for mechanically tripping the throttle valve.

3.11.7 Control Power Failure

If failure of the power supply occurs in systems with power-aided control (e.g., with electric, pneumatic or hydraulic aid), it is to be possible to restore control in a short time.

3.11.8 Protection

Arrangements are to be made so that opening of the control system assemblies or compartments will not cause inadvertent or automatic loss of propulsion. Where steam and oil gauges are mounted on the main-control assembly, provision is to be made so that the oil will not come in contact with the energized parts in case of leakage.

3.11.9 Interlocks

All levers for operating contactors, line switches, field switches and similar devices are to be interlocked to prevent their improper operation. Interlocks are to be provided with the field lever to prevent the opening of any main circuits without first reducing the field excitation to zero, except that when the generators simultaneously supply power to an auxiliary load apart from the propulsion, the field excitation need only be reduced to a low value.

3.13 Instrumentation at the Control Station

3.13.1 Indication, Display and Alarms

The necessary instruments to indicate existing conditions at all times are to be provided and mounted on the control panel convenient to the operating levers and switches. Instruments and other devices mounted on the switchboard are to be labeled and the instruments provided with a distinguishing mark to indicate full-load conditions. Metallic cases of all permanently installed instruments are to be permanently earthed. The following instruments, where applicable, are to be provided.

3.13.1(a) For AC Systems (1997). Ammeter, voltmeter, indicating wattmeter, and field ammeter* for each propulsion generator and for each synchronous motor.

3.13.1(b) For DC Systems. An ammeter for each main circuit and one or more voltmeters with selector switches for reading voltage on each propulsion generator and motor.

3.13.1(c) For Electric Slip Couplings. An ammeter for the coupling excitation circuit.

* Field ammeter is not required for brushless generators.

3.13.2 Indication of Propulsion System Status

The control stations of the propulsion systems are to have at least the following indications for each propeller.

3.13.2(a) "Ready for Operation". Power circuits and necessary auxiliaries are in operation.

3.13.2(b) "Faulty". Propeller is not controllable.

3.13.2(c) "Power Limitation". In case of disturbance, for example, in the ventilators for propulsion motors, in the converters, cooling water supply or load limitation of the generators.

3.15 Equipment Installation and Arrangement

3.15.1 General

The arrangement of bus bars and wiring on the back of propulsion-control assemblies is to be such that all parts, including the connections, are accessible. All nuts and connections are to be fitted with locking devices to prevent loosening due to vibration. Clearance and creepage distance are to be provided between parts of opposite polarity and between live parts and earth to prevent arcing. See 4-3-1/19, 4-3-4/7.11.6 and 4-3-5/1.11.2(d).

3.15.2 Accessibility and Facilities for Repairs

3.15.2(a) Accessibility. For purposes of inspection and repair, provision is to be made for access to the stator and rotor coils, and for the withdrawal and replacement of field coils. Adequate access is to be provided to permit resurfacing of commutators and slip-rings, as well as the renewal and bedding of brushes.

3.15.2(b) Facility for Supporting. Facilities shall be provided for supporting the shaft to permit inspection and withdrawal of bearings.

3.15.2(c) Slip-couplings. Slip-couplings are to be designed to permit removal as a unit without axial displacement of the driving and driven shaft, and without removing the poles.

3.15.3 Semiconductor Converters *(1999)*

Converters are to be installed away from sources of radiant energy in locations where the circulation of air is not restricted to and from the converter, and where the temperature of the inlet air to air-cooled converters will not exceed that for which the converter is designed. Immersed-type converters are to use a nonflammable liquid. Converter stacks are to have a protection of at least IP22 for installations 1 kV or less and IP23 for installations above 1 kV, and mounted in such a manner that they may be removed without dismantling the complete unit.

3.15.4 Propulsion Cables

Propulsion cables are not to have splices or joints, except terminal joints, and all cable terminals are to be sealed against the admission of moisture or air. Similar precautions are to be taken during installation by sealing all cable ends until the terminals are permanently attached. Cable supports are to be designed to withstand short-circuited conditions. They are to be spaced less than 915 mm (36 in.) apart and are to be arranged to prevent chafing of the cable. See 4-3-3/5.9.1.

3.17 Machinery and Equipment

3.17.1 Material Tests

The following materials intended for main propulsion installation are to be tested in accordance with the requirements of Chapter 3 of the ABS *Rules for Materials and Welding (Part 2)*: thrust shafts, line shafts, propeller shafts, shafting for propulsion generators and motors, coupling bolts, and in the case of direct-connected turbine-driven propulsion generators, fan shrouds, centering and retaining rings. Major castings or built-up parts such as frames, spiders and end shields are to be surface-inspected and the welding is to be in accordance with requirements of Chapter 4 of the above referenced Part 2.

3.17.2 Temperature Rating

When generators, motors or slip-couplings for electric propulsion are fitted with an integral fan and will be operated at speeds below the rated speed with full-load torque, full-load current, or full-load excitation, temperature rise limits according to 4-3-4/Table 3 are not to be exceeded.

3.17.3 Protection Against Moisture Condensation

4-3-4/3.13.7 is applicable for rotating machines and converters, regardless of the weight of the machines.

3.17.4 Prime Movers

3.17.4(a) Capability. The prime mover rated output are to have adequate overloading and build-up capacity for supplying the power which is necessary during transitional changes in operating conditions of the electrical equipment. When maneuvering from full propeller speed ahead to full propeller speed astern with the unit making full way ahead, the prime mover is be capable of absorbing a proportion of the regenerated power without tripping due to overspeed.

3.17.4(b) Speed Control. Prime movers of any type are to be provided with a governor capable of maintaining the preset steady speed within a range not exceeding 5% of the rated full-load speed for load changes from full-load to no-load.

3.17.4(c) Manual Controls. Where the speed control of the propeller requires speed variation of the prime mover, the governor is to be provided with means for local manual control as well as for remote control. For turbines driving AC propulsion generators, where required by the system of control, the governor is to be provided with means for local hand control as well as remote adjustment from the control station.

3.17.4(d) Parallel Operation. In case of parallel operation of generators, the governing system is to permit stable operation to be maintained over the entire operational speed range of the prime movers.

3.17.4(e) Protection for Regenerated Power. Braking resistors or ballast consumers are to be provided to absorb excess amounts of regenerated energy and to reduce the speed of rotation of the propulsion motor. These braking resistors or ballast consumers are to be located external to the mechanical and electric rotating machines. Alternatively, the amount of regenerated power may be limited by the action of the control system.

3.17.5 Rotating Machines for Propulsion

The following requirements are applicable to propulsion generators and propulsion motors.

3.17.5(a) Ventilation and Protection. Electric rotating machines for propulsion are to be enclosed ventilated or be provided with substantial wire or mesh screen to prevent personnel injury or entrance of foreign matter. Dampers are to be provided in ventilating air ducts, except when recirculating systems are used.

3.17.5(b) Fire-extinguishing Systems. Electric rotating machines for propulsion which are enclosed or in which the air gap is not directly exposed are to be fitted with fire-extinguishing systems suitable for fires in electrical equipment. This will not be required where it can be established that the machinery insulation is self-extinguishing.

3.17.5(c) Air Coolers (2004). Air cooling systems for propulsion generators are to be in accordance with 4-6-5/7.7.1 and 4-6-5/7.5 of the *Steel Vessel Rules*. Water-air heat exchangers of rotating propulsion machines for single systems (single generator and single motor), as specified in 4-3-5/3.5.1(b), are to have double wall tubes and be fitted with a leak detector feature to monitor for any water leakage. A visual and audible alarm is to be provided at a normally manned location to indicate such water leakage.

3.17.5(d) Temperature Sensors (1997). Stator windings of AC machines and interpole windings of DC machines, rated above 500 kW, are to be provided with temperature sensors.

3.17.6 Propulsion Generators

Excitation current for propulsion generators may be derived from attached rotating exciters, static exciters, excitation motor-generator sets or special purpose generating units. Power for these exciters may be derived from the machine being excited or from any drilling unit main service, emergency or special purpose generating units.

3.17.7 Direct-current (DC) Propulsion Motors

3.17.7(a) Rotors. The rotors of DC propulsion motors are to be capable of withstanding overspeeding up to the limit reached in accordance with the characteristics of the overspeed protection device at its normal operational setting.

3.17.7(b) Overspeed Protection. An overspeed protection device is to be provided to prevent excessive overspeeding of the propulsion motors due to light loads, loss of propeller, etc.

3.17.8 Electric Couplings

3.17.8(a) General. Couplings are to be enclosed ventilated or be provided with wire or mesh screen to prevent personnel injury or the entrance of foreign material. All windings are to be specially treated to resist moisture, oil and salt air.

3.17.8(b) Accessibility for Repairs. The coupling is to be designed to permit removal as a unit without moving the engine. See also 4-3-5/3.15.2(a).

3.17.8(c) Temperature Rating. The limits of temperature rise are to be the same as for alternating-current generators given in 4-3-4/Table 3, except that when a squirrel-cage element is used, the temperature of this element may reach such values as are not injurious. Depending upon the cooling arrangements, the maximum temperature rise may occur at other than full-load rating so that heat runs will require special consideration. For this purpose, when an integral fan is fitted, the coupling temperatures are not to exceed the limits in 4-3-4/Table 3 when operated continuously at 70% of full-load rpm, full excitation and rated torque. Temperature rises for insulation materials above 180°C (356°F) will be considered in accordance with 4-3-1/13.11.

3.17.8(d) Excitation. Excitation is to be provided as required for propulsion generators. See 4-3-4/3.21.1, 4-3-4/3.23.1 and 4-3-5/3.17.6.

3.17.8(e) Control Equipment. Electric-coupling control equipment is to be combined with the prime mover speed and reversing control and is to include a two-pole disconnect switch, short-circuit protection only, ammeter for reading coupling current, discharge resistor and interlocking to prevent energizing the coupling when the prime mover control levers are in an inappropriate position.

3.17.8(f) Nameplates. Nameplates of corrosion-resistant material are to be provided in an accessible position of the electric coupling and are to indicate at least the information as listed in 4-3-5/Table 1.

3.17.9 Semiconductor Converters for Propulsion *(2007)*

3.17.9(a) General. In general, semiconductor converters are to comply with the requirements of a relevant industry standard, such as the IEC 60146 Series. Design of the cooling systems is to apply the ambient air temperature of 45°C and ambient sea water temperature of 32°C.

3.17.9(b) Testing and Inspection. Semiconductor converters for propulsion systems are to be tested to the type test requirements of the relevant standard, in the presence of and inspected by the Surveyor, preferably at the plant of the manufacturer. If the standard is the IEC 60146 Series, then type tests are to include the Insulation Test, Light Load & Function Test, Rated Current Test, Power Loss, Temperature Rise Test and checking the Auxiliary Devices, Properties of the Control Equipment and Protective Devices. Duplicate units of previously tested semiconductor converters are to be tested to the routine test requirements of the relevant standard, in the presence of and inspected by the Surveyor, preferably at the plant of the manufacturer. If the standard is the IEC 60146 Series, then the Routine Tests are to include the Insulation Test and Light Load & Function Test and checking the Auxiliary Devices, Properties of the Control Equipment and Protective Devices.

3.17.9(c) Forced Cooling. Semiconductor converters that are provided with forced ventilation or forced water cooling are to be provided with a means for monitoring the cooling system, such as cooling medium temperature. In case of failure of the cooling system, an audible and visible alarm is to be initiated at the propulsion motor control position and the current should be reduced automatically to avoid overheating.

3.17.9(d) Additional requirements for water cooled converters. Semiconductor converters that are provided with water cooling are to be provided with a means to detect leakage. In case of leakage, an audible and visible alarm is to be initiated at the propulsion motor control position. Further, means to contain any leakage are to be provided so that the water does not cause a failure of the converter or any other electrical equipment located near the converter.

3.17.10 Reactors and Transformers for Semiconductor Converters *(1997)*

3.17.10(a) General. Interphase reactors and transformers used with semiconductor converters are to conform with the requirements of 4-3-4/9.1.1, 4-3-4/9.1.2(c), 4-3-4/9.3, 4-3-4/9.5.1 and 4-3-4/9.5.2, and the following.

3.17.10(b) Voltage Regulation. Means to regulate transformer output voltage are to be provided to take care of the increase in converter forward resistance and, in addition, to obtain the necessary performance characteristics of the converter unit in which the transformer is used.

3.17.10(c) High Temperature Alarm. Interphase reactors and transformers used with the semiconductor converters for main and auxiliary propulsion systems are to be provided with high temperature alarm at the switchboard or the propulsion control station. The setting value of the alarm is to be determined by their specific insulation class and is not to exceed the temperature corresponding to the limit listed in 4-3-4/Table 8.

3.17.11 Switches

3.17.11(a) General Design. All switches are to be arranged for manual operation and so designed that they will not open under ordinary shock or vibration. Contactors, however, may be operated pneumatically, by solenoids or other means in addition to the manual method which is to be provided, unless otherwise approved.

3.17.11(b) Generator and Motor Switches. Switches for generators and motors are preferably to be of the air-break type, but for alternating-current systems where they are to be designed to open full-load current at full voltage, oil-break switches using nonflammable liquid may be used if provided with leak-proof, non-spilling tanks.

3.17.11(c) Field Switches. Where necessary, field switches are to be arranged for discharge resistors unless discharge resistors are permanently connected across the field. For alternating-current systems, means are to be provided for de-energizing the excitation circuits by the unbalance relay and earth relay.

3.17.12 Propulsion Cables

3.17.12(a) Conductors. The conductors of cables external to the components of the propulsion plant, other than cables and interconnecting wiring for computers, data loggers or other automation equipment requiring currents of very small value, are to consist of not less than seven strands and have a cross-sectional area of not less than 1.5 mm^2 (2,960 circ. mils).

3.17.12(b) Insulation Materials. Ethylene-propylene rubber, cross-linked polyethylene, or silicone rubber insulated cables are to be used for propulsion power cables, except that polyvinyl chloride insulated cables may be used where the normal ambient temperature will not exceed 50°C (122°F).

3.17.12(c) Braided Metallic Armor and Impervious Metallic Sheaths (1998). Propulsion cables need not have braided metallic armor nor impervious metallic sheaths. Where metallic sheaths are provided, they are not to be used with single alternating current cables.

3.17.12(d) Inner Wiring. The insulation of internal wiring in main control gear, including switchboard wiring, shall be of flame-retardant quality.

3.17.12(e) Testing. All propulsion cables other than internal wiring in control gears and switchboards are to be subjected to dielectric and insulation tests in the presence of the Surveyor.

3.19 Dock and Sea Trials

Complete tests are to be carried out, including duration runs and tests for operation of all protective devices and stability tests for control, and if the drilling unit is self-propelled, maneuvering tests which should include a reversal of the drilling unit from full speed ahead to full speed astern. All tests necessary to demonstrate that each item of plant and the system as a whole are satisfactory for duty are to be performed. Immediately prior to trials, the insulation resistance is to be measured and recorded.

5 Three-wire Dual-voltage DC System

5.1 Three-wire DC Drilling Unit's Generators

Separate circuit-breaker poles are to be provided for the positive, negative, neutral and also for the equalizer leads unless protection is provided by the main poles. When equalizer poles are provided for the three-wire generators, the overload trips are to be of the algebraic type. No overload trip is to be provided for the neutral pole, but it is to operate simultaneously with the main poles. A neutral overcurrent relay and alarm system is to be provided and set to function at a current value equal to the neutral rating.

5.3 Neutral Earthing

5.3.1 Main Switchboard

The neutral of three-wire dual-voltage direct-current systems is to be solidly earthed at the generator switchboard with a zero-center ammeter in the earthing connection. The zero-center ammeter is to have a full-scale reading of 150% of the neutral-current rating of the largest generator and be marked to indicate the polarity of earth. The earth connection is to be made in such a manner that it will not prevent checking the insulation resistance of the generator to earth before the generator is connected to the bus. The neutrals of three-wire DC emergency power systems are to be earthed at all times when they are supplied from the emergency generator or storage battery. The earthed neutral conductor of a three-wire feeder is to be provided with a means for disconnecting and is to be arranged so that the earthed conductor cannot be opened without simultaneously opening the unearthed conductors.

5.3.2 Emergency Switchboard

No direct earth connection is to be provided at the emergency switchboard. The neutral bus or buses are to be solidly and permanently connected to the neutral bus of the main switchboard. No interrupting device is to be provided in the neutral conductor of the bus-tie feeder connecting the two switchboards.

5.5 Size of Neutral Conductor

The capacity of the neutral conductor of a dual-voltage feeder is to be 100% of the capacity of the unearthed conductors.

7 Systems Associated with Drilling Operations

7.1 Emergency Shutdown Facilities

7.1.1 Shutdown Arrangements

Arrangements are to be provided for the disconnection or shutdown, either selectively or simultaneously, of all electrical equipment and devices, including the emergency generator, except for the services listed under 4-3-5/7.1.2 from the emergency control station (see 5-3-1/7). Initiating of the above shut-downs may vary according to the nature of the emergency. A recommended sequence of shut-downs is to be provided in the unit's operating manual.

7.1.2 Operation After Shutdown

The following services are to be operable after an emergency shutdown:

i) Emergency lighting required by 4-3-2/5.3ii) and 4-3-2/5.3vii) for half an hour

ii) General alarm

iii) Blow-out preventer control system

iv) Public address system

v) Distress and safety radiocommunications

All equipment in exterior locations which is capable of operation after shutdown is to be suitable for installation in Zone 2 locations.

TABLE 1
Nameplates

a. Electric Coupling [See 4-3-5/3.17.8(e)]

The manufacturer's name
The manufacturer's type and frame designation
The output
Kind of rating
The temperature rise at rated load and design ambient temperature
The speed (r.p.m.) at rated load
The rated voltage
The exciter rated voltage
The Exciting current in amperes at rating

b. Semiconductor Converter [See 4-3-5/3.17.9(g)]

The manufacturer's name and address
The manufacturer's serial number
The type (silicon, copper oxide, etc.)
The rated AC volts
The rated AC amperes
Number of phases
Frequency
The rated DC volts
The rated DC amperes
The ambient temperature range
The cooling medium

PART

4

CHAPTER **3 Machinery, Equipment and Their Installation**

SECTION **6 Hazardous Areas**

1 Definitions

1.1 Hazardous Areas

Hazardous areas are all those areas where a flammable atmosphere may be expected to exist continuously or intermittently. Such flammable atmospheres may arise from drilling or well test operations, other operations such as use and storage of flammable liquids, pain and acetylene, or any such operation pertinent to the particular service of the unit. Hazardous areas are subdivided into Zones 0, 1, 2, defined as follows:

- *Zone 0* A zone in which an explosive gas-air mixture is continuously present or present for long periods.
- *Zone 1* A zone in which an explosive gas-air mixture is likely to occur in normal operating conditions.
- *Zone 2* A zone in which an explosive gas-air mixture is not likely to occur, and if it occurs, it will exist only for a short time.

1.3 Enclosed Space

An enclosed space is considered to be a space bounded by decks and bulkheads which may or may not have doors, windows or other similar openings.

1.5 Semi-Enclosed Location

A semi-enclosed location is considered to be a location where natural conditions of ventilation are notably different from those on open decks due to the presence of structure such as roofs, windbreaks and bulkheads and which are arranged so that the dispersion of gas may not occur.

3 Classification of Areas

The following hazardous areas are those which normally apply to offshore drilling units engaged in oil or gas exploration. Hazardous areas as specified may be extended or reduced depending on the actual arrangements in each case by use of windshields, special ventilation arrangements, structural arrangements (e.g., low deck head), etc. Hazardous areas arising from well testing equipment will be specially considered [See 1-1-8/1.15 of the ABS *Rules for Classification of Offshore Units and Structures (Part 1)*].

3.1 Hazardous Areas Zone 0 Include:

i) The internal spaces of closed tanks and pipes of the mud circulating system between the well and the final degassing discharge, e.g., escape gas outlets,

ii) The internal spaces of closed pipes and tanks for oil and gas products,

iii) Other spaces in which an oil-gas mixture is present, continuously or for long periods.

3.3 Hazardous Areas Zone 1 Include:

i) Enclosed spaces containing any part of the mud circulating system that has an opening into the spaces and is between the well and the final degassing discharge.

ii) Outdoor or semi-enclosed locations within 1.5 m (5 ft) from the following: openings to equipment which is part of the mud system, as specified in 4-3-6/3.3i); any ventilation outlets from Zone 1 spaces; and any access to Zone 1 spaces, except where 4-3-6/5.1 or 4-3-6/5.5 applies.

iii) Pits, ducts or similar structures in locations which otherwise would be Zone 2 but which are arranged so the dispersion of gas may not occur.

iv) Enclosed spaces or semi-enclosed locations that are below the drill floor and contain a possible source of release of gas such as the top of a drilling nipple.

v) Enclosed spaces that are on the drill floor and which are not separated by a solid floor from the spaces in 4-3-6/3.3iv).

3.5 Hazardous Areas Zone 2 Include:

i) Enclosed spaces which contain open sections of the mud circulating system from the final degassing discharge to the mud pump suction connection at the mud pit.

ii) Outdoors locations within the boundaries of the drilling derrick up to a height of 3 m (10 ft) above the drill floor.

iii) To the extent of their enclosure, semi-enclosed locations that are on the drill floor and which are not separated by a solid floor from the spaces in 4-3-6/3.3iv).

iv) Semi-enclosed derricks to the extent of their enclosures above the drill floor or to a height of 3 m (10 ft) above the drill floor, whichever is greater.

v) Semi-enclosed locations below and contiguous with the drill floor and to the boundaries of the derrick or to the extent of any enclosure which is liable to trap gases.

vi) Outdoor locations below the drill floor and within a radius of 3 m (10 ft) from a possible source of release gas such as the top of a drilling nipple.

vii) The areas 1.5 m (5 ft) beyond the Zone 1 areas specified in 4-1-3/3.3ii) and beyond the semi-enclosed locations specified in 4-3-6/3.3iv).

viii) Outdoor locations within 1.5 m (5 ft) of the boundaries of any ventilation outlet from Zone 2 spaces, or any access to Zone 2 spaces, except where 4-3-6/5.3 applies.

ix) *(1995)* Air lock spaces between Zone 1 and non-hazardous space, in accordance with 4-3-6/5.5i).

5 Openings, Access, and Ventilation Conditions Affecting the Extent of Hazardous Zones

Except for operational reasons, access doors or other openings are not to be provided between a non-hazardous space and a hazardous zone, nor between a Zone 2 space and a Zone 1 space.

Where such access doors or other openings are provided, any enclosed pace not referred to under 4-3-6/3.3 or 4-3-6/3.5 and having a direct access to any Zone 1 location or Zone 2 location becomes the same zone as the location, except that:

5.1 Enclosed Space with Direct Access to any Zone 1 Location

An enclosed space with direct access to any Zone 1 location is considered as Zone 2, provided: (see also 4-3-6/Figure 1):

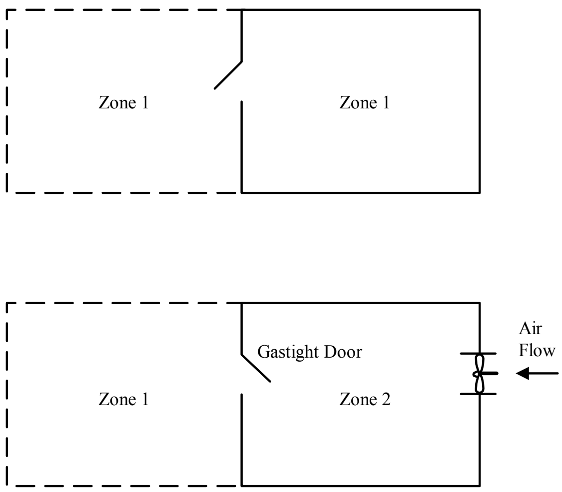
i) The access is fitted with a gas-tight door opening into the zone 2 space, and

ii) Ventilation is such that the air flow with the door open is from the zone 2 space into the zone 1 location, and

iii) Loss of ventilation is alarmed at a normally manned station;

FIGURE 1 Hazardous Zones

Broken lines represent open, semi-enclosed, or enclosed zone.



Note: Loss of ventilation is to be alarmed at a normally manned station

5.3 Enclosed Space with Direct Access to any Zone 2 Location

An enclosed space with direct access to any Zone 2 location is not considered hazardous, provided (see also 4-3-6/Figure 2):

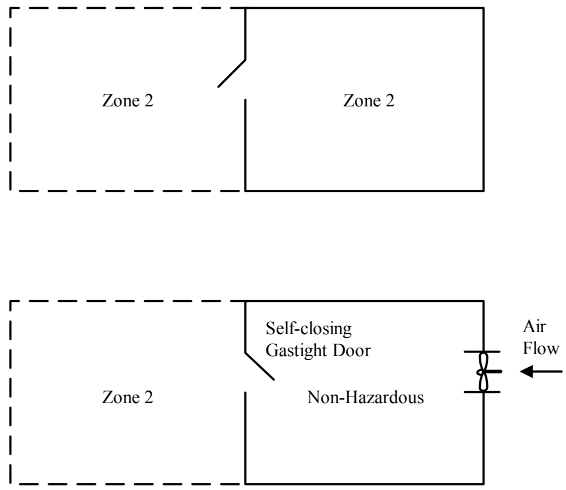
i) The access is fitted with self-closing gas-tight door that opens into the non-hazardous space, and

ii) Ventilation is such that the air flow with the door open is from the non-hazardous space into the Zone 2 locations, and

ii) Loss of ventilation is alarmed at a normally manned station.

FIGURE 2
Hazardous Zones

Broken lines represent open, semi-enclosed, or enclosed zone.



Note: Loss of ventilation is to be alarmed at a normally manned station

5.5 Enclosed Space with Access to any Zone 1 Location

An enclosed space with access to any Zone 1 location is not considered hazardous, provided (see also 4-3-6/Figure 3):

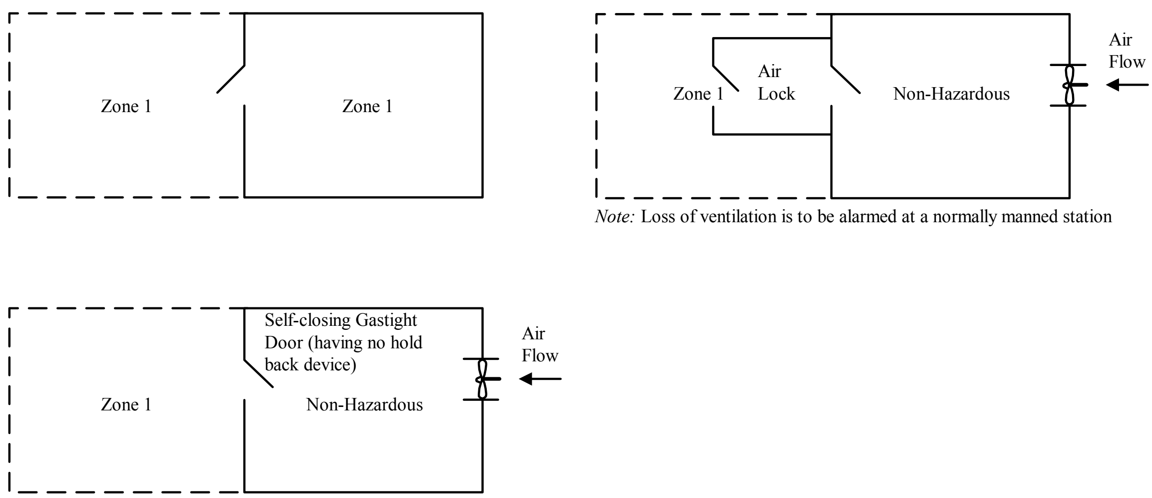
i) The access is fitted with gas-tight self-closing doors forming an air lock, or a single self-closing gas-tight door which opens toward the non-hazardous space and has no hold-back device,

ii) Ventilation is such that the air flow with the door or air lock doors open is from the non-hazardous space into the Zone 1 location (i.e., non-hazardous space has ventilation overpressure in relation to the Zone 1 location), and

iii) Loss of ventilation overpressure is alarmed at a normally manned station.

FIGURE 3
Hazardous Zones

Broken lines represent open, semi-enclosed, or enclosed zone.



Note: Loss of ventilation is to be alarmed at a normally manned station

7 Ventilation

7.1 General

Attention is to be given to ventilation inlet and outlet locations and airflow in order to minimize the possibility of cross contamination. Ventilation inlets are to be located in non-hazardous areas. Ventilation for hazardous areas is to be completely separate from that for non-hazardous areas.

7.3 Ventilation of Hazardous Areas

Enclosed hazardous spaces are to be provided with ventilation so as to maintain them at a lower pressure than less hazardous zones. The arrangement of ventilation inlet and outlet openings in the space is to be such that the entire space is efficiently ventilated, giving special consideration to location of equipment which may release gas and to spaces where gas may accumulate. Enclosed hazardous spaces containing open active mud tanks are to be ventilated with high capacity mechanical venting systems capable of changing the air every two minutes. The outlet air from Zone 1 and Zone 2 spaces is to be led in separate ducts to outdoor locations which in the absence of the considered outlet are of the same or lesser hazard than the ventilated space. The internal spaces of such ducts are the same Zone as the inlet space. Ventilation ducts for hazardous areas are to be at under pressure in relation to less hazardous areas and at overpressure in relation to more hazardous areas, when passing through such areas, and are to be rigidly constructed to avoid air leaks. Fans are to be of non-sparking construction, in accordance with 4-3-3/9.7.

7.5 Ventilation of Non-hazardous Areas

Ventilation inlets and outlets for non-hazardous spaces are to be located in non-hazardous areas. Where passing through hazardous areas, ducts are to have overpressure in relation to the hazardous area.

9 Machinery Installations

9.1 General

Exhaust outlets of internal combustion engines and boilers are to discharge outside of all hazardous areas. Air intakes are to be not less than 3 m (10 ft) from hazardous areas. Exhaust outlets of internal combustion engines are to be fitted with suitable spark-arresting devices, and exhaust piping insulation is to be protected against possible oil absorption in areas or spaces where the exhausting piping is exposed to oil or oil vapors.

9.3 Hazardous Areas

Internal combustion engines are not to be installed in Zone 0 hazardous areas. When essential for operational purposes, internal combustion engines may be installed in Zone 1 and 2 hazardous areas. Such installations will be subject to special consideration. Fired boilers are not to be installed in hazardous areas.

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