RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

RULES

Part N Ships Carrying Liquefied Gases in Bulk

2016 AMENDMENT NO.1

Rule No.40 30th June 2016

Resolved by Technical Committee on 28th July 2015

Approved by Board of Directors on 14th September 2015

Rule No.40 30th June 2016
AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Rules for the survey and construction of steel ships" has been partly amended as follows:

Part N SHIPS CARRYING LIQUEFIED GASES IN BULK

Chapter 1 has been amended as follows.

Chapter 1 GENERAL

1.1 General

1.1.1 Application (~~with reference~~related to *IGC Code* 1.1.1, 1.1.5~~,~~ ~~and~~ 1.1.7 and 1.1.10)

1 The requirements in this Part apply to ships carrying liquefied gases in bulk intended to be registered and classed with the Society (hereinafter referred to as "ship(s)" in this Part). The term "liquefied gases" means those having absolute vapour pressure exceeding 0.28*MPa* at a temperature of 37.8°C, and other similar flammable products as shown in **Table N19.1**.
2 For ships to be classed for restricted service and ships not provided with propulsive machinery, the requirements may be modified as appropriate.
3 As for hull, machinery and equipment specified in this Part, the requirements in this Part are to take precedence of those in other Parts.
4 Where a ship is intended to carry products covered by this Part and those covered by **Part S** simultaneously or alternately, the ship is to comply with the requirements of both Parts as appropriate to the products carried, except the cases which come under the following **(1)** and **(2)**:
(1) Where the requirements of this Part are to take precedence when a ship is designed and constructed for carriage of cargoes mentioned in **(a)** and **(b)** below;
  (a) those listed exclusively in **Table N19.1** of this Part.
  (b) one or more of the products which are listed in both this Part and **Part S** (these products are marked with an asterisk (*) in column "***a***" in **Table N19.1**).
(2) Where the requirements of **Part S** are to apply when a ship is intended exclusively to carry one or more of products mentioned in the ~~preceding~~ **(1)(b)** above.
5 When a ship is intended to operate for periods at a fixed location in a re-gasification and gas discharge mode or a gas receiving, processing, liquefaction and storage mode, it is necessary to ensure that ths ship complies with the additional requirements established by the Administrations and port Administrations as per the provisions of **1.1.10** of the *IGC* Code.
6 It is necessary to ensure that ships carrying liquefied gases in bulk which are at the beginning stage of construction before 1 July 2016 comply with the regulations effective at the time of their construction.

1.1.2 Equivalency

The construction, equipment, etc. which do not fall under the provisions of this Part but ~~is~~are considered to be equivalent to those required in this Part in accordance with **1.3** of the *IGC* Code will be accepted by the Society.

1.1.3 National Requirements

The Society may make special requirements as instructed by flag-government of ships or the government of sovereign nation in which ships navigate.

1.1.4 ~~Hazards~~Risk Assessment (~~with reference~~related to *IGC Code* 1.1.11~~2~~)

~~Hazards of gases covered by this Part include fire, toxicity, corrosivity, reactivity, low temperature and pressure.~~ Where a risk assessment or study of similar intent is utilized within this Part, the results are also to include, but not be limited to, the following as evidence of effectiveness:

(1) description of methodology and standards applied;
(2) potential variation in scenario interpretation or sources of error in the study;
(3) validation of the risk assessment process by an independent and suitable third party;
(4) quality system under which the risk assessment was developed;
(5) the source, suitability and validity of data used within the assessment;
(6) the knowledge base of persons involved within the assessment;
(7) system of distribution of results to relevant parties; and
(8) validation of results by an independent and suitable third party.

1.1.5 Definitions (~~with reference~~related to *IGC Code* 1.2~~3~~ and *MSC/Circ.*1116)

The following definitions apply in this Part unless expressly provided otherwise.

(1) "Accommodation spaces" means those spaces used for public spaces, corridors, lavatories, cabins, offices, hospitals, cinemas, games and hobby rooms, barber shops, pantries without cooking appliances and similar spaces.

(~~1~~2) " '*A*' class divisions" means divisions as defined in **3.2.2, Part R**.

(~~2~~3) "Administration" means the Government of the State whose flag the ship is entitled to fly. For Administration (port), see port Administration.

~~(3) "Port Administration" means the appropriate authority of the country in the port of which the ship is loading or unloading.~~

(4) "Boiling point" means the temperature at which a product exhibits a vapour pressure equal to the atmospheric pressure.

(5) "Breadth (B_f)" means the maximum breadth of the ship, measured amidships to the moulded line of the frame in a ship with a metal shell, and to the outer surface of the hull in a ship with a shell of any other material. The breadth (B_f) is to be measured in *metres*.

(~~5~~6) "Cargo area" means that part of the ship which contains the cargo containment system and cargo pump and compressor rooms and includes the deck areas over the full length and breadth of the part of the ship over ~~the above-mentioned~~these spaces. Where fitted, the cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the ~~forwardmost~~foremost hold space are excluded from the cargo area.

(~~6~~7) "Cargo containment system" means the arrangement for containment of cargo including, where fitted, a primary and secondary barrier, associated insulation and any intervening spaces, and adjacent structure, if necessary, for the support of these elements. If the secondary barrier is part of the hull structure, it may be a boundary of the hold space.

(~~7~~8) "Cargo control room" means a space used in the control of cargo handling operations ~~and complying with the requirements of **3.4**~~.

(9) "Cargo machinery spaces" means the spaces where cargo compressors or pumps, cargo processing units, are located, including those supplying gas fuel to the engine room.

(10) "Cargo pumps" are pumps used for the transfer of liquid cargo including main pumps, booster pumps, spray pumps, etc.

(~~8~~11) "Cargoes" means products listed in **Table N19.1** carried in bulk by ships subject to the requirements in this Part.

(~~9~~12) "Cargo service spaces" means spaces within the cargo area used for workshops, lockers and storerooms ~~of~~that are more than $2m^2$ in area~~, used for cargo handling equipment~~.

(~~10~~13) "Cargo tank" means the liquidtight shell designed to be the primary container of the cargo and includes all such ~~containers~~containment systems whether or not they are associated with the insulation or/and the secondary barriers ~~or both~~.

(14) "Closed loop sampling" means a cargo sampling system that minimizes the escape of cargo vapour to the atmosphere by returning product to the cargo tank during sampling.

(~~11~~15) "Cofferdam" means the isolating space between two adjacent steel bulkheads or decks. This space may be a void space or a ballast space.

(~~12~~16) "Control stations" means those spaces in which ship's radio, main navigating equipment or the emergency source of power is located or where the fire-recording or fire control equipment is centralized ~~as defined in **3.2.18, Part R**~~. This does not include ~~space containing~~ special fire~~-~~control equipment, which can be most practically located in the cargo area.

(~~13~~17) "Flammable products" means those identified by an "*F*" in column "***f***" in **Table N19.1**.

(~~14~~18) "Flammability limits" means the conditions defining the state of fuel-oxidant mixture at which application of an adequately strong external ignition source is only just capable of producing flammability in a given test apparatus.

(19) "*FSS Code"* is the Fire Safety Systems Code meaning the International Code for Fire Safety Systems, adopted by the Maritime Safety Committee of the Organization by resolution *MSC*.98(73), as amended.

(20) "Gas carrier" means a cargo ship constructed or adapted and used for the carriage in bulk of any liquefied gas or other products listed in **Table N19.1**.

(21) "Gas combustion unit (*GCU*)" means a means of disposing excess cargo vapour by thermal oxidation.

(22) "Gas consumer" means any unit within the ship using cargo vapour as a fuel.

(~~15~~23) ~~"Gas-dangerous spaces or zones" mean the hazardous areas specified in **4.2.3-3**, **-4** and **-5**, **Part H**.~~ "Hazardous area" means an area in which an explosive gas atmosphere is, or may be expected to be present, in quantities that require special precautions for the construction, installation and use of electrical equipment. When a gas atmosphere is present, the following hazards may also be present: toxicity, asphyxiation, corrosivity, reactivity and low temperature. These hazards are also to be taken into account and additional precautions for the ventilation of spaces and protection of the crew will need to be considered. Examples of hazardous areas include, but are not limited to, the following:

(a) the interiors of cargo containment systems and any pipework of pressure-relief or other venting systems for cargo tanks, pipes and equipment containing the cargo;

(b) interbarrier spaces;

(c) hold spaces where the cargo containment system requires a secondary barrier;

(d) hold spaces where the cargo containment system does not require a secondary barrier;

(e) a space separated from a hold space by a single gastight steel boundary where the cargo containment system requires a secondary barrier;

(f) cargo machinery spaces;

(g) areas on open deck, or semi-enclosed spaces on open deck, within 3*m* of possible sources of gas release, such as cargo valve, cargo pipe flange, cargo machinery space ventilation outlet, etc.;

(h) areas on open deck, or semi-enclosed spaces on open deck within 1.5*m* of cargo machinery space entrances, cargo machinery space ventilation inlets;

(i) areas on open deck over the cargo area and 3*m* forward and aft of the cargo area on the open deck up to a height of 2.4*m* above the weather deck;

(j) an area within 2.4*m* of the outer surface of a cargo containment system where such surface is exposed to the weather;

(k) enclosed or semi-enclosed spaces in which pipes containing cargoes are located, except those where pipes containing cargo products for boil-off gas fuel burning systems are located;

(l) an enclosed or semi-enclosed space having a direct opening into any hazardous area;

(m) void spaces, cofferdams, trunks, passageways and enclosed or semi-enclosed spaces, adjacent to, or immediately above or below, the cargo containment system;

(n) areas on open deck or semi-enclosed spaces on open deck above and in the vicinity of any vent riser outlet, within a vertical cylinder of unlimited height and 6*m* radius centred upon the centre of the outlet and within a hemisphere of 6*m* radius below the outlet; and

(o) areas on open deck within spillage containment surrounding cargo manifold valves and 3*m* beyond these up to a height of 2.4*m* above deck.

(~~16~~24) "~~Gas-safe space~~Non-hazardous area" means an ~~space~~area other than a ~~gas-dangerous space~~hazardous area.

(~~17~~25) "Hold space" means the space enclosed by the ship's structure in which a cargo containment system is situated.

(26) "*IBC Code*" means the International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk, adopted by the Maritime Safety Committee of the Organization by resolution *MSC*.4(48), as amended.

(~~18~~27) "Independent" means that a piping or venting system, for example, is in no way connected to another system and that there are no provisions available for the potential connection to other systems.

(~~19~~28) "Insulation space" means the space, which may or may not be an interbarrier space, occupied wholly or in part by insulation.

(~~20~~29) "Interbarrier space" means the space between a primary and a secondary barrier, whether or not completely or partially occupied by insulation or other material.

(30) "Length (L_f)" means the length as defined in **2.1.3, Part A**.

(31) "Machinery spaces of category *A*" means those spaces, and trunks to those spaces, which contain either:

(a) internal combustion machinery used for main propulsion; or

(b) internal combustion machinery used for purposes other than main propulsion where such machinery has, in the aggregate, a total power output of not less than 375*kW*; or

(c) any oil-fired boiler or oil fuel unit or any oil-fired equipment other than boilers, such as inert gas generators, incinerators, etc.

(32) "Machinery spaces" means machinery spaces of category *A* and other spaces containing propelling machinery, boilers, oil fuel units, steam and internal-combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air-conditioning machinery, and similar spaces and the trunks to such spaces.

(~~21~~33) "*MARVS*" means the maximum allowable relief valve setting of a cargo tank (gauge pressure).

(~~22~~34) "Oil fuel unit" means the equipment ~~as defined in **3.2.34, Part R**~~used for the preparation of oil fuel for delivery to an oil-fired boiler, or equipment used for the preparation for delivery of heated oil to an internal combustion engine, and includes any oil pressure pumps, filters and heaters dealing with oil at a pressure of more than 0.18*MPa* gauge.

(~~23~~35) "Permeability" of a space means the ratio of the volume within that space which is assumed to be occupied by water to the total volume of that space.

(36) "Port Administration" means the appropriate authority of the country for the port where the ship is loading or unloading.

(~~24~~37) "Primary barrier" means the inner element designed to contain the cargo when the cargo containment system includes two boundaries.

(38) "Products" means the collective term used to cover the list of gases indicated in **Chapter 19** of this Part.

(39) "Public spaces" means those portions of the accommodation that are used for halls, dining rooms, lounges and similar permanently enclosed spaces.

(40) "Recognized standards" means applicable international or national standards acceptable to the Administration, or standards laid down and maintained by the Society.

(41) "Relative density" means the ratio of the mass of a volume of a product to the mass of an equal volume of fresh water.

(42) "Secondary barrier" means the liquid-resisting outer element of a cargo containment system, designed to afford temporary containment of any envisaged leakage of liquid cargo through the primary barrier and to prevent the lowering of the temperature of the ship's structure to an unsafe level. Types of secondary barrier are more fully defined in **Chapter 4** of this Part.

~~(25) "Secondary barrier" means the liquid-resisting outer element of a cargo containment system designed to afford temporary containment of any envisaged leakage of liquid cargo through the primary barrier and to prevent the lowering of the temperature of the ship's structure to an unsafe level. Types of secondary barrier are more fully defined in **Chapter 4**.~~

~~(26) "Relative density" means the ratio of the mass of a volume of a product to the mass of an equal volume of fresh water.~~

~~(27) "Separate" means that a cargo piping system or cargo vent system, for example, is not connected to another cargo piping or cargo vent system. This separation may be achieved by the use of design or operational methods. Operational methods are not to be used within a cargo tank and are to consist of one of the following types:~~

~~(a) removing spool pieces or valves and blanking the pipe ends~~

~~(b) arrangement of two spectacle flanges in series with provisions for detecting leakage into the pipe between the two spectacle flanges~~

(43) "Separate systems" means those cargo piping and vent systems that are not permanently connected to each other.

(44) "Service spaces" means those used for galleys, pantries containing cooking appliances, lockers, mail and specie rooms, store-rooms, workshops other than those forming part of the machinery spaces, and similar spaces and trunks to such spaces.

(~~28~~45) "Tank cover" means the protective structure intended to either protect the cargo containment system against damage where it protrudes through the weather deck or to ensure the continuity and integrity of the deck structure.

(~~29~~46) "Tank dome" means the upward extension of a portion of a cargo tank. In the case of below-deck cargo containment systems, the tank dome protrudes through the weather deck or through a tank cover.

(47) "Thermal oxidation method" means a system where the boil-off vapours are utilized as fuel for shipboard use or as a waste heat system subject to the provisions of **Chapter 16** of this Part or a system not using the gas as fuel complying with this Part.

(~~30~~48) "Toxic products" means those ~~identified~~defined by a "*T*" in column "***f***" in **Table N19.1**.

(49) "Turret compartments" means those spaces and trunks that contain equipment and machinery for retrieval and release of the disconnectable turret mooring system, high-pressure hydraulic operating systems, fire protection arrangements and cargo transfer valves.

(~~31~~50) "Vapour pressure" means the equilibrium pressure of the saturated vapour above the liquid, expressed in ~~bars~~Pascals (*Pa*) absolute at a specified temperature.

(~~32~~51) "Void space" means an enclosed space in the cargo area external to a cargo containment system, other than a hold space, ballast space, ~~fuel~~ oil fuel tank, cargo pumps or compressor room, or any space in normal use by personnel.

(~~33~~52) "*IGC Code*" means the "International Code for a Construction and Equipment of Ships Carrying Liquefied Gases in Bulk", adopted by the Maritime Safety Committee of the Organization by resolution *MSC*.6(48), as amended.

1.2 Operational Conditions

1.2.1 Application

The provisions in **1.2** are not ~~the conditions~~related to surveys necessary for the maintenance of classification, but indicate those matters ~~for~~ which ~~examinations~~ are ~~required but the conditions~~ to be strictly observed by the ship~~-~~owner~~,~~ or the ship master ~~or~~as well as all other persons ~~who may concern with~~responsible for the ship's operation.

1.2.2 Restrictions of Loading Flammable Cargoes (~~with reference~~related to *IGC Code* 1.1.4)

1 When cargo tanks contain products for which this Part requires a type 1*G* ship, neither flammable liquids having a flashpoint of 60°C (closed cup test) or less nor flammable products listed in **Chapter 19** of this Part are to be carried in tanks located within the protective zones described in **2.~~6~~4.1(1)**.

2 Similarly, when cargo tanks contain products for which this Part requires a type 2*G*/2*PG* ship, the ~~above-mentioned~~ flammable liquids in compliance with the requirements given in **1.2.2-1** are not to be carried in tanks located within the protective zones described in **2.~~6~~4.1(2)**.

3 In each case the restriction applies to the protective zones within the longitudinal extent of the hold spaces for the cargo tanks loaded with products for which this Part requires a type 1*G* or 2*G*/2*PG* ship.

4 The above-mentioned flammable liquids and products may be carried within these protective zones when the quantity retained in the cargo tanks of products for which this Part requires a type 1*G* or 2*G*/*PG* ship is solely used for cooling, circulation or fuelling purposes.

Chapter 2 has been amended as follows.

Chapter 2 SHIP SURVIVAL CAPABILITY AND LOCATION OF CARGO TANKS

2.1 General (*IGC Code* 2.1)

2.1.1 General

Ships are to survive the ~~normal~~ hydrostatic effects of flooding following assumed hull damage caused by some external force. In addition, to safeguard the ship and the environment, the cargo tanks are to be protected from penetration in the case of minor damage to the ship resulting, for example, from contact with a jetty or tug, and given a measure of protection from damage in the case of collision or ~~stranding~~ grounding, by locating them at specified minimum distances inboard from the ship's shell plating. Both the damage to be assumed and the proximity of the tanks to the ship's shell are to be dependent upon the degree of hazard presented by the product to be carried. In addition, the proximity of the cargo tanks to the ship's shell is to be dependent upon the volume of the cargo tank.

2.1.2 Ship Types

Ships are to be designed to one of the following standards.

Thus a type 1*G* ship is a gas carrier intended for the transportation of products considered to present the greatest overall hazard and types 2*G* /2*PG* and type 3*G* for products of progressively lesser hazards. Accordingly, a type 1*G* ship is to be designed to survive the most severe standard of damage and its cargo tanks are to be located at the maximum prescribed distance inboard from the shell plating.

(1) A type 1*G* ship is a gas carrier intended to transport products indicated in **Chapter 19** ~~which~~ that require maximum preventive measures to preclude ~~the~~ their escape ~~of such cargo~~.

(2) A type 2*G* ship is a gas carrier intended to transport products indicated in **Chapter 19** ~~which~~ that require significant preventive measures to preclude the escape of such cargo.

(3) A type 2*PG* ship is a gas carrier of 150*m* in length or less intended to transport products indicated in **Chapter 19** ~~which~~ that require significant preventive measures to preclude their escape ~~of such cargo~~, and where the products are carried in ~~independent~~ type C independent tanks designed (*see* ~~**4.2.4-4**~~**4.23.1**) for a *MARVS* of at least 0.7 *MPa* gauge and a cargo containment system design temperature of -55°C or above. ~~Note that a~~ A ship of this description ~~but~~ that over 150*m* in length is to be considered a type 2*G* ship.

(4) A type 3*G* ship is a gas carrier intended to carry products indicated in **Chapter 19** ~~which~~ that require moderate preventive measures to preclude the escape of such cargo.

2.1.3 Ship Types for Individual Products

The ship type required for individual products is indicated in column "**c**" in **Table N19.1**.

2.1.4 Ship Carrying More than One Product

If a ship is intended to carry more than one product listed in **Table N19.1**, the standard of damage is to correspond to that product having the most stringent ship type requirement. The requirements for the location of individual cargo tanks, however, are those for ship types related to the respective products intended to be carried.

2.1.5 Moulded line for Cargo Containment System

For the purpose of this Part, the position of the moulded line for different containment systems is shown in **Fig. N2.5** to **Fig. N2.9**.

2.2 ~~Solid Ballast and Stability Information~~ Freeboard and Stability

2.2.1 Stability (*IGC Code* 2.2.2)

The stability of the ship, in all seagoing conditions and during loading and unloading cargo, is to comply with the requirements of the **Part U of the Rules**. This includes partial filling and loading and unloading at sea, when applicable. Stability during ballast water operations is to fulfil stability criteria.

2.2.~~1~~2 Solid Ballast (*IGC Code* 2.2.4)

Solid ballast is not normally to be used in double bottom spaces in the cargo area. Where, however, because of stability considerations, the fitting of solid ballast in such spaces becomes unavoidable, ~~then~~ its disposition is to be governed by the need to enable access for inspection and to ensure that the impact loads resulting from bottom damage are not directly transmitted to the cargo tank structure.

2.2.~~2~~3 Stability Information (with reference to *IGC Code* 2.2.5)

The information booklet specified in **2.3.2, Part B** is to contain a summary of the ship's survival capabilities.

2.2.~~3~~4 Stability Instruments (with reference to *IGC Code* 2.2.6 and 2.2.7)

1 All ships subject to this Part are to be fitted with a stability instrument, capable of verifying compliance with intact and damage stability requirements, approved by the Administration having regard to the performance standards recommended by the *IMO*.

2 Notwithstanding the requirement in the preceding **-1**, a stability instrument installed on a ship at the beginning stage of construction before 1 July 2016 need not be replaced provided it is capable of verifying compliance with intact and damage stability to the satisfaction of the Administration.

3 In cases where the stability instrument is fitted in accordance with the requirements in the preceding **-1** or **-2**, a document of approval for the stability instrument issued by the Administration is to be maintained on board.

4 The Administration may waive the requirements in the preceding **-1** to **-3** for the following ships, provided the procedures employed for intact and damage stability verification maintain the same degree of safety, as being loaded in accordance with the approved conditions:

(1) Ships which are on a dedicated service, with a limited number of permutations of loading such that all anticipated conditions have been approved in the stability information provided in accordance with the requirements in **2.2.~~2~~3**;

(2) Ships where stability verification is made remotely by a means approved by the Administration;

(3) Ships which are loaded within an approved range of loading conditions; or

(4) Ships at the beginning stage of construction before 1 July 2016 provided with approved limiting KG/GM curves covering all applicable intact and damage stability requirements.

~~2.3 Shipside Discharges below the Freeboard Deck (*IGC Code* 2.3)~~

~~2.3.1 Shipside Discharges~~

~~The provision and control of valves fitted to discharges led through the shell from spaces below the freeboard deck or from within the superstructures and deckhouses on the freeboard deck fitted with weathertight doors are to comply with the requirements of **13.4, Part D** except that the choice of valves are to be limited to:~~

~~(1) One automatic non-return valve with a positive means of closing from above the freeboard deck; or~~

~~(2) Where the vertical distance from the summer load waterline to the inboard end of the discharge pipe exceeds 0.01L_f, two automatic non-return valves without positive means of closing, provided that the inboard valve is always accessible for examination under service conditions.~~

~~2.3.2 Non-return Valves~~

~~The automatic non-return valves referred to in **2.3.1(1)** and **(2)** are to be of a type acceptable to the Society and to be fully effective in preventing admission of water into the ship, taking into account the sinkage, trim and heel in survival requirements in **2.9**.~~

~~2.4 Conditions of Loading~~

2.2.5~~4.1~~ Conditions of Loading (with reference to *IGC Code* ~~2.4~~2.2.8)

~~Damage survival capability is to be investigated for all anticipated conditions of loading and variations in draught and trim. The survival requirements need not be applied to the ship when in the ballast condition (the cargo content of small independent purge tanks on deck need not be taken into account when assessing the ballast condition.), provided that any cargo retained on board is solely used for cooling, circulation or fuelling purposes.~~

Damage survival capability is to be investigated on the basis of loading information submitted to the Society for all anticipated conditions of loading and variations in draught and trim. This is to include ballast and, where applicable, cargo heel.

2.~~5~~3 Damage Assumptions (*IGC Code* 2.~~5~~3)

2.~~5~~3.1 Extent of Damage

1 The assumed maximum extent of damage in the shipside is to be in accordance with **Table N2.1**.

2 The assumed maximum extent of damage in the bottom is to be in accordance with **Table N2.2**.

2.~~5~~3.2 Other Damage

(1) If any damage of a lesser extent than the maximum damage specified in **2.~~5~~3.1** would result in a more severe condition, such damage is to be assumed.

(2) Local ~~side~~ damage anywhere in the cargo area extending inboard 760*mm* measured normal to the ~~hull~~ moulded line of the outer shell is to be considered and ~~transverse~~ bulkheads are to be assumed damaged when ~~also required by the applicable~~ the relevant subparagraphs of **2.~~8~~6.1**

apply. If a damage of a lesser extent than "*d*" would result in a more severe condition, such damage is to be assumed.

2.~~6~~4 Location of Cargo Tanks (*IGC Code* 2.~~6~~4)

2.~~6~~4.1 Location of Cargo Tanks

Cargo tanks are to be located at the following distances inboard:

(1) Type 1*G* ships: from the moulded line of the outer ~~side~~ shell, ~~plating~~ not less than the transverse extent of damage specified in **Table N2.1** and from the moulded line of the bottom shell ~~plating~~ at centreline not less than the vertical extent of damage specified in **Table N2.2** and nowhere less than ~~760*mm* from the shell plating.~~ "*d*" where "*d*" is as follows.

(a) for V_c below or equal 1,000 m^3, $d = 0.8\ m$

(b) for 1,000 m 3 < V_c < 5,000 m^3, $d = 0.75 + V_c \times 0.2/4{,}000\ m$

(c) for 5,000 m3 ≤ V_c < 30,000 m^3, $d = 0.8 + V_c/25{,}000\ m$

(d) for $V_c \geq$ 30,000 m^3, $d = 2\ m$

where:

V_c corresponds to 100% of the gross design volume of the individual cargo tank at 20°C, including domes and appendages (see **Fig. N2.1** and **Fig. N2.2**). For the purpose of cargo tank protective distances, the cargo tank volume is the aggregate volume of all the parts of tank that have a common bulkhead(s); and

"*d*" is measured at any cross section at a right angle from the moulded line of outer shell.

Tank size limitations may apply to type 1*G* ship cargoes in accordance with **Chapter 17**.

(2) Types 2*G* /2*PG* ~~and 3*G* ships~~: from the moulded line of the bottom shell plating at centreline not less than the vertical extent of damage specified in **Table N2.2** and nowhere less than ~~760*mm* from the shell plating.~~ "*d*" as specified in **(1)** above. (see **Fig. N2.1** and **Fig. N2.3**)

(3) Type 3*G* ships: from the moulded line of the bottom shell at centreline not less than the vertical extent of damage specified in **2.3** and **2.5** and nowhere less than " *d* ", where " *d* " = 0.8 *m* from the moulded line of outer shell (see **Fig. N2.1** and **Fig. N2.4**).

2.~~6~~4.2 Vertical Extent of Bottom Damage

For the purpose of tank location, the vertical extent of bottom damage is to be measured to the inner bottom when membrane or semi-membrane tanks are used, otherwise to the bottom of the cargo tanks. The transverse extent of side damage is to be measured to the longitudinal bulkhead when membrane or semi-membrane tanks are used, otherwise to the side of the cargo tanks ~~(*see* **Fig. N2.1**). For internal insulation tanks the extent of damage is to be measured to the supporting tank plating~~. The distances indicated in **2.3** and **2.5** are to be applied as in **Fig. N2.5** to **Fig. N2.9**. These distances are to be measured plate to plate, from the moulded line to the moulded line, excluding insulation.

2.~~6~~4.3 Suction Wells

Except for type 1*G* ships, suction wells installed in cargo tanks may protrude into the vertical extent of bottom damage specified in **Table N2.2** provided that such wells are as small as practicable and the protrusion below the inner bottom plating does not exceed 25% of the depth of the double bottom or 350*mm*, whichever is less. Where there is no double bottom, the protrusion below the upper limit of bottom damage is not to exceed 350*mm*. Suction wells installed in accordance with this paragraph may be ignored in determining the compartments affected by damage.

2.4.4 Location of Cargo Tanks

Cargo tanks are not to be located forward of the collision bulkhead.

Table N2.1 Side Damage

Direction	Extent of Damage
Longitudinal extent:	$1/3L_f^{2/3}$ or 14.5m, whichever is less
Transverse extent:	B_f /5 or 11.5m whichever is less (measured inboard from the ~~ship's side~~ mouldd line of the outer shell at right angles to the centreline at the level of the summer load line)
Vertical extent:	upwards without limit (from the moulded line of the ~~bottom. shell plating at centreline~~outer shell)

Table N2.2 Bottom Damage

Direction	Extent of Damage	
	For 0.3L_f from the forward perpendicular of the ship	Any other part of the ship
Longitudinal extent:	$1/3L_f^{2/3}$ or 14.5m, whichever is less	$1/3L_f^{2/3}$ or ~~5~~14.5m, whichever is less
Transverse extent:	B_f/6 or 10 m, whichever is less	B_f/6 or 5m, whichever is less
Vertical extent:	B_f/15 or 2m, whichever is less (measured from the moulded line of the bottom~~,~~ shell plating at centerline (see **2.~~6~~4.3**).)	B_f/15 or 2m, whichever is less (measured from the moulded line of the bottom~~,~~ shell plating at centerline (see **2.~~6~~4.3**).)

~~Fig. N2.1 Tank Location Requirements as Set out in 2.6~~

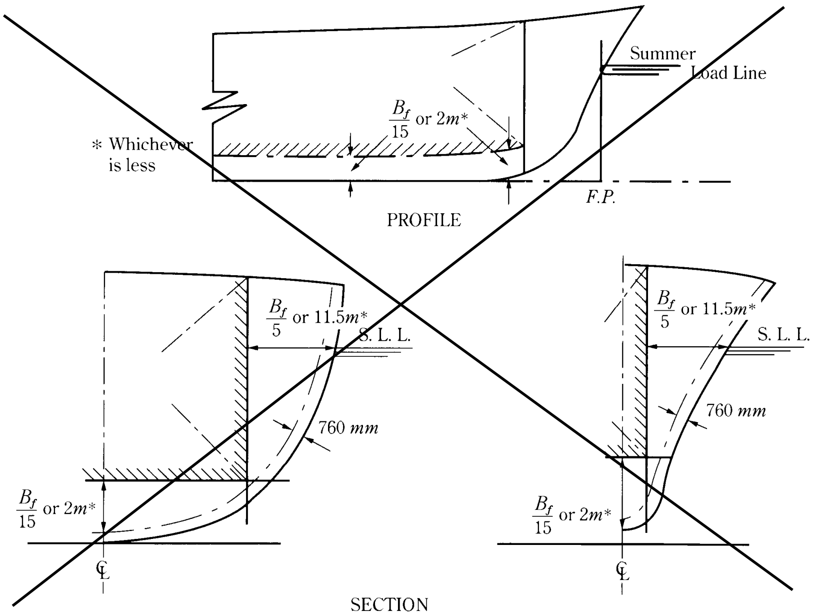
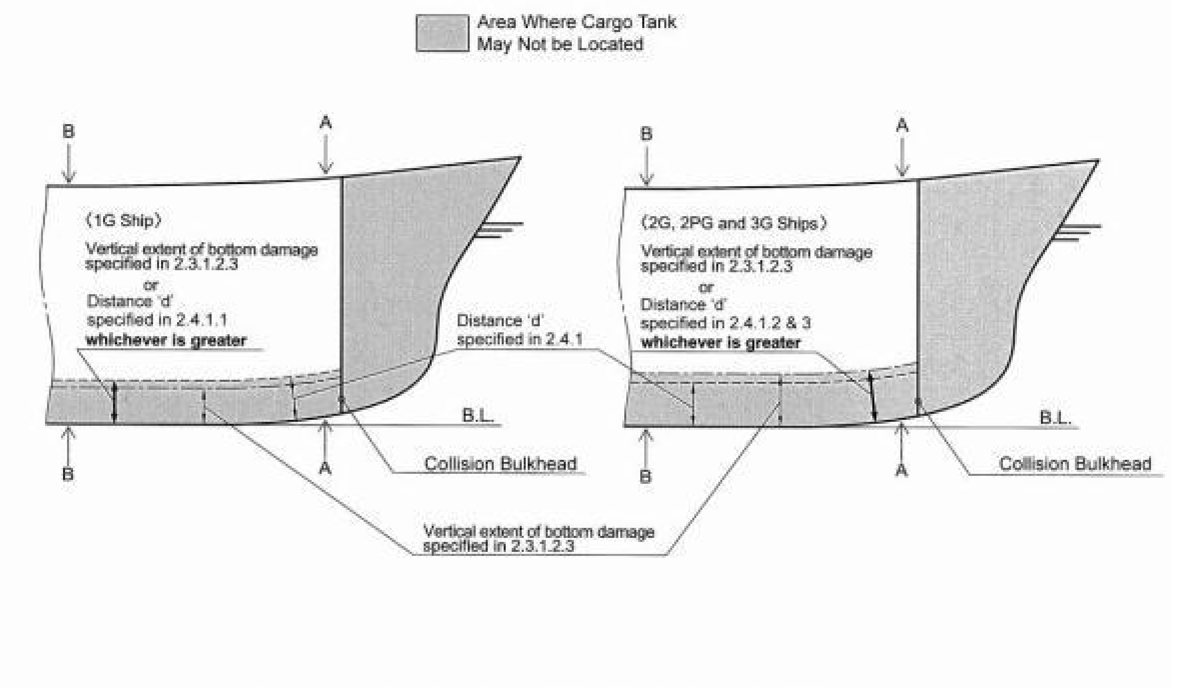
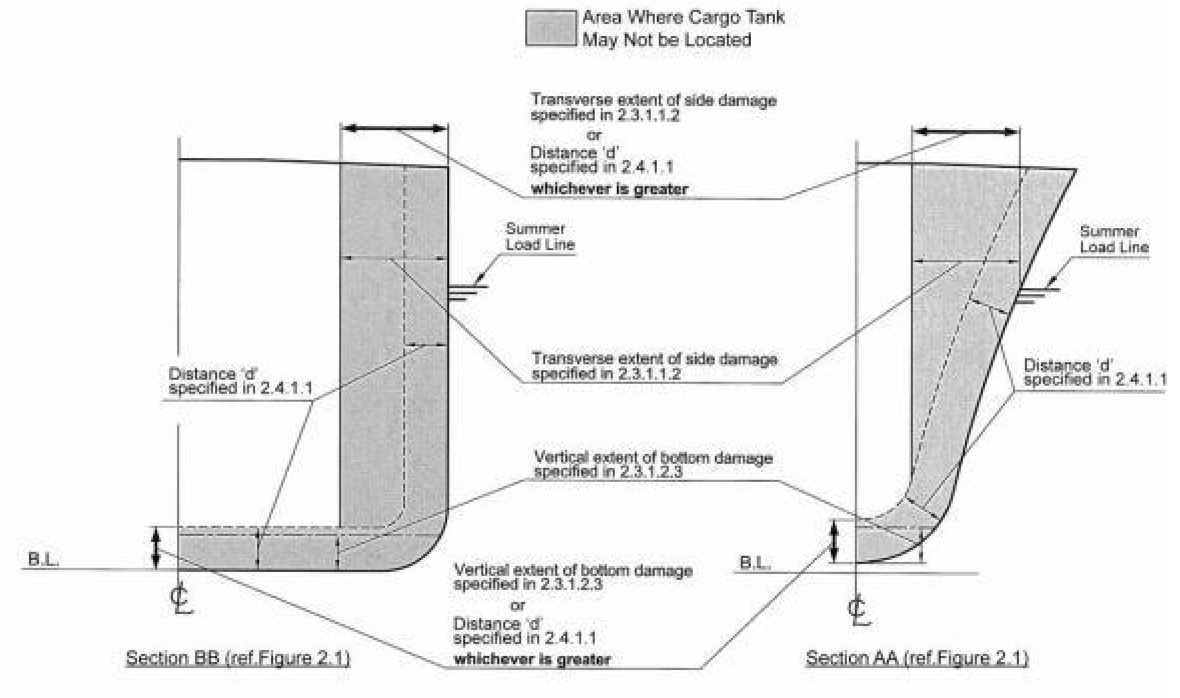


Fig. N2.1 Cargo Tank Loaction Requirements



Centreline Profile - Type 1G, 2G, 2PG and 3G Ships

Fig. N2.2 Cargo Tank Loaction Requirements



Transverse Sections - Type 1G Ship

Fig. N2.3 Cargo Tank Loaction Requirements

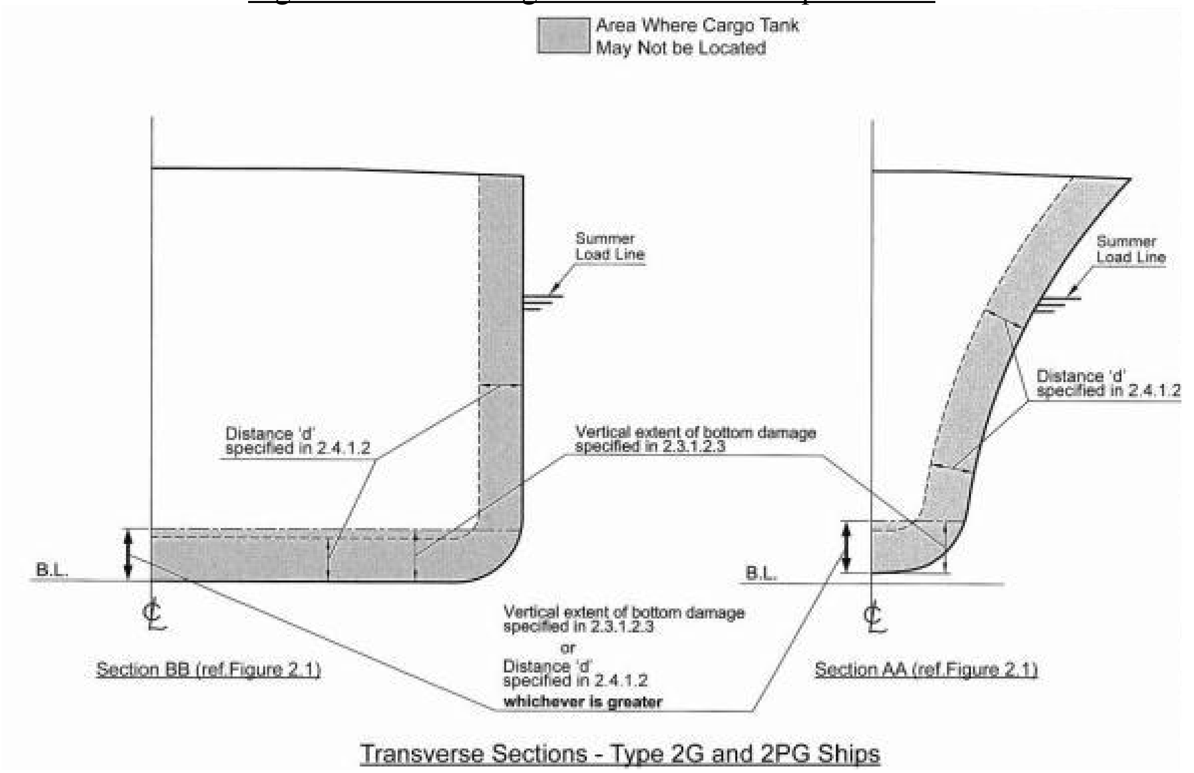


Fig. N2.4 Cargo Tank Loaction Requirements

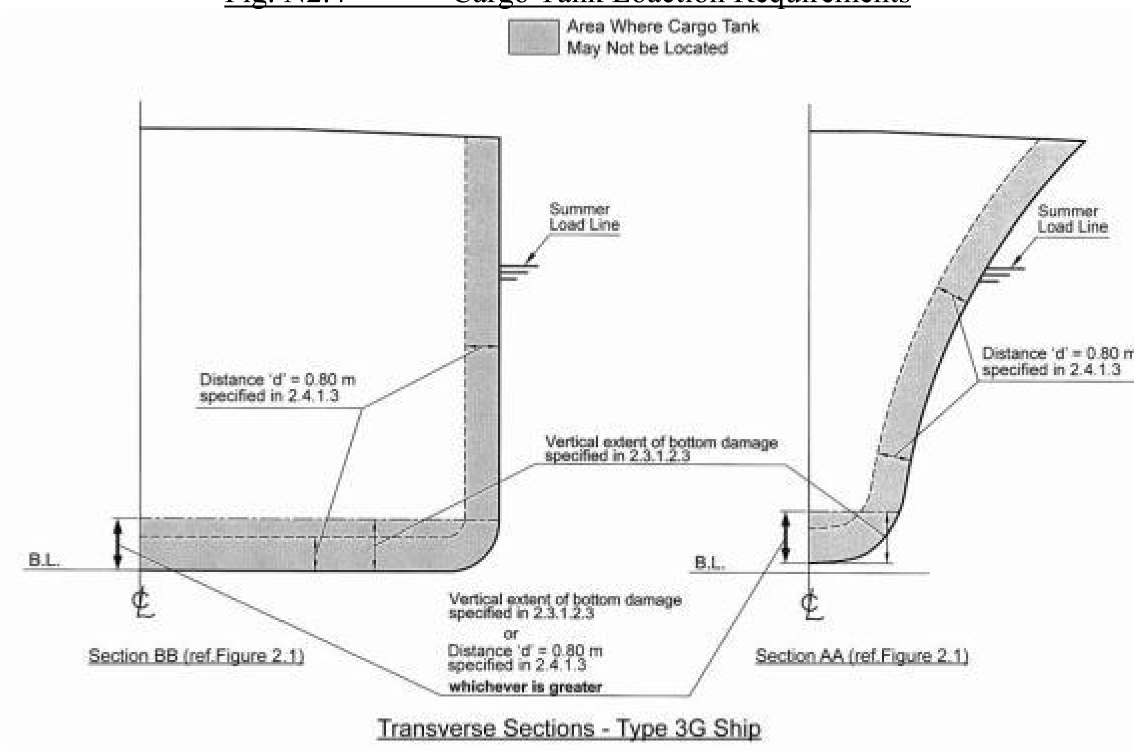
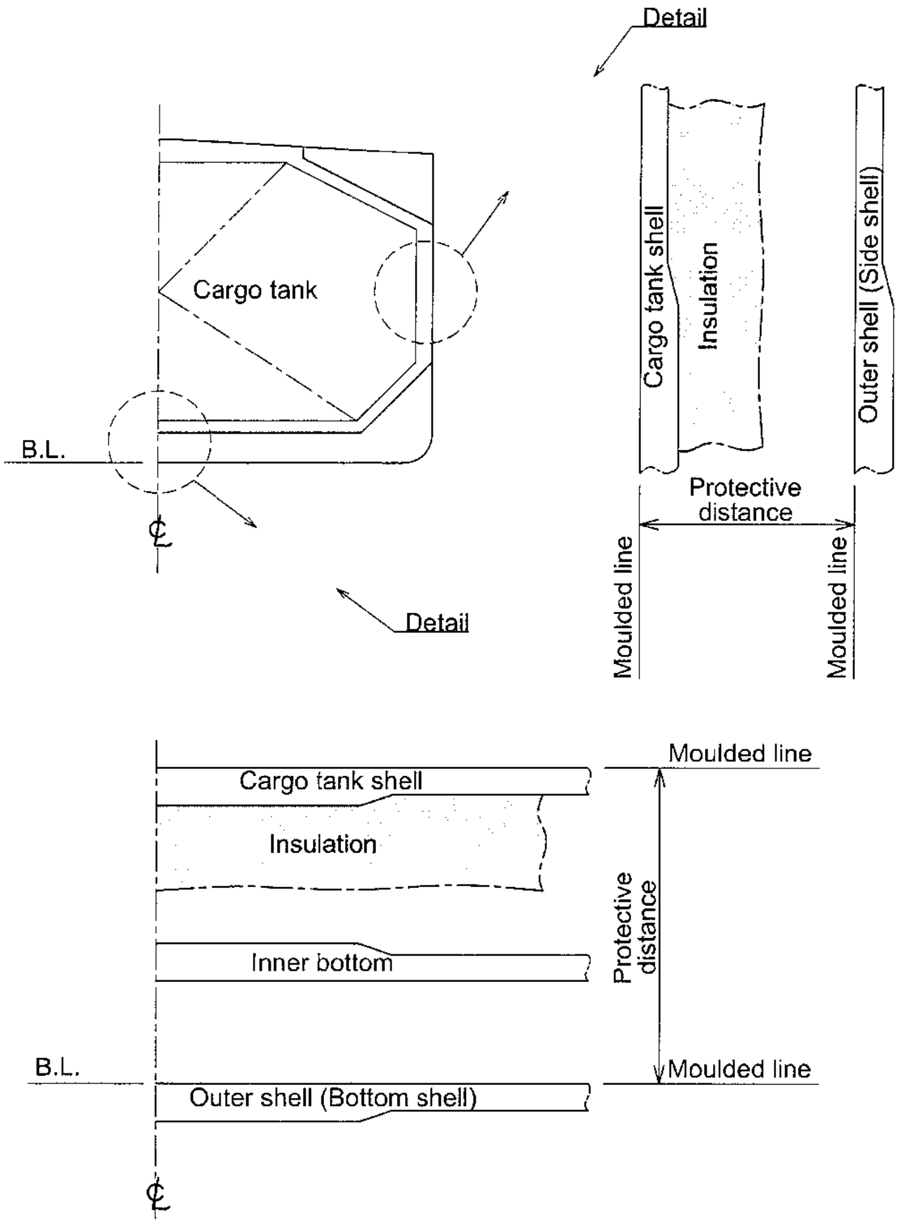
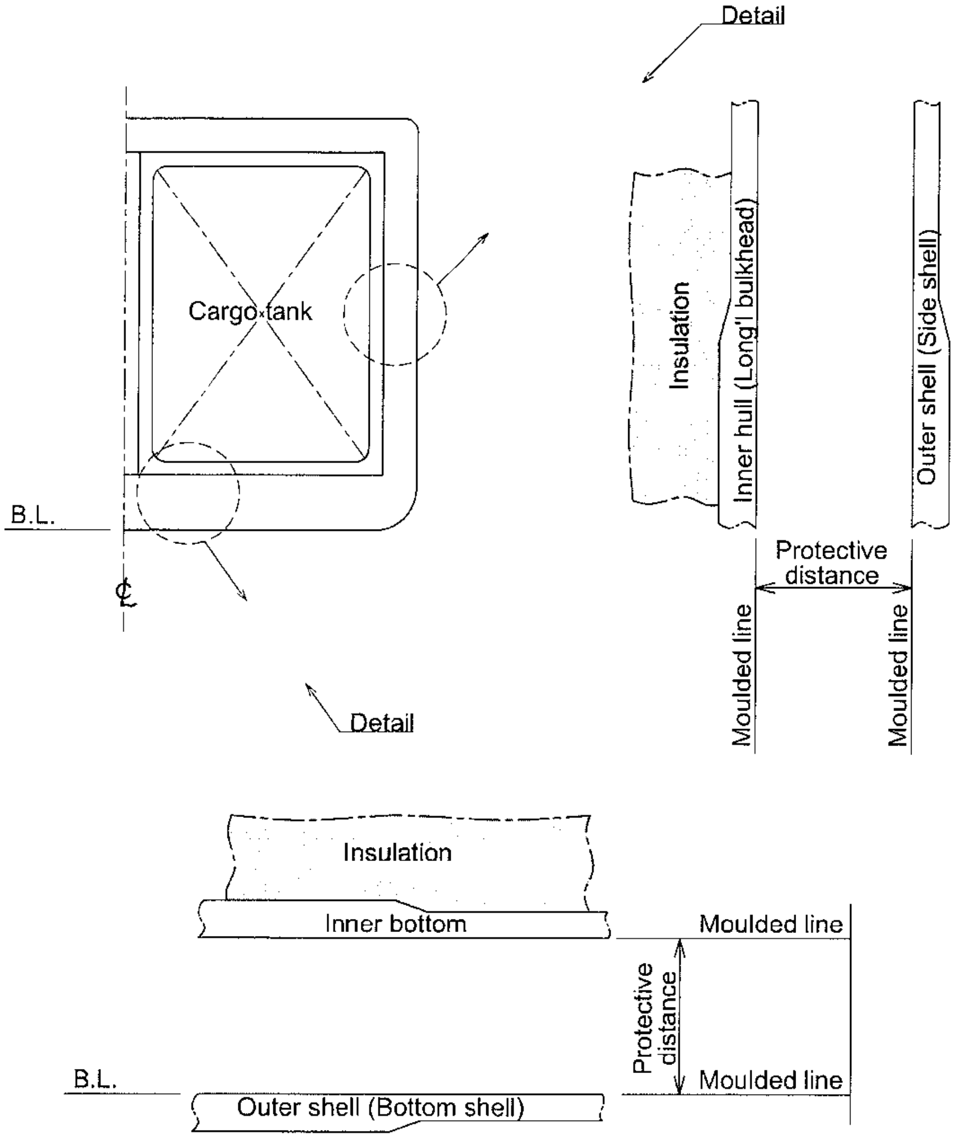


Fig. N2.5 Protective Distance



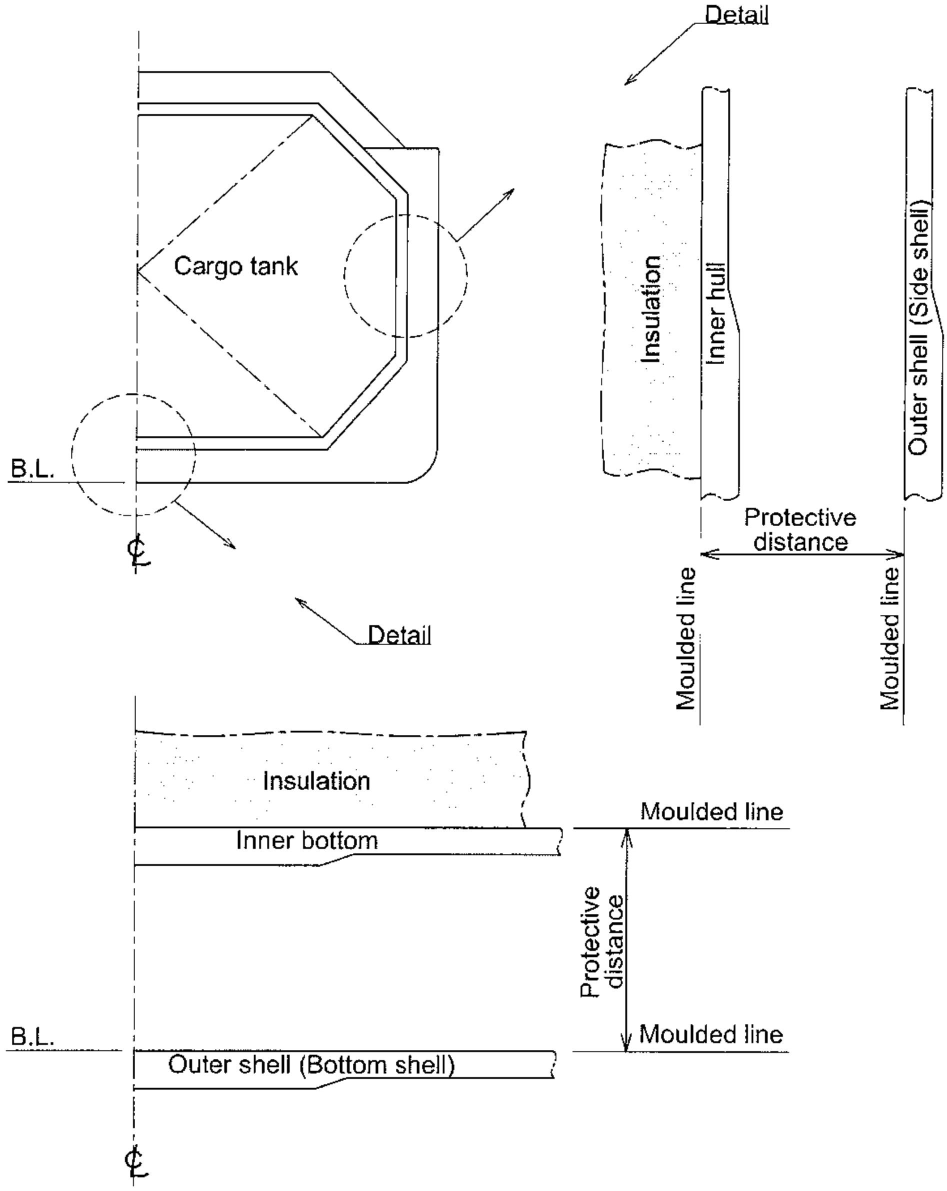
Independent prismatic tank

Fig. N2.6 Protective Distance



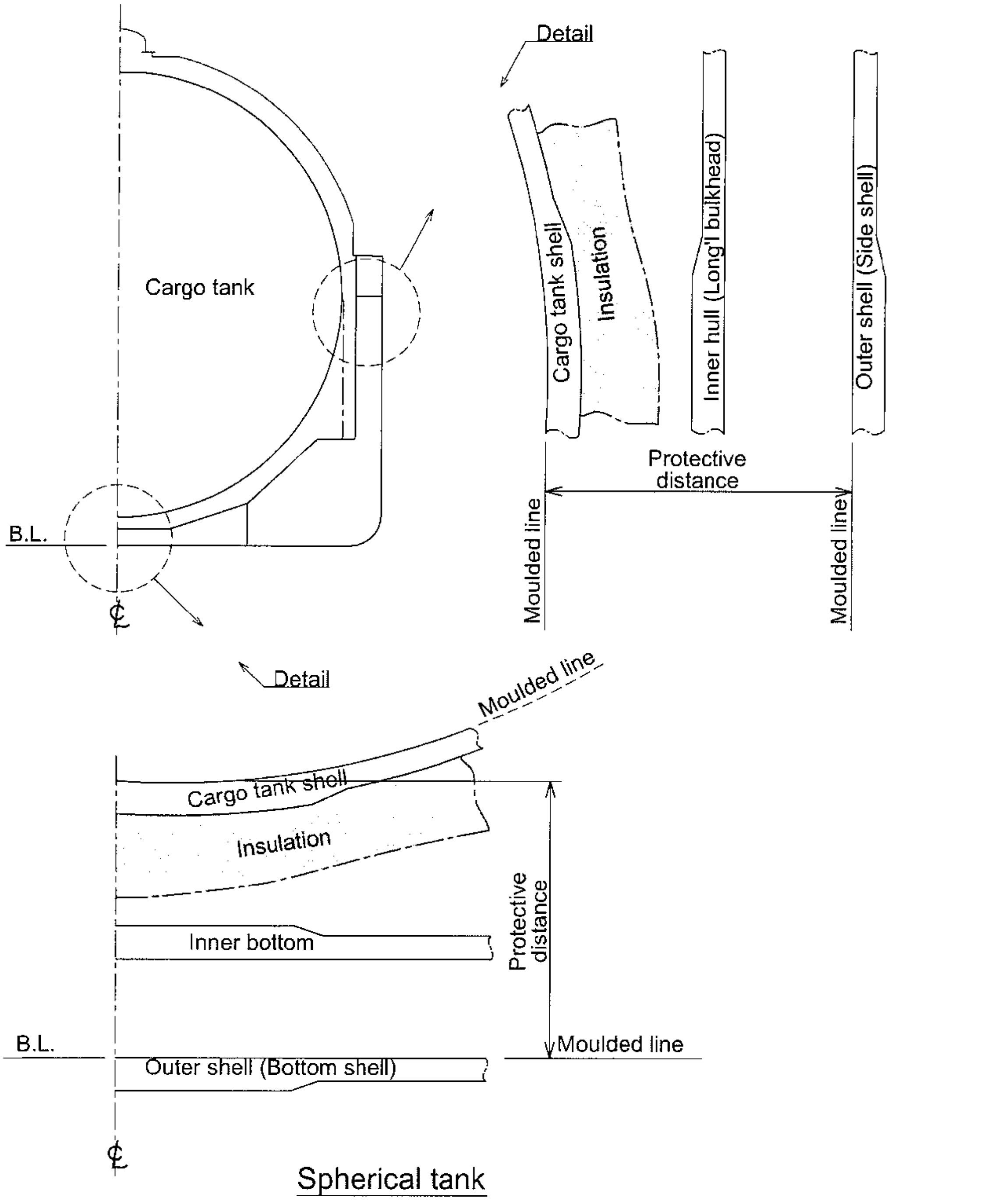
Semi-membrane tank

Fig. N2.7 Protective Distance



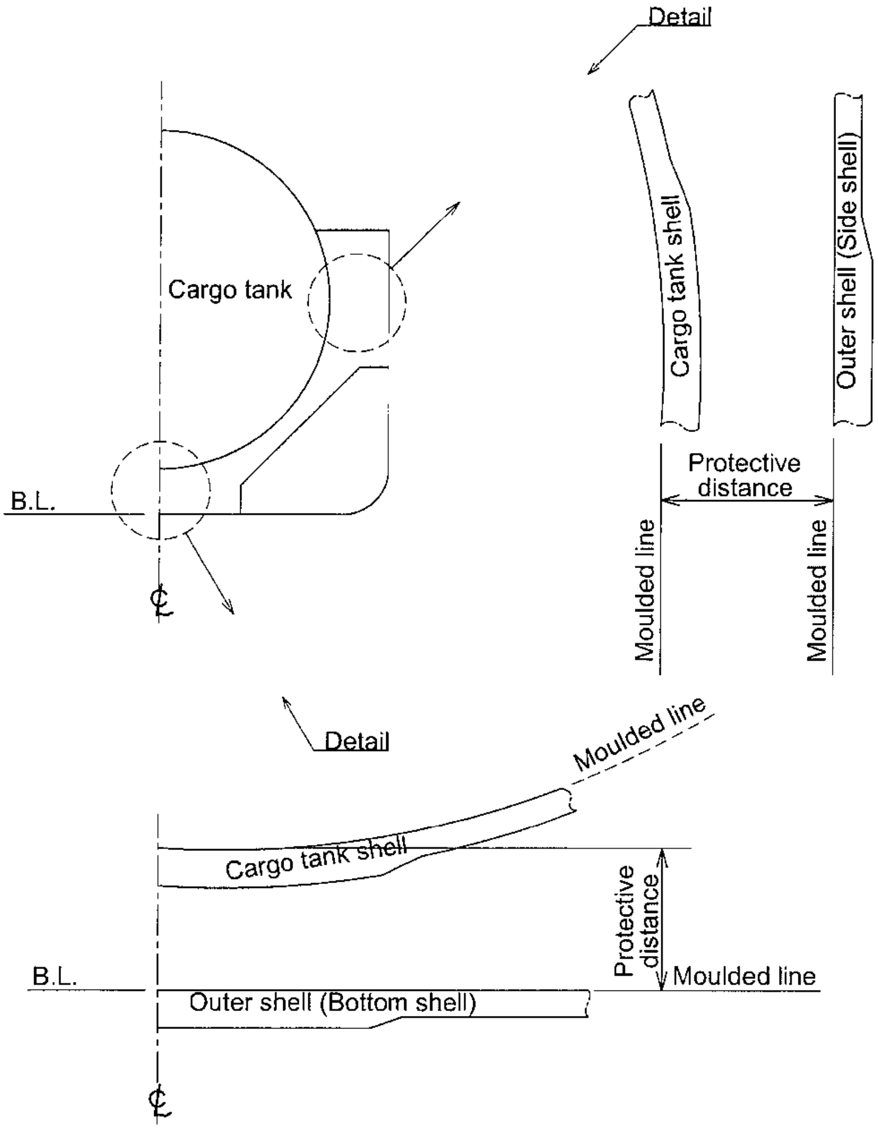
Membrane tank

Fig. N2.8 Protective Distance



Spherical tank

Fig. N2.9 Protective Distance



Pressure type tank

2.~~7~~5 Flooding Assumptions (*IGC Code* 2.~~7~~5)

2.~~7~~5.1 General

The requirements of **2.~~9~~7** are to be confirmed by calculations which take into consideration the design characteristics of the ship; the arrangements, configuration and contents of the damaged compartments; the distribution, relative densities and the free surface effects of liquids and the draught and trim for all conditions of loading.

2.~~7~~5.2 Permeability

The permeabilities of spaces assumed to be damaged are to be in accordance with **Table N2.3**.

Table N2.3 Permeabilities of space

Spaces	Permeabilities
Appropriated to stores	0.60
Occupied by accommodation	0.95
Occupied by machinery	0.85
Voids	0.95
Hold Spaces	0.95(1)
Intended for consumable liquids	0 to 0.95~~*~~(2)
Intended for other liquids	0 to 0.95~~*~~(2)

Note:

(1) Other values of permeability can be considered based on the detailed calculations. (MSC/Circ.651 is referred).

(2) The permeability of partially filled compartments is to be consistent with the amount of liquid carried in the compartment.

2.~~7~~5.3 Damage of Tanks Containing Liquids

Wherever damage penetrates a tank containing liquids, it is to be assumed that the contents are completely lost from that compartment and replaced by salt water up to the level of the final plane of equilibrium.

2.~~7~~5.4 Damage of Transverse Bulkheads

Where the damage between transverse watertight bulkheads is envisaged as specified in **2.~~8~~6.1(4)**, **(5)**, and **(6)**, transverse bulkheads are to be spaced at least at a distance equal to the longitudinal extent of damage specified in **Table N2.1** in order to be considered effective. Where transverse bulkheads are spaced at a lesser distance, one or more of these bulkheads within such extent of damage are to be assumed as non-existent for the purpose of determining flooded compartments. Further, any portion of a transverse bulkhead bounding side compartments or double bottom compartments is to be assumed damaged if the watertight bulkhead boundaries are within the extent of vertical or horizontal penetration required by **2.~~5~~3**. Also, any transverse bulkhead is to be assumed damaged if it contains a step or recess of more than 3 *m* in length located within the extent of penetration of assumed damage. The step formed by the after peak bulkhead and after peak tank top is not to be regarded as a step for the purpose of this paragraph.

2.~~7~~5.5 Unsymmetrical Flooding

The ship is to be so designed as to keep unsymmetrical flooding to the minimum consistent with efficient arrangements.

2.~~7~~5.6 Equalization Arrangements

Equalization arrangements requiring mechanical aids such as valves or cross-levelling pipes, if fitted, are not to be considered for the purpose of reducing an angle of heel or attaining the minimum range of residual stability to meet the requirements of **2.~~9~~7.1-2** and sufficient residual stability is to be maintained during all stages where equalization is used. Spaces which are linked by ducts of large cross-sectional area may be considered to be common.

2.~~7~~5.7 Progressive Flooding

If pipes, ducts, trunks or tunnels are situated within the assumed extent of damage penetration, as defined in **2.~~5~~3**, arrangements are to be such that progressive flooding cannot thereby extend to compartments other than those assumed to be flooded for each case of damage.

2.~~7~~5.8 Buoyancy of Superstructures

The buoyancy of any superstructure directly above the side damage is to be disregarded. The unflooded parts of superstructures beyond the extent of damage, however, may be taken into consideration provided that:

(1) They are separated from the damaged space by watertight divisions and the requirements of **2.~~9~~7.1-2(1)** in respect of these intact spaces are complied with; and

(2) Openings in such divisions are capable of being closed by remotely operated sliding watertight doors and unprotected openings are no immersed within the minimum range of residual stability required in **2.~~9~~7.1-3(1)**; however the immersion of any other openings capable of being closed weathertight may be permitted.

2.~~8~~6 Standard of Damage (*IGC Code* 2.~~8~~6)

2.~~8~~6.1 General

Ships are to be capable of surviving the damage indicated in **2.~~5~~3** with the flooding assumptions in **2.~~7~~5** to the extent determined by the ship's type according to the following standards:

(1) A type 1*G* ship is to be assumed to sustain damage anywhere in its length;

(2) A type 2*G* ship of more than 150*m* in length is to be assumed to sustain damage anywhere in its length;

(3) A type 2*G* ship of 150*m* in length or less is to be assumed to sustain damage anywhere in its length except involving either of the bulkheads bounding a machinery space located aft;

(4) A type 2*PG* ship is to be assumed to sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage as specified in **Table N2.1**;

(5) A type 3*G* ship of ~~125~~80*m* in length or more is to be assumed to sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage specified in **Table N2.1**;

(6) A type 3*G* ship less than ~~125~~80*m* in length is to be assumed to sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage specified in **Table N2.1** and except damage involving the machinery space when located aft. ~~However, the ability to survive the flooding of the machinery space is to be considered by the Society.~~

2.~~8~~6.2 Standard for Small Ship

In the case of small type 2*G* /2*PG* and 3*G* ships which do not comply in all respects with the appropriate requirements of **2.~~8~~6.1(3)**, **(4)** and **(6)**, special dispensations may only be considered by the Society provided that alternative measures can be taken which maintain the same degree of safety.

2.~~9~~7 Survival Requirements

2.~~9~~7.1 Survival Requirements (*IGC Code* 2.~~9~~7)

1 Ships are to be capable of surviving the assumed damage specified in **2.~~5~~3** to the standard provided in **2.~~8~~6** in a condition of stable equilibrium and are to satisfy the following criteria.

2 In any stage of flooding

(1) The waterline, taking into account sinkage, heel and trim, is to be below the lower edge of any opening through which progressive flooding or downflooding may take place. Such openings are to include air pipes and openings which are closed by means of weathertight doors or hatch covers and may exclude those openings closed by means of watertight manhole covers and watertight flush scuttles, small watertight cargo tank hatch covers which maintain the high integrity of the deck, remotely operated watertight sliding doors, and sidescuttles of the non-opening type;

(2) The maximum angle of heel due to unsymmetrical flooding is not to exceed 30°; and

(3) The residual stability during intermediate stages of flooding is not to be ~~to the satisfaction of the Society. However, it is never to be significantly~~ less than that required by **-3(1)**.

3 At final equilibrium after flooding

(1) The righting lever curve is to have a minimum range of 20°beyond the position of equilibrium in association with a maximum residual righting lever of at least 0.1*m* within the 20°range the area under the curve within this range is not to be less than 0.0175*m*・*rad*. The 20° range may be measured from any angle commencing between the position of equilibrium and the angle of 25° (or 30° if no deck immersion occurs). Unprotected openings are not to be immersed within this range unless the space concerned is assumed to be flooded. Within this range, the immersion of any of the openings listed in **-2(1)** and other openings capable of being closed weathertight may be permitted and

(2) The emergency source of power is to be capable of operating.

2.8 Operating Requirements

2.8.1 Application

The provisions in **2.8** are not related to surveys necessary for the maintenance of classification, but indicate those matters which are to be strictly observed by the shipowner or the ship master as well as all other persons responsible for the ship's operation.

2.8.2 Stability (related to *IGC Code* 2.2.2)

The stability of the ship during the loading and unloading of cargo in all seagoing conditions is to comply with the requirements in **Part U of the Rules**.

2.8.3 Stability Information (related to *IGC Code* 2.2.5)

Cargo loading and ship operations are to be carried in a safe and appropriate manner for navigation in accordance with the ship's Stability Information Booklet.

2.8.4 Conditions of Loading (related to *IGC Code* 2.2.8)

The conditions of loading are to be the satisfication of damage survival capabilities determined in accordance with loading information submitted to the Society.

Chapter 3 has been amended as follows.

Chapter 3 SHIP ARRANGEMENTS

3.1 Segregation of the Cargo Area (*IGC Code* 3.1)

3.1.1 Segregation of the Hold Space

Hold spaces are to be segregated from machinery and boiler spaces, accommodation spaces, service spaces ~~and~~, control stations, chain lockers, ~~drinking and~~ domestic water tanks and from stores. Hold spaces are to be located forward of machinery spaces of category *A*~~, other than those deemed necessary by the Society for the safety or navigation of the ship~~. Alternative arrangements, including locating machinery spaces of category *A* forward, may be accepted, based on **Chapter 17, Part R**, after further consideration of involved risks, including that of cargo release and the means of mitigation.

3.1.2 In Case of a Cargo Containment System Not Requiring a Complete or Partial Secondary Barrier

Where cargo is carried in a cargo containment system not requiring a complete or partial secondary barrier, segregation of hold spaces from spaces referred to in **3.1.1** or spaces either below or outboard of the hold spaces may be effected by cofferdams, ~~fuel~~ oil fuel tanks or a single gastight bulkhead of allwelded construction forming an *A*-60 class division. A gastight *A*-0 class division is ~~satisfactory~~acceptable if there is no source of ignition or fire hazard in the adjoining spaces.

3.1.3 In Case of a Cargo Containment System Requiring a Complete or Partial Secondary Barrier

Where cargo is carried in a cargo containment system requiring a complete or partial secondary barrier, segregation of hold spaces from spaces referred to in **3.1.1**, or spaces either below or outboard of the hold spaces ~~which~~that contain a source of ignition or fire hazard, is to be effected by cofferdams or ~~fuel~~ oil fuel tanks. ~~If there is no source of ignition or fire hazard in the adjoining space, segregation may be by a single *A*-0 class division which is gastight~~ A gastight *A*-0 class division is acceptable if there is no source of ignition or fire hazard in the adjoining spaces.

3.1.4 Turret Compartments Segregation

Turret compartments segregation from spaces referred to in **3.1.1**, or spaces either below or outboard of the turret compartment that contain a source of ignition or fire hazard, are to be effected by cofferdams or an *A*-60 class division. A gastight *A*-0 class division is acceptable if there is no source of ignition or fire hazard in the adjoining spaces.

3.1.5 The Risk Analysis of the Turret Compartments

In addition to **3.1.1** to **3.1.4**, the risk of fire propagation from turret compartments to adjacent spaces are to be evaluated by a risk analysis (*see* **1.1.4**) and further preventive measures, such as the arrangement of a cofferdam around the turret compartment, are to be provided if needed.

3.1.~~4~~6 Segregation from the Sea

When cargo is carried in a cargo containment system requiring a complete or partial secondary barrier:

(1) At temperatures below -10°C, hold spaces are to be segregated from the sea by a double bottom; and

(2) At temperatures below -55°C, the ship is also to have a longitudinal bulkhead forming side tanks.

~~3.1.5 Segregation of Cargo Piping~~

~~Any piping system which may contain cargo or cargo vapour is to:~~

~~(1) be segregated from other piping systems, except where interconnections are required for cargo-related operations such as purging, gas-freeing or inerting. In such cases, precautions are to be taken to ensure that cargo or cargo vapour cannot enter such other piping systems through the interconnections;~~

~~(2) except as provided in **Chapter 16**, not pass through any accommodation space, service space or control station or through a machinery space other than a cargo pump room or cargo compressor space;~~

~~(3) be connected into the cargo containment system directly from the open deck except that pipes installed in a vertical trunkway or equivalent may be used to traverse void spaces above a cargo containment system and except that pipes for drainage, venting or purging may traverse cofferdams;~~

~~(4) except for bow or stern loading and unloading arrangements in accordance with **3.8** and emergency cargo jettisoning piping systems in accordance with **3.1.6**, and except in accordance with **Chapter 16**, be located in the cargo area above the open deck; and~~

~~(5) except for thwartship shore connection piping not subject to internal pressure at sea or emergency cargo jettisoning piping systems, be located inboard of the transverse tank location requirements of **2.6.1**.~~

~~3.1.6 Emergency Cargo Jettisoning Piping System~~

~~Any emergency cargo jettisoning piping system is to comply with **3.1.5** as appropriate and may be led aft externally to accommodation spaces, service spaces or control stations or machinery spaces, but is not to pass through them. If an emergency cargo jettisoning piping system is permanently installed a suitable means of isolation from the cargo piping is to be provided within the cargo area.~~

3.1.7 Openings for Cargo Containment System

Arrangements are to be made for sealing the weather decks in way of openings for cargo containment systems.

3.2 Accommodation, Service and Machinery Spaces and Control Stations (*IGC Code* 3.2)

3.2.1 Segregation of Hold Spaces Requiring a Secondary Barrier~~Location of Accommodation, Service and Machinery Spaces and Control Stations~~

No accommodation space, service space or control station is to be located within the cargo area. The bulkhead of accommodation spaces, service spaces or control stations ~~which~~that face the cargo area is to be so located as to avoid the entry of gas from the hold space to such spaces through a single failure of a deck or bulkhead on a ship having a containment system requiring a secondary barrier.

3.2.2 Location of Air Intakes and Openings

~~In order to~~ To guard against the danger of hazardous vapours, due consideration is to be given to the location of air intakes/outlets and openings into accommodation, service and machinery spaces and control stations in relation to cargo piping, cargo vent systems and machinery space exhausts from gas burning arrangements.

3.2.3 Access from a ~~Gas-safe Space to a Gas-dangerous Space~~ Non-hazardous Area to a Hazardous Area

Access through doors, gastight or otherwise, is not to be permitted from a ~~gas-safe space to a gas-dangerous space,~~ non-hazardous area to a hazardous area except for access to service spaces forward of the cargo area through air~~-~~locks, as permitted by **3.6.1**, when accommodation spaces are aft.

3.2.4 Arrangements of Entrances, Air Inlets and Openings

1 Entrances, air inlets and openings to accommodation spaces, service spaces, machinery spaces and control stations are not to face the cargo area. They are to be located on the end bulkhead not facing the cargo area or on the outboard side of the superstructure or deckhouse or on both at a distance of at least 4% of the length (*L*) of the ship but not less than 3*m* from the end of the superstructure or deckhouse facing the cargo area. This distance, however, need not exceed 5*m*.

2 Windows and sidescuttles facing the cargo area and on the sides of the superstructures or deckhouses within the distance mentioned above are to be of the fixed (non-opening) type. Wheelhouse windows may be non-fixed and wheelhouse doors may be located within the above limits so long as they are ~~so~~ designed in a manner that a rapid and efficient gas and vapour tightening of the wheelhouse can be ensured.

3 For ships dedicated to the carriage of cargoes ~~which~~that have neither flammable nor toxic hazards, the Society may approve relaxations from the above requirements.

4 Accesses to forecastle spaces containing sources of ignition may be permitted through a single door facing the cargo area, provided the doors are located outside hazardous areas as defined in **Chapter 10** of this Part.

3.2.5 Windows and Sidescuttles

Windows and sidescuttles facing the cargo area and on the sides of the superstructures and deckhouses within the limits specified in **3.2.4**, except wheelhouse windows, are to be constructed to *A*-60 class. Wheelhouse windows are to be constructed to not less than *A*-0 class (for external fire load). Sidescuttles in the shell below the uppermost continuous deck and in the first tier of ~~a~~the superstructure or deckhouse is to be of ~~the~~ fixed (non-opening) type.

3.2.6 Closing Devices of Air Intakes, Outlets and Other Openings

All air intakes, outlets and other openings into the accommodation spaces, service spaces and control stations are to be fitted with closing devices. ~~For~~When carrying toxic ~~gases~~ products, they are to be capable of being operated from inside the space. The requirement for fitting air intakes and openings with closing devices operated from inside the space for toxic products need not apply to spaces not normally manned, such as deck stores, forecastle stores, workshops. In addition, the requirement does not apply to cargo control rooms located within the cargo area.

3.2.7 Access to Spaces with Turret Systems, etc.

Control rooms and machinery spaces of turret systems may be located in the cargo area forward or aft of cargo tanks in ships with such installations. Access to such spaces containing sources of ignition may be permitted through doors facing the cargo area, provided the doors are located outside hazardous areas or access is through airlocks.

3.3 ~~Cargo Pump Rooms and Cargo Compressor Rooms~~ Cargo Machinery Spaces and Turret Compartments (*IGC Code* 3.3)

3.3.1 Location

~~1~~ ~~Cargo pump rooms and cargo compressor rooms~~ Cargo machinery spaces are to be situated above the weather deck and located within the cargo area ~~unless specially approved by the Society~~. ~~Cargo compressor rooms~~ Cargo machinery spaces and turret compartments are to be treated as cargo pump rooms for the purpose of fire protection according to **9.2.4~~-2~~, Part R**, and for the purpose of prevention of potential explosion according to **4.5.10, Part R**.

3.3.2 Extension of the Limits of the Cargo Area

~~2~~ When ~~cargo pump rooms and cargo compressor rooms~~ cargo machinery spaces are ~~permitted to be fitted above or below the weather deck~~ located at the after end of the aftermost hold space or at the forward end of the ~~forwardmost~~ foremost hold space, the limits of the cargo area, as defined in **1.1.5(6)**, are to be extended to include the ~~cargo pump rooms and cargo compressor rooms~~ cargo machinery spaces for the full breadth and depth of the ship and the deck areas above those spaces.

3.3.3 Bulkheads of the Cargo Machinery Spaces

~~3~~ Where the limits of the cargo area are extended by ~~-2~~ **3.3.2**, the bulkhead ~~which~~that separates the ~~cargo pump rooms and cargo compressor rooms~~ cargo machinery spaces from accommodation and service spaces, control stations and machinery spaces of category *A* is to be ~~so~~ located so as to avoid the entry of gas to these spaces through a single failure of a deck or bulkhead.

~~3.3.2 Gastight Seal of Shaft~~

~~Where pumps and compressors are driven by shafting passing through a bulkhead or deck, gastight seals with efficient lubrication or other means of ensuring the permanence of the gas seal are to be fitted in way of the bulkhead or deck.~~

3.3.4 Cargo Compressors and Cargo Pumps

Cargo compressors and cargo pumps may be driven by electric motors in an adjacent non-hazardous space separated by a bulkhead or deck, if the seal around the bulkhead penetration ensures effective gastight segregation of the two spaces. Alternatively, such equipment may be driven by certified safe electric motors adjacent to them if the electrical installation complies with the requirements of **Chapter 10** of this Part.

3.3.~~3~~5 Access ~~and Discharge~~ of ~~Drainage~~ Cargo Machinery Spaces and Turret Compartments

Arrangements of ~~cargo pump rooms and cargo compressor rooms~~ cargo machinery spaces and turret compartments are to ~~be such as to~~ ensure safe unrestricted access for personnel wearing protective clothing and breathing apparatus, and in the event of injury to allow unconscious personnel to be removed. At least two widely separated escape routes and doors are to be provided in cargo machinery spaces, except that a single escape route may be accepted where the maximum travel distance to the door is 5*m* or less.

3.3.6 Drainage

All valves necessary for cargo handling are to be readily accessible to personnel wearing protective clothing. Suitable arrangements are to be made to deal with drainage of pump and compressor rooms.

3.3.7 Structural Integrity of Turret Compartments

Turret compartments are to be designed to retain their structural integrity in case of explosion or uncontrolled high-pressure gas release (overpressure and/or brittle fracture), the characteristics of which are to be substantiated on the basis of a risk analysis with due consideration of the capabilities of the pressure relieving devices.

3.4 Cargo Control Rooms (*IGC Code* 3.4)

3.4.1 Location

Any cargo control room is to be above the weather deck and may be located in the cargo area. The cargo control room may be located within the accommodation spaces, service spaces or control stations provided the following conditions are complied with:

(1) the cargo control room is a ~~gas-safe space~~ non-hazardous area; ~~and~~

(~~a~~2) if the entrance complies with **3.2.4-1**, the control room may have access to the spaces described above; and

(~~b~~3) if the entrance does not comply with **3.2.4-1**, the cargo control room is to have no access to the spaces described above and the boundaries ~~to~~ for such spaces are to be insulated to "*A*-60" class ~~integrity~~.

3.4.2 Instrumentation

If the cargo control room is designed to be a ~~gas-safe space~~ non-hazardous area, instrumentation is, as far as possible, to be by indirect reading systems and, in any case, to be designed to prevent any escape of gas into the atmosphere of that space. Location of the gas ~~detector~~detection system within the cargo control room will not ~~violate the gas-safe space~~ cause the room to be classified as a hazardous area, if installed in accordance with **13.6.~~5~~11**.

3.4.3 Source of Ignition

If the cargo control room for ships carrying flammable cargoes is ~~a gas-dangerous space~~ classified as a hazardous area, sources of ignition are to be excluded~~. Consideration is to be paid to the safety characteristics of any electrical installations~~ and any electrical equipment is to be installed in accordance with **Chapter 10** of this Part.

3.5 Access to Spaces in the Cargo Area (*IGC Code* 3.5)

3.5.1 Access for Inspection of Inner Hull

Visual inspection ~~is to be possible~~ of at least one side of the inner hull structure is to be possible without the removal of any fixed structure or fitting. If such a visual inspection, whether combined with those inspections required in **3.5.2**, **4.6.2(4)~~7.7~~** or **4.20.3-7~~10.16~~** or not, is only possible at the outer face of the inner hull, the inner hull is not to be a fuel-oil tank boundary wall.

3.5.2 Access for Inspection of Insulation

Inspection of one side of any insulation in hold spaces is to be possible. If the integrity of the ~~insulation~~ system can be verified by inspection of the outside of the hold space boundary when tanks are at service temperature, inspection of one side of the insulation in the hold space need not be required.

3.5.3 Access to Hold Spaces, etc.

Arrangements for hold spaces, void spaces, cargo tanks and other spaces ~~that could be considered gas-dangerous and cargo tanks~~ classified as hazardous areas, are to be such as to allow entry and inspection of any such space by personnel wearing protective clothing and breathing apparatus and ~~in the event of injury to allow~~ are also to allow for the evacuation of injured and/or unconscious personnel ~~to be removed from the space and should~~. Such arrangements are to comply with the following:

(1) Access is to be provided as follows:

(a) access to all cargo tanks. Access is to be direct from the ~~open~~ weather deck;

(b) access through horizontal openings, hatches or manholes~~,~~. ~~t~~The dimensions ~~of which~~ are to be sufficient to allow a person wearing a breathing apparatus to ascend or descend any ladder without obstruction, and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space~~;~~. ~~t~~The minimum clear opening is to be not less than 600*mm* ~~by~~ × 600*mm*; ~~and~~

(c) access through vertical openings~~,~~ or manholes providing passage through the length and breadth of the space~~,~~. ~~t~~The minimum clear opening ~~of which~~ is to be not less than 600*mm* ~~by~~ × 800*mm* at a height of not more than 600*mm* from the bottom plating unless gratings or other foot~~-~~holds are provided~~.~~; and

(d) circular access openings to type *C* tanks are to have a diameter of not less than 600*mm*.

(2) The dimensions referred to in **(1)(b)** and **(c)** may be decreased, if the ~~ability to traverse such openings or to remove an injured person~~ requirements of **3.5.3** can be ~~proved~~ met to the satisfaction of the Society.

(3) ~~The requirements of **(1)(b)** and **(c)** do not apply to spaces described in **4.7.1(2)(d), Part H**. Such spaces are to be provided only with direct or indirect access from the open weather deck, not including an enclosed gas-safe space.~~ Where cargo is carried in a containment system requiring a secondary barrier, the requirements of **(1)(b)** and **(c)** do not apply to spaces separated from a hold space by a single gastight steel boundary. Such spaces are to be provided only with direct or indirect access from the weather deck, not including any enclosed non-hazardous area.

(4) Access required for inspection is to be a designated access through structures below and above cargo tanks, which are to have at least the cross-sections as required by **(1)(c)**.

(5) For the purpose of **3.5.1** or **3.5.2**, the following is to apply:

(a) where it is required to pass between the surface to be inspected, flat or curved, and structures such as deck beams, stiffeners, frames, girders, etc., the distance between that surface and the free edge of the structural elements are to be at least 380*mm*. The distance between the surface to be inspected and the surface to which the above structural elements are fitted, e.g. deck, bulkhead or shell, are to be at least 450*mm* for a curved tank surface (e.g. for a type *C* tank), or 600*mm* for a flat tank surface (e.g. for a type *A* tank) (*see* Fig. **N3.1**);

(b) where it is not required to pass between the surface to be inspected and any part of the structure, for visibility reasons the distance between the free edge of that structural element and the surface to be inspected are to be at least 50*mm* or half the breadth of the structure's face plate, whichever is the larger (*see* Fig. **N3.2**);

(c) if for inspection of a curved surface where it is required to pass between that surface and another surface, flat or curved, to which no structural elements are fitted, the distance between both surfaces is to be at least 380*mm* (*see* Fig. **N3.3**). Where it is not required to pass between that curved surface and another surface, a smaller distance than 380*mm* may be accepted taking into account the shape of the curved surface;

(d) if for inspection of an approximately flat surface where it is required to pass between two approximately flat and approximately parallel surfaces, to which no structural elements are fitted, the distance between those surfaces are to be at least 600*mm*. Where fixed access ladders are fitted, a clearance of at least 450*mm* is to be provided for access (*see* Fig. **N3.4**);

(e) the minimum distances between a cargo tank sump and adjacent double bottom structure in way of a suction well are to be not less than those shown in Fig. **N3.5** (Fig. **N3.5** shows that the distance between the plane surfaces of the sump and the well is a minimum of 150*mm* and that the clearance between the edge between the inner bottom plate, and the vertical side of the well and the knuckle point between the spherical or circular surface and sump of the tank is at least 380*mm*). If there is no suction well, the distance between the cargo tank sump and the inner bottom are not to be less than 50*mm*;

(f) the distance between a cargo tank dome and deck structures are not to be less than 150*mm* (*see* Fig. **N3.6**);

(g) fixed or portable staging is to be installed as necessary for inspection of cargo tanks, cargo tank supports and restraints (e.g. anti-pitching, anti-rolling and anti-flotation chocks), cargo tank insulation etc. This staging is not to impair the clearances specified in **(a)** to **(d)**; and

(h) if fixed or portable ventilation ducting is to be fitted in compliance with **12.1.2**, such ducting is not to impair the distances required under **(a)** to **(d)**.

Fig. N3.1

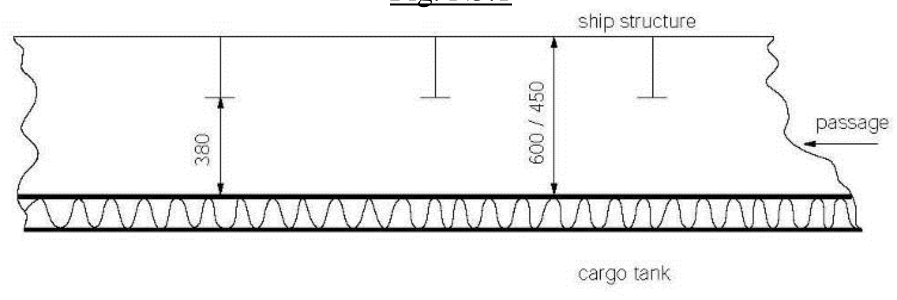


Fig. N3.2

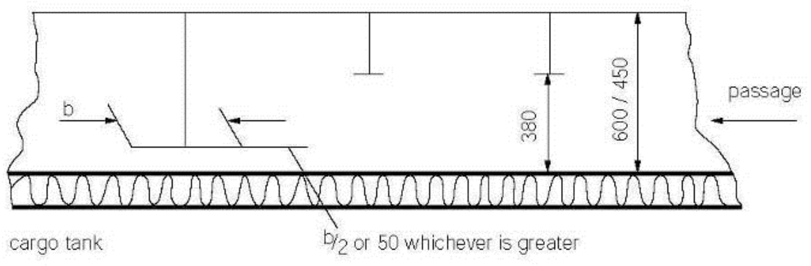


Fig. N3.3

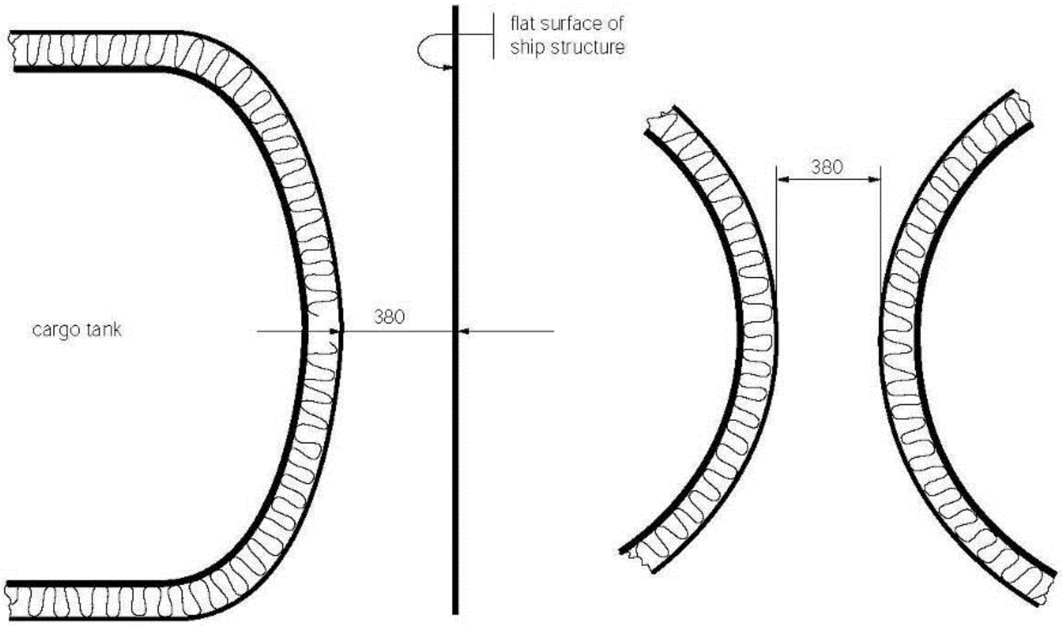


Fig. N3.4

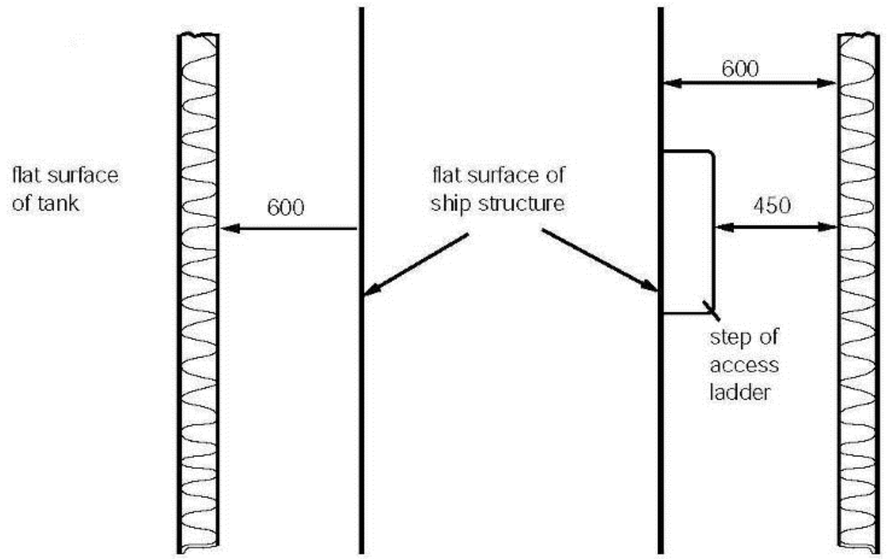


Fig. N3.5

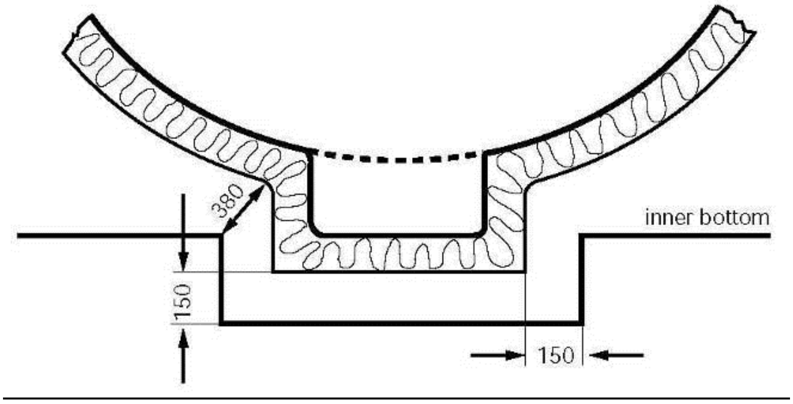
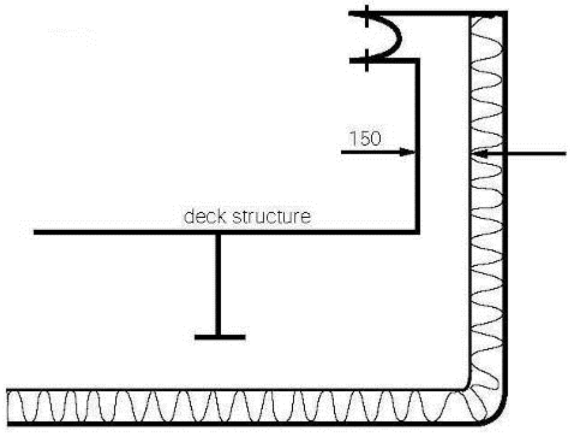


Fig. N3.6



3.5.4 Access to ~~Gas-safe Spaces~~ Non-hazardous Areas

Access from the open weather deck to ~~gas-safe spaces~~ non-hazardous areas is to be located ~~in a gas-safe zone at least 2.4*m* above the weather deck~~ outside the hazardous areas as defined in **Chapter 10** of this Part, unless the access is by means of an air-lock in accordance with **3.6**.

3.5.5 Access/Egress to Turret Compartments

Turret compartments are to be arranged with two independent means of access/egress.

3.5.6 Access from a Hazardous Area to a Non-hazardous Area

Access from a hazardous area below the weather deck to a non-hazardous area is not permitted.

3.6 Air-locks (*IGC Code* 3.6)

3.6.1 Location of Gastight Doors

~~An air-lock is only to be permitted between a gas-dangerous zone on the open weather deck and a gas-safe space and is to consist of two steel doors substantially gastight spaced at least 1.5*m*~~

~~but not more than 2.5*m* apart.~~ Access between hazardous area on the open weather deck and non-hazardous spaces is to be by means of an airlock. This is to consist of two self-closing, substantially gastight, steel doors without any holding back arrangements, capable of maintaining the overpressure, at least 1.5*m* but no more than 2.5*m* apart. The airlock space is to be artificially ventilated from a non-hazardous area and maintained at an overpressure to the hazardous area on the weather deck.

~~3.6.2 Self-closing of the Doors~~

~~The doors are to be self-closing and without any holding back arrangements.~~

3.6.2 Design and Arrangement of the Ventilation

Where spaces are protected by pressurization, the ventilation is to be designed and installed in accordance with recognized standards.

3.6.3 Alarms of Non-closing

An audible and ~~visual~~visible alarm system to give a warning on both sides of the air-lock is to be provided ~~to indicate if more than one door is moved from the closed position~~. The visible alarm is to indicate if one door is open. The audible alarm is to sound if doors on both sides of the airlock are moved from the closed positions.

3.6.4 Maintenance of Overpressure~~Electrical Equipments~~ in the Protected Space

In ships carrying flammable products, electrical equipment ~~which is not of the certified safe type~~ that is located in spaces protected by air-locks and not of the certified safe type, is to be de-energized ~~upon~~ in case of loss of overpressure in the space ~~(*see* also **10.1.4**)~~.

3.6.5 Electrical Equipments in the Protected Space

Electrical equipment ~~which is not of the certified safe type~~ for manoeuvring, anchoring and mooring, ~~equipment~~ as well as ~~the~~ emergency fire pumps that are ~~not to be~~ located in spaces ~~to be~~ protected by air-locks, is to be of a certified safe type in accordance with **10.2.4**.

~~3.6.5 Ventilation~~

~~The air-lock space is to be mechanically ventilated from a gas-safe space and maintained at an overpressure to the gas-dangerous zone on the open weather deck.~~

3.6.6 Monitoring of Cargo Vapour

The air-lock space is to be monitored for cargo vapours (*see* **13.6.2**).

3.6.7 Door Sill

Subject to the requirements of the **Chapters 18**~~, **19** and~~ to **20 of Part C** or **Chapters 18** and **19, Part CS**, the door sill is not to be less than 300 *mm* in height.

3.7 Bilge, Ballast and ~~Fuel~~ Oil Fuel Arrangements (*IGC Code* 3.7)

3.7.1 Drainage Arrangement ~~of Hold Spaces~~ Not Requiring a Secondary Barrier

~~1~~ Where cargo is carried in a cargo containment system not requiring a secondary barrier, ~~hold spaces are to be provided with~~ suitable drainage arrangements for the hold spaces that are not connected with the machinery space are to be provided. Means of detecting any leakage are to be provided.

3.7.2 Drainage Arrangements Requiring a Secondary Barrier

~~2~~ Where there is a secondary barrier, suitable drainage arrangements for dealing with any leakage into the hold or insulation spaces through the adjacent ship structure are to be provided. The suction is not to ~~be led~~lead to pumps inside the machinery space. Means of detecting such leakage are to be provided.

3.7.~~2~~3 Drainage System of Interbarrier Spaces

~~1~~ The hold or interbarrier spaces of Type ~~A~~*A* independent tank ships are to be provided with a drainage system suitable for handling liquid cargo in the event of cargo tank leakage or rupture. Such arrangements are to provide for the return of any cargo leakage to the liquid cargo piping.

3.7.4 Spool Piece

~~2~~ Arrangements referred to in ~~preceding -1~~ **3.7.3** are to be provided with a removable spool piece.

~~**3.7.3 Leakage Detection and Drainage System of Interbarrier Space of Internal Insulation Tanks**~~

~~In case of internal insulation tanks, means of detecting leakage and drainage arrangements are not required for interbarrier spaces and spaces between the secondary barrier and the inner hull or independent tank structure which are completely filled by insulation material complying with **4.9.7-2**.~~

3.7.~~4~~5 Connection to Pumps in the Machinery Spaces

1 Ballast spaces, including wet duct keels used as ballast piping, ~~fuel~~ oil fuel tanks and ~~gas-safe~~ non-hazardous spaces, may be connected to pumps in the machinery spaces.

2 Dry duct keels with ballast piping passing through~~,~~ may be connected to pumps in the machinery spaces, provided the connections are led directly to the pumps, and the discharge from the pumps is ~~lead~~led directly overboard with no valves or manifolds in either line ~~which~~that could connect the line from the duct keel to lines serving ~~gas-safe~~ non-hazardous spaces.

3 Pump vents are not to be open to machinery spaces.

3.8 Bow ~~or~~and Stern Loading and Unloading Arrangements (*IGC Code* 3.8)

3.8.1 General

Subject to the requirements **3.8** of this section and **Chapter 5** of this Part, cargo piping may be arranged to permit bow or stern loading and unloading.

3.8.2 Bow and Stern Loading and Unloading Arrangement for Individual Cargoes (related to *IGC Code* 3.8.2)

Bow or stern loading and unloading lines that are led past accommodation spaces, service spaces or control stations are not to be used for the transfer of products requiring a type 1*G* ship. Bow or stern loading and unloading lines are not to be used for the transfer of toxic products as specified in **1.1.5(48)**, where the design pressure is above 2.5*MPa*.

3.8.~~2~~3 Portable Arrangements

Portable arrangements are not to be permitted.

~~3.8.3 Piping Equipment~~

~~In addition to the requirements of Chapter 5 the following provisions apply to cargo piping and related piping equipment:~~

~~(1) Cargo piping and related piping equipment outside the cargo area are to have only welded connections. The piping outside the cargo area is to run on the open deck and to be at least 760*mm* inboard except for thwartships shore connection piping. Such piping is to be clearly identified and fitted with a shutoff valve at its connection to the cargo piping system within the cargo area. At this location, it is also to be capable of being separated by means of a removable spool piece and blank flanges when not in use.~~

~~(2) The piping is to be full penetration butt welded, and fully radiographed regardless of pipe diameter and design temperature. Flange connections in the piping are only permitted within the cargo area and at the shore connection.~~

~~(3) Arrangements are to be made to allow such piping to be purged and gas-freed after use. When not in use, the spool pieces are to be removed and the pipe ends be blank-flanged. The vent pipes connected with the purge are to be located in the cargo area.~~

3.8.4 Arrangements of Entrance, Air Inlets and Openings

1 Entrances, air inlets and openings to accommodation spaces, service spaces, machinery spaces and controls stations, are not to face the cargo shore connection location of bow or stern loading and unloading arrangements. They are to be located on the outboard side of the superstructure or deckhouse at a distance of at least 4% of the length ~~(L_f)~~ of the ship, but not less than 3*m* from the end of the superstructure or deckhouse facing the cargo shore connection location of the bow or stern loading and unloading arrangements. This distance~~, however,~~ need not exceed 5*m*.

2 ~~Sidescuttles~~ Windows and sidescuttles facing the shore connection location and on the sides of the superstructure or deckhouse within the distance mentioned above is to be of the fixed (non-opening) type.

3 In addition, during the use of the bow or stern loading and unloading arrangements, all doors, ports and other openings on the corresponding superstructure or deckhouse side is to be ~~capable of being~~ kept closed.

4 Where, in the case of small ships, compliance with **3.2.4-1 to 3.2.4-4** and ~~this paragraph~~ in **-1** to **-3** above is not possible, the Society may approve relaxations from the above requirements.

3.8.5 Closing of Deck Openings and Air Inlets

Deck openings and air inlets and outlets to spaces within distances of 10*m* from the cargo shore connection location are to be ~~capable of being~~ kept closed during the use of bow or stern loading or unloading arrangements.

~~3.8.6 Electrical Equipment~~

~~Electrical equipment within a zone of 3*m* from the cargo shore connection location is to be in accordance with **Chapter 10**~~.

3.8.~~7~~6 Fire-fighting Arrangements

Fire-fighting arrangements for the bow or stern loading and unloading areas are to be in accordance with **11.3.1(~~3~~4)** and **11.4.~~7~~6**.

3.8.~~8~~7 Means of Communication

Means of communication between the cargo control station and the shore connection location are to be provided and ~~if necessary certified safe~~, where applicable, certified for use in hazardous areas.

3.9 Operating Requirements

3.9.1 Application

The provisions in **3.9** are not related to surveys necessary ~~the conditions~~ for the maintenance of classification, but indicate those matters ~~for~~ which ~~examinations~~ are ~~required but the conditions~~ to be strictly observed by the shipowner or the~~,~~ ship master as well as ~~or~~all other persons responsible for~~who may concern with~~ the ship's operation.

3.9.2 Bow or Stern Loading and Unloading Arrangement for Individual Cargoes (~~with reference~~related to *IGC Code* 3.8.~~1.1~~2)

Bow or stern loading and unloading lines ~~which~~ that are led past accommodation spaces, service spaces or control stations are not to be used for the transfer of products requiring a type 1*G* ship. Bow or stern loading and unloading lines are not to be used for the transfer of toxic products ~~unless specifically approved by the Administration~~ as specified in **1.1.5(48)**, where the design pressure is above 2.5*MPa*.

3.9.3 Closing of Openings (~~with reference~~related to *IGC Code* 3.8.4.3)

During the use of the bow or stern loading and unloading arrangements, all doors, ports and other openings on the corresponding superstructure or deckhouse side is to be kept closed.

3.9.4 Closing of Deck Openings and Air Inlets (~~with reference~~related to *IGC Code* 3.8.5)

Deck openings and air inlets and outlets to spaces within distances of 10*m* from the cargo shore connection location are to be kept closed during the use of bow or stern loading or unloading arrangements.

Chapter 4 has been deleted and new Chapter 4 has been added as follows.

Chapter 4 CARGO CONTAINMENT

4.1 Definitions (*IGC Code* 4.1)

4.1.1 Cold Spot

A cold spot is a part of the hull or thermal insulation surface where a localized temperature decrease occurs with respect to the allowable minimum temperature of the hull or of its adjacent hull structure, or to design capabilities of cargo pressure/temperature control systems required in **Chapter 7**.

4.1.2 Design Vapour Pressure

Design vapour pressure "P_0" is the maximum gauge pressure, at the top of the tank, to be used in the design of the tank.

4.1.3 Design Temperature

Design temperature for selection of materials is the minimum temperature at which cargo may be loaded or transported in the cargo tanks.

4.1.4 Independent Tanks

Independent tanks are self-supporting tanks. They do not form part of the ship's hull and are not essential to the hull strength. There are three categories of independent tank, which are referred to in **4.21**, **4.22** and **4.23**.

4.1.5 Membrane Tanks

Membrane tanks are non-self-supporting tanks that consist of a thin liquid and gastight layer (membrane) supported through insulation by the adjacent hull structure. Membrane tanks are covered in **4.24**.

4.1.6 Integral Tanks

Integral tanks are tanks that form a structural part of the hull and are influenced in the same manner by the loads that stress the adjacent hull structure. Integral tanks are covered in **4.25**.

4.1.7 Semi-membrane Tanks

Semi-membrane tanks are non-self-supporting tanks in the loaded condition and consist of a layer, parts of which are supported through insulation by the adjacent hull structure. Semi-membrane tanks are covered in **4.26**.

4.1.8 Others

In addition to the definitions in **1.2**, the definitions given in this chapter are to apply throughout this Part.

4.2 Application (*IGC Code* 4.2)

Unless otherwise specified in **4.21** to **4.26**, the requirements of **4.3** to **4.20** are to apply to all types of tanks, including those covered in **4.27**.

4.3 Functional Requirements (*IGC Code* 4.3)

4.3.1 Design Life

The design life of the cargo containment system is not to be less than the design life of the ship.

4.3.2 Environmental Condition

Cargo containment systems are to be designed for North Atlantic environmental conditions and relevant long-term sea state scatter diagrams for unrestricted navigation. Lesser environmental conditions, consistent with the expected usage, may be accepted by the Society for cargo containment systems used exclusively for restricted navigation. Greater environmental conditions may be required for cargo containment systems operated in conditions more severe than the North Atlantic environment.

4.3.3 Safety Margins

Cargo containment systems are to be designed with suitable safety margins:

(1) to withstand, in the intact condition, the environmental conditions anticipated for the cargo containment system's design life and the loading conditions appropriate for them, which include full homogeneous and partial load conditions, partial filling within defined limits and ballast voyage loads; and

(2) being appropriate for uncertainties in loads, structural modelling, fatigue, corrosion, thermal effects, material variability, ageing and construction tolerances.

4.3.4 Design Condition

The cargo containment system structural strength is to be assessed against failure modes, including but not limited to plastic deformation, buckling and fatigue. The specific design conditions which are to be considered for the design of each cargo containment system are given in **4.21** to **4.26**. There are three main categories of design conditions:

(1) Ultimate design conditions – the cargo containment system structure and its structural components are to withstand loads liable to occur during its construction, testing and anticipated use in service, without loss of structural integrity. The design is to take into account proper combinations of the following loads:
   (a) internal pressure;
   (b) external pressure;
   (c) dynamic loads due to the motion of the ship;
   (d) thermal loads;
   (e) sloshing loads;
   (f) loads corresponding to ship deflections;
   (g) tank and cargo weight with the corresponding reaction in way of supports;
   (h) insulation weight;
   (i) loads in way of towers and other attachments; and
   (j) test loads.

(2) Fatigue design conditions – the cargo containment system structure and its structural components are not to fail under accumulated cyclic loading.

(3) The cargo containment system is to meet the following criteria:
   (a) Collision – the cargo containment system is to be protectively located in accordance with **2.4.1** and withstand the collision loads specified in **4.15.1** without deformation of the supports, or the tank structure in way of the supports, likely to endanger the tank structure.

(b) Fire – the cargo containment systems are to sustain, without rupture, the rise in internal pressure specified in **8.4.1** under the fire scenarios envisaged therein.

(c) Flooded compartment causing buoyancy on tank – the anti-flotation arrangements are to sustain the upward force, specified in **4.15.2**, and there is to be no endangering plastic deformation to the hull.

4.3.5 Corrosion Allowance, etc.

Measures are to be applied to ensure that scantlings required meet the structural strength provisions and be maintained throughout the design life. Measures may include, but are not limited to, material selection, coatings, corrosion additions, cathodic protection and inerting. Corrosion allowance need not be required in addition to the thickness resulting from the structural analysis. However, where there is no environmental control, such as inerting around the cargo tank, or where the cargo is of a corrosive nature, the Society may require a suitable corrosion allowance.

4.3.6 Inspection/Survey Plan

An inspection/survey plan for the cargo containment system is to be developed and approved by the Society. The inspection/survey plan is to identify areas that need inspection during surveys throughout the cargo containment system's life and, in particular, all necessary in-service survey and maintenance that was assumed when selecting cargo containment system design parameters. Cargo containment systems are to be designed, constructed and equipped to provide adequate means of access to areas that need inspection as specified in the inspection/survey plan. Cargo containment systems, including all associated internal equipment, are to be designed and built to ensure safety during operations, inspection and maintenance (see **3.5**).

4.4 Cargo Containment Safety Principles (*IGC Code* 4.4)

4.4.1 General

The containment systems are to be provided with a full secondary liquid-tight barrier capable of safely containing all potential leakages through the primary barrier and, in conjunction with the thermal insulation system, of preventing lowering of the temperature of the ship structure to an unsafe level.

4.4.2 Reducing Secondary Barrier

However, the size and configuration or arrangement of the secondary barrier may be reduced where an equivalent level of safety is demonstrated in accordance with the requirements of **4.4.3** to **4.4.5**, as applicable.

4.4.3 Small Leak Procection System

Cargo containment systems for which the probability for structural failures to develop into a critical state has been determined to be extremely low, but where the possibility of leakages through the primary barrier cannot be excluded, are to be equipped with a partial secondary barrier and small leak protection system capable of safely handling and disposing of the leakages. The arrangements are to comply with the following requirements:

(1) failure developments that can be reliably detected before reaching a critical state (e.g. by gas detection or inspection) are to have a sufficiently long development time for remedial actions to be taken; and

(2) failure developments that cannot be safely detected before reaching a critical state are to have a predicted development time that is much longer than the expected lifetime of the tank.

4.4.4 Secondary Barriers when the Probability of Leakage is Negligible

No secondary barrier is required for cargo containment systems, e.g. type *C* independent tanks, where the probability for structural failures and leakages through the primary barrier is extremely low and can be neglected.

4.4.5 Secondary Barrier where the cargo temperature is not more than -10°C

No secondary barrier is required where the cargo temperature at atmospheric pressure is at or above -10°C.

4.5 Secondary Barriers in relation to Tank Types (*IGC Code* 4.5)

Secondary barriers in relation to the tank types defined in **4.21** to **4.26** are to be provided in accordance with the **Table N4.1**.

Table N4.1 Tank Type and Secondary Barrier

Cargo temperature at atmospheric pressure	-10°C and above	Below -10°C down to -55°C	Below -55°C
Basic tank type	No secondary barrier required	Hull may act as secondary barrier	Separate secondary barrier where required
Integral		Tank type not normally allowed[1]	
Membrane		Complete secondary barrier	
Semi-membrane		Complete secondary barrier[2]	
Independent:			
-type A		Complete secondary barrier	
-type B		Partial secondary barrier	
-type C		No secondary barrier required	
Note 1: A complete secondary barrier is to normally be required if cargoes with a temperature at atmospheric pressure below -10°C are permitted in accordance with **4.25.1**.			
Note 2: In the case of semi-membrane tanks that comply in all respects with the requirements applicable to type *B* independent tanks, except for the manner of support, the Society may, after special consideration, accept a partial secondary barrier.			

4.6 Design of Secondary Barriers (*IGC Code* 4.6)

4.6.1 Hull Structure Acting as a Secondary Barrier

Where the cargo temperature at atmospheric pressure is not below -55°C, the hull structure may act as a secondary barrier based on the following:

(1) the hull material is to be suitable for the cargo temperature at atmospheric pressure as required by **4.19.1-4**; and

(2) the design is to be such that this temperature will not result in unacceptable hull stresses.

4.6.2 Standards of Secondary Barrier

The design of the secondary barrier is to be such that:

(1) it is capable of containing any envisaged leakage of liquid cargo for a period of 15 *days*, unless different criteria apply for particular voyages, taking into account the load spectrum referred to in **4.18.2-6;**

(2) physical, mechanical, or operational events within the cargo tank that could cause failure of

the primary barrier are not to impair the due function of the secondary barrier, or vice versa;

(3) failure of a support or an attachment to the hull structure will not lead to loss of liquid tightness of both the primary and secondary barriers;

(4) it is capable of being periodically checked for its effectiveness by means acceptable to the Society. This may be by means of a visual inspection or a pressure/vacuum test or other suitable means carried out according to a documented procedure agreed with the Society;

(5) the methods required in **(4)** above are to be approved by the Society and to include, where applicable to the test procedure:

  (a) details on the size of defect acceptable and the location within the secondary barrier, before its liquid-tight effectiveness is compromised;

  (b) accuracy and range of values of the proposed method for detecting defects in **(a)** above;

  (c) scaling factors to be used in determining the acceptance criteria, if full scale model testing is not undertaken; and

  (d) effects of thermal and mechanical cyclic loading on the effectiveness of the proposed test; and

(6) the secondary barrier is to fulfil its functional requirements at a static angle of heel of 30°.

4.7 Partial Secondary Barriers and Primary Barrier Small Leak Protection System (*IGC Code* 4.7)

4.7.1 General

Partial secondary barriers as permitted in **4.4.3** are to be used with a small leak protection system and meet all the requirements in **4.6.2**. The small leak protection system is to include means to detect a leak in the primary barrier, provision such as a spray shield to deflect any liquid cargo down into the partial secondary barrier, and means to dispose of the liquid, which may be by natural evaporation.

4.7.2 Partial Secondary Barriers

The capacity of the partial secondary barrier is to be determined, based on the cargo leakage corresponding to the extent of failure resulting from the load spectrum referred to in **4.18.2-6**, after the initial detection of a primary leak. Due account may be taken of liquid evaporation, rate of leakage, pumping capacity and other relevant factors.

4.7.3 Liquid Leakage Detection

The required liquid leakage detection may be by means of liquid sensors, or by an effective use of pressure, temperature or gas detection systems, or any combination thereof.

4.8 Supporting Arrangements (*IGC Code* 4.8)

4.8.1 General

The cargo tanks are to be supported by the hull in a manner that prevents bodily movement of the tank under the static and dynamic loads defined in **4.12** to **4.15**, where applicable, while allowing contraction and expansion of the tank under temperature variations and hull deflections without undue stressing of the tank and the hull.

4.8.2 Anti- flotation Arrangements

Anti-flotation arrangements are to be provided for independent tanks and capable of withstanding the loads defined in **4.15.2** without plastic deformation likely to endanger the hull structure.

4.8.3 Load Combination

Supports and supporting arrangements are to withstand the loads defined in **4.13.9** and **4.15**, but these loads need not be combined with each other or with wave-induced loads.

4.9 Associated Structure and Equipment (*IGC Code* 4.9)

4.9.1 General

Cargo containment systems are to be designed for the loads imposed by associated structure and equipment. This includes pump towers, cargo domes, cargo pumps and piping, stripping pumps and piping, nitrogen piping, access hatches, ladders, piping penetrations, liquid level gauges, independent level alarm gauges, spray nozzles, and instrumentation systems (such as pressure, temperature and strain gauges).

4.10 Thermal Insulation (*IGC Code* 4.10)

4.10.1 Protection of Hull Structure for Low Temperature Products

Thermal insulation is to be provided, as required, to protect the hull from temperatures below those allowable (see **4.19.1**) and limit the heat flux into the tank to the levels that can be maintained by the pressure and temperature control system applied in **Chapter 7**.

4.10.2 Insulation Performance

In determining the insulation performance, due regard is to be given to the amount of the acceptable boil-off in association with the reliquefaction plant on board, main propulsion machinery or other temperature control system.

4.11 General (*IGC Code* 4.11)

This section defines the design loads to be considered with regard to the requirements in **4.16**, **4.17** and **4.18**. This includes:

(1) load categories (permanent, functional, environmental and accidental) and the description of the loads;

(2) the extent to which these loads are to be considered depending on the type of tank, and is more fully detailed in the following paragraphs; and

(3) tanks, together with their supporting structure and other fixtures, that are to be designed taking into account relevant combinations of the loads described below.

4.12 Permanent Loads (*IGC Code* 4.12)

4.12.1 Gravity Loads

The weight of tank, thermal insulation, loads caused by towers and other attachments are to be considered.

4.12.2 Permanent External Loads

Gravity loads of structures and equipment acting externally on the tank are to be considered.

4.13 Functional Loads (*IGC Code* 4.13)

4.13.1 General

Loads arising from the operational use of the tank system are to be classified as functional loads. All functional loads that are essential for ensuring the integrity of the tank system, during all design conditions, are to be considered. As a minimum, the effects from the following criteria, as applicable, are to be considered when establishing functional loads:

(1) internal pressure;
(2) external pressure;
(3) thermally induced loads;
(4) vibration;
(5) interaction loads;
(6) loads associated with construction and installation;
(7) test loads;
(8) static heel loads; and
(9) weight of cargo.

4.13.2 Internal Pressure

1 In all cases, including **4.13.2-2**, P_0 is not to be less than *MARVS*.

2 For cargo tanks, where there is no temperature control and where the pressure of the cargo is dictated only by the ambient temperature, P_0 is not to be less than the gauge vapour pressure of the cargo at a temperature of 45°C except as follows:

(1) lower values of ambient temperature may be accepted by the Society for ships operating in restricted areas. Conversely, higher values of ambient temperature may be required; and
(2) for ships on voyages of restricted duration, P_0 may be calculated based on the actual pressure rise during the voyage, and account may be taken of any thermal insulation of the tank.

3 Subject to special consideration by the Society and to the limitations given in **4.21** to **4.26**, for the various tank types, a vapour pressure P_h higher than P_0 may be accepted for site specific conditions (harbour or other locations), where dynamic loads are reduced.

4 The internal pressure P_{eq} results from the vapour pressure P_0 or P_h plus the maximum associated dynamic liquid pressure P_{gd}, but not including the effects of liquid sloshing loads. Guidance formulae for associated dynamic liquid pressure P_{gd} are given in **4.28.1**.

4.13.3 External Pressure

External design pressure loads are to be based on the difference between the minimum internal pressure and the maximum external pressure to which any portion of the tank may be simultaneously subjected.

4.13.4 Thermally Induced loads

1 Transient thermally induced loads during cooling down periods are to be considered for tanks intended for cargo temperatures below -55°C.

2 Stationary thermally induced loads are to be considered for cargo containment systems where the design supporting arrangements or attachments and operating temperature may give rise to significant thermal stresses (see **7.2**).

4.13.5 Vibration

The potentially damaging effects of vibration on the cargo containment system are to be considered.

4.13.6 Interaction Loads

The static component of loads resulting from interaction between cargo containment system and the hull structure, as well as loads from associated structure and equipment, are to be considered.

4.13.7 Loads associated with Construction and Installation

Loads or conditions associated with construction and installation, e.g. lifting, are to be considered.

4.13.8 Test Loads

Account is to be taken of the loads corresponding to the testing of the cargo containment system referred to in **4.21** to **4.26**.

4.13.9 Static Heel Loads

Loads corresponding to the most unfavourable static heel angle within the range 0° to 30° are to be considered.

4.13.10 Other Loads

Any other loads not specifically addressed, which could have an effect on the cargo containment system, are to be taken into account.

4.14 Environmental Loads (*IGC Code* 4.14)

Environmental loads are defined as those loads on the cargo containment system that are caused by the surrounding environment and that are not otherwise classified as a permanent, functional or accidental load.

4.14.1 Loads due to Ship Motion

1 The determination of dynamic loads is to take into account the long-term distribution of ship motion in irregular seas, which the ship will experience during its operating life. Account may be taken of the reduction in dynamic loads due to necessary speed reduction and variation of heading.

2 The ship's motion is to include surge, sway, heave, roll, pitch and yaw. The accelerations acting on tanks are to be estimated at their centre of gravity and include the following components:

(1) vertical acceleration: motion accelerations of heave, pitch and, possibly, roll (normal to the ship base);

(2) transverse acceleration: motion accelerations of sway, yaw and roll and gravity component of roll; and

(3) longitudinal acceleration: motion accelerations of surge and pitch and gravity component of

pitch.

3 Methods to predict accelerations due to ship motion are to be proposed and approved by the Society.

4 Guidance formulae for acceleration components are given in **4.28.2**.

5 Ships for restricted service may be given special consideration.

4.14.2 Dynamic Interaction Loads

Account is to be taken of the dynamic component of loads resulting from interaction between cargo containment systems and the hull structure, including loads from associated structures and equipment.

4.14.3 Sloshing Loads

1 The sloshing loads on a cargo containment system and internal components are to be evaluated based on allowable filling levels.

2 When significant sloshing-induced loads are expected to be present, special tests and calculations are to be required covering the full range of intended filling levels.

4.14.4 Snow and Ice Loads

Snow and icing are to be considered, if relevant.

4.14.5 Loads due to Navigation in Ice

Loads due to navigation in ice are to be considered for vessels intended for such service.

4.15 Accidental Loads (*IGC Code* 4.15)

Accidental loads are defined as loads that are imposed on a cargo containment system and its supporting arrangements under abnormal and unplanned conditions.

4.15.1 Collision Loads

The collision load is to be determined based on the cargo containment system under fully loaded condition with an inertial force corresponding to 0.5 *g* in the forward direction and 0.25 *g* in the aft direction, where "*g*" is gravitational acceleration.

4.15.2 Loads due to Flooding on Ship

For independent tanks, loads caused by the buoyancy of an empty tank in a hold space flooded to the summer load draught are to be considered in the design of the anti-flotation chocks and the supporting hull structure.

4.16 General (*IGC Code* 4.16)

4.16.1 Safety Margin

The structural design is to ensure that tanks have an adequate capacity to sustain all relevant loads with an adequate margin of safety. This is to take into account the possibility of plastic deformation, buckling, fatigue and loss of liquid and gas tightness.

4.16.2 General

The structural integrity of cargo containment systems is to be demonstrated by compliance with **4.21** to **4.26**, as appropriate, for the cargo containment system type.

4.16.3 Novel Design

The structural integrity of cargo containment system types that are of novel design and differ significantly from those covered by **4.21** to **4.26** is to be demonstrated by compliance with **4.27** to ensure that the overall level of safety provided in this chapter is maintained.

4.17 Structural Analyses (*IGC Code* 4.17)

4.17.1 Analysis

1 The design analyses are to be based on accepted principles of statics, dynamics and strength of materials.

2 Simplified methods or simplified analyses may be used to calculate the load effects, provided that they are conservative. Model tests may be used in combination with, or instead of, theoretical calculations. In cases where theoretical methods are inadequate, model or full-scale tests may be required.

3 When determining responses to dynamic loads, the dynamic effect is to be taken into account where it may affect structural integrity.

4.17.2 Load Scenarios

1 For each location or part of the cargo containment system to be considered and for each possible mode of failure to be analysed, all relevant combinations of loads that may act simultaneously are to be considered.

2 The most unfavourable scenarios for all relevant phases during construction, handling, testing and in service, and conditions are to be considered.

4.17.3 Allowable Stresses

When the static and dynamic stresses are calculated separately, and unless other methods of calculation are justified, the total stresses are to be calculated according to:

$$\sigma_x = \sigma_{x\cdot st} \pm \sqrt{\sum \left(\sigma_{x\cdot dyn}\right)^2}$$

$$\sigma_y = \sigma_{y\cdot st} \pm \sqrt{\sum \left(\sigma_{y\cdot dyn}\right)^2}$$

$$\sigma_z = \sigma_{z\cdot st} \pm \sqrt{\sum \left(\sigma_{z\cdot dyn}\right)^2}$$

$$\tau_{xy} = \tau_{xy\cdot st} \pm \sqrt{\sum \left(\tau_{xy\cdot dyn}\right)^2}$$

$$\tau_{xz} = \tau_{xz\cdot st} \pm \sqrt{\sum \left(\tau_{xz\cdot dyn}\right)^2}$$

$$\tau_{yz} = \tau_{yz\cdot st} \pm \sqrt{\sum \left(\tau_{yz\cdot dyn}\right)^2}$$

where:

$\sigma_{x\cdot st}$, $\sigma_{y\cdot st}$, $\sigma_{z\cdot st}$, $\tau_{xy\cdot st}$, $\tau_{xz\cdot st}$ and $\tau_{yz\cdot st}$ are static stresses; and

$\sigma_{x\cdot dyn}$, $\sigma_{y\cdot dyn}$, $\sigma_{z\cdot dyn}$, $\tau_{xy\cdot dyn}$, $\tau_{xz\cdot dyn}$ and $\tau_{yz\cdot dyn}$ are dynamic stresses,

each is to be determined separately from acceleration components and hull strain components due to deflection and torsion.

4.18 Design Conditions (*IGC Code* 4.18)

All relevant failure modes are to be considered in the design for all relevant load scenarios and design conditions. The design conditions are given in the earlier part of this chapter, and the load scenarios are covered by **4.17.2**.

4.18.1 Ultimate Design Condition

Structural capacity may be determined by testing, or by analysis, taking into account both the elastic and plastic material properties, by simplified linear elastic analysis or by this Part provisions.

(1) Plastic deformation and buckling are to be considered.

(2) Analysis is to be based on characteristic load values as follows:

Permanent loads:	Expected values
Functional loads:	Specified values
Environmental loads:	For wave loads: most probable largest load encountered during 10^8 wave encounters.

(3) For the purpose of ultimate strength assessment, the following material parameters apply:

(a) R_e : specified minimum yield stress at room temperature (N/mm^2). If the stress-strain curve does not show a defined yield stress, the 0.2% proof stress applies.

(b) R_m : specified minimum tensile strength at room temperature (N/mm^2).
For welded connections where under-matched welds, i.e. where the weld metal has lower tensile strength than the parent metal, are unavoidable, such as in some aluminium alloys, the respective R_e and R_m of the welds, after any applied heat treatment, are to be used. In such cases, the transverse weld tensile strength is not to be less than the actual yield strength of the parent metal. If this cannot be achieved, welded structures made from such materials are not to be incorporated in cargo containment systems.

(c) The above properties are to correspond to the minimum specified mechanical properties of the material, including the weld metal in the as-fabricated condition. Subject to special consideration by the Society, account may be taken of the enhanced yield stress and tensile strength at low temperature.

(4) The equivalent stress σ_C (von Mises, Huber) is to be determined by:

$$\sigma_C = \sqrt{\sigma_x^2 + \sigma_y^2 + \sigma_z^2 - \sigma_x\sigma_y - \sigma_x\sigma_z - \sigma_y\sigma_z + 3\left(\tau_{xy}^2 + \tau_{xz}^2 + \tau_{yz}^2\right)}$$

where:

σ_x : total normal stress in x-direction;

σ_y : total normal stress in y-direction;

σ_z : total normal stress in z-direction;

τ_{xy} : total shear stress in x-y plane;

τ_{xz} : total shear stress in x-z plane; and

τ_{yz} : total shear stress in y-z plane.

The above values are to be calculated as described in **4.17.3**.

(5) Allowable stresses for materials other than those covered by **Chapter 6** are to be subject to approval by the Society in each case.

(6) Stresses may be further limited by fatigue analysis, crack propagation analysis and buckling criteria.

4.18.2 Fatigue Design Condition

1 The fatigue design condition is the design condition with respect to accumulated cyclic loading.

2 Where a fatigue analysis is required, the cumulative effect of the fatigue load is to comply with:

$$\Sigma\frac{n_i}{N_i}+\frac{n_{Loading}}{N_{Loading}}\leq C_w$$

where:

n_i : number of stress cycles at each stress level during the life of the tank;

N_i : number of cycles to fracture for the respective stress level according to the Wohler (S-N) curve;

$n_{Loading}$: number of loading and unloading cycles during the life of the tank, not to be less than 1,000 (1,000 cycles normally corresponds to 20 years of operation). Loading and unloading cycles include a complete pressure and thermal cycle;

$N_{Loading}$: number of cycles to fracture for the fatigue loads due to loading and unloading; and

C_w : maximum allowable cumulative fatigue damage ratio.

The fatigue damage is to be based on the design life of the tank but not less than 10^8 wave encounters.

3 Where required, the cargo containment system is to be subject to fatigue analysis, considering all fatigue loads and their appropriate combinations for the expected life of the cargo containment system. Consideration is to be given to various filling conditions.

4

(1) Design *S-N* curves used in the analysis are to be applicable to the materials and weldments, construction details, fabrication procedures and applicable state of the stress envisioned.

(2) The *S-N* curves are to be based on a 97.6% probability of survival corresponding to the mean-minus-two-standard-deviation curves of relevant experimental data up to final failure. Use of *S-N* curves derived in a different way requires adjustments to the acceptable C_w values specified in **4.18.2-7** to **4.18.2-9**.

5 Analysis is to be based on characteristic load values as follows:

Permanent loads:	Expected values
Functional loads:	Specified values or specified history
Environmental loads:	Expected load history, but not less than 10^8 cycles

If simplified dynamic loading spectra are used for the estimation of the fatigue life, they are to be specially considered by the Society.

6

(1) Where the size of the secondary barrier is reduced, as is provided for in **4.4.3**, fracture mechanics analyses of fatigue crack growth are to be carried out to determine:

(a) crack propagation paths in the structure;

(b) crack growth rate;

(c) the time required for a crack to propagate to cause a leakage from the tank;

(d) the size and shape of through thickness cracks; and

(e) the time required for detectable cracks to reach a critical state.

The fracture mechanics are, in general, based on crack growth data taken as a mean value plus two standard deviations of the test data.

(2) In analysing crack propagation, the largest initial crack not detectable by the inspection method applied is to be assumed, taking into account the allowable non-destructive testing and visual inspection criterion, as applicable.

(3) Crack propagation analysis under the condition specified in **4.18.2-7**: the simplified load distribution and sequence over a period of 15 *days* may be used. Such distributions may be obtained as indicated in **Fig. N4.4**. Load distribution and sequence for longer periods, such as in **4.18.2-8** and **4.18.2-9** are to be approved by the Society.
(4) The arrangements are to comply with **4.18.2-7** to **4.18.2-9**, as applicable.

7 For failures that can be reliably detected by means of leakage detection:

C_w is to be less than or equal to 0.5.

Predicted remaining failure development time, from the point of detection of leakage till reaching a critical state, is not to be less than 15 *days*, unless different requirements apply for ships engaged in particular voyages.

8 For failures that cannot be detected by leakage but that can be reliably detected at the time of in-service inspections:

C_w is to be less than or equal to 0.5.

Predicted remaining failure development time, from the largest crack not detectable by in-service inspection methods until reaching a critical state, is not to be less than three times the inspection interval.

9 In particular locations of the tank, where effective defect or crack development detection cannot be assured, the following, more stringent, fatigue acceptance criteria are to be applied as a minimum:

C_w is to be less than or equal to 0.1.

Predicted failure development time, from the assumed initial defect until reaching a critical state, is not to be less than three times the lifetime of the tank.

4.18.3 Accident Design Condition

1 The accident design condition is a design condition for accidental loads with extremely low probability of occurrence.

2 Analysis is to be based on the characteristic values as follows:

Permanent loads:	Expected values
Functional loads:	Specified values
Environmental loads:	Specified values
Accidental loads:	Specified values or expected values

3 Loads mentioned in **4.13.9** and **4.15** need not be combined with each other or with wave-induced loads.

4.19 Materials (*IGC Code* 4.19)

4.19.1 Materials forming Ship Structure

1 To determine the grade of steels used in the hull structure, a temperature calculation is to be performed for all tank types when the cargo temperature is below -10°C. The following assumptions are to be made in this calculation:
(1) the primary barrier of all tanks is to be assumed to be at the cargo temperature;
(2) in addition to **-1**, where a complete or partial secondary barrier is required, it is to be assumed to be at the cargo temperature at atmospheric pressure for any one tank only;
(3) for worldwide service, ambient temperatures are to be taken as 5°C for air and 0ºC for seawater. Higher values may be accepted for ships operating in restricted areas and, conversely, lower values may be fixed by the Society for ships trading to areas where lower temperatures are expected during the winter months;

(4) still air and seawater conditions are to be assumed, i.e. no adjustment for forced convection;
(5) degradation of the thermal insulation properties over the life of the ship due to factors such as thermal and mechanical ageing, compaction, ship motions and tank vibrations, as defined in **4.19.3-6** and **4.19.3-7**, are to be assumed;
(6) the cooling effect of the rising boil-off vapour from the leaked cargo is to be taken into account, where applicable;
(7) credit for hull heating may be taken in accordance with **4.19.1-5**, provided the heating arrangements are in compliance with **4.19.1-6**;
(8) no credit is to be given for any means of heating, except as described in **4.19.1-5**; and
(9) for members connecting inner and outer hulls, the mean temperature may be taken for determining the steel grade.

2 The shell and deck plating of the ship and all stiffeners attached thereto are to be in accordance with recognized standards. If the calculated temperature of the material in the design condition is below -5°C due to the influence of the cargo temperature, the material is to be in accordance with **Table N6.5**.

3 The materials of all other hull structures for which the calculated temperature in the design condition is below 0°C, due to the influence of cargo temperature and that do not form the secondary barrier, are also to be in accordance with **Table N6.5**. This includes hull structure supporting the cargo tanks, inner bottom plating, longitudinal bulkhead plating, transverse bulkhead plating, floors, webs, stringers and all attached stiffening members.

4 The hull material forming the secondary barrier is to be in accordance with **Table N6.2**. Where the secondary barrier is formed by the deck or side shell plating, the material grade required by **Table N6.2** is to be carried into the adjacent deck or side shell plating, where applicable, to a suitable extent.

5 Means of heating structural materials may be used to ensure that the material temperature does not fall below the minimum allowed for the grade of material specified in **Table N6.5**. In the calculations required in **4.19.1-1**, credit for such heating may be taken in accordance with the following:
(1) for any transverse hull structure;
(2) for longitudinal hull structure referred to in **4.19.1-2** and **4.19.1-3** where colder ambient temperatures are specified, provided the material remains suitable for the ambient temperature conditions of +5°C for air and 0°C for seawater with no credit taken in the calculations for heating; and
(3) as an alternative to **-2**, for longitudinal bulkhead between cargo tanks, credit may be taken for heating, provided the material remain suitable for a minimum design temperature of -30°C, or a temperature 30°C lower than that determined by **4.19.1-1** with the heating considered, whichever is less. In this case, the ship's longitudinal strength is to comply with the relevant provisions of **Part C of the Rules** for both when those bulkhead(s) are considered effective and not.

6 The means of heating referred to in **4.19.1-5** are to comply with the following requirements:
(1) the heating system is to be arranged so that, in the event of failure in any part of the system, standby heating can be maintained equal to not less than 100% of the theoretical heat requirement;
(2) the heating system is to be considered as an essential auxiliary. All electrical components of at least one of the systems provided in accordance with **4.19.1-5(1)** are to be supplied from the emergency source of electrical power; and
(3) the design and construction of the heating system are to be included in the approval of the containment system by the Society.

4.19.2 Materials of Primary and Secondary Barriers

1 Metallic materials used in the construction of primary and secondary barriers not forming the hull, are to be suitable for the design loads that they may be subjected to, and be in accordance with, **Table N6.1**, **Table N6.2** or **Table N6.3**.

2 Materials, either non-metallic or metallic but not covered by **Table N6.1**, **Table N6.2** and **Table N6.3**, used in the primary and secondary barriers may be approved by the Society, considering the design loads that they may be subjected to, their properties and their intended use.

3 Where non-metallic materials, including composites, are used for, or incorporated in the primary or secondary barriers, they are to be tested for the following properties, as applicable, to ensure that they are adequate for the intended service:

(1) compatibility with the cargoes;
(2) ageing;
(3) mechanical properties;
(4) thermal expansion and contraction;
(5) abrasion;
(6) cohesion;
(7) resistance to vibrations;
(8) resistance to fire and flame spread; and
(9) resistance to fatigue failure and crack propagation.

4 The above properties, where applicable, are to be tested for the range between the expected maximum temperature in service and +5°C below the minimum design temperature, but not lower than -196°C.

5

(1) Where non-metallic materials, including composites, are used for the primary and secondary barriers, the joining processes are also to be tested as described above.
(2) uidance on the use of non-metallic materials in the construction of primary and secondary barriers is provided in **Annex 6**.

6 Consideration may be given to the use of materials in the primary and secondary barrier, which are not resistant to fire and flame spread, provided they are protected by a suitable system such as a permanent inert gas environment, or are provided with a fire-retardant barrier.

4.19.3 Thermal Insulation and Other Materials used in Cargo Containment Systems

1 Load-bearing thermal insulation and other materials used in cargo containment systems are to be suitable for the design loads.

2 Thermal insulation and other materials used in cargo containment systems are to have the following properties, as applicable, to ensure that they are adequate for the intended service:

(1) compatibility with the cargoes;
(2) solubility in the cargo;
(3) absorption of the cargo;
(4) shrinkage;
(5) ageing;
(6) closed cell content;
(7) density;
(8) mechanical properties, to the extent that they are subjected to cargo and other loading effects, thermal expansion and contraction;
(9) abrasion;
(10) cohesion;
(11) thermal conductivity;
(12) resistance to vibrations;

(13) resistance to fire and flame spread; and
(14) resistance to fatigue failure and crack propagation.

3 The above properties, where applicable, are to be tested for the range between the expected maximum temperature in service and 5°C below the minimum design temperature, but not lower than -196°C.

4 Due to location or environmental conditions, thermal insulation materials are to have suitable properties of resistance to fire and flame spread and are to be adequately protected against penetration of water vapour and mechanical damage. Where the thermal insulation is located on or above the exposed deck, and in way of tank cover penetrations, it is to have suitable fire resistance properties in accordance with recognized standards or be covered with a material having low flame-spread characteristics and forming an efficient approved vapour seal.

5 Thermal insulation that does not meet recognized standards for fire resistance may be used in hold spaces that are not kept permanently inerted, provided its surfaces are covered with material with low flame-spread characteristics and that forms an efficient approved vapour seal.

6 Testing for thermal conductivity of thermal insulation is to be carried out on suitably aged samples.

7 Where powder or granulated thermal insulation is used, measures are to be taken to reduce compaction in service and to maintain the required thermal conductivity and also prevent any undue increase of pressure on the cargo containment system.

4.20 Construction Processes (*IGC Code* 4.20)

4.20.1 Weld Joint Design

1 All welded joints of the shells of independent tanks are to be of the in-plane butt weld full penetration type. For dome-to-shell connections only, tee welds of the full penetration type may be used depending on the results of the tests carried out at the approval of the welding procedure. Except for small penetrations on domes, nozzle welds are also to be designed with full penetration.

2 Welding joint details for type *C* independent tanks, and for the liquid-tight primary barriers of type *B* independent tanks primarily constructed of curved surfaces, is to be as follows:

(1) all longitudinal and circumferential joints are to be of butt welded, full penetration, double vee or single vee type. Full penetration butt welds are to be obtained by double welding or by the use of backing rings. If used, backing rings are to be removed except from very small process pressure vessels. Other edge preparations may be permitted, depending on the results of the tests carried out at the approval of the welding procedure; and

(2) the bevel preparation of the joints between the tank body and domes and between domes and relevant fittings is to be designed according to a standard acceptable to the Society. All welds connecting nozzles, domes or other penetrations of the vessel and all welds connecting flanges to the vessel or nozzles are to be full penetration welds.

3 Where applicable, all the construction processes and testing, except that specified in **4.20.3**, are to be done in accordance with the applicable provisions of **Chapter 6**.

4.20.2 Design for Gluing and Other Joining Processes

The design of the joint to be glued (or joined by some other process except welding) is to take account of the strength characteristics of the joining process.

4.20.3 Testing

1 All cargo tanks and process pressure vessels are to be subjected to hydrostatic or hydropneumatic pressure testing in accordance with **4.21** to **4.26**, as applicable for the tank type.

2 All tanks are to be subject to a tightness test which may be performed in combination with the pressure test referred to in **4.20.3-1**.
3 Requirements with respect to inspection of secondary barriers are to be decided by the Society in each case, taking into account the accessibility of the barrier (see **4.6.2**).
4 The Society may require that for ships fitted with novel type *B* independent tanks, or tanks designed according to **4.27** at least one prototype tank and its supporting structures are to be instrumented with strain gauges or other suitable equipment to confirm stress levels. Similar instrumentation may be required for type *C* independent tanks, depending on their configuration and on the arrangement of their supports and attachments.
5 The overall performance of the cargo containment system is to be verified for compliance with the design parameters during the first full loading and discharging of the cargo, in accordance with the survey procedure and requirements in **1.4** as well as requirements deemed appropriate by the Society. Records of the performance of the components and equipment essential to verify the design parameters, are to be maintained and be available to the Society.
6 Heating arrangements, if fitted in accordance with **4.19.1-5** and **4.19.1-6**, are to be tested for required heat output and heat distribution.
7 The cargo containment system is to be inspected for cold spots during, or immediately following, the first loaded voyage. Inspection of the integrity of thermal insulation surfaces that cannot be visually checked is to be carried out in accordance with recognized standards.

4.21 Type *A* Independent Tanks (*IGC Code* 4.21)

4.21.1 Design Basis

1 Type *A* independent tanks are tanks primarily designed using classical ship-structural analysis procedures in accordance with recognized standards. Where such tanks are primarily constructed of plane surfaces, the design vapour pressure P_0 is to be less than 0.07 *MPa*.
2 If the cargo temperature at atmospheric pressure is below -10°C, a complete secondary barrier is to be provided as required in **4.5**. The secondary barrier is to be designed in accordance with **4.6**.

4.21.2 Structural Analysis

1 A structural analysis is to be performed taking into account the internal pressure as indicated in **4.13.2**, and the interaction loads with the supporting and keying system as well as a reasonable part of the ship's hull.
2 For parts, such as supporting structures, not otherwise covered by the requirements of this Part, stresses are to be determined by direct calculations, taking into account the loads referred to in **4.12** to **4.15** as far as applicable, and the ship deflection in way of supporting structures.
3 The tanks with supports are to be designed for the accidental loads specified in **4.15**. These loads need not be combined with each other or with environmental loads.

4.21.3 Ultimate Design Condition

1 For tanks primarily constructed of plane surfaces, the nominal membrane stresses for primary and secondary members (stiffeners, web frames, stringers, girders), when calculated by classical analysis procedures, are to not exceed the lower of R_m /2.66 or R_e /1.33 for nickel steels, carbon-manganese steels, austenitic steels and aluminium alloys, where R_m and R_e are defined in **4.18.1-3**. However, if detailed calculations are carried out for the primary members, the equivalent stress σ_C, as defined in **4.18.1-4**, may be increased over that indicated above to a stress acceptable to the Society. Calculations are to take into account the effects of bending, shear, axial and torsional deformation as well as the hull/cargo tank interaction forces due to the deflection of the double bottom and cargo tank bottoms.

2 Tank boundary scantlings are to meet at least the requirements of **Chapter 14**, **Part C of the Rules** for deep tanks taking into account the internal pressure as indicated in **4.13.2** and any corrosion allowance required by **4.3.5**.

3 The cargo tank structure is to be reviewed against potential buckling.

4.21.4 Accident Design Condition

1 The tanks and the tank supports are to be designed for the accidental loads and design conditions specified in **4.3.4(3)** and **4.15**, as relevant.

2 When subjected to the accidental loads specified in **4.15**, the stress is to comply with the acceptance criteria specified in **4.21.3**, modified as appropriate, taking into account their lower probability of occurrence.

4.21.5 Testing

All type *A* independent tanks are to be subjected to a hydrostatic or hydropneumatic test. This test is to be performed such that the stresses approximate, as far as practicable, the design stresses, and that the pressure at the top of the tank corresponds at least to the *MARVS*. When a hydropneumatic test is performed, the conditions are to simulate, as far as practicable, the design loading of the tank and of its support structure, including dynamic components, while avoiding stress levels that could cause permanent deformation.

4.22 Type *B* Independent Tanks (*IGC Code* 4.22)

4.22.1 Design Basis

1 Type *B* independent tanks are tanks designed using model tests, refined analytical tools and analysis methods to determine stress levels, fatigue life and crack propagation characteristics. Where such tanks are primarily constructed of plane surfaces (prismatic tanks), the design vapour pressure P_0 is to be less than 0.07 *MPa*.

2 If the cargo temperature at atmospheric pressure is below -10°C, a partial secondary barrier with a small leak protection system is to be provided as required in **4.5**. The small leak protection system is to be designed according to **4.7**.

4.22.2 Structural Analysis

1 The effects of all dynamic and static loads are to be used to determine the suitability of the structure with respect to:

(1) plastic deformation;
(2) buckling;
(3) fatigue failure; and
(4) crack propagation.

Finite element analysis or similar methods and fracture mechanics analysis, or an equivalent approach, are to be carried out.

2 A three-dimensional analysis is to be carried out to evaluate the stress levels, including interaction with the ship's hull. The model for this analysis is to include the cargo tank with its supporting and keying system, as well as a reasonable part of the hull.

3 A complete analysis of the particular ship accelerations and motions in irregular waves, and of the response of the ship and its cargo tanks to these forces and motions is to be performed, unless the data is available from similar ships.

4.22.3 Ultimate Design Condition

1 Plastic deformation

(1) For type B independent tanks, primarily constructed of bodies of revolution, the allowable stresses are to not exceed:

$$\sigma_m \leq f$$

$$\sigma_L \leq 1.5f$$

$$\sigma_b \leq 1.5F$$

$$\sigma_L + \sigma_b \leq 1.5F$$

$$\sigma_m + \sigma_b \leq 1.5F$$

$$\sigma_m + \sigma_b + \sigma_g \leq 3.0F$$

$$\sigma_L + \sigma_b + \sigma_g \leq 3.0F$$

σ_m : equivalent primary general membrane stress;

σ_L : equivalent primary local membrane stress;

σ_b : equivalent primary bending stress;

σ_g : equivalent secondary stress;

f : the lesser of (R_m/A or R_e/B); and

F : the lesser of (R_m/C or R_e/D),

with R_m and R_e as defined in **4.18.1-3.** With regard to the stresses σ_m, σ_L, σ_b and σ_g, the definition of stress categories in **4.28.3** are referred. The above figures may be altered, taking into account the design condition considered in acceptance with the Society.

Table N4.2 Values of *A*, *B*, *C* and *D* (Type *B*, Indipendent Tanks)

	Nickel steels and carbon manganese steels	Austenitic steels	Aluminium alloys
A	3	3.5	4
B	2	1.6	1.5
C	3	3	3
D	1.5	1.5	1.5

(2) For type B independent tanks, primarily constructed of plane surfaces, the allowable membrane equivalent stresses applied for finite element analysis are not to exceed:

(a) for nickel steels and carbon-manganese steels, the lesser of $R_m/2$ or $R_e/1.2$;

(b) for austenitic steels, the lesser of $R_m/2.5$ or $R_e/1.2$; and

(c) for aluminium alloys, the lesser of $R_m/2.5$ or $R_e/1.2$.

The above figures may be amended, taking into account the locality of the stress, stress analysis methods and design condition considered in acceptance with the Society.

(3) The thickness of the skin plate and the size of the stiffener is not to be less than those required for type A independent tanks.

2 Buckling

Buckling strength analyses of cargo tanks subject to external pressure and other loads causing compressive stresses are to be carried out as deemed appropriate by the Society. The method is to adequately account for the difference in theoretical and actual buckling stress as a result of plate edge misalignment, lack of straightness or flatness, ovality and deviation from true circular form over a specified arc or chord length, as applicable.

4.22.4 Fatigue Design Condition

1 Fatigue and crack propagation assessment are to be performed in accordance with **4.18.2**. The acceptance criteria are to comply with **4.18.2-7**, **4.18.2-8** or **4.18.2-9**, depending on the detectability of the defect.
2 Fatigue analysis is to consider construction tolerances.
3 Where deemed necessary by the Society, model tests may be required to determine stress concentration factors and fatigue life of structural elements.

4.22.5 Accident Design Condition

1 The tanks and the tank supports are to be designed for the accidental loads and design conditions specified in **4.3.4(3)** and **4.15**, as applicable.
2 When subjected to the accidental loads specified in **4.15**, the stress is to comply with the acceptance criteria specified in **4.22.3**, modified as appropriate, taking into account their lower probability of occurrence.

4.22.6 Testing

Type *B* independent tanks are to be subjected to a hydrostatic or hydropneumatic test as follows:
(1) the test is to be performed as required in **4.21.5** for type *A* independent tanks; and
(2) in addition, the maximum primary membrane stress or maximum bending stress in primary members under test conditions is not to exceed 90% of the yield strength of the material (as fabricated) at the test temperature. To ensure that this condition is satisfied, when calculations indicate that this stress exceeds 75% of the yield strength, the prototype test is to be monitored by the use of strain gauges or other suitable equipment.

4.22.7 Marking

Any marking of the pressure vessel is to be achieved by a method that does not cause unacceptable local stress raisers.

4.23 Type *C* Independent Tanks (*IGC Code* 4.23)

4.23.1 Design Basis

1 The design basis for type *C* independent tanks is based on pressure vessel criteria modified to include fracture mechanics and crack propagation criteria. The minimum design pressure defined in **4.23.1-2** is intended to ensure that the dynamic stress is sufficiently low, so that an initial surface flaw will not propagate more than half the thickness of the shell during the lifetime of the tank.
2 The design vapour pressure is to not be less than:

$$P_0 = 0.2 + A \cdot C(\rho_r)^{1.5}\ (MPa)$$

where:

$$A = 0.00185\left(\frac{\sigma_m}{\Delta\sigma_A}\right)^2$$

with:

σ_m : design primary membrane stress;

$\Delta\sigma_A$: allowable dynamic membrane stress (double amplitude at probability level Q=10^{-8}) and equal to:

$55 N/mm^2$: for ferritic-perlitic, martensitic and austenitic steel;

$25 N/mm^2$:for aluminium alloy (*5083-O*);

C: a characteristic tank dimension to be taken as the greatest of the following:

h, $0.75b$ or $0.45l$

with:

h: height of tank (dimension in ship's vertical direction) (m);

b: width of tank (dimension in ship's transverse direction)(m);

l: length of tank (dimension in ship's longitudinal direction) (m);

ρ_r: the relative density of the cargo ($\rho_r = 1$ for fresh water) at the design temperature.

When a specified design life of the tank is longer than 10^8 wave encounters, $\Delta\sigma_A$ is to be modified to give equivalent crack propagation corresponding to the design life.

3 The Society may allocate a tank complying with the criteria of type *C* tank minimum design pressure as in **4.23.1-2**, to a type *A* or type *B*, dependent on the configuration of the tank and the arrangement of its supports and attachments.

4.23.2 Shell Thickness

1 The shell thickness is to be as follows:

(1) For pressure vessels, the thickness calculated according to **4.23.2-4** is to be considered as a minimum thickness after forming, without any negative tolerance.

(2) For pressure vessels, the minimum thickness of shell and heads including corrosion allowance, after forming, are not to be less than 5 *mm* for carbon-manganese steels and nickel steels, 3 *mm* for austenitic steels or 7 *mm* for aluminium alloys.

(3) The welded joint efficiency factor to be used in the calculation according to **4.23.2-4** is to be 0.95 when the inspection and the non-destructive testing referred to in **6.5.6-5** are carried out. This figure may be increased up to 1 when account is taken of other considerations, such as the material used, type of joints, welding procedure and type of loading. For process pressure vessels, the Society may accept partial non-destructive examinations, but not less than those of **6.5.6-5**, depending on such factors as the material used, the design temperature, the nil-ductility transition temperature of the material, as fabricated, and the type of joint and welding procedure, but in this case an efficiency factor of not more than 0.85 is to be adopted. For special materials, the above-mentioned factors are to be reduced, depending on the specified mechanical properties of the welded joint.

2 The design liquid pressure defined in **4.13.2** is to be taken into account in the internal pressure calculations.

3 The design external pressure P_e, used for verifying the buckling of the pressure vessels, is not to be less than that given by:

$$P_e = P_1 + P_2 + P_3 + P_4 \ (MPa)$$

where:

P_1: setting value of vacuum relief valves. For vessels not fitted with vacuum relief valves, P_1 is to be specially considered, but is not, in general, to be taken as less than 0.025 *MPa*;

P_2: the set pressure of the pressure relief valves (*PRVs*) for completely closed spaces containing pressure vessels or parts of pressure vessels; elsewhere P_2=0;

P_3: compressive actions in or on the shell due to the weight and contraction of thermal insulation, weight of shell including corrosion allowance and other miscellaneous external pressure loads to which the pressure vessel may be subjected. These include, but are not limited to, weight of domes, weight of towers and piping, effect of product in the partially filled condition, accelerations and hull deflection. In addition, the local effect of external or internal pressures or both are to be taken into account; and

P_4 : external pressure due to head of water for pressure vessels or part of pressure vessels on exposed decks; elsewhere P_4= 0.

4 Scantlings based on internal pressure are to be calculated as follows:

The thickness and form of pressure-containing parts of pressure vessels, under internal pressure, as defined in **4.13.2**, including flanges, are to be determined according to requirements of **Chapter 10, Part D**. These calculations are in all cases to be based on accepted pressure vessel design theory. Openings in pressure-containing parts of pressure vessels are to be reinforced in accordance with **Chapter 10, Part D**.

5 Stress analysis in respect of static and dynamic loads is to be performed as follows:

(1) Pressure vessel scantlings are to be determined in accordance with **4.23.2-1** to **4.23.2-4** and **4.23.3**.

(2) Calculations of the loads and stresses in way of the supports and the shell attachment of the support are to be made. Loads referred to in **4.12** to **4.15** are to be used, as applicable. Stresses in way of the supports are not to exceed 90% of the yield stress or 75% of the tensile strength of the material. In special cases a fatigue analysis may be required by the Society.

(3) If required by the Society, secondary stresses and thermal stresses are to be specially considered.

4.23.3 Ultimate Design Condition

1 Plastic deformation

(1) For type *C* independent tanks, the allowable stresses are not to exceed:

$$\sigma_m \le f$$

$$\sigma_L \le 1.5f$$

$$\sigma_b \le 1.5f$$

$$\sigma_L + \sigma_b \le 1.5f$$

$$\sigma_m + \sigma_b \le 1.5f$$

$$\sigma_m + \sigma_b + \sigma_g \le 3.0f$$

$$\sigma_L + \sigma_b + \sigma_g \le 3.0f$$

where:

σ_m : equivalent primary general membrane stress;

σ_L : equivalent primary local membrane stress;

σ_b : equivalent primary bending stress;

σ_g : equivalent secondary stress; and

f : f = the lesser of R_m/A or R_e/B,

with R_m and R_e as defined in **4.18.1-3**. With regard to the stresses $\sigma_{m,}$, σ_L , σ_b and σ_g , the definition of stress categories in **4.28.3** are referred.

Table N4.3 Values of *A*, *B*, *C* and *D* (Type *C*, Indipendent Tanks)

	Nickel steels and carbon manganese steels	Austenitic steels	Aluminium alloys
A	3	3.5	4
B	2	1.5	1.5

2 Buckling criteria are to be as follows: the thickness and form of pressure vessels subject to external pressure and other loads causing compressive stresses are to be based on calculations using accepted pressure vessel buckling theory and are to adequately account for the difference in theoretical and actual buckling stress as a result of plate edge misalignment, ovality and deviation from true circular form over a specified arc or chord length.

4.23.4 Fatigue Design Condition

For large type *C* independent tanks, where the cargo at atmospheric pressure is below -55°C, the Society may require additional verification to check their compliance with **4.23.1-1** regarding static and dynamic stress.

4.23.5 Accident Design Condition

1 The tanks and the tank supporting structures are to be designed for the accidental loads and design conditions specified in **4.3.4(3)** and **4.15**, as applicable.

2 When subjected to the accidental loads specified in **4.15**, the stress is to comply with the acceptance criteria specified in **4.23.3-1**, modified as appropriate taking into account their lower probability of occurrence.

4.23.6 Testing

1 Each pressure vessel is to be subjected to a hydrostatic test at a pressure measured at the top of the tanks, of not less than 1.5 P_0. In no case during the pressure test is the calculated primary membrane stress at any point to exceed 90% of the yield stress of the material. To ensure that this condition is satisfied where calculations indicate that this stress will exceed 0.75 times the yield strength, the prototype test is to be monitored by the use of strain gauges or other suitable equipment in pressure vessels other than simple cylindrical and spherical pressure vessels.

2 The temperature of the water used for the test is to be at least 30°C above the nil-ductility transition temperature of the material, as fabricated.

3 The pressure is to be held for 2 *h* per 25 *mm* of thickness, but in no case less than 2 *h*.

4 Where necessary for cargo pressure vessels, a hydropneumatic test may be carried out under the conditions prescribed in **4.23.6-1** to **4.23.6-3**.

5 Special consideration may be given to the testing of tanks in which higher allowable stresses are used, depending on service temperature. However, the requirements of **4.23.6-1** are to be fully complied with.

6 After completion and assembly, each pressure vessel and its related fittings are to be subjected to an adequate tightness test which may be performed in combination with the pressure testing referred to in **4.23.6-1**.

7 Pneumatic testing of pressure vessels other than cargo tanks is only to be considered on an individual case basis. Such testing is only to be permitted for those vessels designed or supported such that they cannot be safely filled with water, or for those vessels that cannot be dried and are to be used in a service where traces of the testing medium cannot be tolerated.

4.23.7 Marking

The required marking of the pressure vessel is to be achieved by a method that does not cause unacceptable local stress raisers.

4.24 Membrane tanks (*IGC Code* 4.24)

4.24.1 Design Basis

1 The design basis for membrane containment systems is that thermal and other expansion or contraction is compensated for without undue risk of losing the tightness of the membrane.

2 A systematic approach based on analysis and testing is to be used to demonstrate that the system will provide its intended function in consideration of the events identified in service as specified in **4.24.2-1**.

3 If the cargo temperature at atmospheric pressure is below -10°C, a complete secondary barrier is to be provided as required in **4.5**. The secondary barrier is to be designed according to **4.6.**

4 The design vapour pressure P_0 is not to normally exceed 0.025 *MPa*. If the hull scantlings are increased accordingly and consideration is given, where appropriate, to the strength of the supporting thermal insulation, P_0 may be increased to a higher value, but less than 0.07 *MPa*.

5 The definition of membrane tanks does not exclude designs such as those in which non-metallic membranes are used or where membranes are included or incorporated into the thermal insulation.

6 The thickness of the membranes is to not normally exceed 10 *mm*.

7 The circulation of inert gas throughout the primary insulation space and the secondary insulation space, in accordance with **9.2.1**, is to be sufficient to allow for effective means of gas detection.

4.24.2 Design Considerations

1 Potential incidents that could lead to loss of fluid tightness over the life of the membranes is to be evaluated. These include, but are not limited to:

(1) Ultimate design events:
- (a) tensile failure of membranes;
- (b) compressive collapse of thermal insulation;
- (c) thermal ageing;
- (d) loss of attachment between thermal insulation and hull structure;
- (e) loss of attachment of membranes to thermal insulation system;
- (f) structural integrity of internal structures and their supporting structures; and
- (g) failure of the supporting hull structure.

(2) Fatigue design events:
- (a) fatigue of membranes including joints and attachments to hull structure;
- (b) fatigue cracking of thermal insulation;
- (c) fatigue of internal structures and their supporting structures; and
- (d) fatigue cracking of inner hull leading to ballast water ingress.

(3) Accident design events:
- (a) accidental mechanical damage (such as dropped objects inside the tank while in service);
- (b) accidental overpressurization of thermal insulation spaces;
- (c) accidental vacuum in the tank; and
- (d) water ingress through the inner hull structure.

Designs where a single internal event could cause simultaneous or cascading failure of both membranes are unacceptable.

2 The necessary physical properties (mechanical, thermal, chemical, etc.) of the materials used in the construction of the cargo containment system are to be established during the design development in accordance with **4.24.1.2**.

4.24.3 Loads and Load Combinations

Particular consideration is to be given to the possible loss of tank integrity due to either an overpressure in the interbarrier space, a possible vacuum in the cargo tank, the sloshing effects, hull vibration effects, or any combination of these events.

4.24.4 Structural Analyses

1 Structural analyses and/or testing for the purpose of determining the ultimate strength and fatigue assessments of the cargo containment and associated structures, e.g. structures as defined in **4.9**, are to be performed. The structural analysis is to provide the data required to assess each failure mode that has been identified as critical for the cargo containment system.

2 Structural analyses of the hull are to take into account the internal pressure as indicated in **4.13.2**. Special attention is to be paid to deflections of the hull and their compatibility with the membrane and associated thermal insulation.

3 The analyses referred to in **4.24.4-1** and **4.24.4-2** are to be based on the particular motions, accelerations and response of ships and cargo containment systems.

4.24.5 Ultimate Design Condition

1 The structural resistance of every critical component, subsystem or assembly is to be established, in accordance with **4.24.1-2**, for in-service conditions.

2 The choice of strength acceptance criteria for the failure modes of the cargo containment system, its attachments to the hull structure and internal tank structures, is to reflect the consequences associated with the considered mode of failure.

3 The inner hull scantlings are to meet the requirements for deep tanks, taking into account the internal pressure as indicated in **4.13.2** and the specified appropriate requirements for sloshing load as defined in **4.14.3**.

4.24.6 Fatigue Design Condition

1 Fatigue analysis is to be carried out for structures inside the tank, i.e. pump towers, and for parts of membrane and pump tower attachments, where failure development cannot be reliably detected by continuous monitoring.

2 The fatigue calculations are to be carried out in accordance with **4.18.2**, with relevant requirements depending on:

(1) the significance of the structural components with respect to structural integrity; and

(2) availability for inspection.

3 For structural elements for which it can be demonstrated by tests and/or analyses that a crack will not develop to cause simultaneous or cascading failure of both membranes, C_w is to be less than or equal to 0.5.

4 Structural elements subject to periodic inspection, and where an unattended fatigue crack can develop to cause simultaneous or cascading failure of both membranes, are to satisfy the fatigue and fracture mechanics requirements stated in **4.18.2-8**.

5 Structural element not accessible for in-service inspection, and where a fatigue crack can develop without warning to cause simultaneous or cascading failure of both membranes, is to satisfy the fatigue and fracture mechanics requirements stated in **4.18.2-9**.

4.24.7 Accident Design Condition

1 The containment system and the supporting hull structure are to be designed for the accidental loads specified in **4.15**. These loads need not be combined with each other or with environmental loads.

2 Additional relevant accident scenarios are to be determined based on a risk analysis.

Particular attention is to be paid to securing devices inside tanks.

4.24.8 Design Development Testing

1 The design development testing required in **4.24.1-2** is to include a series of analytical and physical models of both the primary and secondary barriers, including corners and joints, tested to verify that they will withstand the expected combined strains due to static, dynamic and thermal loads. This will culminate in the construction of a prototype-scaled model of the complete cargo containment system. Testing conditions considered in the analytical and physical models are to represent the most extreme service conditions the cargo containment system will be likely to encounter over its life. Proposed acceptance criteria for periodic testing of secondary barriers required in **4.6.2** may be based on the results of testing carried out on the prototype-scaled model.
2 The fatigue performance of the membrane materials and representative welded or bonded joints in the membranes is to be determined by tests. The ultimate strength and fatigue performance of arrangements for securing the thermal insulation system to the hull structure are to be determined by analyses or tests.

4.24.9 Testing

1 In ships fitted with membrane cargo containment systems, all tanks and other spaces that may normally contain liquid and are adjacent to the hull structure supporting the membrane, are to be hydrostatically tested as deemed appropriate by the Society.
2 All hold structures supporting the membrane are to be tested for tightness before installation of the cargo containment system.
3 Pipe tunnels and other compartments that do not normally contain liquid need not be hydrostatically tested.

4.25 Integral Tanks (*IGC Code* 4.25)

4.25.1 Design Basis

Integral tanks that form a structural part of the hull and are affected by the loads that stress the adjacent hull structure are to comply with the following:

(1) the design vapour pressure P_0 as defined in **4.1.2** is not to normally exceed 0.025 *MPa*. If the hull scantlings are increased accordingly, P_0 may be increased to a higher value, but less than 0.07 *MPa*;

(2) integral tanks may be used for products, provided the boiling point of the cargo is not below -10°C. A lower temperature may be accepted by the Society subject to special consideration, but in such cases a complete secondary barrier is to be provided; and

(3) products required by **Chapter 19** to be carried in type 1*G* ships are not to be carried in integral tanks.

4.25.2 Structural Analysis

The structural analysis of integral tanks is to be in accordance with recognized standards.

4.25.3 Ultimate Design Condition

1 The tank boundary scantlings are to meet the requirements for deep tanks, taking into account the internal pressure as indicated in **4.13.2**.
2 For integral tanks, allowable stresses are to normally be those given for hull structure in the requirements of the Society.

4.25.4 Accident Design Condition

1 The tanks and the tank supports are to be designed for the accidental loads specified in **4.3.4(3)** and **4.15**, as relevant.
2 When subjected to the accidental loads specified in **4.15**, the stress is to comply with the acceptance criteria specified in **4.25.3**, modified as appropriate, taking into account their lower probability of occurrence.

4.25.5 Testing

All integral tanks are to be hydrostatically or hydropneumatically tested. The test is to be performed so that the stresses approximate, as far as practicable, to the design stresses and that the pressure at the top of the tank corresponds at least to the *MARVS*.

4.26 Semi-membrane Tanks (*IGC Code* 4.26)

4.26.1 Design Basis

1 Semi-membrane tanks are non-self-supporting tanks when in the loaded condition and consist of a layer, parts of which are supported through thermal insulation by the adjacent hull structure, whereas the rounded parts of this layer connecting the above-mentioned supported parts are designed also to accommodate the thermal and other expansion or contraction.
2 The design vapour pressure P_0 is not to normally exceed 0.025 *MPa*. If the hull scantlings are increased accordingly, and consideration is given, where appropriate, to the strength of the supporting thermal insulation, P_0 may be increased to a higher value, but less than 0.07 *MPa*.
3 For semi-membrane tanks the relevant requirements in this section for independent tanks or for membrane tanks are to be applied as appropriate.
4 In the case of semi-membrane tanks that comply in all respects with the requirements applicable to type *B* independent tanks, except for the manner of support, the Society may, after special consideration, accept a partial secondary barrier.

4.27 Limit State Design for Novel Concepts (*IGC Code* 4.27)

4.27.1 General

Cargo containment systems that are of a novel configuration that cannot be designed using sections **4.21** to **4.26** are to be designed using this section and **4.1** to **4.20**, as applicable. Cargo containment system design according to this section is to be based on the principles of limit state design which is an approach to structural design that can be applied to established design solutions as well as novel designs. This more generic approach maintains a level of safety similar to that achieved for known containment systems as designed using **4.21** to **4.26**.

4.27.2 Limit State Design

1 The limit state design is a systematic approach where each structural element is evaluated with respect to possible failure modes related to the design conditions identified in **4.3.4**. A limit state can be defined as a condition beyond which the structure, or part of a structure, no longer satisfies the requirements.
2 For each failure mode, one or more limit states may be relevant. By consideration of all relevant limit states, the limit load for the structural element is found as the minimum limit load resulting from all the relevant limit states. The limit states are divided into the three following

categories:

(1) Ultimate limit states (ULS), which correspond to the maximum load-carrying capacity or, in some cases, to the maximum applicable strain or deformation; under intact (undamaged) conditions.

(2) Fatigue limit states (FLS), which correspond to degradation due to the effect of time varying (cyclic) loading.

(3) Accident limit states (ALS), which concern the ability of the structure to resist accidental situations.

4.27.3 Design Standard

The procedure and relevant design parameters of the limit state design are to comply with the Standards for the Use of limit state methodologies in the design of cargo containment systems of novel configuration (LSD Standard), as set out in **Annex 7**.

4.28 Guidance Notes for Chapter 4 (*IGC Code* 4.28)

4.28.1 Guidance to Detailed Calculation of Internal Pressure for Static Design Purpose

1 This section provides guidance for the calculation of the associated dynamic liquid pressure for the purpose of static design calculations. This pressure may be used for determining the internal pressure referred to in **4.13.2-4**, where:

(1) $(P_{gd})max$ is the associated liquid pressure determined using the maximum design accelerations.

(2) $(P_{gd}site)max$ is the associated liquid pressure determined using site specific accelerations.

(3) P_{eq} should be the greater of P_{eq1} and P_{eq2} calculated as follows:

$$P_{eq1} = P_0 + (P_{gd})\max\ (MPa)$$

$$P_{eq2} = P_h + (P_{gd}site)\max\ (MPa)$$

2 The internal liquid pressures are those created by the resulting acceleration of the centre of gravity of the cargo due to the motions of the ship referred to in **4.14.1**. The value of internal liquid pressure P_{gd} resulting from combined effects of gravity and dynamic accelerations should be calculated as follows:

$$P_{gd} = a_\beta \cdot z_\beta \frac{\rho}{1.02 \times 10^5}\ (MPa)$$

where:

a_β : dimensionless acceleration (i.e. relative to the acceleration of gravity), resulting from gravitational and dynamic loads, in an arbitrary direction β (see **Fig. N4.1**).
For large tanks, an acceleration ellipsoid taking account of transverse vertical and longitudinal accelerations, should be used.

z_β : largest liquid height (m) above the point where the pressure is to be determined measured from the tank shell in the β direction (see **Fig. N4.2** and **Fig. N4.3**).
Tank domes considered to be part of the accepted total tank volume are to be taken into account when determining z_β, unless the total volume of tank domes V_d does not exceed the following value:

$$V_d = V_t \frac{100 - FL}{FL}$$

with:

V_t : tank volume without any domes; and

FL :filling limit according to **Chapter 15**.

ρ: maximum cargo density (kg/m^3) at the design temperature.

The direction that gives the maximum value $(P_{gd})max$ or $(P_{gd}site)max$ should be considered. The above formula applies only to full tanks.

3 Equivalent calculation procedures may be applied.

4.28.2 Guidance Formulae for Acceleration Components

The following formulae are given as guidance for the components of acceleration due to ship's motions corresponding to a probability level of 10^{-8} in the North Atlantic and apply to ships with a length exceeding 50 *m* and at or near their service speed:

- vertical acceleration, as defined in **4.14.1**:

$$a_z = \pm a_0 \sqrt{1 + (5.3 - \frac{45}{L})^2 (\frac{x}{L} + 0.05)^2 (\frac{0.6}{C_b})^{1.5} + \left(\frac{0.6yK^{1.5}}{B}\right)^2}$$

- transverse acceleration, as defined in **4.14.1**:

$$a_y = \pm a_0 \sqrt{0.6 + 2.5(\frac{x}{L} + 0.05)^2 + K(1 + 0.6K\frac{z}{B})^2}$$

- longitudinal acceleration, as defined in **4.14.1**:

$$a_x = \pm a_0 \sqrt{0.06 + A^2 - 0.25A}$$

where:

$$a_0 = 0.2\frac{V}{\sqrt{L}} + \frac{34 - \frac{600}{L}}{L}$$

x : longitudinal distance (*m*) from amidships to the centre of gravity of the tank with contents; x is positive forward of amidships, negative aft of amidships;

y : transverse distance (*m*) from centreline to the centre of gravity of the tank with contents;

z : vertical distance (*m*) from the ship's actual waterline to the centre of gravity of tank with contents; z is positive above and negative below the waterline;

K : 1 in general. For particular loading conditions and hull forms, determination of K according to the following formula may be necessary:

$K = 13GM/B$,

where $K \geq 1.0$ and

GM: metacentric height (*m*);

$A = (0.7 - \frac{L}{1200} + 5\frac{z}{L})(\frac{0.6}{C_b})$; and

V: Service speed (*knots*);

a_x, a_y, a_z : maximum dimensionless accelerations (i.e. relative to the acceleration of gravity) in the respective directions. They are considered as acting separately for calculation purposes, and a_z does not include the component due to the static weight, a_y includes the component due to the static weight in the transverse direction due to rolling and a_x includes the component due to the static weight in the longitudinal direction due to pitching. The accelerations derived from the above formulae are applicable only to ships at or near their service speed, not while at anchor or otherwise near stationary in exposed locations.

4.28.3 Stress Categories

1 For the purpose of stress evaluation, stress categories are defined in this section as follows.
2 Normal stress is the component of stress normal to the plane of reference.
3 Membrane stress is the component of normal stress that is uniformly distributed and equal to the average value of the stress across the thickness of the section under consideration.
4 Bending stress is the variable stress across the thickness of the section under consideration, after the subtraction of the membrane stress.
5 Shear stress is the component of the stress acting in the plane of reference.
6 Primary stress is a stress produced by the imposed loading, which is necessary to balance the external forces and moments. The basic characteristic of a primary stress is that it is not self-limiting. Primary stresses that considerably exceed the yield strength will result in failure or at least in gross deformations.
7 Primary general membrane stress is a primary membrane stress that is so distributed in the structure that no redistribution of load occurs as a result of yielding.
8 Primary local membrane stress arises where a membrane stress produced by pressure or other mechanical loading and associated with a primary or a discontinuity effect produces excessive distortion in the transfer of loads for other portions of the structure. Such a stress is classified as a primary local membrane stress, although it has some characteristics of a secondary stress. A stress region may be considered as local, if:

$S_1 \leq 0.5\sqrt{Rt}$ and

$S_2 \geq 2.5\sqrt{Rt}$,

where:

S_1: distance in the meridional direction over which the equivalent stress exceeds $1.1f$;

S_2: distance in the meridional direction to another region where the limits for primary general membrane stress are exceeded;

R: mean radius of the vessel;

t: wall thickness of the vessel at the location where the primary general membrane stress limit is exceeded; and

f: allowable primary general membrane stress.

9 Primary bending stress is a bending stress produced by pressure or other mechanical loading in areas without holistic and local structural discontinuity.
10 Secondary stress is a normal stress or shear stress developed by constraints of adjacent parts or by self-constraint of a structure. The basic characteristic of a secondary stress is that it is self-limiting. Local yielding and minor distortions can satisfy the conditions that cause the stress to occur.

Fig. N4.1 Acceleration Ellipsoid

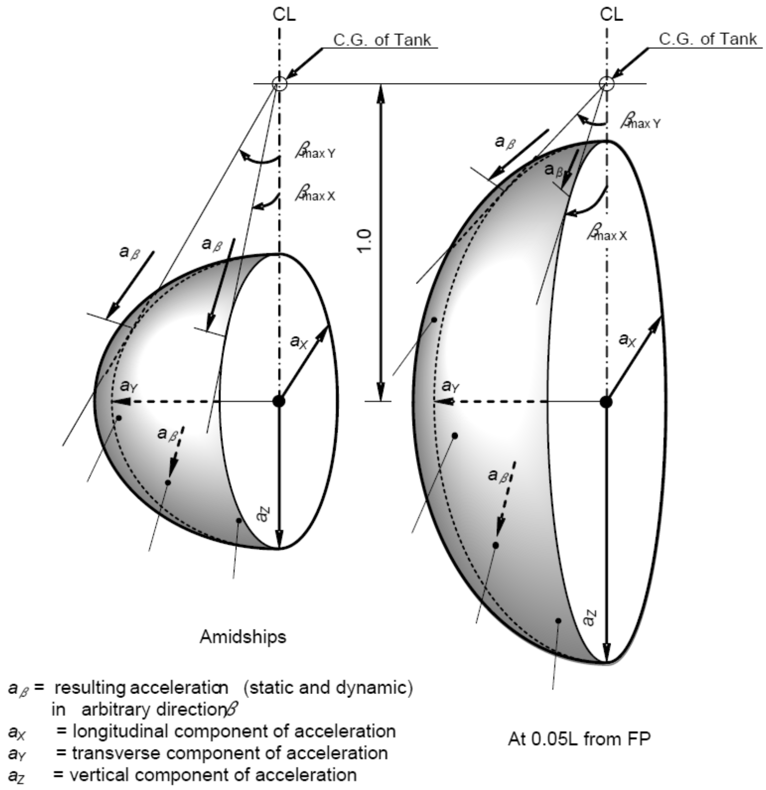


Fig. N4.2 Determination of Internal Pressure Heads

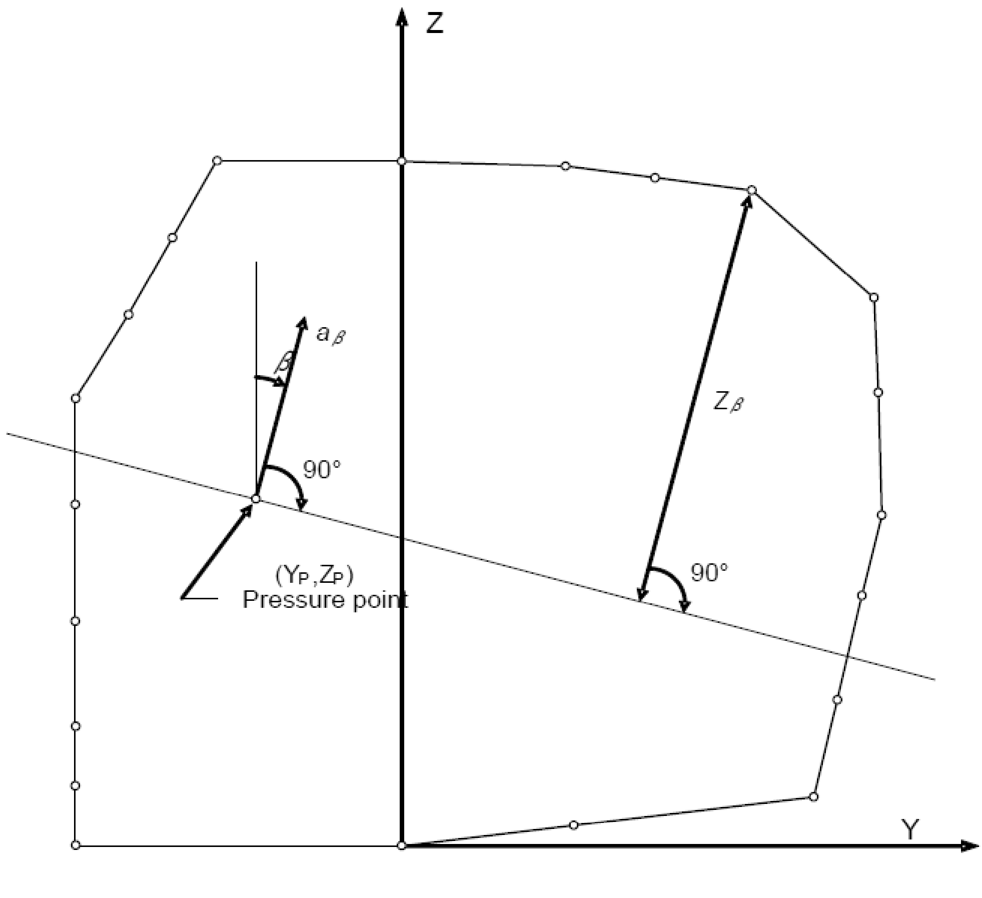


Fig. N4.3 Determination of Liquid Height Zβ for Points 1, 2 and 3

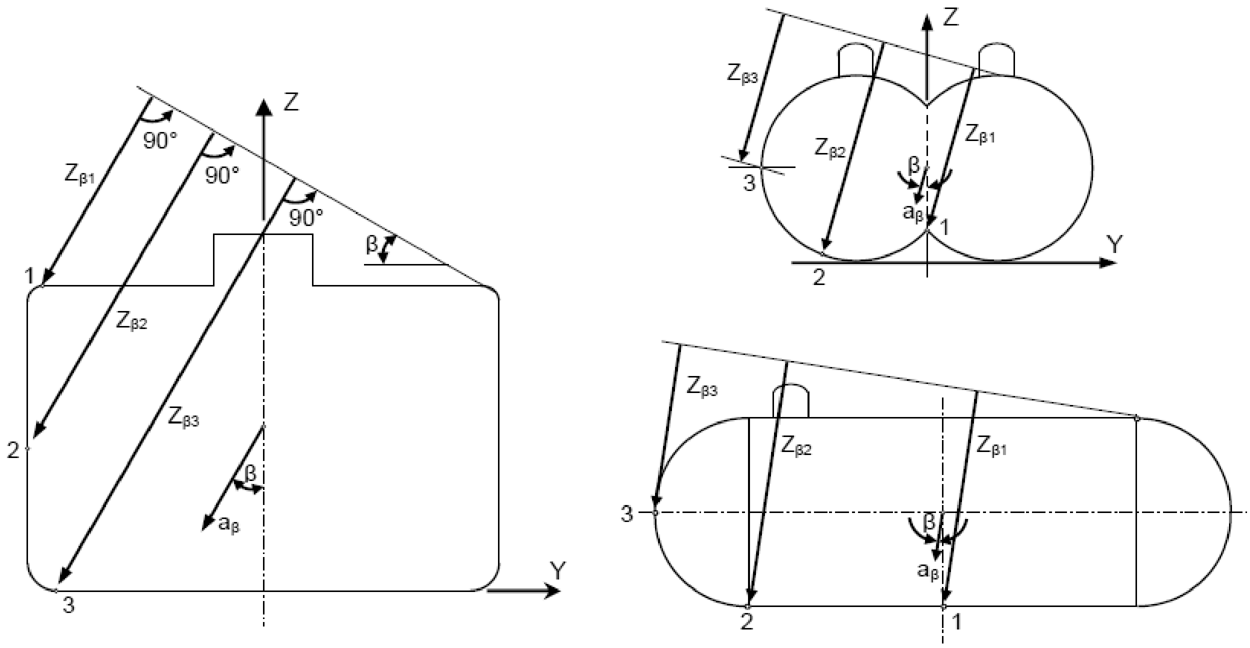
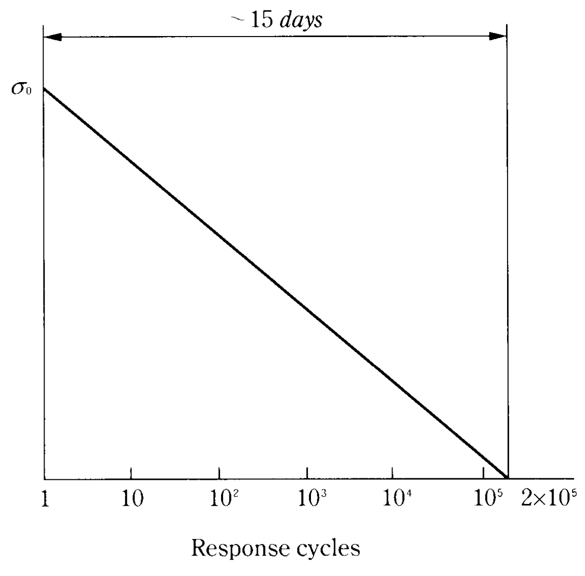


Fig. N4.4 Simplified Load Distribution



σ_0 : most probable maximum stress over the life of the ship Response cycle scale is logarithmic ; the value of 2×10^5 is given as an example of estimate.

Chapter 5 has been amended as follows.

Chapter 5 PROCESS PRESSURE VESSELS AND LIQUID, VAPOUR, AND PRESSURE PIPING SYSTEMS

5.1 General (*IGC Code* 5.1)

~~5.1.1 Process Pressure Vessels (*IGC Code* 5.1.2)~~

~~The requirements for type *C* independent tanks in **Chapter 4** may also apply to process pressure vessels if required by the Society. If so required the term "pressure vessels" as used in **Chapter 4** covers both type *C* independent tanks and process pressure vessels.~~

~~5.2 Cargo and Process Piping (*IGC Code* 5.2)~~

5.~~2~~1.1 General

1 The requirements of this Chapter~~sections **5.2 to 5.5**~~ are to apply to products and process piping, including vapour piping, gas fuel piping and vent lines of safety valves or similar piping. ~~Instrument~~Auxiliary piping systems not containing cargo ~~is~~are exempt from the general requirements of this Chapter~~these requirements~~.

~~**2** Provision is to be made by the use of offsets, loops, bends, mechanical expansion joints such as bellows, slip joints and ball joints or similar suitable means to protect the piping, piping system components and cargo tanks from excessive stresses due to thermal movement and from movements of the tank and hull structure. Where mechanical expansion joints are used in piping they are to be held to a minimum and, where located outside cargo tanks, are to be of the bellows type.~~

~~**3** Low-temperature piping is to be thermally isolated from the adjacent hull structure, where necessary, to prevent the temperature of the hull from falling below the design temperature of the hull material. Where liquid piping is dismantled regularly, or where liquid leakage may be anticipated, such as at shore connections and at pump seals, protection for the hull beneath is to be provided.~~

~~**4** Where tanks or piping are separated from the ship's structure by thermal isolation, provision is to be made for electrically bonding both the piping and the tanks. All gasketed pipe joints and hose connections are to be electrically bonded.~~

~~**5** Suitable means are to be provided to relieve the pressure and remove liquid contents from cargo loading and discharging crossover headers and cargo hoses to the cargo tanks or other suitable location, prior to disconnecting the cargo hoses.~~

~~**6** All pipelines of components which may be isolated in a liquid full condition are to be provided with relief valves.~~

~~**7** Relief valves discharging liquid cargo from the cargo piping system are to discharge into the cargo tanks; alternatively they may discharge to the cargo vent mast if means are provided to detect and dispose of any liquid cargo which may flow into the vent system. Relief valves on cargo pumps are to discharge to the pump suction.~~

5.1.2 Process Pressure Vessels

The requirements for type C independent tanks provided in **Chapter 4** of this Part may also apply to process pressure vessels if required by the Society. If so required, the term "pressure vessels" as used in **Chapter 4** of this Part, covers both type *C* independent tanks and process pressure vessels.

5.1.3 Definition of Process Pressure Vessels

Process pressure vessels include surge tanks, heat exchangers and accumulators that store or treat liquid or vapour cargo.

~~5.2.2 Scantlings Based on Internal Pressure~~

~~Subject to the conditions stated in **5.2.4**, the wall thickness of pipes is not to be less than:~~

$$\cancel{t = \frac{t_0 + b + c}{1 - \frac{a}{100}} \ (mm)}$$

~~where:~~

~~t_0 : theoretical thickness~~

$$\cancel{t_0 = PD/(2Ke+P)\ (mm)}$$

~~with~~

~~P : design pressure (*MPa*) referred to in **5.2.3**~~

~~D : outside diameter (*mm*)~~

~~K : allowable stress (N/mm^2) referred to in **5.2.4**~~

~~e : efficiency factor equal to 1.0 for seamless pipes and for longitudinally or spirally welded pipes, delivered by approved manufactures of welded pipes, which are considered equivalent to seamless pipes when non-destructive testing on welds is carried out in accordance with the Society. In other cases an efficiency factor of less than 1.0 may be determined by the Society depending on the manufacturing process.~~

~~b : allowance of bending (*mm*). The value of b is to be chosen so that the calculated stress in the bend, due to internal pressure only, does not exceed the allowable stress. Where such justification is not given, b is to be:~~

$$\cancel{b = \frac{Dt_0}{2.5r}\ (mm)}$$

~~with:~~

~~r : mean radius of the bend (*mm*)~~

~~c : corrosion allowance (*mm*). If corrosion or erosion is expected, the wall thickness of the piping is to be increased over the required by other design requirements. This allowance is to be consistent with the expected life of the piping.~~

~~a : negative manufacturing to tolerance for thickness (%).~~

5.2 System Requirements (*IGC Code* 5.2)

5.2.1 Cargo Handling and Cargo Control Systems

The cargo handling and cargo control systems are to be designed taking into account the following **(1)** to **(5)**:

(1) prevention of an abnormal condition escalating to a release of liquid or vapour cargo;
(2) the safe collection and disposal of cargo fluids released;
(3) prevention of the formation of flammable mixtures;
(4) prevention of ignition of flammable liquids or gases and vapours released; and
(5) limiting the exposure of personnel to fire and other hazards.

5.2.2 Arrangements: General

1 Any piping system that may contain cargo liquid or vapour is:

(1) to be segregated from other piping systems, except where interconnections are required for cargo-related operations such as purging, gas-freeing or inerting. The requirements of **9.4.4** are to be taken into account with regard to preventing back-flow of cargo. In such cases, precautions are to be taken to ensure that cargo or cargo vapour cannot enter other piping systems through the interconnections;

(2) except as provided in **Chapter 16** of this Part, not to pass through any accommodation space, service space or control station or through a machinery space other than a cargo machinery space;

(3) to be connected to the cargo containment system directly from the weather decks except where pipes installed in a vertical trunkway or equivalent are used to traverse void spaces above a cargo containment system and except where pipes for drainage, venting or purging traverse cofferdams;

(4) to be located in the cargo area above the weather deck except for bow or stern loading and unloading arrangements in accordance with **3.8**, emergency cargo jettisoning piping systems in accordance with **5.3.1**, turret compartment systems in accordance with **5.3.3** and except in accordance with **Chapter 16** of this Part; and

(5) to be located inboard of the transverse tank location requirements of **2.4.1**, except for athwartship shore connection piping not subject to internal pressure at sea or emergency cargo jettisoning piping systems.

2 Suitable means are to be provided to relieve the pressure and remove liquid cargo from loading and discharging crossover headers; likewise, any piping between the outermost manifold valves and loading arms or cargo hoses to the cargo tanks, or other suitable location, prior to disconnection.

3 Piping systems carrying fluids for direct heating or cooling of cargo are not to be led outside the cargo area unless a suitable means is provided to prevent or detect the migration of cargo vapour outside the cargo area (See **13.6.2(6)**).

4 Relief valves discharging liquid cargo from the piping system are to discharge into the cargo tanks. Alternatively, they may discharge to the cargo vent mast, if means are provided to detect and dispose of any liquid cargo that may flow into the vent system. Where required to prevent overpressure in downstream piping, relief valves on cargo pumps are to discharge to the pump suction.

5.3 Arrangements for Cargo Piping outside the Cargo Area (*IGC Code* 5.3)

5.3.1 Emergency Cargo Jettisoning

If fitted, an emergency cargo jettisoning piping system is to comply with **5.2.2**, as appropriate, and may be led aft, external to accommodation spaces, service spaces or control stations or machinery spaces, but is not to pass through them. If an emergency cargo jettisoning piping system is permanently installed, a suitable means of isolating the piping system from the cargo piping is to be provided within the cargo area.

5.3.2 Bow and Stern Loading Arrangements

1 Subject to the requirements of **3.8**, this section and **5.10.1**, cargo piping may be arranged to permit bow or stern loading and unloading.

2 Arrangements are to be made to allow such piping to be purged and gas-freed after use. When not in use, the spool pieces are to be removed and the pipe ends blank-flanged. The vent pipes connected with the purge are to be located in the cargo area.

5.3.3 Turret Compartment Transfer Systems

For the transfer of liquid or vapour cargo through an internal turret arrangement located outside the cargo area, the piping serving this purpose is to comply with **5.2.2**, as applicable, **5.10.2** and the following **(1)** to **(3)**:

(1) piping is to be located above the weather deck, except for the connection to the turret;
(2) portable arrangements are not to be permitted; and
(3) arrangements are to be made to allow such piping to be purged and gas-freed after use. When not in use, the spool pieces for isolation from the cargo piping are to be removed and the pipe ends blank-flanged. The vent pipes connected with the purge are to be located in the cargo area.

5.3.4 Gas Fuel Piping Systems

Gas fuel piping in machinery spaces are to comply with all applicable sections of this Chapter in addition to the requirements of **Chapter 16** of this Part.

5.4~~2.3~~ Design Pressure (*IGC Code* 5.4)

5.4.1 General

1 The design pressure ~~P~~P_0 ~~in the formula for t_0 in **5.2.2** is~~ used to determine minimum scantlings of piping and piping system components, is not to be less than the maximum gauge pressure to which the system may be subjected in service.

~~**2** The greater of the following design conditions is to be used for piping, piping systems and components as appropriate:~~

~~(1) for vapour piping systems or components which may be separated from their relief valves and which may contain some liquid: the saturated vapour pressure at 45°C, or higher or lower if agreed upon by the Society (*see* **4.2.6-2**);~~
~~(2) for systems or components which may be separated form their relief valves and which contain only vapour at all times: the superheated vapour pressure at 45°C, or higher or lower if agreed upon by the Society (*see* **4.2.6-2**), assuming an initial condition of saturated vapour in the system at the system operating pressure and temperature; or~~
~~(3) the *MARVS* of the cargo tanks and cargo processing systems; or~~
~~(4) the pressure setting of the associated pump or compressor discharge relief valve; or~~
~~(5) the maximum total discharge or loading head of the cargo piping system; or~~
~~(6) the relief valve setting on a pipeline system.~~

~~**3**~~ The minimum design pressure used is not to be less than 1 *MPa* gauge, except for open-ended lines or pressure relief valve discharge lines, where it is not to be ~~not~~ less than the lower of 0.5 *MPa* gauge, or 10 times the relief valve set pressure.

5.4.2 Design Pressure

The greater of the following design conditions **(1)** to **(5)** are to be used for piping, piping systems and components, based on the cargoes being carried:

(1) for vapour piping systems or components that may be separated from their relief valves and which may contain some liquid, the saturated vapour pressure at a design temperature of 45°C. Higher or lower values may be used (See **4.13.2-2**); or

(2) for systems or components that may be separated from their relief valves and which contain only vapour at all times, the superheated vapour pressure at 45°C. Higher or lower values may be used (See **4.13.2-2**), assuming an initial condition of saturated vapour in the system at the system operating pressure and temperature; or
(3) the *MARVS* of the cargo tanks and cargo processing systems; or
(4) the pressure setting of the associated pump or compressor discharge relief valve; or
(5) the maximum total discharge or loading head of the cargo piping system considering all possible pumping arrangements or the relief valve setting on a pipeline system.

5.4.3 Liquid Piping Systems that may be subjected to Surge Pressures

Those parts of the liquid piping systems that may be subjected to surge pressures are to be designed to withstand this pressure.

5.4.4 Design Pressures of the Outer Pipe or Duct of Gas Fuel Systems

The design pressure of the outer pipe or duct of gas fuel systems is not to be less than the maximum working pressure of the inner gas pipe. Alternatively, for gas fuel piping systems with a working pressure greater than 1 *MPa*, the design pressure of the outer duct is not to be less than the maximum built-up pressure arising in the annular space considering the local instantaneous peak pressure in way of any rupture and the ventilation arrangements.

~~**5.2.4 Permissible Stresses**~~

~~**1** For pipes, the permissible stress to be considered in the formula for t in **5.2.2** is the lower of the following values:~~

$$\cancel{\frac{R_m}{A} \text{ or } \frac{R_e}{B}}$$

~~where:~~

~~R_m : specified minimum tensile strength at room temperature (N/mm^2)~~

~~R_e : specified minimum yield stress at room temperature (N/mm^2). If the stress-strain curve does not show a defined yield stress, the 0.2% proof stress applies.~~

~~The values of A and B are to be at least A = 2.7 and B = 1.8.~~

~~**2** The minimum wall thickness is to be to the satisfaction of the Society.~~

~~**3** Where necessary for mechanical strength to prevent damage, collapse, excessive sag or buckling of pipes due to superimposed loads from supports, ship deflection or other causes, the wall thickness is to be increased over that required by **5.2.2**, or, if this is impracticable or would cause excessive local stresses, these loads are to be reduced, protected against or eliminated by other design methods.~~

~~**4** Flanges, valves and other fittings are to be to a standard acceptable to the Society taking into account the design pressure defined in **5.2.2**. For bellows expansion joints used in vapour service, a lower minimum design pressure may be accepted by the Society.~~

~~**5** For flanges not complying with a standard, the dimension of flanges and related bolts are to be to the satisfaction of the Society.~~

~~**5.2.5 Stress Analysis**~~

~~When the design temperature is -110°C or lower, a complete stress analysis, taking into account all the stresses due to weight of pipes, including acceleration loads if significant, internal pressure, thermal contraction and loads induced by hog and sag of the ship for each branch of the piping system are to be submitted to the Society. For temperatures of above -110°C, a stress analysis may be required by the Society in relation to such matters as the design or stiffness of the~~

~~piping system and the choice of materials. In any case, consideration is to be given to thermal stresses, even though calculations are not submitted. The analysis may be carried out according to a code of practice acceptable to the Society.~~

~~5.2.6 Materials~~

~~**1** The choice and testing of materials used in piping systems are to comply with the requirements of **Chapter 6** taking into account the minimum design temperature. However, some relaxation may be permitted in the quality of material of open-ended vent piping, provided the temperature of the cargo at the pressure relief valve setting is -55°C or greater and provided no liquid discharge to the vent piping can occur. Similar relaxations may be permitted under the same temperature conditions to open-ended piping inside cargo tanks, excluding discharge piping and all piping inside membrane and semi-membrane tanks.~~

~~**2** Materials having a melting point below 925°C are not to be used for piping outside the cargo tanks except for short lengths of pipes attached to the cargo tanks, in which case fire-resisting insulation is to be provided.~~

~~5.3 Type Tests on Piping Components (*IGC Code* 5.3)~~

~~5.3.1 Requirements of Type Tests~~

~~Each type of piping component is to be subject to type tests as follows:~~

~~(1) Each size and type of valve intended to be used at a working temperature below -55°C is to be subjected to a tightness test to the minimum design temperature or lower, and to a pressure not lower than the design pressure of the valve. During the test the satisfactory operation of the valve is to be ascertained.~~

~~(2) The following type tests are to be performed on each type of expansion bellows intended for use on cargo piping outside the cargo tank and, where required, on those expansion bellows installed within the cargo tanks:~~

~~(a) A type element of the bellows, not precompressed, is to be pressure tested at not less than 5 *times* the design pressure without bursting. The duration of the test is not to be less than 5 *min*.~~

~~(b) A pressure test is to be performed on a type expansion joint complete with all the accessories such as flanges, stays and articulations, at twice the design pressure at the extreme displacement conditions recommended by the manufacturer without permanent deformation. Depending on the materials used, the Society may require the test to be at the minimum design temperature.~~

~~(c) A cyclic test (thermal movements) is to be performed on a complete expansion joint, which is to successfully withstand at least as many cycles, under the conditions of pressure, temperature, axial movement, rotational movement and transverse movement, as it will encounter in actual service. Testing at ambient temperature is permitted, when this testing is at least as severe as testing at the service temperature.~~

~~(d) A cyclic fatigue test (ship deformation) is to be performed on a complete expansion joint, without internal pressure, by simulating the bellows movement corresponding to a compensated pipe length, for at least 2,000,000 *cycles* at a frequency not higher than 5 *cycles/s*. This test is only required when, due to the piping arrangement, ship deformation loads are actually experienced.~~

~~(e) The Society may waive performance of the tests referred to in this paragraph provided that complete documentation is supplied to establish the suitability of the expansion joints to~~

~~withstand the expected working conditions. When the maximum internal pressure exceeds 0.1*MPa* gauge this documentation is to include sufficient test data to justify the design method used, with particular reference to correlation between calculation and test results.~~

~~5.4 Piping Fabrication and Joining Details (*IGC Code* 5.4)~~

~~5.4.1 Application~~

~~The requirements of this section apply to piping inside and outside the cargo tanks. However, the Society may accept relaxations from these requirements for piping inside cargo tanks and open-ended piping.~~

~~5.4.2 Connection of Pipes without Flanges~~

~~The following direct connection of pipe lengths, without flanges, may be considered:~~

~~(1) Butt welded joints with complete penetration at the root may be used in all applications. For design temperatures below -10℃, butt welds are to be either double welded or equivalent to a double welded butt joint. This may be accomplished by use of a backing ring, consumable insert or inert gas back-up on the first pass. For design pressures in excess of 1*MPa* and design temperatures of -10℃ or lower, backing rings are to be removed~~.

~~(2) Slip-on welded joints with sleeves and related welding, having dimensions satisfactory to the Society, are only to be used for open-ended lines with external diameter of 50*mm* or less and design temperatures not lower than -55℃.~~

~~(3) Screwed couplings acceptable to the Society are only to be used for accessory lines and instrumentation lines with external diameters of 25*mm* or less. However, they are not to be used for the connections of the gas sampling points specified in **9.1.2** except as deemed appropriate by the Society.~~

~~5.4.3 Flange Connection~~

~~**1** Flanges in flange connection are to be of the welded neck, slip-on or socket welded type.~~

~~**2** Flanges are to comply with standards acceptable to the Society as to their type, manufacture and test. In particular, for all piping except open ended, the following restrictions apply:~~

~~(1) For design temperatures lower than -55℃, only welded neck flanges are to be used~~.

~~(2) For design temperatures lower than -10℃, slip-on flanges are not to be used in nominal sizes above 100*mm* and socket welded flanges are not to be used in nominal sizes above 50*mm*.~~

~~5.4.4 Connection~~

~~Piping connections, other than those mentioned in **5.4.2** and **3**~~, ~~may be accepted by the Society in each case.~~

~~5.4.5 Bellows and Expansion Joints~~

~~Bellows and expansion joints are to be provided to allow for expansion of piping.~~

~~(1) If necessary, bellows are to be protected against icing.~~

~~(2) Slip joints are not to be used except within the cargo tanks.~~

~~5.4.6 Welding, Post-weld Heat Treatment and Non-destructive Testing~~

~~**1** Welding is to be carried out in accordance with **6.3**~~.

~~**2** Post-weld heat treatment is to be required for all butt welds of pipes made with carbon, carbon-manganese and low alloy steels. The Society may waive the requirement for thermal stress~~

~~relieving of pipes having wall thickness less than 10*mm* in relation to the design temperature and pressure of the piping system concerned.~~

~~**3** For butt welded joints, in addition to normal controls before and during the welding and to the visual inspection of the finished welds, as necessary for proving that the welding has been carried out correctly and according to the requirements of this paragraph, the following tests are to be required:~~

~~(1) 100% radiographic inspection of butt welded joints for piping systems with design temperatures lower than -10°C and with inside diameters of more than 75*mm* or wall thicknesses greater than 10*mm*. When such butt welded joints of piping sections are made by automatic welding procedures in the pipe fabrication shop, upon special approval by the Society, the extent of radiographic inspection may be progressively reduced but in no case to less than 10% of each joint. If defects are revealed the extent of examination is to be increased to 100% and is to include inspection of previously accepted welds.~~

~~(2) For other butt welded joints of pipes not covered by **(1)** above, spot radiograhic tests or other non-destructive tests are to be carried out at the discretion of the Society depending upon service, position and materials. In general, at least 10% of butt welded joints of pipes are to be radio-graphed.~~

~~5.5 Testing of Piping (*IGC Code* 5.5)~~

~~5.5.1 Application~~

~~The requirements of this section apply to piping inside and outside the cargo tanks. However, the Society may accept relaxations from these requirements for piping inside cargo tanks and open-ended piping.~~

~~5.5.2 Hydrostatic Test~~

~~After assembly, all cargo and process piping are to be subjected to a hydrostatic test to at least 1.5 *times* the design pressure. When piping systems or parts of systems are completely manufactured and equipped with all fittings, the hydrostatic test may be conducted prior to installation aboard ship. Joints welded on board are to be hydrostatically tested to at least 1.5 *times* the design pressure. Where water cannot be tolerated and the piping cannot be dried prior to putting the system into service, proposals for alternative testing fluids or testing means are to be submitted to the Society for approval.~~

~~5.5.3 Leak Test~~

~~After assembly on board, each cargo and process piping system is to be subjected to a leak test using air, halides, or other suitable medium to a pressure depending on the leak detection method applied.~~

~~5.5.4 Test under Operating Condition~~

~~All piping systems including valves, fittings and associated equipment for handling cargo or vapours is to be tested under normal operating conditions not later than at the first loading operation.~~

5.5~~6~~ Cargo System Valve~~ing~~ Requirements (*IGC Code* 5.5~~6~~)

5.5~~6~~.1 Stop Valves

1 Every cargo tank and piping system ~~and cargo tank~~ is to be ~~provided~~fitted with ~~the following~~manually operated valves for isolation purposes as specified in this Section~~, as applicable:~~.

2 In addition, remotely operated valves are also to be fitted, as appropriate, as part of the emergency shutdown (ESD) system the purpose of which is to stop cargo flow or leakage in the event of an emergency when cargo liquid or vapour transfer is in progress. The ESD system is intended to return the cargo system to a safe static condition so that any remedial action can be taken. Due regard is to be given in the design of the ESD system to avoid the generation of surge pressures within the cargo transfer pipework. The equipment to be shut down on ESD activation includes manifold valves during loading or discharge, any pump or compressor, etc., transferring cargo internally or externally (e.g. to shore or another ship/barge) and cargo tank valves, if the *MARVS* exceeds 0.07 *MPa*.

5.5.2 Cargo Tank Connections

~~(1)~~**1** ~~For cargo tanks with a *MARVS* not exceeding 0.07*MPa* gauge, a~~All liquid and vapour connections, except for safety relief valves and liquid level gauging devices, are to have shutoff valves located as close to the tank as practicable. These valves are to provide full closure and are to~~may be remotely controlled but are to~~ be capable of local manual operation ~~and provide full closure~~. They may also be capable of remote operation.~~One or more remotely controlled emergency shutdown valves are to be provided on the ship for shutting down liquid and vapour cargo transfer between ship and shore. Such valves may be arranged to suit the ship's design and may be the same valve as required in **5.6.3** and are to comply with the requirements of **5.6.4**.~~

~~(2)~~**2** For cargo tanks with a *MARVS* exceeding 0.07*MPa* gauge, ~~all liquid and vapour~~the above connections~~, except safety relief valves and liquid level gauging devices,~~ are to be equipped with ~~a manually operated stop valve and a~~ remotely controlled ~~emergency shutdown~~ESD valves. These valves are to be located as close to the tank as practicable. ~~Where the pipe size does not exceed 50*mm* in diameter, excess flow valves may be used in lieu of the emergency shutdown valve.~~ A single valve may be substituted for the two separate valves, provided the valve complies with the requirements of ~~**5.6.4**~~**18.3.1-2**~~, is capable of local manual operation~~ and provides full closure of the line.

~~(3) Cargo pumps and compressors are to be arranged to shutdown automatically if the emergency shutdown valves required by **(1)** and **(2)** are closed by the emergency shutdown system required by **5.6.4**.~~

~~5.6.2 Cargo Tank Connections for Gauging~~

~~Cargo tank connections for gauging or measuring devices need not be equipped with excess flow or emergency shutdown valves provided that the devices are so constructed that the outward flow of tank contents cannot exceed that passed by a 1.5*mm* diameter circular hole.~~

5.5~~6~~.3 Cargo ~~Hose~~Manifold Connections

1 One remotely ~~operated~~controlled ~~emergency shutdown~~ESD valve is to be provided at each cargo ~~hose~~transfer connection in use to stop liquid and vapour transfer to or from the ship. Transfer ~~C~~connections not ~~used~~ in use ~~transfer operations may~~are to be ~~blinded~~isolated with suitable blank flanges ~~in lieu of valves~~.

2 If the cargo tank *MARVS* exceeds 0.07 *MPa*, an additional manual valve is to be provided for each transfer connection in use, and may be inboard or outboard of the ESD valve to suit the ship's design.

~~5.6.4 Emergency Shutdown Valves~~

~~**1** The control system for all required emergency shutdown valves is to be so arranged that all such valves may be operated by single controls situated in at least two remote locations on the ship. One of these locations is to be the control position required by **13.1.3** or cargo control room. The control system is also to be provided with fusible elements designed to melt at temperatures between 98 °C and 104 °C which will cause the emergency shutdown valves to close in the event of fire. Locations for such fusible elements are to include the tank domes and loading stations. Emergency shutdown valves are to be of the fail-closed (closed on loss of power) type and be capable of local manual closing operation. Emergency shutdown valves in liquid piping are to fully close under all service conditions within 30*s* of actuation. Information about the closing time of the valves and their operating characteristics is to be available on board and the closing time is to be verifiable and reproducible. Such valves are to close smoothly.~~

~~**2** Emergency shutdown valves are to be fitted with an indicator which clearly shows whether they are open or closed.~~

~~5.6.5 Additional Requirement of Emergency Shutdown Valves~~

~~The closure time of 30*s* for the emergency shutdown valves referred to in **5.6.4-1** is to be measured from the time of manual or automatic initiation to final closure. This is called the total shutdown time and is made up of a signal response time and a valve closure time. The valve closure time is to be such as to avoid surge pressure in pipelines. Such valves are to close in such a manner as to cut off the flows smoothly.~~

5.5.4~~6.6~~ Excess Flow Valves

Excess flow valves may be used in lieu of ESD valves, if the diameter of the protected pipe does not exceed 50 *mm*. Excess flow valves are to close automatically at the rated closing flow of vapour or liquid as specified by the manufacturer. The piping including fittings, valves~~,~~ and appurtenances protected by an excess flow valve~~,~~ is to have a capacity greater ~~capacity~~ than the rated closing flow of the excess flow valve. Excess flow valves may be designed with a bypass not exceeding ~~an~~the area of 1~~.0~~ *mm* diameter circular opening to allow equalization of pressure~~,~~ after a~~n~~ ~~operating~~ shutdown activation.

5.5.5 Cargo Tank Connections for Gauging or Measuring Devices

Cargo tank connections for gauging or measuring devices need not be equipped with excess flow valves or ESD valves, provided that the devices are constructed so that the outward flow of tank contents cannot exceed that passed by a 1.5 *mm* diameter circular hole.

5.5.6 Relief Valves

All pipelines or components which may be isolated in a liquid full condition are to be protected with relief valves for thermal expansion and evaporation.

5.5.7 Pressure Relief Valves

All pipelines or components which may be isolated automatically due to a fire with a liquid volume of more than 0.05 m^3 entrapped are to be provided with PRVs sized for a fire condition.

~~5.7 Ship's Cargo Hoses (*IGC Code* 5.7)~~

~~5.7.1 General~~

~~Liquid and vapour hoses used for cargo transfer are to be compatible with the cargo and suitable for the cargo temperature.~~

~~5.7.2 Design Pressure~~

~~Hoses subject to tank pressure, or the discharge pressure of pumps or vapour compressors, are to be designed for a bursting pressure not less than 5 *times* the maximum pressure the hose will be subjected to during cargo transfer.~~

~~5.7.3 Prototype Test~~

~~Each new type of cargo hose, complete with end-fittings, is to be prototype-tested at a normal ambient temperature with 200 pressure cycles from zero to at least twice the specified maximum working pressure. After this cycle pressure test has been carried out, the prototype test is to demonstrate a bursting pressure of at least 5 *times* its specified maximum working pressure at the extreme service temperature. Hoses used for prototype testing are not to be used for cargo service. Thereafter, before being placed in service, each new length of cargo hose produced is to be hydrostatically tested at ambient temperature to a pressure not less than 1.5 *times* its specified maximum working pressure but not more than two-fifths of its bursting pressure. The hose is to be stencilled or otherwise marked with the date of testing, its specified maximum working pressure and, if used in services other than the ambient temperature services, its maximum and minimum service temperature, as applicable. The specified maximum working pressure is not to be less than 1 *MPa* gauge.~~

5.6~~8~~ Cargo Transfer Arrangements~~Methods~~ (*IGC Code* 5.6~~8~~)

5.6~~8~~.1 Means of Cargo Transfer

Where cargo transfer is by means of cargo pumps that are not accessible for repair with the tanks in service, at least two separate means are to be provided to transfer cargo from each cargo tank, and the design is to be such that failure of one cargo pump~~,~~ or means of transfer~~,~~ will not prevent the cargo transfer by another pump or pumps, or other cargo transfer means.

5.6~~8~~.2 Cargo Transfer by Gas Pressurization

The procedure for transfer of cargo by gas pressurization is to preclude lifting of the relief valves during such transfer. Gas pressurization may be accepted as a means of transfer of cargo for those tanks ~~so designed that~~where the design factor of safety is not reduced under the conditions prevailing during the cargo transfer operation. If the cargo tank relief valves or set pressure are changed for this purpose, as it is permitted in accordance with **8.2.7**, **8.2.8**, **8.5.3** and **8.5.4**, the new set pressure is not to exceed P_h as is defined in **4.13.2**.

~~5.9 Vapour Return Connections (*IGC Code* 5.9)~~

5.6.3~~9.1~~ Vapour Return Connections

Connections for vapour return ~~lines~~ to the shore installations are to be provided.

5.6.4 Cargo Tank Vent Piping Systems

The pressure relief system is to be connected to a vent piping system designed to minimize the possibility of cargo vapour accumulating on the decks, or entering accommodation spaces, service spaces, control stations and machinery spaces, or other spaces where it may create a dangerous condition.

5.6.5 Cargo Sampling Connections

1 Connections to cargo piping systems for taking cargo liquid samples are to be clearly marked and are to be designed to minimize the release of cargo vapours. For vessels permitted to carry toxic products, the sampling system is to be of a closed loop design to ensure that cargo liquid and vapour are not vented to atmosphere.

2 Liquid sampling systems are to be provided with two valves on the sample inlet. One of these valves is to be of the multi-turn type to avoid accidental opening, and is to be spaced far enough apart to ensure that they can isolate the line if there is blockage, by ice or hydrates for example.

3 On closed loop systems, the valves on the return pipe are also to comply with **-2** above.

4 The connection to the sample container is to comply with recognized standards and be supported so as to be able to support the weight of a sample container. Threaded connections are to be tack-welded, or otherwise locked, to prevent them being unscrewed during the normal connection and disconnection of sample containers. The sample connection is to be fitted with a closure plug or flange to prevent any leakage when the connection is not in use.

5 Sample connections used only for vapour samples may be fitted with a single valve in accordance with **5.5**, **5.8** and **5.13**, and are also to be fitted with a closure plug or flange.

5.6.6 Cargo Filters

The cargo liquid and vapour systems are to be capable of being fitted with filters to protect against damage by extraneous objects. Such filters may be permanent or temporary, and the standards of filtration are to be appropriate to the risk of debris, etc., entering the cargo system. Means are to be provided to indicate that filters are becoming blocked, and to isolate, depressurize and clean the filters safely.

5.7 Installation Requirements (*IGC Code* 5.7)

5.7.1 Design for Expansion and Contraction

Provision are to be made to protect the piping, piping system and components and cargo tanks from excessive stresses due to thermal movement and from movements of the tank and hull structure. The preferred method outside the cargo tanks is by means of offsets, bends or loops, but multi-layer bellows may be used if offsets, bends or loops are not practicable.

5.7.2 Precautions against Low Temperatures

Low temperature piping is to be thermally isolated from the adjacent hull structure, where necessary, to prevent the temperature of the hull from falling below the design temperature of the hull material. Where liquid piping is dismantled regularly, or where liquid leakage may be anticipated, such as at shore connections and at pump seals, protection for the hull beneath is to be provided.

5.7.3 Water Curtain

For cargo temperatures below -110°C, a water distribution system is to be fitted in way of the hull under the shore connections to provide a low-pressure water curtain for additional protection of the hull steel and the ship's side structure. This system is in addition to the requirements of **11.3.1(4)**, and is to be operated when cargo transfer is in progress.

5.7.4 Bonding

Where tanks or cargo piping and piping equipment are separated from the ship's structure by thermal isolation, provision is to be made for electrically bonding both the piping and the tanks. All gasketed pipe joints and hose connections are to be electrically bonded. Except where bonding straps are used, it is to be demonstrated that the electrical resistance of each joint or connection is less than 1*MΩ*.

5.8 Piping Fabrication and Joining Details (*IGC Code* 5.8)

5.8.1 General

The requirements of this section apply to piping inside and outside the cargo tanks. Relaxation from these requirements may be accepted, in accordance with recognized standards for piping inside cargo tanks and open-ended piping.

5.8.2 Direct Connections

The following direct connection of pipe lengths, without flanges, may be considered:

(1) butt-welded joints with complete penetration at the root may be used in all applications. For design temperatures colder than -10°C, butt welds are to be either double welded or equivalent to a double welded butt joint. This may be accomplished by use of a backing ring, consumable insert or inert gas backup on the first pass. For design pressures in excess of 1 *MPa* and design temperatures of -10°C or colder, backing rings are to be removed;

(2) slip-on welded joints with sleeves and related welding, having dimensions in accordance with recognized standards, are only to be used for instrument lines and open-ended lines with an external diameter of 50 *mm* or less and design temperatures not colder than -55°C; and

(3) screwed couplings complying with recognized standards are only to be used for accessory lines and instrumentation lines with external diameters of 25 *mm* or less.

5.8.3 Flanged Connections

1 Flanges in flanged connections are to be of the welded neck, slip-on or socket welded type.

2 Flanges are to comply with recognized standards for their type, manufacture and test. For all piping, except open ended, the following restrictions apply:

(1) for design temperatures colder than -55°C, only welded-neck flanges are to be used; and

(2) for design temperatures colder than -10°C, slip-on flanges are not to be used in nominal sizes above 100 *mm* and socket welded flanges are not to be used in nominal sizes above 50 *mm*.

5.8.4 Expansion Joints

Where bellows and expansion joints are provided in accordance with **5.7.1**, the following requirements apply:

(1) if necessary, bellows are to be protected against icing; and

(2) slip joints are not to be used except within the cargo tanks.

5.8.5 Other connections

Piping connections are to be joined in accordance with **5.8.2** to **5.8.4**, but for other exceptional cases alternative arrangements approved by the Administration may be acceptable.

5.9 Welding, Post-weld Heat Treatment and Non-destructive Testing (*IGC Code* 5.9)

5.9.1 General

Welding is to be carried out in accordance with **6.5**.

5.9.2 Post-weld Heat Treatment

Post-weld heat treatment is to be required for all butt welds of pipes made with carbon, carbon-manganese and low alloy steels. The Administration or the Society may waive the requirements for thermal stress relieving of pipes with wall thickness less than 10 *mm* in relation to the design temperature and pressure of the piping system concerned.

5.9.3 Non-destructive Testing

In addition to normal controls before and during the welding, and to the visual inspection of the finished welds, as necessary for proving that the welding has been carried out correctly and according to the requirements of this Chapter, the following tests are to be required:

(1) 100% radiographic or ultrasonic inspection of butt-welded joints for piping systems with design temperatures colder than -10°C, and with inside diameters of more than 75 *mm*, or wall thicknesses greater than 10 *mm*;

(2) when such butt-welded joints of piping sections are made by automatic welding procedures approved by the Administration or the Society, then a progressive reduction in the extent of radiographic or ultrasonic inspection can be agreed, but in no case to less than 10% of each joint. If defects are revealed, the extent of examination is to be increased to 100% and is to include inspection of previously accepted welds. This approval can only be granted if well-documented quality assurance procedures and records are available to assess the ability of the manufacturer to produce satisfactory welds consistently; and

(3) for other butt-welded joints of pipes not covered by **(1)** and **(2)** above, spot radiographic or ultrasonic inspection or other non-destructive tests are to be carried out depending upon service, position and materials. In general, at least 10% of butt-welded joints of pipes are to be subjected to radiographic or ultrasonic inspection.

5.10 Installation Requirements for Cargo Piping outside the Cargo Area (*IGC Code* 5.10)

5.10.1 Bow and Stern Loading Arrangements

The following requirements are to apply to cargo piping and related piping equipment located outside the cargo area:

(1) cargo piping and related piping equipment outside the cargo area are to have only welded connections. The piping outside the cargo area is to run on the weather decks and is to be at least 0.8 *m* inboard, except for athwartships shore connection piping. Such piping is to be clearly identified and fitted with a shutoff valve at its connection to the cargo piping system within the cargo area. At this location, it is also to be capable of being separated by means of a removable spool piece and blank flanges, when not in use; and

(2) the piping is to be full penetration butt-welded and subjected to full radiographic or ultrasonic inspection, regardless of pipe diameter and design temperature. Flange connections in the piping are only to be permitted within the cargo area and at the shore connection.

5.10.2 Turret Compartment Transfer Systems

The following requirements are to apply to liquid and vapour cargo piping where it is run outside the cargo area:

(1) cargo piping and related piping equipment outside the cargo area are to have only welded connections; and

(2) the piping is to be full penetration butt-welded, and subjected to full radiographic or ultrasonic inspection, regardless of pipe diameter and design temperature. Flange connections in the piping are only to be permitted within the cargo area and at connections to cargo hoses and the turret connection.

5.10.3 Gas Fuel Piping

Gas fuel piping, as far as practicable, is to have welded joints. Those parts of the gas fuel piping that are not enclosed in a ventilated pipe or duct according to **16.4.3**, and are on the weather decks outside the cargo area, are to have full penetration butt-welded joints and are to be subjected to full radiographic or ultrasonic inspection.

5.11 Piping System Component Requirements (*IGC Code* 5.11)

5.11.1 Piping Scantlings

Piping systems are to be designed in accordance with recognized standards.

5.11.2 Pipe Wall Thickness

1 The criteria specified in the following **-2** to **-4** are to be used for determining pipe wall thickness.

2 The wall thickness of pipes is not to be less than:

$$t = \frac{t_0 + b + c}{1 - \frac{a}{100}} (mm)$$

where:

t_0 : theoretical thickness, determined by the following formula:

$$t_0 = PD/(2Ke + P)\ (mm)$$

with

P : design pressure (MPa) referred to in **5.4**;

D : outside diameter (mm);

K : allowable stress (N/mm^2) referred to in **5.11.3**;

e : efficiency factor equal to 1.0 for seamless pipes and for longitudinally or spirally welded pipes, delivered by approved manufacturers of welded pipes, that are considered equivalent to seamless pipes when non-destructive testing on welds is carried out in accordance with recognized standards. In other cases, an efficiency factor of less than 1.0, in accordance with recognized standards, may be required, depending on the manufacturing process;

b : allowance for bending (mm). The value of b is to be chosen so that the calculated stress in the bend, due to internal pressure only, does not exceed the allowable stress. Where such justification is not given, b is to be:

$$b = \frac{Dt_0}{2.5r}(mm)$$

with:

r : mean radius of the bend (mm);

c : corrosion allowance (mm). If corrosion or erosion is expected, the wall thickness of the piping is to be increased over that required by other design requirements. This allowance is to be consistent with the expected life of the piping; and

a : negative manufacturing tolerance for thickness (%).

3 The minimum wall thickness is to be in accordance with recognized standards.

4 Where necessary for mechanical strength to prevent damage, collapse, excessive sag or buckling of pipes due to superimposed loads, the wall thickness is to be increased over that required by **5.11.2-2** or, if this is impracticable or would cause excessive local stresses, these loads may be reduced, protected against or eliminated by other design methods.

5.11.3 Allowable Stress

For pipes, the allowable stress K referred to in the formula in **5.11.2** is the lower of the following values:

$$\frac{R_m}{A} \text{ or } \frac{R_e}{B}$$

where:

R_m : specified minimum tensile strength at room temperature (N/mm^2); and

R_e : specified minimum yield stress at room temperature (N/mm^2). If the stress-strain curve does not show a defined yield stress, the 0.2% proof stress applies.

The values of A and B are to have values of at least A = 2.7 and B = 1.8.

5.11.4 High-pressure Gas Fuel Outer Pipes or Ducting Scantlings

In fuel gas piping systems of design pressure greater than the critical pressure, the tangential membrane stress of a straight section of pipe or ducting is not to exceed the tensile strength divided by 1.5 (R_m /1.5) when subjected to the design pressure specified in **5.4**. The pressure ratings of all other piping components are to reflect the same level of strength as straight pipes.

5.11.5 Stress Analysis

When the design temperature is -110°C or lower, a complete stress analysis, taking into account all the stresses due to the weight of pipes, including acceleration loads if significant, internal pressure, thermal contraction and loads induced by hog and sag of the ship for each branch of the piping system is to be submitted to the Society. For temperatures above -110°C, a stress analysis may be required by the Society in relation to such matters as the design or stiffness of the piping system and the choice of materials. In any case, consideration is to be given to thermal stresses even though calculations are not submitted. The analysis may be carried out according to a code of practice acceptable to the Society.

5.11.6 Flanges, Valves and Fittings

1 Flanges, valves and other fittings are to comply with recognized standards, taking into account the material selected and the design pressure defined in **5.4**. For bellows expansion joints used in vapour service, a lower minimum design pressure may be accepted by the Society.

2 For flanges not complying with a recognized standard, the dimensions of flanges and related bolts are to be to the satisfaction of the Administration or the Society.

3 All emergency shutdown valves are to be of the "fire closed" type (See **5.13.1-1** and **18.3.1-2**).
4 The design and installation of expansion bellows are to be in accordance with recognized standards and be fitted with means to prevent damage due to over-extension or compression.

5.11.7 Ship's Cargo Hoses

1 Liquid and vapour hoses used for cargo transfer are to be compatible with the cargo and suitable for the cargo temperature.
2 Hoses subject to tank pressure, or the discharge pressure of pumps or vapour compressors, are to be designed for a bursting pressure not less than five times the maximum pressure the hose will be subjected to during cargo transfer.
3 Each new type of cargo hose, complete with end-fittings, is to be prototype-tested at a normal ambient temperature, with 200 pressure cycles from zero to at least twice the specified maximum working pressure. After this cycle pressure test has been carried out, the prototype test is to demonstrate a bursting pressure of at least 5 times its specified maximum working pressure at the upper and lower extreme service temperature. Hoses used for prototype testing are not to be used for cargo service. Thereafter, before being placed in service, each new length of cargo hose produced is to be hydrostatically tested at ambient temperature to a pressure not less than 1.5 times its specified maximum working pressure, but not more than two fifths of its bursting pressure. The hose is to be stencilled, or otherwise marked, with the date of testing, its specified maximum working pressure and, if used in services other than ambient temperature services, its maximum and minimum service temperature, as applicable. The specified maximum working pressure is not to be less than 1 *MPa* gauge.

5.12 Materials (*IGC Code* 5.12)

5.12.1 Materials

The choice and testing of materials used in piping systems are to comply with the requirements of **Chapter 6** of this Part, taking into account the minimum design temperature. However, some relaxation may be permitted by the Society in the quality of material of open-ended vent piping, provided that the temperature of the cargo at the pressure relief valve setting is not lower than -55°C, and that no liquid discharge to the vent piping can occur. Similar relaxations may be permitted under the same temperature conditions to open-ended piping inside cargo tanks, excluding discharge piping and all piping inside membrane and semi-membrane tanks.

5.12.2 Materials having a Lower Melting Point

Materials having a melting point below 925°C are not to be used for piping outside the cargo tanks except for short lengths of pipes attached to the cargo tanks, in which case fire-resisting insulation is to be provided.

5.12.3 Cargo Piping Insulation System

1 Cargo piping systems are to be provided with a thermal insulation system as required to minimize heat leak into the cargo during transfer operations and to protect personnel from direct contact with cold surfaces.
2 Where applicable, due to location or environmental conditions, insulation materials are to have suitable properties of resistance to fire and flame spread and are to be adequately protected against penetration of water vapour and mechanical damage.

5.12.4 Corrosion Protection Measures for Cargo Piping

Where the cargo piping system is of a material susceptible to stress corrosion cracking in the presence of a salt-laden atmosphere, adequate measures to avoid this occurring are to be taken by considering material selection, protection of exposure to salty water and/or readiness for inspection.

5.13 Testing Requirements (*IGC Code* 5.13)

5.13.1 Type Testing of Piping Components

1 Valves

Each type of valve intended to be used at a working temperature below -55°C is to be subject to the following type tests:

(1) each size and type of valve is to be subjected to seat tightness testing over the full range of operating pressures for bi-directional flow and temperatures, at intervals, up to the rated design pressure of the valve. Allowable leakage rates are to be to the requirements of the Administration or the Society. During the testing, satisfactory operation of the valve is to be verified;

(2) the flow or capacity is to be certified to a recognized standard for each size and type of valve;

(3) pressurized components are to be pressure tested to at least 1.5 times the rated pressure; and

(4) for emergency shutdown valves, with materials having melting temperatures lower than 925°C, the type testing is to include a fire test to a standard acceptable to the Society.

2 Expansion bellows

The following type tests are to be performed on each type of expansion bellows intended for use on cargo piping outside the cargo tank and where required by the Administration or the Society, on those installed within the cargo tanks:

(1) elements of the bellows, not pre-compressed, are to be pressure tested at not less than five times the design pressure without bursting. The duration of the test is not to be less than 5 *minutes*;

(2) a pressure test is to be performed on a type expansion joint, complete with all the accessories such as flanges, stays and articulations, at the minimum design temperature and twice the design pressure at the extreme displacement conditions recommended by the manufacturer, without permanent deformation;

(3) a cyclic test (thermal movements) is to be performed on a complete expansion joint, which is to withstand at least as many cycles under the conditions of pressure, temperature, axial movement, rotational movement and transverse movement as it will encounter in actual service. Testing at ambient temperature is permitted when this testing is at least as severe as testing at the service temperature; and

(4) a cyclic fatigue test (ship deformation) is to be performed on a complete expansion joint, without internal pressure, by simulating the bellows movement corresponding to a compensated pipe length, for at least 2,000,000 cycles at a frequency not higher than 5 *Hz*. This test is only required when, due to the piping arrangement, ship deformation loads are actually experienced.

5.13.2 System Testing Requirements

1 The requirements of section are to apply to piping inside and outside the cargo tanks.

2 After assembly, all cargo and process piping are to be subjected to a strength test with a suitable fluid. The test pressure is to be at least 1.5 times the design pressure (1.25 times the design pressure where the test fluid is compressible) for liquid lines and 1.5 times the maximum system working pressure (1.25 times the maximum system working pressure where the test fluid is compressible) for vapour lines. When piping systems or parts of systems are completely manufactured and equipped with all fittings, the test may be conducted prior to installation on board the ship. Joints welded on board are to be tested to at least 1.5 times the design pressure.

3 After assembly on board, each cargo and process piping system is to be subjected to a leak test using air, or other suitable medium, to a pressure depending on the leak detection method applied.

4 In double wall gas-fuel piping systems, the outer pipe or duct is also to be pressure tested to show that it can withstand the expected maximum pressure at gas pipe rupture.

5 All piping systems, including valves, fittings and associated equipment for handling cargo or vapours, are to be tested under normal operating conditions not later than at the first loading operation, in accordance with recognized standards.

5.13.3 Emergency Shutdown Valves

The closing characteristics of emergency shutdown valves used in liquid cargo piping systems are to be tested to demonstrate compliance with **18.3.1-2(1)(c)**. This testing may be carried out on board after installation.

5.14 Operating Requirements

5.14.1 Application

The provisions in **5.14** are not related to surveys necessary for the maintenance of classification, but indicate those matters which are to be strictly observed by the shipowner or the ship master as well as all other persons responsible for the ship's operation.

5.14.2 Bow and Stern Loading Arrangements (related to *IGC Code* 5.3.2)

Cargo piping used for bow and stern loading is to be purged and gas-freed after use. When not in use, spool pieces are to be removed and pipe ends blank-flanged.

5.14.3 Turret Compartment Transfer Systems (related to *IGC Code* 5.3.3)

Piping for the transfer of liquid or vapour cargo through an internal turret arrangement located outside the cargo area is to be purged and gas-freed after use. When not in use, the spool pieces for isolation from the cargo piping are to be removed and the pipe ends blank-flanged.

5.14.4 Sampling Operations (related to *IGC Code* 5.6.5)

Cargo sampling operations are to be undertaken as prescribed in **18.4.8**.

5.14.5 Water Curtain (related to *IGC Code* 5.7.3)

For cargo temperatures below -110°C, the water curtain specified in **5.7.3** is to be operated when cargo transfer is in progress.

Chapter 6 has been deleted and new Chapter 6 has been added as follows.

Chapter 6 MATERIALS OF CONSTRUCTION AND QUALITY CONTROL

6.1 Definitions (*IGC Code* 6.1)

6.1.1 Hull Structural Steels

Where reference is made in this Chapter to *A*, *B*, *D*, *E*, *AH*, *DH*, *EH* and *FH* hull structural steels, these steel grades are the grades of steel as follows:

A: *KA*
B: *KB*
D: *KD*
E: *KE*
AH: *KA*32, *KA*36 and *KA*40
DH: *KD*32, *KD*36 and *KD*40
EH: *KE*32, *KE*36 and *KE*40
FH: *KF*32, *KF*36 and *KF*40

6.1.2 Piece

A piece is the rolled product from a single slab or billet or from a single ingot, if this is rolled directly into plates, strips, sections or bars.

6.1.3 Lot

A lot is the number of items or pieces to be accepted or rejected together, on the basis of the tests to be carried out on a sampling basis. The size of a lot is given in the **Part K of the Rules**.

6.1.4 Controlled Rolling (CR)

Controlled rolling (CR) is to be according to **Table K3.3 Notes(3)**, **Chapter 3**, **Part K of the Rules**.

6.1.5 Thermo-Mechanical Controlled Processing (TMCP)

Thermo-mechanical controlled processing (TMCP) is to be according to **Table K3.3 Notes(3)**, **Chapter 3**, **Part K of the Rules**.

6.1.6 Accelerated Cooling (AcC)

Accelerated cooling (AcC) is to be according to **Table K3.3 Notes(3)**, **Chapter 3**, **Part K of the Rules**.

6.2 Scope and General Requirements (*IGC Code* 6.2)

6.2.1 Materials and Welding

This chapter gives the requirements for metallic and non-metallic materials used in the construction of the cargo system. This includes requirements for joining processes, production process, personnel qualification, NDT and inspection and testing including production testing. The requirements for rolled materials, forgings and castings are given in **6.4** and **Table N6.1** to **Table N6.5**. The requirements for weldments are given in **6.5**, and the guidance for non-metallic materials is given in **Annex 6**. A quality assurance/quality control programme is to be implemented to ensure that the requirements of **6.2** are complied with.

6.2.2 Manufacture, Testing, Inspection and Documentation

The manufacture, testing, inspection and documentation are to be in accordance with the requirements of relevant Parts and the specific requirements given in this Part.

6.2.3 Properties after Post-weld Heat Treatment

Where post-weld heat treatment is specified or required, the properties of the base material are to be determined in the heat-treated condition, in accordance with the applicable table of this chapter, and the weld properties are to be determined in the heat treated condition in accordance with **6.5**. In cases where a post-weld heat treatment is applied, the test requirements may be modified at the discretion of the Society.

6.3 General Test Requirements and Specifications (*IGC Code* 6.3)

6.3.1 Tensile Test

1 Tensile testing is to be carried out in accordance with the requirements of **Chapter 2**, **Part K of the Rules** for base metals and **Chapter 3**, **Part K of the Rules** for welds.

2 Tensile strength, yield stress and elongation are to be to the satisfaction of the Society. For carbon-manganese steel and other materials with definitive yield points, consideration is to be given to the limitation of the yield to tensile ratio.

6.3.2 Toughness Test

1 Acceptance tests are to include Charpy *V*-notch toughness tests unless otherwise specified by the Society. The specified Charpy *V*-notch requirements are minimum average energy values for three full size (10*mm* × 10*mm*) specimens and minimum single energy values for individual specimens. Dimensions and tolerances of Charpy *V*-notch specimens are to be in accordance with the requirements of **Chapter 2**, **Part K**. The testing and requirements for specimens smaller than 5.0*mm* size are to be in accordance with Recognized Standards. Minimum average values for subsized specimens are to be in accordance with **Table N6.6**.

Table N6.6

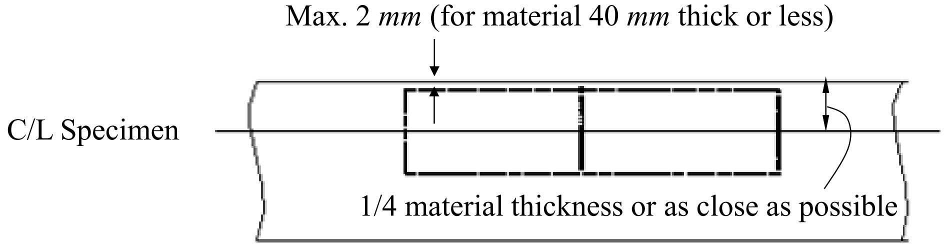
Charpy V-notch specimen size (*mm*)	Minimum average energy of three specimens
10 x 10	*KV*
10 x 7.5	5/6 *KV*
10 x 5.0	2/3 *KV*

Note:
KV = the minimum average energy values (*J*) specified in **Table N6.1** to **Table N6.4**.

Only one individual value may be below the specified average value, provided it is not less than 70% of that value.

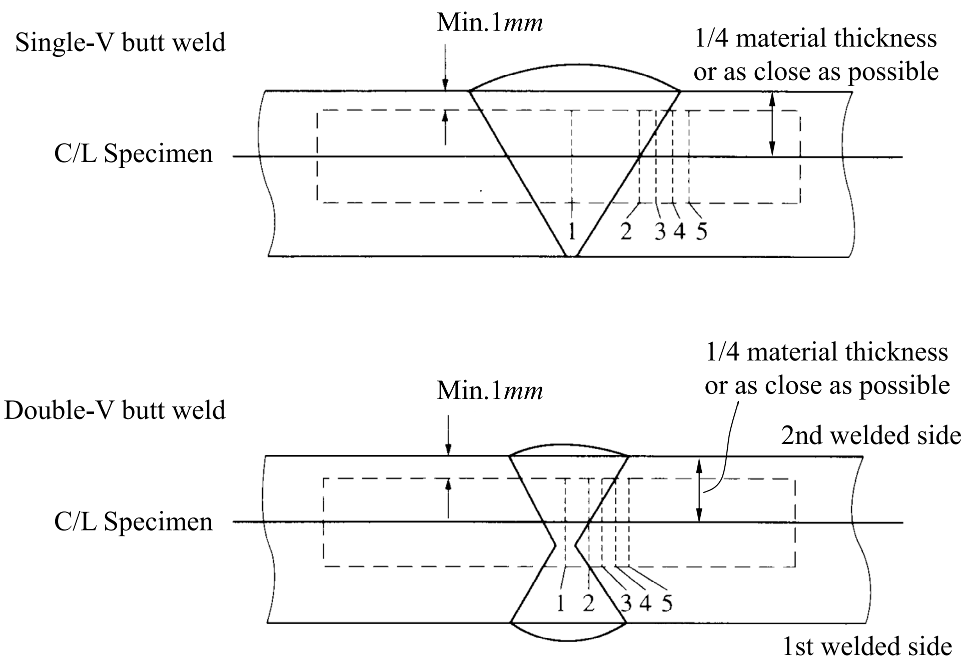
2 For base metal, the largest size Charpy *V*-notch specimens possible for the material thickness are to be machined with the specimens located as near as practicable to a point midway between the surface and the centre of the thickness and the length of the notch perpendicular to the surface as shown in **Fig. N6.1**. When the material thickness does not exceed 40*mm*, the test specimens are to be cut with their edge within 2*mm* from the surface.

Fig. N6.1 Orientation of Base Metal Test Specimen



3 For a weld test specimen, the largest size Charpy *V*-notch specimens possible for the material thickness are to be machined, with the specimens located as near as practicable to a point midway between the surface and the centre of the thickness. In all cases, the distance from the surface of the material to the edge of the specimen is to be approximately 1 *mm* or greater. In addition, for double-*V* butt welds, specimens are to be machined closer to the surface of the second welded section. The specimens are to be taken generally at each of the following locations, as shown in **Fig. N6.2**, on the centreline of the welds, the fusion line and 1 *mm*, 3 *mm* and 5 *mm* from the fusion line.

Fig. N6.2 Orientation of Weld Test Specimen



Notch locations in **Fig. N6.2**:

1. Centreline of the weld.
2. Fusion line.
3. In heat-affected zone (*HAZ*), 1 *mm* from the fusion line.
4. In *HAZ*, 3 *mm* from the fusion line.
5. In *HAZ*, 5 *mm* from the fusion line.

4 If the average value of the three initial Charpy *V*-notch specimens fails to meet the stated requirements, or the value for more than one specimen is below the required average value, or when the value for one specimen is below the minimum value permitted for a single specimen, three additional specimens from the same material may be tested and the results be combined with those previously obtained to form a new average. If this new average complies with the requirements and if no more than two individual results are lower than the required average and no more than one result is lower than the required value for a single specimen, the piece or lot may be accepted.

6.3.3 Bend Test

1 The bend test may be omitted as a material acceptance test, but is required for weld tests. Where a bend test is performed, this is to be done in accordance with the requirements of **Chaprter 3**, **Part M of the Rules**.

2 The bend tests are to be transverse bend tests, which may be face, root or side bends at the discretion of the Society. However, longitudinal bend tests may be required in lieu of transverse bend tests in cases where the base material and weld metal have different strength levels.

6.3.4 Section Observation and Other Testing

Macrosection, microsection observations and hardness tests may also be required by the Society, and they are to be carried out as deemed appropriate by the Society, where required.

6.4 Requirements for Metallic Materials (*IGC Code* 6.4)

6.4.1 General Requirements for Metallic Materials

The requirements for materials of construction are shown in the tables as follows:

(1) **Table N6.1**: Plates, pipes (seamless and welded), sections and forgings for cargo tanks and process pressure vessels for design temperatures not lower than 0°C.
(2) **Table N6.2**: Plates, sections and forgings for cargo tanks, secondary barriers and process pressure vessels for design temperatures below 0°C and down to -55°C.
(3) **Table N6.3**: Plates, sections and forgings for cargo tanks, secondary barriers and process pressure vessels for design temperatures below -55°C and down to -165°C.
(4) **Table N6.4**: Pipes (seamless and welded), forgings and castings for cargo and process piping for design temperatures below 0°C and down to -165°C.
(5) **Table N6.5**: Plates and sections for hull structures required by **4.19.1-2** and **4.19.1-3**.
(6) Castings for cargo and process piping for design temperatures not lower than 0°C are to be as deemed appropriate by the Society.

Table N6.1 Plates, Pipes (Seamless and Welded)[1][2], Sections and Forgings for Cargo Tanks and Process Pressure Vessels for Design Temperatures not lower than 0 ˚C

Chemical Composition and Head Treatment: Carbon - manganese steel (to be Fully killed fine grain steel) Small additions of alloying elements by agreement with the Society Composition limits to be approved by the Society Normalized, or quenched and tempered[4]		
Tensile and Toughness (Impact) Test Requirements:		
Sampling frequency:		
Plates	Each “piece” to be tested	
Sections and Forgings	Each “lot” to be tested	
Mechanical propaties:		
Tensile Properties	Specified minimum yield stress not to exceed 410*N/mm*^{2}[5]	
Toughness (Charpy *V*- Notch Test):		
Plates	Transverse test pieces. Minimum average energy value (*KV*) 27*J*	
Sections and Forgings:	Longitudinal test pieces. Minimum average energy value (*KV*) 41*J*	
Test Temperature:	Thickness *t* (*mm*)	Test temperature (˚C)
	$t \leq 20$	0
	$20 < t \leq 40$ [3]	-20

Notes:

(1) For seamless pipes and fittings the requirements of **Part K** applies. The use of longitudinally and spirally welded pipes to be specially approved by the Society.

(2) Charpy *V*-notch impact tests are not required for pipes.

(3) This table is generally applicable for material thicknesses up to 40 *mm*. Proposals for greater thicknesses are to be approved by the Society.

(4) A controlled rolling procedure or TMCP may be used as an alternative.

(5) Materials with specified minimum yield stress exceeding 410*N/mm*^{2} may be specially approved by the Society. For these materials, particular attention is to be given to the hardness of the weld and heat affected zone.

Table N6.2 Plates, Sections and Forgings[1] for Cargo Tanks, Secondary Barriers and Process Pressure Vessels for Design Temperatures Below 0°C and down to -55°C (Maximum thickness 25*mm*[2])

Chemical Composition and Head Treatment:					
Carbon-manganese Steel (to be fully-killed aluminium treated grain steel)					
Chemical composition (ladle analysis)					
C	*Mn*	*Si*	*S*	*P*	
0.16%max[3]	0.70 - 1.60%	0.10 - 0.50%	0.025%max.	0.025%max.	
Optional additions: Alloys and grain refining elements may be generally in accordance with the following:					
Ni	*Cr*	*Mo*	*Cu*	*Nb*	*V*
0.80%max.	0.25%max.	0.08%max.	0.35%max.	0.05%max.	0.10%max.
Al content total 0.02% min (Acid soluble 0.015% min)					
Normalized or quenched and tempered[4]					

Tensile and Toughness (Impact) Test Requirements:	
Sampling frequency:	
Plates Sections and Forgings	Each "piece" to be tested Each "lot" to be tested
Mechanical properties:	
Tensile properties	Specified minimum yield stress not to exceed 410N/mm^2[5]
Toughness (Charpy *V*- Notch Test):	
Test Temperatures Plates Sections and Forgings[1]	Test temperatures 5°C below the design temperatures or -20°C whichever is lower Transverse test pieces. Minimum average energy value (*KV*) 27*J* Longitudinal test pieces. Minimum average energy value (*KV*) 41*J*

Notes:

(1) The Charpy *V*-notch and Chemistry requirements for forgings may be specially considered by the Society.

(2) For material thickness of more than 25*mm*, Charpy *V*-notch tests are to be conducted as follows:

Material thickness (*mm*)	Test temperature (°C)
$25 < t \leq 30$	10°C below design temperature or -20°C, whichever is lower
$30 < t \leq 35$	15°C below design temperature or -20°C, whichever is lower
$35 < t \leq 40$	20°C below design temperature
$40 < t$	Temperature approved by the Society

The minimum average energy value is to be in accordance with the table for the applicable type of test specimen.

Materials for tanks and parts of tanks which are completely thermally stress relieved after welding welding may be tested at a temperature 5°C below design temperature or -20°C whichever is lower.

For thermally stress relieved reinforcements and other fittings, the test temperature are to be the same as that required for the adjacent tank-shell thickness.

(3) By special agreement with the Society, the carbon content may be increased to 0.18% maximum provided the design temperature is not lower than -40°C

(4) A controlled rolling procedure or TMCP may be used as an alternative.

(5) Materials with specified minimum yield stress exceeding 410 N/mm^2 may be approved by the Society. For these materials, particular attention is to be given to the hardness of the welded and heat affected zones.

Guidance:

For materials exceeding 25*mm* in thickness for which the test temperature is -60°C or lower, the application of specially treated steels or steels in accordance with **Table N6.3** may be necessary.

Table N6.3 Plates, Sections and Forgings[1] for Cargo Tanks, Secondary Barriers and Process Pressure Vessels for Design Temperatures Below -55°C and down to -165°C [2] (Maximum thickness 25*mm*[3][4])

Minimum design temp. (°C)	Chemical composition[5] and heat treatment	Impact test temp (°C)
-60	1.5%nickel steel - normalized or normalized and tempered or quenched and tempered or TMCP[6]	-65
-65	2.25%nickel steel - normalized or normalized and tempered or quenched and tempered or TMCP[6][7]	-70
-90	3.5%nickel steel - normalized or normalized and tempered or quenched and tempered or TMCP[6][7]	-95
-105	5%nickel steel - normalized or normalized and tempered or quenched and tempered[6][7][8]	-110
-165	9%nickel steel - double normalized and tempered or quenched and tempered[6]	-196
-165	Austenitic stainless steels, such as types 304, 304*L*, 316, 316*L*, 321 and 347 solution treated[9]	-196
-165	Aluminium alloys[10]: such as type 5083 annealed	Not required
-165	Austenitic *Fe-Ni* alloy (36% nickel) Heat treatment as agreed	Not required

Tensile and Toughness (Impact) Test Requirements:	
Sampling frequency:	
Plates Sections and Forgings	Each “piece” to be tested Each “lot” to be tested
Toughness (Charpy *V*- Notch Test):	
Plates Sections and Forgings	Transverse test pieces. Minimum average energy value (*KV*) 27*J* Longitudinal test pieces. Minimum average energy value (*KV*) 41*J*

Notes:

(1) The impact test required for forgings used in critical applications is to be subject to special consideration by the Society.

(2) The requirements for design temperatures below-165°C is to be specially agreed with the Society.

(3) For materials 1.5% *Ni*, 2.25% *Ni*, 3.5% *Ni* and 5% *Ni*, with thicknesses greater than 25*mm*, the impact tests are to be conducted as follows :

Material thickness (*mm*)	Test temperature (°C)
$25 < t \leq 30$	10°C below design temperature
$30 < t \leq 35$	15°C below design temperature
$35 < t \leq 40$	20°C below design temperature

The minimum average energy value is to be in accordance with the table for the applicable type of test specimen. For material thickness of more than 40*mm*, the Charpy *V*-notch values are to be specially considered.

(4) For 9% *Ni*, austenitic stainless steels and aluminium alloys, thicknesses greater than 25*mm* may be used at the discretion of the Society.

(5) The chemical composition limits are to be in accordance with recognized standards deemed appropriate by the Society.

(6) TMCP nickel steels will be subject to acceptance by the Society.

(7) A lower minimum design temperature for quenched and tempered steels may be specially agreed with the Society.

(8) A specially heat treated 5% nickel steel, for example triple heat treated 5% nickel steel, may be used down to -165°C upon special agreement with the Society, provided that the impact tests are carried out at-196°C

(9) The impact test may be omitted subject to agreement with the Society.

(10) For aluminimum alloys other than type 5083, additional tests may be required to verify the toughness of the material.

Table N6.4 Pipes, (Seamless and welded)(1), Forgings(2) and Castings(2) for Cargo and Progress Piping for Design Temperatures below 0 °C and down to -165 °C (3) (Maximum thickness 25*mm*)

Minimum design temp. (°C)	Chemical composition(5) and heat treatment	Impact test	
		Test temp. (°C)	Minimum average energy (E)(J)
-55	Carbon - manganese steel. (to be Fully killed fine grain) Normalized or as agreed(6)	(4)	27
-65	2.25%nickel steel. Normalized or normalized and tempered or quenched and tempered(6)	-70	34
-90	3.5%nickel steel. Normalized or normalized and tempered or quenched and tempered(6)	-95	34
-165	9%nickel steel(7). Double normalized and tempered or quenched and tempered	-196	41
	Austenitic stainless steels, such as types 304, 304*L*, 316, 316*L*, 321 and 347. Solution treated(8)	-196	41
	Aluminium alloys(9), such as type 5083 annealed		Not required
Tensile and Toughness (Impact) Test Requirements Sample frequency: Each lot to be tested Toughness (Charpy *V*- Notch Test): Impact Test - Longitudinal test pieces			

Notes:
(1) The use of longitudinally or spirally welded pipes is to be specially approved the Society.
(2) The requirements for forgings and castings may be subject to special consideration by the Society.
(3) The requirements for design temperature below -165 °C are to be specially agreed with the Society.
(4) The test temperature is to be 5 °C below the design temperature or -20 °C whichever is lower.
(5) The composition limits are to be in accordance with recognized standards deemed appropriate by the Society.
(6) A lower design temperature may be specially agreed with the Society for quenched and tempered materials.
(7) This chemical composition is not suitable for castings.
(8) Impact tests may be omitted subject to agreement with the Society.
(9) For aluminimum alloys other than type 5083, additional tests may be required to verify the toughness of the material.

Table N6.5 Plates and Sections for Hull Structures Required by 4.19.1-2 and 4.19.1-4

Minimum design temperature of hull structure (°C)	Maximum thickness (*mm*) for steel grades						
	A	*B*	*D*	*E*	*AH*	*DH*	*EH*
0 and above(1)-5 and above(2)	In accordance with **Part C of the Rules**						
down to -5	15	25	30	50	25	45	50
down to -10	×	20	25	50	20	40	50
down to -20	×	×	20	50	×	30	50
down to -30	×	×	×	40	×	20	40
below -30	In accordance with **Table N6.2** except that the thickness limitation given in **Table N6.2** and in footnote **(2)** of that table does not apply.						

Notes:
"×" means steel grade not to be used.
(1) For the purpose of **4.9.1-3**
(2) For the purpose of **4.9.1-2**

6.5 Welding of Metallic Materials and Non-Destructive Testing (*IGC Code* 6.5)

6.5.1 General

This section is to apply to primary and secondary barriers only, including the inner hull where this forms the secondary barrier. Acceptance testing is specified for carbon, carbon-manganese, nickel alloy and austenitic stainless steels, but these tests may be adapted for other materials. At the discretion of the Society, impact testing of austenitic stainless steel and aluminium alloy weldments may be omitted and other tests may be specially required for any material.

6.5.2 Welding Consumables

Consumables intended for welding of cargo tanks are to be in accordance with the requirements of **Chapter 6**, **Part M of the Rules**. Deposited weld metal tests and butt weld tests are to be required for all consumables. The results obtained from tensile and Charpy *V*-notch impact tests are to be in accordance with the requirements of **Chapter 6**, **Part M of the Rules**. The chemical composition of the deposited weld metal is to be recorded for information.

6.5.3 Welding Procedure Tests for Cargo Tanks, Process Pressure Vessels and Secondary Barriers

1 Welding procedure tests for cargo tanks and process pressure vessels are required subject to the following **-2** to **-5** for all butt welds.

2 The test assemblies are to be representative of:

(1) Each base material;
(2) Each type of consumable and welding process; and
(3) Each welding position.

3 For butt welds in plates, the test assemblies are to be so prepared that the rolling direction is parallel to the direction of welding. The range of thickness qualified by each welding procedure test is to be in accordance with the requirements of **Chapter 11**, **Part D of the Rules** and **Chapter 4**, **Part M of the Rules**. Non-destructive tests are to be in accordance with the requirements of **Chapter 11**, **Part D of the Rules** and **Chapter 4**, **Part M of the Rules**.

4 The following welding procedure tests for cargo tanks and process pressure vessels are to be carried out in accordance with **6.3**, with specimens made from each test assembly:

(1) Cross-weld tensile tests;
(2) Longitudinal all-weld testing, where required by the requirements of **Chapter 4**, **Part M of the Rules**;
(3) Transverse bend tests, which may be face, root or side bends as required by **Chapter 4**, **Part M of the Rules**. However, longitudinal bend tests may be required in lieu of transverse bend tests in cases where the base material and weld metal have different strength levels;
(4) One set of three Charpy *V*-notch impacts, generally at each of the following locations, as shown in **Fig. N6.2**:
    (a) Centreline of the weld;
    (b) Fusion line;
    (c) 1 *mm* from the fusion line;
    (d) 3 *mm* from the fusion line; and
    (e) 5 *mm* from the fusion line; and
(5) Macrosection, microsection and hardness survey may also be required.

5 Each test is to satisfy the following requirements:

(1) Tensile tests: cross-weld tensile strength is not to be less than the specified minimum tensile strength for the appropriate parent materials. For aluminium alloys, reference is to be made to **4.18.1-3** with regard to the requirements for weld metal strength of under-matched welds

(where the weld metal has a lower tensile strength than the parent metal). In every case, the position of fracture is to be recorded for information;

(2) Bend tests: no fracture is acceptable after a 180° bend over a former of a diameter four times the thickness of the test pieces; and

(3) Charpy *V*-notch impact tests: Charpy *V*-notch tests are to be conducted at the temperature prescribed for the base material being joined. The results of weld metal impact tests, minimum average energy (*KV*), are to be no less than 27 *J*. The weld metal requirements for subsize specimens and single energy values are to be in accordance with **6.3.2**. The results of fusion line and heat-affected zone impact tests are to show a minimum average energy (*KV*) in accordance with the transverse or longitudinal requirements of the base material, whichever is applicable, and for subsize specimens, the minimum average energy (*KV*) is to be in accordance with **6.3.2**. If the material thickness does not permit machining either full-size or standard subsize specimens, the testing procedure and acceptance standards are to be to the satisfaction of the Society.

6 Procedure tests for fillet welding of cargo tanks and process pressure vessels are to be in accordance with the requirements of **Chapter 11**, **Part D of the Rules** and **Chapter 4**, **Part M of the Rules**. In such cases, consumables are to be so selected that exhibit satisfactory impact properties.

7 Procedure tests for all welding of secondary barriers are to be in accordance with the requirements of **Chapter 4**, **Part M of the Rules**.

6.5.4 Welding Procedure Tests for Piping

Welding procedure tests for piping are to be carried out and are to be similar to those detailed for cargo tanks in **6.5.3**.

6.5.5 Production Weld Tests

1 For all cargo tanks and process pressure vessels, except integral and membrane tanks, production weld tests are to generally be performed for approximately each 50 *m* of butt-weld joints and are to be representative of each welding position. For secondary barriers, the same type production tests as required for primary tanks are to be performed, except that the number of tests may be reduced subject to agreement with the Society. Tests, other than those specified in **-2** to **-5** may be required for cargo tanks or secondary barriers.

2 The production tests for type *A* and type *B* independent tanks and semi-membrane tanks are to include bend tests and, where required for procedure tests, one set of three Charpy *V*-notch tests. The tests are to be made for each 50 *m* of weld. The Charpy *V*-notch tests are to be made with specimens having the notch alternately located in the centre of the weld and in the heat-affected zone (most critical location based on procedure qualification results). For austenitic stainless steel, all notches are to be in the centre of the weld.

3 For type *C* independent tanks and process pressure vessels, transverse weld tensile tests are required in addition to the tests listed in **-2**. Tensile tests are to meet the requirements of **6.5.3-5**.

4 The quality assurance/quality control programme is to ensure the continued conformity of the production welds as defined in the material manufacturers' quality manual.

5 The test requirements for integral and membrane tanks are the same as the applicable test requirements listed in **6.5.3**.

6.5.6 Non-Destructive Testing

1 All test procedures and acceptance standards are to be to the satisfaction of the Society, unless the designer specifies a higher standard in order to meet design assumptions. Radiographic testing is to be used, in principle, to detect internal defects. However, an approved ultrasonic test procedure in lieu of radiographic testing may be conducted, but, in addition, supplementary radiographic testing at selected locations is to be carried out to verify the results. Radiographic and ultrasonic testing records are to be retained.

2 For type *A* independent tanks and semi-membrane tanks, where the design temperature is below -20°C, and for type *B* independent tanks, regardless of temperature, all full penetration butt welds of the shell plating of cargo tanks are to be subjected to non-destructive testing suitable to detect internal defects over their full length. Ultrasonic testing in lieu of radiographic testing may be carried out under the same conditions as described in **-1** above.

3 Where the design temperature is higher than -20°C, all full penetration butt welds in way of intersections and at least 10% of the remaining full penetration welds of tank structures are to be subjected to radiographic testing or ultrasonic testing under the same conditions as described in **-1** above.

4 In each case, the remaining tank structure, including the welding of stiffeners and other fittings and attachments, is to be examined by magnetic particle or dye penetrant inspection, as considered necessary.

5 For type *C* independent tanks, the extent of non-destructive testing is to be total or partial according to the requirements of **Chapter 11**, **Part D of the Rules**, but the controls to be carried out are not to be less than the following:

(1) Total non-destructive testing referred to in **4.23.2-1(3)**:

Radiographic testing:

all butt welds over their full length;

Non-destructive testing for surface crack detection:

all welds over 10% of their length;

reinforcement rings around holes, nozzles, etc., over their full length.

As an alternative, ultrasonic testing as described in **-1** above may be accepted as a partial substitute for the radiographic testing. In addition, the Society may require total ultrasonic testing on welding of reinforcement rings around holes, nozzles, etc.

(2) Partial non-destructive testing referred to in **4.23.2-1(3)**:

Radiographic testing:

all butt-welded crossing joints and at least 10% of the full length of butt welds at selected positions uniformly distributed;

Non-destructive testing for surface crack detection:

reinforcement rings around holes, nozzles, etc., over their full length;

Ultrasonic testing:

as may be required by the Society or recognized organization acting on its behalf in each instance.

6 The quality assurance/quality control programme is to ensure the continued conformity of the non-destructive testing of welds, as defined in the material manufacturer's quality manual.

7 Inspection of piping is to be carried out in accordance with the requirements of **Chapter 5**.

8 The secondary barrier is to be non-destructive tested for internal defects as considered necessary. Where the outer shell of the hull is part of the secondary barrier, all sheer strake butts and the intersections of all butts and seams in the side shell are to be tested by radiographic testing.

9 For integral and membrane tanks, special weld inspection procedures and acceptance criteria are to be to the satisfaction of the Society.

6.6 Other Requirements for Construction in Metallic Materials (*IGC Code* 6.6)

6.6.1 General

Inspection and non-destructive testing of welds are to be in accordance with the requirements of **6.5.5** and **6.5.6**. Where higher standards or tolerances are assumed in the design, they are to also be satisfied.

6.6.2 Independent Tank

1 For type *C* tanks and type *B* tanks primarily constructed of bodies of revolution, the tolerances relating to manufacture, such as out-of-roundness, local deviations from the true form, welded joints alignment and tapering of plates having different thicknesses, are to comply with the requirements of **Chapter 11**, **Part D of the Rules**. The tolerances are to also be related to the buckling analysis referred to in **4.22.3-2** and **4.23.3-2**.

2 For type *C* tanks of carbon and carbon-manganese steel, post-weld heat treatment is to be performed after welding, if the design temperature is below -10°C. Post-weld heat treatment in all other cases and for materials other than those mentioned above is to be at the discretion of the Society. The soaking temperature and holding time are to be at the discretion of the Society.

3 In the case of type *C* tanks and large cargo pressure vessels of carbon or carbon-manganese steel, for which it is difficult to perform the heat treatment, mechanical stress relieving by pressurizing may be carried out as an alternative to the heat treatment and subject to the following conditions:

(1) Complicated welded pressure vessel parts such as sumps or domes with nozzles, with adjacent shell plates are to be heat treated before they are welded to larger parts of the pressure vessel;

(2) The mechanical stress relieving process is to preferably be carried out during the hydrostatic pressure test required by **4.23.6**, by applying a higher pressure than the test pressure required by **4.23.6-1**. The pressurizing medium is to be water;

(3) For the water temperature, **4.23.6-2** applies;

(4) Stress relieving is to be performed while the tank is supported by its regular saddles or supporting structure or, when stress relieving cannot be carried out on board, in a manner which will give the same stresses and stress distribution as when supported by its regular saddles or supporting structure;

(5) The maximum stress relieving pressure is to be held for 2 *hours* per 25 *mm* of thickness, but in no case less than 2 *hours*;

(6) The upper limits placed on the calculated stress levels during stress relieving are to be the following:

  (a) Equivalent general primary membrane stress: 0.9 R_e;

  (b) Equivalent stress composed of primary bending stress plus membrane stress: 1.35 R_e, where R_e is the specific lower minimum yield stress or 0.2% proof stress at test temperature of the steel used for the tank;

(7) Strain measurements will normally be required to prove these limits for at least the first tank of a series of identical tanks built consecutively. The location of strain gauges is to be included in the mechanical stress relieving procedure to be submitted in accordance with **6.6.2-3**;

(8) The test procedure is to demonstrate that a linear relationship between pressure and strain is achieved at the end of the stress relieving process when the pressure is raised again up to the design pressure;

(9) High-stress areas in way of geometrical discontinuities such as nozzles and other openings are to be checked for cracks by dye penetrant or magnetic particle inspection after mechanical stress relieving. Particular attention in this respect is to be paid to plates exceeding 30 *mm* in thickness;

(10) Steels which have a ratio of yield stress to ultimate tensile strength greater than 0.8 are to generally not be mechanically stress relieved. If, however, the yield stress is raised by a method giving high ductility of the steel, slightly higher rates may be accepted upon consideration in each case;

(11) Mechanical stress relieving cannot be substituted for heat treatment of cold formed parts of tanks, if the degree of cold forming exceeds the limit above which heat treatment is required;

(12) The thickness of the shell and heads of the tank are to not exceed 40 *mm*. Higher thicknesses may be accepted for parts which are thermally stress relieved;

(13) Local buckling is to be guarded against, particularly when tori-spherical heads are used for tanks and domes; and

(14) The procedure for mechanical stress relieving is to be submitted beforehand to the Society for approval.

6.6.3 Secondary Barriers

During construction, the requirements for testing and inspection of secondary barriers are to be approved or accepted by the Society or recognized organization acting on its behalf (see **4.6.2(5)** and **4.6.2(6)**).

6.6.4 Semi-Membrane Tanks

For semi-membrane tanks, the relevant requirements in section **6.6** for independent tanks or for membrane tanks are to be applied as appropriate.

6.6.5 Membrane Tanks

The quality assurance/quality control programme is to ensure the continued conformity of the weld procedure qualification, design details, materials, construction, inspection and production testing of components. These standards and procedures are to be developed during the prototype testing programme.

6.7 Non-Metallic Materials (*IGC Code* 6.7)

6.7.1 General

The information in the attached **Annex 6** is given for guidance in the selection and use of these materials, based on the experience to date.

Chapter 7 has been amended as follows.

Chapter 7 CARGO PRESSURE/TEMPERATURE CONTROL

7.1 ~~General~~ Methods of Control (*IGC Code* 7.1)

7.1.1 Means of Control ~~(with reference to *IGC Code* 7.1.1.1~.4)~~

Unless the ~~entire cargo system~~ tanks is designed to withstand the full gauge vapour pressure of the cargo under conditions of the upper ambient design temperatures, ~~maintenance of the cargo tank pressure below the *MARVS* is to be provided by one or more of the following means, except as otherwise provided in this section~~ cargo tanks' pressure and temperature are to be maintained at all times within their design range by either one, or a combination of, the following methods:

1 reliquefaction of cargo vapours;
2 thermal oxidation of vapours;
3 pressure accumulation; and
4 liquid cargo cooling.

~~(1) a system which regulates the pressure in the cargo tanks by the use of mechanical refrigeration;~~
~~(2) a system whereby the boil-off vapours are utilized as fuel for shipboard use or waste heat system subject to the provisions of **Chapter 16**. This system may be used at all times, including while in port and while manoeuvring, provided that a means of disposing of excess energy is provided, such as a steam dump system, that is satisfactory to the Society;~~
~~(3) a system allowing the product to warm up and increase in pressure. The insulation or cargo tank design pressure or both are to be adequate to provide for a suitable margin for the operating time and temperatures involved. The system is to be acceptable to the Society in each case;~~
~~(4) other systems acceptable to the Society.~~

7.1.~~3~~2 Design Requirement for Dangerous Cargoes ~~(*IGC Code* 7.1.3)~~

For certain ~~highly dangerous~~ cargoes specified in **Chapter 17 of this Part**, the cargo containment system is to be capable of withstanding the full vapour pressure of the cargo under conditions of the upper ambient design temperatures irrespective of any system provided for dealing with boil-off gas.

7.2 Design of Systems (*IGC Code* 7.2)

~~7.1.2 Design Requirement of the Systems (*IGC Code* 7.1.2)~~

~~The systems required by **7.1.1** are to be constructed, fitted and tested to the satisfaction of the Society. Materials used in their construction are to be suitable for use with the cargoes to be carried.~~ For normal service, the upper ambient design temperature is to be:

sea 32°C

air 45°C

For service in especially hot or cold zones these design temperatures are to be increased or reduced, as appropriate, by the Society. The overall capacity of the system is to be such that it can control the pressure within the design conditions without venting to atmosphere.

7.~~2~~3 ~~Refrigeration Systems~~ Reliquefaction of Cargo Vapours (*IGC Code* 7.~~2~~3)

7.~~2.4~~3.1 ~~Type of Refrigeration System~~ General

The ~~refrigeration~~ reliquefaction system may be arranged in one of the following ways. The requirements of **chapters 17 and 19 of this Part** may preclude the use of one or more of these systems or may specify the use of a particular system:

(1) a direct system where evaporated cargo is compressed, condensed and returned to cargo tanks~~. For certain cargoes specified in **Chapter 17** this system is not to be used~~;

(2) an indirect system where cargo or evaporated cargo is cooled or condensed by refrigerant without being compressed;

(3) a combined system where evaporated cargo is compressed and condensed in a cargo/refrigerant heat exchanger and returned to the cargo tanks~~. For certain cargoes specified in **Chapter 17** this system is not to be used.~~; and

(4) if the reliquefaction system produces a waste stream containing methane during pressure control operations within the design conditions, these waste gases, as far as reasonably practicable, are disposed of without venting to atmosphere.

7.~~2.5~~3.2 ~~Heat Exchange~~ Compatibility

~~All primary and secondary~~ R~~r~~efrigerants used for reliquefaction must be compatible with ~~each other and with~~ the cargo ~~with which~~ they may come into contact with. ~~The heat exchange may take place either remotely from the cargo tank or by cooling coils fitted inside or outside the cargo tank.~~ In addition, when several refrigerants are used and may come into contact, they are to be compatible with each other.

7.4 Thermal Oxidation of Vapours (*IGC Code* 7.4)

7.4.1 General

Maintaining the cargo tank pressure and temperature by means of thermal oxidation of cargo vapours, as defined in **1.1.4(47)** and **16.2** is to be permitted only for LNG cargoes. In general:

(1) thermal oxidation systems are to exhibit no externally visible flame and are to maintain the uptake exhaust temperature below 535°C;

(2) arrangement of spaces where oxidation systems are located are to comply with **16.3** and supply systems are to comply with **16.4**; and

(3) if waste gases coming from any other system are to be burnt, the oxidation system is to be designed to accommodate all anticipated feed gas compositions.

7.4.2 Thermal Oxidation Systems

Thermal oxidation systems are to comply with the following:

(1) each thermal oxidation system is to have a separate uptake;

(2) each thermal oxidation system is to have a dedicated forced draught system; and

(3) combustion chambers and uptakes of thermal oxidation systems are to be designed to prevent any accumulation of gas.

7.4.3 Burners

Burners are to be designed to maintain stable combustion under all design firing conditions.

7.4.4 Safety

1 Suitable devices are to be installed and arranged to ensure that gas flow to the burner is cut off unless satisfactory ignition has been established and maintained.

2 Each oxidation system is to have provision to manually isolate its gas fuel supply from a safely accessible position.

3 Provisions are to be made for automatic purging the gas supply piping to the burners by means of an inert gas, after the extinguishing of these burners.

4 In case of flame failure of all operating burners for gas or oil or for a combination thereof, the combustion chambers of the oxidation system are to be automatically purged before relighting.

5 Arrangements are to be made to enable the combustion chamber to be manually purged.

7.5 Pressure Accumulation Systems (*IGC Code* 7.5)

The containment system insulation, design pressure or both are to be adequate to provide for a suitable margin for the operating time and temperatures involved. No additional pressure and temperature control system is required. Conditions for acceptance are recorded in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk.

7.6 Liquid Cargo Cooling (*IGC Code* 7.6)

The bulk cargo liquid may be refrigerated by coolant circulated through coils fitted either inside the cargo tank or onto the external surface of the cargo tank.

7.7 Segregation (*IGC Code* 7.7)

~~**7.2.2 Requirement for Carrying Cargoes of Chemical Reaction Simultaneously**~~

~~**1**~~ Where two or more ~~refrigerated~~ cargoes which may react chemically in a dangerous manner are carried simultaneously, ~~special consideration is to be given to the refrigeration systems to avoid the possibility of mixing cargoes. For the carriage of such cargoes, separate refrigeration systems, each complete with a stand-by unit as specified in **7.2.1**, are to be provided for each cargo. However, where cooling is provided by an indirect or combined system and leakage in the heat exchangers cannot cause mixing of the cargoes under any envisaged condition, separate refrigeration units need not be fitted~~ separate systems as defined in **1.1.4(43)**, each complying with availability criteria as specified in **7.8**, are to be provided for each cargo. For simultaneous carriage of two or more cargoes that are not reactive to each other but where, due to properties of their vapour, separate systems are necessary, separation may be by means of isolation valves.

~~**2** Where two or more refrigerated cargoes are not mutually soluble under the conditions of carriage, so that the vapour pressures would be additive on mixing, special consideration is to be given to the refrigeration systems to avoid the possibility of mixing cargoes.~~

7.8 Availability (*IGC Code* 7.8)

7.~~2~~8.1 ~~Stand-by Unit and Heat Exchanger~~ General Requirements

~~A refrigeration system is to consist of one or more units capable of maintaining the required cargo pressure/temperature under conditions of the upper ambient design temperatures. Unless an alternative means of controlling the cargo pressure/temperature is provided to the satisfaction of the Society, a stand-by unit (or units) affording spare capacity at least equal to the largest required single unit is to be provided. A stand-by unit is to consist of a compressor with its driving motor, control system and any necessary fittings to permit operation independently of the normal service units. A stand-by heat exchanger is to be provided unless the normal heat exchanger for the unit has an excess capacity of at least 25% of the largest required capacity. Separate piping systems are not required.~~

The availability of the system and its supporting auxiliary services are to be such that:

1 in case of a single failure of a mechanical non-static component or a component of the control systems, the cargo tanks' pressure and temperature can be maintained within their design range without affecting other essential services;

2 redundant piping systems are not required;

3 heat exchangers that are solely necessary for maintaining the pressure and temperature of the cargo tanks within their design ranges are to have a standby heat exchanger, unless they have a capacity in excess of 25% of the largest required capacity for pressure control and they can be repaired on board without external resources. Where an additional and separate method of cargo tank pressure and temperature control is fitted that is not reliant on the sole heat exchanger, then a standby heat exchanger is not required; and

4 for any cargo heating or cooling medium, provisions are to be made to detect the leakage of toxic or flammable vapours into an otherwise non-hazardous area or overboard in accordance with **13.6**. Any vent outlet from this leak detection arrangement is to be to a safe location and be fitted with a flame screen.

~~7.2.3 Cooling Water~~

~~Where cooling water is required in refrigeration systems, an adequate supply is to be provided by a pump or pumps used exclusively for this purpose. This pump or these pumps are to have at least two sea suction lines, where practicable leading from sea-chests, one port and one starboard. A spare pump of adequate capacity is to be provided, which may be a pump used for other services so long as its use for cooling would not interfere with any other essential service.~~

7.~~3~~9 Operating Requirements

7.~~3~~9.1 Application

The provisions in **7.~~3~~9** are not related to surveys necessary ~~the conditions~~ for the maintenance of classification, but indicate those matters ~~for~~ which ~~examinations~~ are ~~required but the conditions~~ to be strictly observed by the ~~ship owner~~ shipowner or the~~,~~ ship master ~~or~~ as well as all other persons ~~who may concern with~~ responsible for the ship's operation.

7.~~3~~9.2 Pressure Control (with reference to *IGC Code* 7.1.~~1.5~~3)

~~In addition to the means specified in **7.1.1**,~~ Venting of the cargo to maintain cargo tank pressure and temperature is not to be acceptable except in emergency situations. T~~t~~he Administration may permit certain cargoes to be controlled by venting cargo vapour to the atmosphere at sea. This may also be permitted in port with the permission of the port Administration.

Chapter 8 has been amended as follows.

Chapter 8 CARGO TANK VENT SYSTEMS

8.1 General

8.1.1 General (*IGC Code* 8.1)

All cargo tanks are to be provided with a pressure relief system appropriate to the design of the cargo containment system and the cargo being carried. Hold spaces~~,~~ and interbarrier spaces ~~and cargo piping~~, which may be subject to pressures beyond their design capabilities, are also to be provided with a suitable pressure relief system. ~~The pressure relief system is to be connected to a vent piping system so designed as to minimize the possibility of cargo vapour accumulating on the decks, or entering accommodation spaces, service spaces, control stations and machinery spaces, or other spaces where it may create a dangerous condition.~~ Pressure control systems specified ~~by~~in **Chapter 7** of this Part are to be independent of the pressure relief ~~valves~~systems.

8.2 Pressure Relief Systems (*IGC Code* 8.2)

8.2.1 General ~~(*IGC Code* 8.2.1)~~

~~Each cargo tank with a volume exceeding $20m^3$~~Cargo tanks, including deck tanks, ~~is~~are to be fitted with ~~at least~~a minimum of two pressure relief valves (PRVs), each being of ~~approximately~~ equal ~~capacity,~~size within manufacturer's tolerances and suitably designed and constructed for the prescribed service. ~~For cargo tanks with a volume not exceeding $20m^3$, a single relief valve may be fitted.~~

8.2.2 Pressure Relief ~~System~~Devices for Interbarrier Spaces ~~(*IGC Code* 8.2.2)~~

Interbarrier spaces are to be provided with pressure relief devices ~~to the satisfaction of the Society~~. For membrane systems, the designer is to demonstrate adequate sizing of interbarrier space PRVs.

8.2.3 ~~Setting~~ Pressure Setting of ~~Pressure Relief Systems~~PRVs ~~(*IGC Code* 8.2.3)~~

~~In general, t~~The setting of the ~~pressure relief valves~~PRVs ~~should~~is not to be higher than the vapour pressure ~~which~~that has been used in the design of the tank. ~~However, w~~Where two or more ~~pressure relief valves~~PRVs are fitted, valves comprising not more than 50% of the total relieving capacity may be set at a pressure up to ~~10~~5% ~~of~~above *MARVS* to allow sequential lifting, minimizing unnecessary release of vapour.

8.2.4 Arrangements of ~~Pressure Relief Valves~~PRVs ~~(*IGC Code* 8.2.4)~~

~~Pressure relief valves are to be connected be to the highest part of the cargo tank above deck level.~~ The following temperature requirements apply to PRVs fitted to pressure relief systems:

(1) ~~Pressure relief valves~~PRVs on cargo tanks with a design temperature below 0°C are to be designed and arranged to prevent their becoming inoperative due to ice formation ~~when they are closed.~~

(2) ~~Due consideration~~the effects of ice formation due to ambient temperatures ~~is~~are to be ~~given to~~ considered in the construction and arrangement of ~~pressure valves~~PRVs; ~~on cargo tanks subject to low ambient temperatures.~~

(3) ~~Valves~~PRVs ~~should be considered~~are to be constructed of materials with a melting point above 925°C. ~~Consideration of l~~Lower melting point materials for internal parts and seals ~~should be given if their use provides significant improvement to the general operation of the valve.~~may be accepted, provided that fail-safe operation of the PRV is not compromised; and

(4) sensing and exhaust lines on pilot operated relief valves are to be of suitably robust construction to prevent damage.

8.2.5 Valve Testing~~Capacity of Pressure Relief Valves (with reference to *IGC Code* 8.2.5)~~

~~Pressure relief valves are to be prototype tested to ensure that the valves have the capacity required. Each valve is to be tested to ensure that it opens at the prescribed pressure setting with an allowance not exceeding ±10% for 0 to 0.15*MPa*, ±6% for 0.15 to 0.30*MPa*, ±3% for 0.30*MPa* and above. Pressure relief valves are to be set and sealed by a competent authority acceptable to the Society.~~

1 PRVs are to be type-tested. Type tests are to include the following **(1)** to **(4)**. PRVs are to be tested in accordance with recognized standards.

(1) verification of relieving capacity;

(2) cryogenic testing when operating at design temperatures colder than -55°C;

(3) seat tightness testing; and

(4) pressure containing parts are pressure tested to at least 1.5 times the design pressure.

2 Each PRV is to be tested to ensure that:

(1) it opens at the prescribed pressure setting, with an allowance not exceeding:

(a) ± 10% for 0 to 0.15 *MPa*;

(b) ± 6% for 0.15 to 0.3 *MPa*;

(c) ± 3% for 0.3 *MPa* and above;

(2) seat tightness is acceptable; and

(3) pressure containing parts will withstand at least 1.5 times the design pressure.

8.2.6 Sealing of PRVs

PRVs are to be set and sealed by the Administration or the Society.

8.2.7~~6~~ Changing ~~of~~ Set Pressure of PRVs~~Relief Valves (*IGC Code* 8.2.6)~~

~~In the case of c~~Cargo tanks may be permitted to have more than one relief valve set pressure in the following cases~~setting this may be accomplished by~~:

(1) installing two or more properly set and sealed ~~valves~~PRVs and providing means, as necessary, for isolating the valves not in use from the cargo tank; or

(2) installing relief valves whose settings may be changed by the ~~insertion~~use of a previously approved ~~spacer pieces or alternative springs or by other similar means~~device not requiring pressure testing to verify the new set pressure. All other valve adjustments are to be capable of being sealed.

8.2.8~~7~~ Procedures for~~of~~ Changing ~~of~~ Set Pressure ~~(with reference to *IGC Code* 8.2.7)~~

The procedures for~~of~~ changing ~~of the~~ set pressures in accordance with~~under the provisions of~~ **8.2.7~~6~~**, and ~~the corresponding~~ for resetting ~~of the~~ alarms in accordance with~~referred to in~~ **13.4.2~~1~~**~~,~~ are to be specified in the ship's operating manual.

~~8.2.8 Stop Valves between Tanks and Pressure Relief Valves (*IGC Code* 8.2.8)~~

~~Stop valves or other means of blanking off pipes between tanks and pressure relief valves to facilitate maintenance are not to be fitted unless all the following arrangements are provided:~~

~~(1) suitable arrangements to prevent more than one pressure relief valve being out of service at the same time;~~

~~(2) a device which automatically and in a clearly visible way indicates which one of the pressure relief valves is out of service; and~~

~~(3) pressure relief valve capacities such that if one valve is out of service the remaining valves have the combined relieving capacity required by **8.5**. However, this capacity may be provided by the combined capacity of all valves, if a suitably maintained spare valve is carried on board.~~

8.2.9 Means of Emergency Isolation of PRVs

In the event of a failure of a cargo tank-installed PRV, a safe means of emergency isolation is to be available:

(1) Procedures are to be provided and included in the cargo operations manual (See **18.2**).

(2) The procedures are to allow only one of the cargo tank installed PRVs to be isolated.

8.2.10~~9~~ Venting Systems ~~(*IGC Code* 8.2.9)~~

Each ~~pressure relief valve~~PRV installed on a cargo tank is to be connected to a venting system, which is to be:

(1) so constructed that the discharge ~~of gas~~ will be unimpeded and directed vertically upwards at the exit ~~and so~~;

(2) arranged ~~as~~ to minimize the possibility of water or snow entering the vent system~~.~~;

(3) arranged such that ~~T~~the height of vent exits ~~should~~is not to be less than *B*/3 or 6*m*, whichever is the greater, above the weather deck ~~and~~;

(4) 6*m* above ~~the~~ working areas and walkways~~, the fore and aft gangway, deck storage tanks and cargo liquid lines~~.

8.2.11~~0~~ Arrangement of Vent Outlets~~Exits (*IGC Code* 8.2.10)~~

1 Cargo tank ~~pressure relief valve~~PRV vent exits are to be arranged at a distance at least equal to *B* or 25*m*, whichever is less, from the nearest air intake, outlet or opening to accommodation spaces, service spaces and control stations, or other ~~gas-safe spaces~~non-hazardous areas. For ships less than 90*m* in length (L_f), smaller distances may be permitted ~~by the Society~~.

2 All other vent outlets~~exits~~ connected to the cargo containment system are to be arranged at a distance of at least 10*m* from the nearest air intake, outlet or opening to accommodation spaces, service spaces and control stations, or other ~~gas-safe spaces~~non-hazardous areas.

8.2.12~~1~~ Arrangement of All Other Cargo Vent Outlets~~Exits (*IGC Code* 8.2.11)~~

All other cargo vent outlets~~exits~~ not dealt with in other Chapters are to be arranged in accordance with **8.2.10~~9~~** and **8.2.11~~0~~**. Means are to be provided to prevent liquid overflow from vent mast outlets, due to hydrostatic pressure from spaces to which they are connected.

8.2.13~~2~~ Pressure Relief Systems for Simultaneously Carrying Cargoes which React in a Dangerous Manner~~of Hazardous Reaction Simultaneously (*IGC Code* 8.2.12)~~

If cargoes ~~which~~that react in a ~~hazardous~~dangerous manner with each other are carried simultaneously, a separate pressure relief system is to be fitted for each one~~cargo carried~~.

8.2.14~~3~~ Means for Draining ~~(*IGC Code* 8.2.13)~~

In the vent piping system, means for draining liquid from places where it may accumulate are to be provided. The ~~pressure relief valves~~PRVs and piping are to be ~~so~~ arranged so that liquid can, under no circumstances, accumulate in or near the ~~pressure relief valves~~PRVs.

8.2.1~~4~~5 Protection Screens on Vent Outlets ~~(*IGC Code* 8.2.14)~~

Suitable protection screens of not more than 13 *mm* square mesh are to be fitted on vent outlets to prevent the ingress of ~~foreign~~extraneous objects without adversely affecting the flow. Other requirements for protection screens apply when carrying specific cargoes (See **17.9** and **17.21**).

8.2.1~~5~~6 Design of Vent Piping ~~(*IGC Code* 8.2.15)~~

All vent piping is to be ~~so~~ designed and arranged ~~that it will~~ not to be damaged by temperature variations to which it may be exposed, forces due to flow or ~~by~~ the ship's motions.

~~8.2.16 Back Pressure in Vent Lines (*IGC Code* 8.2.16)~~

~~The back pressure in the vent lines from the pressure relief valves is to be taken into account in determining the flow capacity required by **8.5**. The pressure drop in the vent line from the tank to the pressure relief valve inlet should not exceed 3% of the valve set pressure. For unbalanced pressure relief valves the back pressure in the discharge line should not exceed 10% of the gauge pressure at the relief valve inlet with the vent lines under fire exposure as referred to in **8.5.1(2)**.~~

8.2.17 Position of ~~Pressure Relief Valves~~PRVs ~~(*IGC Code* 8.2.17)~~

PRVs are to be connected to the highest part of the cargo tank above deck level. ~~Pressure relief valves~~PRVs are to be positioned on the cargo tank so that they will remain in the vapour phase ~~under condition 15° list and 0.015L_f trim~~ at the ~~maximum allowable~~ filling limit (*FL*) as defined in **Chapter 15** of this Part, under conditions of 15° list and 0.015L_f trim.

8.2.18 Adequacy of the Vent System ~~(with reference to *IGC Code* 8.2.18)~~

The ~~A~~adequacy of the vent system fitted on tanks ~~is to be approved by the Society, in relation to calculating filling limits specified in~~ loaded in accordance with **15.5~~1~~.2**~~, where the reference temperature is the maximum temperature of the cargo upon termination of loading, during transport, or unloading specified in **15.1.4(1)**~~ is to be demonstrated by the Society, taking into account the *IMO* resolution *A*.829(19). A relevant certificate shall be permanently kept on board the ship. For the purposes of this paragraph, vent system means:

(1) the tank outlet and the piping to the ~~pressure relief valve~~PRV
(2) the ~~pressure relief valve~~PRV
(3) the piping from the ~~pressure relief valve~~PRVs to the location of discharge to the atmosphere, and including any interconnections and piping ~~which~~that joins other tanks

~~8.3 Additional Pressure Relieving System for Liquid Level Control (*IGC Code* 8.3)~~

~~8.3.1 Requirement of Additional Pressure Relieving Systems~~

~~Where required by **15.1.4(2)**, an additional pressure relieving system to prevent the tank from becoming liquid full at any time during relief under the fire exposure conditions referred to in **8.5** is to be fitted to each tank. This pressure relieving system is to consist of:~~

~~(1) one or more relief valves set at a pressure corresponding to the gauge vapour pressure of the cargo at the reference temperature defined in **15.1.4(2)**, and~~
~~(2) an override arrangement, whenever necessary, to prevent its normal operation. This arrangement is to include fusible elements designed to melt at temperatures between 98°C and 104°C and to cause relief valves specified in **(1)** to become operable. The fusible elements are to be located, in particular, in the vicinity of relief valves. The system is to become operable~~

~~upon loss of system power if provided. The override arrangement is not to be dependent on any source of ship's power.~~

~~8.3.2 Capacity of Additional Pressure Relieving Systems~~

~~The total relieving capacity of the additional pressure relieving system at the pressure mentioned in **8.3.1(1)** is not to be less than:~~

$$\cancel{Q' = FG'A^{0.82} (m^3/s)}$$

~~where:~~

~~Q' : minimum required rate of discharge of air at standard conditions of 273 K and 0.1013MPa.~~

$$\cancel{G' = \frac{12.4}{(L_h + \rho_r m)C}\sqrt{\frac{ZT'}{M}}}$$

~~with:~~

~~ρ_r : relative density of liquid phase of product at relieving conditions ($\rho_r = 1.0$ for fresh water);~~

~~m : $-di/d\rho_r$ = gradient of decrease of liquid phase enthalpy against increase of liquid phase density (kJ/kg) at relieving conditions. For set pressures not higher than 0.2MPa the values in **Table N8.1** may be used. For products not listed in the table and for higher set pressures, the value of m is to be calculated on the basis of the thermodynamic data of the product itself;~~

~~i : enthalpy of liquid (kJ/kg);~~

~~T' : temperature in kelvins (K) at relieving conditions, i.e. at the pressure at which the additional pressure relieving system is set;~~

~~F, A, L_h, C, Z and M are defined in **8.5.1(2)**~~

~~8.3.3 Changing of Set Pressure of Additional Pressure Relief Valves~~

~~Compliance with **8.3.1(1)** requires changing of the setting of the relief valves provided for in this section. This is to be accomplished in accordance with the provisions of **8.2.6** and **8.2.7**.~~

~~8.3.4 Relief Valves and Pressure Relief Valves in 8.2~~

~~Relief valves mentioned under **8.3.1(1)** above may be the same as the pressure relief valves mentioned in **8.2**, provided the setting pressure and the relieving capacity are in compliance with the requirements of this section.~~

~~8.3.5 Exhaust of Additional Pressure Relief Valves~~

~~The exhaust of such pressure relief valves may be led to the venting system referred to in **8.2.9**. If separate venting arrangements are fitted these are to be in accordance with the requirements of **8.2.9** to **8.2.15**.~~

~~Table N8.1 Factor *m*~~

~~Product~~	~~$m = -di/dp_r$ (kJ/kg)~~
~~Ammonia,anhydrous~~	~~3400~~
~~Butadiene~~	~~1800~~
~~Butane~~	~~2000~~
~~Butylenes~~	~~1900~~
~~Ethane~~	~~2100~~
~~Ethylene~~	~~1500~~
~~Methane~~	~~2300~~
~~Methyl chloride~~	~~816~~
~~Nitrogen~~	~~400~~
~~Propane~~	~~2000~~
~~Propylene~~	~~1600~~
~~Propylene oxide~~	~~1550~~
~~Vinyl chloride~~	~~900~~

~~Note:~~

~~The values in this table may be used for set pressures not higher than 0.2*MPa*.~~

8.3~~4~~ Vacuum Protection Systems (*IGC Code* 8.3~~4~~)

~~8.4.1 Omission of Vacuum Protection Systems~~

~~Cargo tanks designed to withstand a maximum external pressure differential exceeding 0.025*MPa*, and capable of withstanding the maximum external pressure differential which can be attained at maximum discharge rates with no vapour return into the cargo tanks, or by operation of a cargo refrigeration system, need no vacuum protection systems.~~

8.3.1~~4.2~~ Fitting of Vacuum Protection Systems

Cargo tanks not designed to withstand a maximum external pressure differential ~~not exceeding~~ 0.025*MPa*, or tanks ~~which~~that cannot withstand the maximum external pressure differential that can be attained at maximum discharge rates with no vapour return into the cargo tanks, or by operation of a cargo refrigeration system, or by thermal oxidation~~sending boil-off vapour to the machinery spaces~~, are to be fitted with:

(1) two independent pressure switches to sequentially alarm and subsequently stop all suction of cargo liquid or vapour from the cargo tank, and refrigeration equipment, if fitted, by suitable means at a pressure sufficiently below the maximum external designed pressure differential of the cargo tank; or

(2) vacuum relief valves with a gas flow capacity at least equal to the maximum cargo discharge rate per cargo tank, set to open at a pressure sufficiently below the external design differential pressure of the cargo tank.~~; or~~

~~(3) other vacuum protection systems acceptable to the Society.~~

8.3.2~~4.3~~ Requirements of Vacuum Relief Valves~~Protection Systems~~

Subject to the requirements of **Chapter 17** of this Part, the vacuum relief valves are to admit an inert gas, cargo vapour or air to the cargo tank and to be arranged to minimize the possibility of the entrance of water or snow. If cargo vapour is admitted, it is to be from a source other than the cargo vapour lines.

8.3.3~~4.4~~ Testing of Vacuum Protection Systems

The vacuum protection system is to be capable of being tested to ensure that it operates at the prescribed pressure.

8.4~~5~~ Sizing~~e~~ of Pressure Relieving Systems~~Valves~~ (*IGC Code* 8.4~~5~~)

8.4~~5~~.1 Sizing~~e~~ of PRVs~~Pressure Relief Valves~~

~~Pressure relief valves~~PRVs are to have a combined relieving capacity for each cargo tank to discharge the greater of the following with not more than a 20% rise in cargo tank pressure above the *MARVS*:

(1) ~~t~~The maximum capacity of the cargo tank inerting system, if the maximum attainable working pressure of the cargo tank inerting system exceeds the *MARVS* of the cargo tanks; or

(2) ~~v~~Vapours generated under fire exposure computed using the following formula:

$$Q = FGA^{0.82}\,(m^3/s)$$

where:

Q: minimum required rate of discharge of air at standard conditions of 273.15 Kelvin (*K*) and 0.1013*MPa*.

F: fire exposure factor for different cargo tank types as follows:

- $F = 1.0$ for tanks without insulation located on deck;
- $F = 0.5$ for tanks above the deck when insulation is approved by the Society. (Approval will be based on the use of a~~n approved~~ fireprooing material, the thermal conductance of insulation, and its stability under fire exposure);
- $F = 0.5$ for uninsulated independent tanks installed in holds;
- $F = 0.2$ for insulated independent tanks in holds (or uninsulated independent tanks in insulated holds);
- $F = 0.1$ for insulated independent tanks in inerted holds (or uninsulated independent tanks in inerted, insulated holds);
- $F = 0.1$ for membrane and semi-membrane tanks.

For independent tanks partly protruding through the ~~open deck~~weather decks, the fire exposure factor is to be determined on the basis of the surface areas above and below deck.

G: gas factor according to formula:

$$\cancel{G = \frac{12.4}{L_h C}\sqrt{\frac{ZT}{M}}} \quad G = \frac{12.4}{L_h D_h}\sqrt{\frac{ZT}{M}}$$

with:

T: temperature in degree ~~k~~Kelvin~~s~~ (*K*) at relieving conditions, i.e. 120% of the pressure at which the pressure relief valve is set;

L_h: latent heat of the material being vaporized at relieving conditions, in *kJ/kg*;

~~C~~ D_h: a constant based on relation of specific heats *k* and is calculated as follows~~, shown in **Table N8.2**;~~ (*k* = ratio of specific heats at relieving conditions, and the value of which is between 1 and 2.2. if *k* is not known ~~C~~D_h = 0.606 is to be used.): ~~The constant C may also be calculated by the following formula:~~

$$\cancel{C}D_h = \sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

Z: compressibility factor of the gas at relieving conditions.~~;~~ ~~i~~If not known, Z = 1~~.0~~ is to be used~~.~~; and

M: molecular mass of the product

The gas factor of each cargo to be carried is to be determined and the highest value is to be used for PRV sizing.

A : external surface area of the tank (m^2), as defined in **1.1.4(13)**, for different tank types, as shown in **Fig. N8.1**.~~:~~

~~for body-of-revolution type tanks:~~

~~A : external surface area;~~

~~for other than body-of-revolution type tanks:~~

~~A : external surface area less the projected bottom surface area;~~

~~for tanks consisting of an array of pressure vessel tanks:~~

~~-insulation on the ship's structure:~~

~~A : external surface area of the hold less its projected bottom area;~~

~~-insulation on the tank structure:~~

~~A : external surface area of the array of pressure vessels excluding insulation, less the projected bottom area as shown in **Fig. N8.1**.~~

(3) The required mass flow of air at relieving conditions is given by the formula:

$M_{air} = Q\,\rho_{air}$ (kg/s)

where:

density of air (ρ_{air}) = 1.293 kg/m^3 (air at 273.15 K, 0.1013 MPa).

8.4.2 Sizing of Vent Pipe System

Pressure losses upstream and downstream of the PRVs are to be taken into account when determining their size to ensure the flow capacity required by **8.4.1**.

8.4.3 Upstream Pressure Losses

1 The pressure drop in the vent line from the tank to the PRV inlet is not to exceed 3% of the valve set pressure at the calculated flow rate, in accordance with **8.4.1**.

2 Pilot-operated PRVs are to be unaffected by inlet pipe pressure losses when the pilot senses directly from the tank dome.

3 Pressure losses in remotely sensed pilot lines are to be considered for flowing type pilots.

8.4.4 Downstream Pressure Losses

1 Where common vent headers and vent masts are fitted, calculations are to include flow from all attached PRVs.

2 The built-up back pressure in the vent piping from the PRV outlet to the location of discharge to the atmosphere, and including any vent pipe interconnections that join other tanks, is not to exceed the following values. Alternative values provided by the PRV manufacturer may be accepted.

(1) for unbalanced PRVs, 10% of *MARVS*;

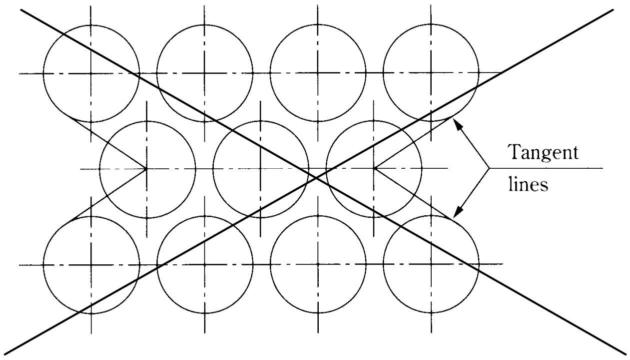
(2) for balanced PRVs, 30% of *MARVS*; and

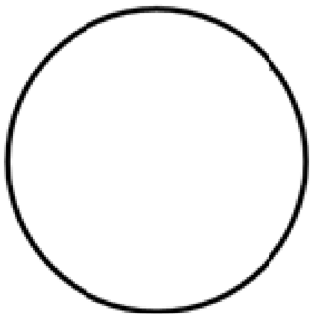
(3) for pilot operated PRVs, 50% of *MARVS*.

8.4.5 Blow-down

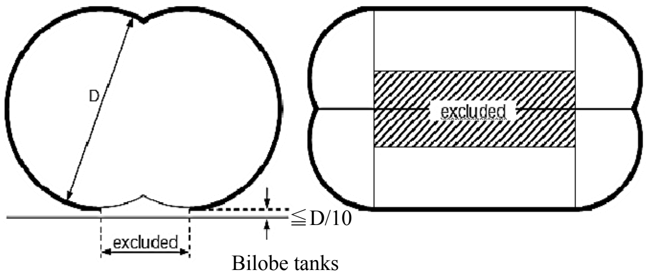
To ensure stable PRV operation, the blow-down is not to be less than the sum of the inlet pressure loss and 0.02 *MARVS* at the rated capacity.

Fig. N8.1

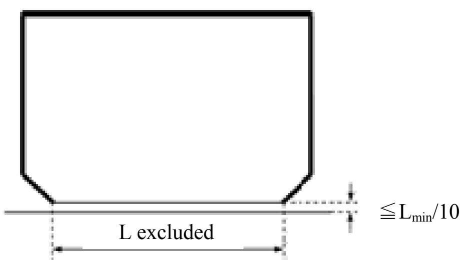




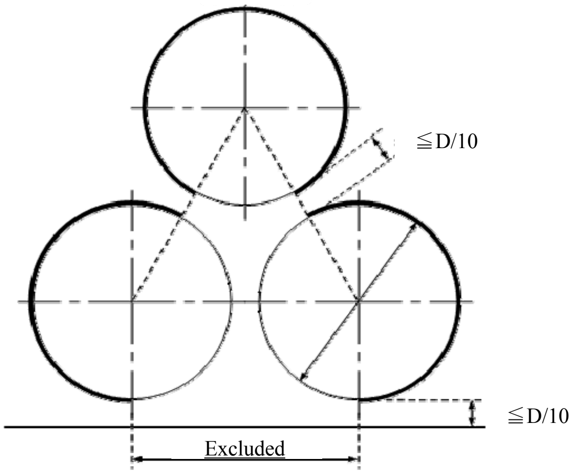
Cylindrical tanks with spherically dished, hemispherical or semi-ellipsoidal heads or spherical tanks



Bilobe tanks



Prismatic tanks



Horizontal cylindrical tanks arrangement

~~Table N8.2 Constant C~~

~~*k*~~	~~*C*~~		~~*k*~~	~~*C*~~		~~*k*~~	~~*C*~~
~~1.00~~	~~0.606~~		~~1.36~~	~~0.677~~		~~1.72~~	~~0.734~~
~~1.02~~	~~0.611~~		~~1.38~~	~~0.681~~		~~1.74~~	~~0.736~~
~~1.04~~	~~0.615~~		~~1.40~~	~~0.685~~		~~1.76~~	~~0.739~~
~~1.06~~	~~0.620~~		~~1.42~~	~~0.688~~		~~1.78~~	~~0.742~~
~~1.08~~	~~0.624~~		~~1.44~~	~~0.691~~		~~1.80~~	~~0.745~~
~~1.10~~	~~0.628~~		~~1.46~~	~~0.695~~		~~1.82~~	~~0.747~~
~~1.12~~	~~0.633~~		~~1.48~~	~~0.698~~		~~1.84~~	~~0.750~~
~~1.14~~	~~0.637~~		~~1.50~~	~~0.701~~		~~1.86~~	~~0.752~~
~~1.16~~	~~0.641~~		~~1.52~~	~~0.704~~		~~1.88~~	~~0.755~~
~~1.18~~	~~0.645~~		~~1.54~~	~~0.707~~		~~1.90~~	~~0.758~~
~~1.20~~	~~0.649~~		~~1.56~~	~~0.710~~		~~1.92~~	~~0.760~~
~~1.22~~	~~0.652~~		~~1.58~~	~~0.713~~		~~1.94~~	~~0.763~~
~~1.24~~	~~0.656~~		~~1.60~~	~~0.716~~		~~1.96~~	~~0.765~~
~~1.26~~	~~0.660~~		~~1.62~~	~~0.719~~		~~1.98~~	~~0.767~~
~~1.28~~	~~0.664~~		~~1.64~~	~~0.722~~		~~2.00~~	~~0.770~~
~~1.30~~	~~0.667~~		~~1.66~~	~~0.725~~		~~2.02~~	~~0.772~~
~~1.32~~	~~0.671~~		~~1.68~~	~~0.728~~		~~2.20~~	~~0.792~~
~~1.34~~	~~0.674~~		~~1.70~~	~~0.731~~			

8.5~~6~~ Operating Requirements

8.5~~6~~.1 Application

The provisions in **8.5~~6~~** are not related to surveys necessary ~~the conditions~~ for the maintenance of classification, but indicate those matters ~~for~~ which ~~examinations~~ are ~~required but the conditions~~ to be strictly observed by the ship~~-~~owner~~,~~ or the ship master as well as ~~or~~all other persons responsible for ~~who may concern with~~ the ship's operation.

8.5~~6~~.2 Pressure Relief Valves (related~~with reference~~ to *IGC Code* 8.2.6~~5~~)

~~A r~~Records of the actions specified in **8.2.6~~5~~**, including the set pressures of valves ~~of set pressure~~, are~~is~~ to be retained aboard the ship.

8.5.3 Changing Set Pressure of PRVs (related to *IGC Code* 8.2.7)

All valve adjustments, excluding those for relief valves whose settings are changed, are to be sealed when applying **8.2.7(2)**.

8.5.4~~6.3~~ Procedure of Changing ~~of~~ Set Pressure (related~~with reference~~ to *IGC Code* 8.2.8~~7~~)

~~The c~~Changing ~~of the~~ set pressures, in accordance with~~under the provisions of~~ **8.2.7~~6~~**, and ~~the corresponding~~ resetting ~~of the~~ alarms, in accordance with~~referred to in~~ **13.4.2~~1~~**, are to be carried out under the supervision of the ship's master in accordance with approved procedures ~~approved by the Administration~~ and as specified in the ship's operating manual. Changes in set pressure are to be recorded in the ship's log and a sign is to be posted in the cargo control room, if provided, and at each relief valve, stating the set pressure.

8.5.5 Means of Emergency Isolation of PRVs (related to *IGC Code* 8.2.9)

Emergency isolation of PRVs under the provisions of **8.2.9** is to be carried out under the supervision of the ship's master. This action is to be recorded in the ship's log and a sign posted in the cargo control room, if provided, and at the PRV. The tank is not to be loaded until the full relieving capacity is restored.

Chapter 9 has been amended as follows.

Chapter 9 ~~ENVIRONMENTAL~~ CARGO CONTAINMENT SYSTEM ATMOSPHERE CONTROL ~~(*IGC Code* CHAPTER 9)~~

9.1 ~~Environmental~~Atmosphere Control within the Cargo ~~Tanks and Cargo Piping~~Containment Systems (related to *IGC Code* 9.1)

9.1.1 ~~Gas-free and Purge~~Atmosphere Control Systems of Cargo Tanks

A piping system is to be ~~provided~~arranged to enable each cargo tank to be safely gas-freed, and to be safely ~~purged~~filled with cargo ~~gas~~vapour from a gas-free condition. The system is to be arranged to minimize the possibility of pockets of gas or air remaining after ~~gas-freeing or purging~~changing the atmosphere.

~~9.1.2 Monitoring of Purging and Gas-freeing~~

~~A sufficient number of gas sampling points is to be provided for each cargo tank in order to adequately monitor the progress of purging and gas-freeing. Gas sampling connections are to be valved and capped above the main deck.~~

9.1.~~3~~2 Inerting of Cargo Tanks

For flammable ~~gases~~ cargoes, the system is to be ~~arranged to minimize~~ designed to eliminate the possibility of a flammable mixture existing in the cargo tank during any part of the ~~gas-freeing~~ atmosphere change operation by utilizing an inerting medium as an intermediate step. ~~In addition, the system is to enable the cargo tank to be purged with an inerting medium prior to filling with cargo vapour or liquid, without permitting a flammable mixture to exist at any time within the cargo tank.~~

9.1.~~4~~3 ~~Gas-free and Purge of~~ Piping Systems

Piping systems ~~which~~that may contain flammable cargoes are to ~~be capable of being gas-freed and purged as provided in~~ comply with **9.1.1** and **9.1.~~3~~2**.

9.1.4 Monitoring of Atmosphere Change

A sufficient number of gas sampling points is to be provided for each cargo tank and cargo piping system to adequately monitor the progress of atmosphere change. Gas sampling connections are to be fitted with a single valve above the main deck, sealed with a suitable cap or blank (see **5.6.5-5**).

9.1.5 Provision of Inert Gas

Inert gas utilized in these procedures may be provided from the shore or from the ship.

9.2 ~~Environmental~~Atmosphere Control within the Hold Spaces (~~c~~Cargo ~~c~~Containment ~~s~~Systems ~~o~~Other than ~~t~~Type *C* ~~i~~Independent ~~t~~Tanks) (related to *IGC Code* 9.2)

9.2.1 ~~Environmental~~ Atmosphere Control, Requiring Full or Partial Secondary Barriers

Interbarrier and hold spaces associated with cargo containment systems for flammable gases requiring full or partial secondary barriers are to be inerted with a suitable dry inert gas and kept inerted with make-up gas provided by a shipboard inert gas generation system, or by shipboard storage, which is to be sufficient for normal consumption for at least 30 days.

9.2.2 Alternative Arrangements ~~Environmental~~of Atmosphere Control, Requiring Partial Secondary Barriers

~~1 Interbarrier and hold spaces associated with cargo containment systems for flammable gases requiring partial secondary barriers are to be inerted with suitable dry inert gas and kept inerted with make-up gas provided by a shipboard inert gas generation system or by shipboard storage which is to be sufficient for normal consumption for at least 30 days.~~

~~2~~ Alternatively, subject to the restrictions specified in **Chapter 17** of this Part, ~~the Society may allow~~ the spaces referred to in ~~-1~~**9.2.1** requiring only a partial secondary barrier ~~to~~ may be filled with dry air provided that the ship maintains a stored charge of inert gas or is fitted with an inert gas generation system sufficient to inert the largest of these spaces~~;~~, and provided that the configuration of the spaces and the relevant vapour detection systems, together with the capability of the inerting arrangements, ensures that any leakage from the cargo tanks will be rapidly detected and inerting effected before a dangerous condition can develop. Equipment for the provision of sufficient dry air of suitable quality to satisfy the expected demand is to be provided.

9.2.3 ~~Environmental~~ Atmosphere Control of Non-flammable Gases

For non-flammable gases, the spaces referred to in **9.2.1** and **9.2.2**~~-1~~ may be maintained with a suitable dry air or inert atmosphere.

~~9.2.4 Environmental Control of Internal Insulation Tanks~~

~~In case of internal insulation tanks, environmental control arrangements are not required for interbarrier spaces and spaces between the secondary barrier and the inner hull or independent tank structures completely filled with insulation materials complying with **4.9.7-2**.~~

9.3 Environmental Control of Spaces Surrounding Type *C* Independent Tanks (related to *IGC Code* 9.3)

9.3.1 Environmental Control of Spaces Surrounding Type *C* Independent Tanks

Spaces surrounding ~~refrigerated~~ cargo tanks ~~not having~~that do not have secondary barriers are to be filled with suitable dry inert gas or dry air and be maintained in this condition with make-up inert gas provided by a shipboard inert gas generation system, shipboard storage of inert gas, or with dry air provided by suitable air drying equipment. If the cargo is carried at ambient temperature, the requirement for dry air or inert gas is not applicable.

9.4 Inerting (related to *IGC Code* 9.4)

9.4.1 Properties of Inert Gas and Its Supply

Inerting refers to the process of providing a non-combustible environment ~~by the addition of compatible gases, which may be carried in storage vessels or produced on board the ship or supplied from the shore~~. ~~The i~~Inert gases are to be compatible chemically and operationally~~,~~ at all temperatures likely to occur within the spaces ~~to be inerted, with the materials of construction of the spaces~~ and the cargo. The dew points of the gases are to be taken into consideration.

9.4.2 Inert Gas for Fire-fighting

Where inert gas is also stored for fire-fighting purposes, it is to be carried in separate containers and is not to be used for cargo services.

9.4.3 Storage of Inert Gas at Low Temperature

Where inert gas is stored at temperatures below 0°C, either as a liquid or as a vapour, the storage and supply system are to be ~~so~~ designed so that the temperature of the ship's structure is not reduced below the limiting values imposed on it.

9.4.4 Prevention of the Backflow of Cargo Vapour

Arrangements ~~suitable for the cargo carried are to be provided~~ to prevent the backflow of cargo vapour into the inert gas system that are suitable for the cargo carried, are to be provided. If such plants are located in machinery spaces or other spaces outside the cargo area, two non-return valves or equivalent devices and, in addition, a removable spool piece is to be fitted in the inert gas main in the cargo area. When not in use, the inert gas system is to be made separate from the cargo system in the cargo area except for connections to the hold spaces or interbarrier spaces.

9.4.5 Isolation of Inerted Spaces

The arrangements are to be such that each space being inerted can be isolated and the necessary controls and relief valves, etc., are to be provided for controlling pressure in these spaces.

9.4.6 Insulation Spaces

Where insulation spaces are continually supplied with an inert gas as part of a leak detection system, means are to be provided to monitor the quantity of gas being supplied to individual spaces.

9.5 Inert Gas Production on Board (related to *IGC Code* 9.5)

9.5.1 Inert Gas Production Equipment

The equipment is to be capable of producing inert gas with an oxygen content at no time greater than 5% by volume, subject to the special requirements of **Chapter 17** of this Part. A continuous-reading oxygen content meter is to be fitted to the inert gas supply from the equipment and is to be fitted with an alarm set at a maximum of 5% oxygen content by volume, subject to the requirements of **Chapter 17** of this Part. ~~Additionally, where inert gas is made by an on-board process of fractional distillation of air which involves the storage of the cryogenic liquefied nitrogen for subsequent release, the liquefied gas entering the storage vessel is to be monitored for traces of oxygen to avoid possible initial high oxygen enrichment of the gas when released for inerting purposes.~~

9.5.2 Pressure Controls

An inert gas system is to have pressure controls and monitoring arrangements appropriate to the cargo containment system. ~~A means acceptable to the Society, located in the cargo area, of preventing the backflow of cargo gas is to be provided.~~

9.5.3 Spaces Containing Inert Gas ~~Generating~~Generation Plants

Spaces containing inert gas ~~generating~~generation plants are to have no direct access to accommodation spaces, service spaces or control stations, but may be located in machinery spaces. ~~If such plants are located in machinery spaces or other spaces outside the cargo area, two non-return~~

~~valves, or equivalent devices are to be fitted in the inert gas main in the cargo area as required in **9.5.2**.~~ Inert gas piping is not to pass through accommodation spaces, service spaces or control stations. ~~When not in use, the inert gas system is to be made separate from the cargo system in the cargo area except for connections to the hold spaces or interbarrier spaces.~~

9.5.4 ~~Flame Burning~~Combustion Equipment for Generating Inert Gas

~~Flame burning~~Combustion equipment for generating inert gas is not to be located within the cargo area. Special consideration may be given to the location of inert gas generating equipment using ~~the~~a catalytic combustion process.

Chapter 10 has been amended as follows.

Chapter 10 ELECTRICAL INSTALLATIONS

10.1 General

10.1.1 ~~Application~~Definition (related to *IGC Code* 10.1.~~1~~)

~~The provisions of this Chapter are applicable to ships carrying flammable products.~~For the purpose of this chapter, unless expressly provided otherwise, the definitions below are to apply.

(1) "Hazardous areas" are those areas or the spaces where flammable or explosive substances are placed and where it is likely that flammable or explosive gases or vapours will be given of by these substances.
  - (a) Zone 0: areas or spaces in which an explosive gas atmosphere is either continuously present or is present for long periods of time
  - (b) Zone 1: areas or spaces in which an explosive gas atmosphere is likely to occur under normal conditions
  - (c) Zone 2: areas or spaces in which an explosive gas atmosphere is likely to occur under abnormal conditions

(2) "Non-hazardous areas" are those areas or the spaces in which an explosive gas atmosphere is not expected to be present in quantities sufficient enough to require any special precautions be taken regarding the construction, installation and use of electrical apparatus.

~~10.1.3 Arrangements (with reference to *IGC Code* 10.1.2)~~

~~Electrical installations complying with this Chapter need not be considered as a source of ignition for the purposes of **Chapter 3**.~~

10.2 General Requirements (*IGC Code* 10.2)

10.~~1.2~~2.1 Risk of Fire and Explosion from Flammable Product ~~(with reference to *IGC Code* 10.1.2)~~

Electrical installations are to be such as to minimize risk of fire and explosion from flammable products.

10.2.2 Electrical Installations

Electrical installations are to comply with those relevant requirements given in **Chapter 4**, **Part H**.

10.~~1.4~~2.3 Restriction of Electrical Equipment in Gas-dangerous Spaces ~~(*IGC Code* 10.1.4)~~

Electrical equipment and cables are not to be installed in the ~~gas-dangerous spaces or zones~~ hazardous areas, unless it conforms to the requirements in **4.2.4**, **Part H**.

10.~~1.5~~2.4 Certified Safe Type Equipment ~~(*IGC Code* 10.1.5)~~

Where electrical equipment is installed in ~~gas-dangerous spaces or zones~~ hazardous areas as provided in **10.~~1.4~~2.3**, it is to be to the satisfaction of the Society~~, for operation in the flammable atmosphere concerned~~ and to be of approved or certified one as the ~~certified~~ safe type. Automatic isolation of non-certified equipment on detection of a flammable gas is not to be accepted as an alternative to the use of certified equipment.

10.2.5 Classification of Hazardous Areas

To facilitate the selection of appropriate electrical apparatus and the design of suitable electrical installations, hazardous areas are to be categorized in accordance with whose requirements given in **4.2.3-3**, **-4** and **-5**, **Part H**.

10.2.6 Electrical Generation and Distribution Systems

Electrical generation and distribution systems, and associated control systems are to be designed such that a single fault will not result in the loss of ability to maintain cargo tank pressures, as required by **7.8.1**, and hull structure temperature, as required by **4.19.1-6**, within normal operating limits. Failure modes and effects are to be analyzed and documented to the standard deemed appropriate by the Society.

10.2.7 Lighting System in Hazardous Areas

The lighting system in hazardous areas is to be divided between at least two branch circuits. All switches and protective devices are to interrupt all poles or phases and are to be located in non-hazardous areas.

10.2.8 Hull Fittings in Hazardous Areas

Transducers for electrical depth sounding or log devices and impressed current cathodic protection system anodes or electrodes are to be housed in gastight enclosures.

10.2.9 Submerged Cargo Pump Motors

Submerged cargo pump motors and their supply cables may be fitted in cargo containment systems. Arrangements are to be made to automatically shut down the motors in the event of low-liquid level. This may be accomplished by sensing low pump discharge pressure, low motor current or low liquid level. This shutdown is to be alarmed at the cargo control station. Cargo pump motors are to be capable of being isolated from their electrical supply during gas-freeing operations.

Chapter 11 has been amended as follows.

Chapter 11 FIRE PROTECTION AND ~~FIRE~~ EXTINCTION

11.1 Fire Safety Requirements (*IGC Code* 11.1)

11.1.1 General

The requirements for tankers in **Part R** are to apply to ships covered by this Part, irrespective of tonnage including ships of less than 500 *gross tonnage*, except those specified in **(1)** to **(4)** below. Where alternative and supplementary arrangements are provided to the satisfaction of the Society, the requirements in **Part R** need not apply to ships covered by this Part. Where alternative arrangements for inert gas systems are provided to ships covered by this Part, the requirements in **4.5.5-1, Part R** need not apply to these ships, even if these ships carry crude oil and petroleum products having a flashpoint not exceeding 60°C and other liquid products having a similar fire hazard.

(1) **1.1.1** (except **1.1.1-2**), **4.5.1-6~~ and~~, 4.5.10** and **Chapter 21, Part R** are not to apply;

(2) ~~**10.2,**~~ **10.4~~.4~~** and **10.5**(except **10.5.5**)**, Part R** are to apply, ~~regarding the ships to be~~ as they would apply to tankers of 2,000 *gross tonnage* and over;

(3) The following requirements in other Parts related to tankers are not to apply and are to be replaced by Chapters and Sections of this Part as ~~shown~~detailed in **Table N11.1**.

(4) **13.3.3** and **13.4.7**, **Part R** are to apply to ships of 500 *gross tonnage* and over.

Table N11.1

Requirements	*Replaced by*
10.10, Part R	**11.6**
4.5.1-1 and **4.5.1-2, Part R**	**Chapter 3**
4.5.5, Part R	Relevant sections in this Part
~~**4.5.5 and**~~ **10.8, Part R**	**11.3** and **11.4**
10.9, Part R	**11.5**
10.2, Part R	**11.2.1** to **11.2.4**

11.1.2 Exclusion of Ignition Source

All sources of ignition are to be excluded from spaces where flammable vapour may be present, except as otherwise provided in **Chapters 10** and **16** of this Part.

11.1.3 Application

The provisions of this section apply in conjunction with **Chapter 3** of this Part.

11.1.4 Requirement for Cargo Area

For the purposes of fire fighting, any ~~open~~ weather deck areas above cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forwardmost hold space are to be included in the cargo area.

11.2 Fire ~~Water~~ Mains ~~Equipment~~ and Hydrants (*IGC Code* 11.2)

11.2.1 Fire Pump and Fire Main

~~All ships, irrespective~~ Irrespective of size ~~and~~, ships carrying products ~~which~~that are subject to this Part are to comply with the requirements of **10.2~~, 10.4 and 10.5~~, Part R**, as applicable to cargo ships, except that the required fire pump capacity and fire main and water service pipe diameter are not to be limited by the provisions of **10.2.1-3** and **10.2.2-4(1), Part R** when ~~the~~a fire pump is used to supply ~~and fire main are used as part of~~ the water spray system, as permitted by **11.3.3** of this Part. ~~In addition, the **10.2.1-6(1), Part R** is to be met~~ The capacity of this fire pump is to be such that these areas can be protected when simultaneously supplying two jets of water from fire hoses with 19 *mm* nozzles at a pressure of at least 0.5*MPa* gauge.

11.2.2 Arrangement of Fire Main and Fire Hydrants

The arrangements are to be such that at least two jets of water can reach any part of the deck in the cargo area and those portions of the cargo containment system and tank covers that are above the deck. The necessary number of fire hydrants is to be located to satisfy the above arrangements and to comply with the requirements of **10.2.1-5** and **10.2.3-3, Part R**, with hose lengths as specified in **10.2.3-1(1)**. In addition, the requirements of **10.2.1-6(1), Part R** are to be met at a pressure of at least 0.5 *MPa* gauge.

11.2.3 Stop Valves

Stop valves are to be fitted in any crossover provided and in the fire main or mains ~~at the poop front and at intervals of not more than 40*m* between hydrants on the deck in the cargo area for the purpose of isolating damaged sections of the main~~ in a protected location, before entering the cargo area and at intervals ensuring isolation of any damaged single section of the fire main, so that **11.2.2** can be complied with using not more than two lengths of hoses from the nearest fire hydrant. The water supply to the fire main serving the cargo area is to be a ring main supplied by the main fire pumps or a single main supplied by fire pumps positioned fore and aft of the cargo area, one of which is to be independently driven.

11.2.4 Nozzles

~~All pipes, valves, nozzles and other fittings in the fire-fighting systems are to be resistant to the effects of fire and to corrosion by water~~ Nozzles are to be of a dual-purpose type (i.e. spray/jet type) incorporating a shutoff approved by the Society.

~~11.2.5 Remote Control~~

~~Where the ship's engine-room is unattended, arrangements are to be made to start and connect to the fire main at least one fire pump by remote control from the navigating bridge or other control station outside the cargo area.~~

11.2.5 Test after Installation

After installation, the pipes, valves, fittings and assembled system are to be subject to a tightness and function test.

11.3 Water Spray System (*IGC Code* 11.3)

11.3.1 Area to be Covered

On ships carrying flammable and/or toxic products ~~or both~~, a water spray system, for cooling, fire prevention and crew protection are to be installed to cover. Ships intended for operation as listed in **1.1.1-5** are to be subject to special consideration (*see* **11.3.3(2)**):

(1) exposed cargo tank domes ~~and~~, any exposed parts of cargo tanks and any part of cargo tank covers that may be exposed to heat from fires in adjacent equipment containing cargo such as exposed booster pumps/heaters/re-gasification or re-liquefaction plants, hereafter addressed as gas process units, positioned on weather decks;

(2) exposed on-deck storage vessels for flammable or toxic products;

(3) gas process units positioned on deck;

(~~3~~4) cargo liquid and vapour discharge and loading ~~manifolds~~ connections, including the presentation flange and the area ~~of their control valves and any other areas~~ where ~~essential~~their control valves are situated, ~~and~~ which are to be at least equal to the area of the drip trays provided; ~~and~~

(5) all exposed emergency shut-down (ESD) valves in the cargo liquid and vapour pipes, including the master valve for supply to gas consumers;

(~~4~~6) exposed boundaries facing the cargo area, such as bulkheads of superstructures and deckhouses normally manned, cargo ~~compressor rooms, cargo pump rooms~~ machinery spaces, store-rooms containing high fire risk items and cargo control rooms~~, all facing the cargo area~~. Exposed horizontal boundaries of these areas do not require protection unless detachable cargo piping connections are arranged above or below. Boundaries of unmanned forecastle structures not containing high fire risk items or equipment do not require water spray protection~~.~~;

(7) exposed lifeboats, liferafts and muster stations facing the cargo area, regardless of distance to cargo area; and

(8) any semi-enclosed cargo machinery spaces and semi-enclosed cargo motor room.

11.3.2 Arrangement and Capacity

1 The system is to be capable of covering all areas mentioned in **11.3.1(1) to (8)** with a uniformly distributed water ~~spray~~application rate of at least 10 $l/m^2/min$ ~~per minute~~ for the largest ~~horizontal~~ projected horizontal surfaces and 4$l/m^2/min$ ~~per minute~~ for vertical surfaces. For structures having no clearly defined horizontal or vertical surface~~s~~, the capacity of the water spray system is not to be ~~the greater of the following.~~ less than the projected horizontal surface multiplied by 10$l/m^2/min$.

2 On vertical surfaces, spacing of nozzles protecting lower areas may take account of anticipated rundown from higher areas. Stop valves are to be fitted ~~at intervals~~ in the ~~spray~~ main supply line(s) in the water spray system, at intervals not exceeding 40*m*, for the purpose of isolating damaged sections. Alternatively, the system may be divided into two or more sections ~~which~~that may be operated independently, provided the necessary controls are located together~~,~~ ~~aft of~~ in a readily accessible position outside the cargo area. A section protecting any area included in **11.3.1(1)** and **(2)** is to cover ~~the whole of~~ at least the entire athwartship tank grouping ~~which includes~~in that area. Any gas process unit(s) included in **11.3.1(3)** may be served by an independent section.

~~(1) projected horizontal surface multiplied by 10l/m^2 per minute; or~~

~~(2) actual surface multiplied by 4l/m^2 per minute.~~

11.3.3 Capacity of Water Spray Pumps

The capacity of the water spray pumps is to be ~~sufficient to deliver the required amount of water to all areas simultaneously or where the system is divided into sections, the arrangements and~~

~~capacity are to be such as to supply water simultaneously to any one section and to the surfaces specified in **11.3.1(3)** and **(4)**.~~ capable of simultaneous protection of the greater of the following:

(1) any two complete athwartship tank groupings, including any gas process units within these areas; or

(2) for ships intended for operation as listed in **1.1.~~10~~1-5**, necessary protection subject to special consideration under **11.3.1** of any added fire hazard and the adjacent athwartship tank grouping,

in addition to surfaces specified in **11.3.1(4)** to **11.3.1(8)**. Alternatively, the main fire pumps may be used for this service, provided that their total capacity is increased by the amount needed for the water spray system. In either case, a connection, through a stop valve, is to be made between the fire main and water spray system main supply line outside the cargo area.

11.3.4 Protection by the Fire Pumps

The boundaries of superstructures and deckhouses normally manned, and lifeboats, liferafts and muster areas facing the cargo area, are also to be capable of being served by one of the fire pumps or the emergency fire pump, if a fire in one compartment could disable both fire pumps.

11.3.~~4~~5 Use for Other Services

~~Subject to the approval of the Society, water~~ Water pumps normally used for other services may be arranged to supply the water spray system main supply line.

11.3.~~5~~6 Pipes, Valves, Nozzles and Other Fittings

All pipes, valves, nozzles and other fittings in the water spray system~~s~~ are to be resistant to corrosion by seawater~~, for which purpose galvanized pipe, for example, may be used, and to the effect of fire~~. Piping, fittings and related components within the cargo area (except gaskets) are to be designed to withstand 925℃. The water spray system is to be arranged with in-line filters to prevent blockage of pipes and nozzles. In addition, means are to be provided to back-flush the system with fresh water.

11.3.~~6~~7 Position of Remote Control System of Pumps and Valves

Remote starting of pumps supplying the water spray system and remote operation of any normally closed valves in the system are to be arranged in suitable locations outside the cargo area, adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the ~~areas~~ protected areas.

11.3.8 Test after Installation

After installation, the pipes, valves, fittings and assembled system are to be subject to a tightness and function test.

11.4 Dry Chemical Powder Fire-extinguishing Systems (*IGC Code* 11.4)

11.4.1 General

Ships in which the carriage of flammable products is intended are to be fitted with fixed dry chemical powder ~~type~~ fire-extinguishing systems, ~~for the purpose of fighting fire on the deck in the cargo area and bow or stern cargo handling areas if applicable. The system and the dry chemical powder are to be adequate for this purpose and satisfactory to the Society.~~ approved by the Society, for the purpose of firefighting on the deck in the cargo area, including any cargo liquid and vapour discharge and loading connections on deck and bow or stern cargo handling areas, as applicable.

11.4.2 ~~Component~~ Performance of the Systems

The system is to be capable of delivering powder from at least two hand hose lines, or a combination of monitor/hand hose lines, to any part of the ~~above-deck~~ exposed cargo ~~area including above-deck product piping~~ liquid and vapour piping, load/unload connection and exposed gas process units. ~~The system is to be activated by an inert gas such as nitrogen, used exclusively for this purpose and stored in pressure vessels adjacent to the powder containers.~~

11.4.3 Monitors and Hand Hose Lines, etc.

The ~~system for use in the cargo area is to consist of at least two independent self-contained~~ dry chemical powder fire-extinguishing system is to be designed with not less than two independent units. Any part required to be protected by **11.4.2** is to be capable of being reached from not less than two independent units with associated controls, pressurizing medium fixed piping, monitors or hand hose lines. For ships with a cargo capacity of less than 1,000m^3 only one such unit need be fitted~~, subject to approval by the Society~~. A monitor is to be ~~provided and so~~ arranged ~~as~~ to protect ~~the cargo loading and discharge manifold areas~~ any load/unload connection area and be capable of actuation and discharge both locally and remotely. The monitor is not required to be remotely aimed, if it can deliver the necessary powder to all required areas of coverage from a single position. ~~All hand hose lines and monitors are to be capable of actuation at the hose storage reel or monitor. At least one hand~~ One hose line ~~or monitor~~ is to be ~~situated~~ provided at both port and starboard side at the ~~after~~ end of the cargo area facing the accommodation and readily available from the accommodation.

~~11.4.4 Fire-extinguishing Unit~~

~~A fire-extinguishing unit having two or more monitors, hand hose lines, or combinations thereof, is to have independent pipes with a manifold at the powder container, unless a suitable alternative means is provided to ensure proper performance as approved by the Society. Where two or more pipes are attached to a unit the arrangement is to be such that any or all of the monitors and hand hose lines are to be capable of simultaneous or sequential operation at their rated capacities.~~

11.4.~~5~~4 Capacity of Monitor and Hand Hose Line

The capacity of a monitor is to be not less than 10*kg/s*. Hand hose lines are to be non-kinkable and be fitted with a nozzle capable of on/off operation and discharge at a rate not less than 3.5*kg/s*. The maximum discharge rate is to ~~be such as to~~ allow operation by one man. The length of a hand hose line is not to exceed 33 *m*. Where fixed piping is provided between the powder container and a hand hose line or monitor, the length of piping is not to exceed that length which is capable of maintaining the powder in a fluidized state during sustained or intermittent use, and which can be purged of powder when the system is shut down. Hand hose lines and nozzles are to be of weather-resistant construction or stored in weather-resistant housing or covers and be readily accessible.

11.4.~~6~~5 ~~Capacity of Dry Chemical Powder~~ Maximum Effective Distance of Hand Hose Lines

~~A sufficient quantity of dry chemical powder is to be stored in each container to provide a minimum 45 seconds discharge time for all monitors and hand hose lines attached to each powder unit. Coverage from fixed monitors is to be in accordance with the following requirements:~~

~~Capacity of fixed monitors (*kg/s*) each~~	~~10~~	~~25~~	~~45~~
~~Maximum distance of coverage (*m*)~~	~~10~~	~~30~~	~~40~~

Hand hose lines are to be considered to have a maximum effective distance of coverage equal to the length of hose. Special consideration is to be given where areas to be protected are substantially higher than the monitor or hand hose reel locations.

11.4.~~7~~6 Additional Fire-extinguishing Unit

Ships fitted with bow ~~or~~ /stern ~~loading and discharge arrangements~~ load/unload connections are to be provided with ~~an additional~~ independent dry ~~chemical~~ powder unit ~~complete with at least one monitor~~ protecting the cargo liquid and ~~one hand~~ vapour piping, aft or forward of the cargo area, by hose ~~line~~ lines and a monitor covering the bow/stern load/unload complying with the requirements of **11.4.1** to **11.4.~~6~~5**. ~~This additional unit is to be located to protect the bow or stern loading and discharge arrangements. The area of the cargo line forward or aft of the cargo area is to be protected by hand hose lines.~~

11.4.7 Special Consideration

Ships intended for operation as listed in **1.1.1-5** are to be subject to special consideration.

11.4.8 Test after installation

After installation, the pipes, valves, fittings and assembled systems are to be subjected to a tightness test and functional testing of the remote and local release stations. The initial testing is also to include a discharge of sufficient amounts of dry chemical powder to verify that the system is in proper working order. All distribution piping are to be blown through with dry air to ensure that the piping is free of obstructions.

~~11.5 Cargo Compressor and Pump Room (*IGC Code* 11.5)~~

~~11.5.1 Fixed Fire-extinguishing Installation for Cargo Compressor and Pump Rooms (*IGC Code* 11.5)~~

~~The cargo compressor and pump rooms of any ships are to be provided with a carbon dioxide system as specified in **25.2.1** and **25.2.2, Part R**. A notice is to be exhibited at the controls stating that the system is only to be used for fire-extinguishing and not for inerting purposes, due to the electrostatic ignition hazard. The alarms referred to in the requirements of **25.2.1-3(2)** are to be safe for use in a flammable cargo vapour-air mixture. For the purpose of this requirement, an extinguishing system is to be provided which would be suitable for machinery spaces. However, the amount of carbon dioxide gas carried is to be sufficient to provide a quantity of free gas equal to 45% of the gross volume of the cargo compressor and pump rooms in all cases.~~

~~11.5.2 Fire-extingushing System for the Ships Dedicated to the Carriage of a Restricted Number of Cargoes~~

~~Cargo compressor and pump rooms of ships which are dedicated to the carriage of a restricted number of cargoes are to be protected by an appropriate fire-extinguishing system approved by the Society.~~

11.5 Enclosed Spaces Containing Cargo Handling Equipment

11.5.1 Fixed Fire-extinguishing System

Enclosed spaces meeting the criteria of cargo machinery spaces in **1.1.5(9)**, and the cargo motor room within the cargo area of any ship, are to be provided with a fixed fire-extinguishing system complying with the provisions of **Chapter 22** and subsequent chapters, **Part R** and taking into account the necessary concentrations/application rate required for extinguishing gas fires.

11.5.2 Fire-extingushing System for the Ships Dedicated to the Carriage of a Restricted Number of Cargoes

Enclosed spaces meeting the criteria of cargo machinery spaces in **3.3**, within the cargo area of ships that are dedicated to the carriage of a restricted number of cargoes, are to be protected by an appropriate fire-extinguishing system for the cargo carried.

11.5.3 Protection of Turret Compartments

Turret compartments of any ship are to be protected by internal water spray, with an application rate of not less than 10 $l/m^2/min$ of the largest projected horizontal surface. If the pressure of the gas flow through the turret exceeds 4 MPa, the application rate is to be increased to 20 $l/m^2/min$. The system is to be designed to protect all internal surfaces.

11.6 Fire-fighter's Outfits

11.6.1 Number of Outfits (*IGC Code* 11.6.1)

Every ship carrying flammable products are to carry fire-fighter's outfits complying with the requirements of **10.10, Part R** as shown in **Table N11.2**.

Table N11.2

Total cargo capacity	Number of outfits
5,000m^3 and below	4
above 5,000m^3	5

11.6.2 Additional Requirements for Safety Equipment (*IGC Code* 11.6.2)

Additional requirements for safety equipment are given in **Chapter 14** of this Part.

11.6.~~2~~3 Breathing Apparatus (*IGC Code* 11.6.3)

Any breathing apparatus required as part of a fire-fighter's outfit is to be a self-contained compressed air-operated breathing apparatus having a capacity of at least 1,200 *l* of free air.

~~11.7 Operating Requirements~~

~~11.7.1 Additional Safety Equipment (*IGC Code* 11.6.2)~~

~~Additional requirements for safety equipment are given in **Chapter 14**.~~

Chapter 12 has been amended as follows.

Chapter 12 MECHANICAL VENTILATION IN THE CARGO AREA
~~(*IGC Code* CHAPTER 12)~~

12.1 Spaces Required to be Entered During Normal Cargo Handling Operations (*IGC Code* 12.1)

12.1.1 Mechanical Ventilation of Cargo Compressor and Pump Rooms

Electric motor rooms, cargo compressor and pump rooms, ~~other enclosed~~ spaces ~~which contain~~ containing cargo handling equipment and ~~similar~~ other enclosed spaces ~~in which~~ where cargo ~~handling operations are performed~~ vapours may accumulate are to be fitted with ~~mechanical~~ fixed artificial ventilation systems capable of being controlled from outside such spaces. ~~Provision is to be made to ventilate such spaces prior to entering the compartment and operating the equipment and a~~ The ventilation is to be run continuously to prevent the accumulation of toxic and/or flammable vapours, with a means of monitoring acceptable to the Society to be provided. A warning notice requiring the use of such ventilation prior to entering is to be placed outside the compartment.

12.1.2 Arrangement and Capacity of Mechanical Ventilation Inlets and Outlets

~~Mechanical~~ Artificial ventilation inlets and outlets are to be arranged to ensure sufficient air movement through the space to avoid ~~the~~ accumulation of flammable ~~or~~, toxic or asphyxiant vapours, and to ensure a safe working environment~~, but in no case the ventilation system is to have a capacity of less than 30 changes of air per hour based upon the total volume of the space. As an exception, gas-safe cargo control rooms may have eight changes of air per hour~~.

12.1.3 Capacity of Ventilation Systems

The ventilation system is to have a capacity of not less than 30 changes of air per hour, based upon the total volume of the space. As an exception, non-hazardous cargo control rooms may have eight changes of air per hour.

~~12.1.3 Type of Ventilation Systems~~

~~Ventilation systems are to be fixed and, if of the negative pressure type, permit extraction from either the upper or the lower parts of the spaces, or from both the upper and the lower parts, depending on the density of the vapours of the products carried.~~

~~12.1.4 Ventilation of Gas-safe Spaces~~

~~In rooms housing electric motors driving cargo compressors or pumps, spaces except machinery spaces containing inert gas generators, cargo control rooms if considered as gas-safe spaces and other gas-safe spaces within the cargo area, the ventilation is to be of the positive pressure type.~~

~~12.1.5 Ventilation of Gas-dangerous Spaces~~

~~In cargo compressor and pump rooms and in cargo control rooms if considered gas-dangerous, the ventilation is to be of the negative pressure type.~~

~~**12.1.6 Ventilation Exhaust Ducts from Gas-dangerous Spaces**~~

~~Ventilation exhaust ducts from gas-dangerous spaces are to discharge upwards in locations at least 10 *m* in the horizontal direction from ventilation intakes and openings to accommodation spaces, service spaces and control stations and other gas-safe spaces.~~

12.1.4 Maintenance of Overpressure

Where a space has an opening into an adjacent more hazardous space or area, it is to be maintained at an overpressure. It may be made into a less hazardous space or non-hazardous space by overpressure protection in accordance with recognized standards.

12.1.~~7~~5 Arrangement of Ventilation Ducts, Air Intakes and Outlets

Ventilation ducts, air intakes ~~are to be so arranged as to minimize the possibility of re-cycling hazardous vapours from any ventilation discharge opening~~ and exhaust outlets serving artificial ventilation systems are to be positioned in accordance with recognized standards.

12.1.~~8~~6 Ventilation Ducts ~~from Gas-dangerous Spaces~~ serving hazardous areas

Ventilation ducts ~~from gas-dangerous spaces~~ serving hazardous areas are not to be led through accommodation, service and machinery spaces or control stations, except as allowed in **Chapter 16** of this Part.

12.1.~~9~~7 Construction of Ventilation Fans

Electric motors' driving fans are to be placed outside the ventilation ducts ~~if the carriage of~~ that may contain flammable ~~products is intended~~ vapours. Ventilation fans are not to produce a source of ~~vapour~~ ignition in either the ventilated space or the ventilation system associated with the space. For hazardous areas, ~~Ventilation~~ ventilation fans and ~~fan~~ ducts, adjacent to the fans, are to be of non-sparking construction, as defined below:

Any combination of an aluminium or magnesium alloy fixed or rotating component and a ferrous fixed or rotating component, regardless of tip clearance, is considered a sparking hazard and is not to be used in these places.

(1) impellers or housing of non-metallic construction, with due regard being paid to the elimination of static electricity;
(2) impellers and housing of non-ferrous materials; ~~and~~
(3) impellers and housing of austenitic stainless steel; and
(~~3~~4) ferrous impellers and housing with design tip clearance of not less than 13*mm* ~~design tip clearance~~.

12.1.~~10~~8 Spare Parts

~~Spare parts are to be carried for each type of fan on board referred to in this Chapter~~ Where fans are required by this chapter, full required ventilation capacity for each space is to be available after failure of any single fan, or spare parts are to be provided comprising a motor, starter spares and complete rotating element, including bearings of each type.

12.1.~~11~~9 Protection Screens of Ventilation Duct Opening

Protection screens of not more than 13*mm* square mesh are to be fitted ~~in~~ to outside openings of ventilation ducts.

12.1.10 Design and Arrangement of the Ventilation

Where spaces are protected by pressurization, the ventilation is to be designed and installed in accordance with recognized standards.

12.2 Spaces not Normally Entered (*IGC Code* 12.2)

12.2.1 Ventilation of ~~Hold Spaces~~ Enclosed spaces

~~Hold spaces, interbarrier spaces, void spaces, cofferdams, spaces containing cargo piping and other spaces~~ Enclosed spaces where cargo vapours may accumulate~~,~~ are to be capable of being ventilated to ensure a safe environment when entry into ~~the spaces~~ them is necessary. This is to be capable of being achieved without the need for prior entry.

12.2.2 Capacity of Ventilation

~~Where a permanent ventilation system is not provided for such spaces, approved means of portable mechanical ventilation are to be provided. Where necessary owing to the arrangement of spaces, such as hold spaces and interbarrier spaces, essential ducting for such ventilation is to be permanently installed.~~ For permanent installations, the capacity of 8 air changes per hour is to be provided and for portable systems, the capacity of 16 air changes per hour.

12.2.3 Fans and Blowers

Fans or blowers are to be clear of personnel access openings, and are to comply with **12.1.~~9~~7**.

Chapter 13 has been amended as follows.

Chapter 13 INSTRUMENTATION AND AUTOMATION SYSTEMS ~~(GAUGING, GAS DETECTION)~~

13.1 General (*IGC Code* 13.1.1)

13.1.1 General ~~(*IGC Code* 13.1.1)~~

Each cargo tank is to be provided with means for indicating level, pressure and temperature of the cargo. Pressure gauges and temperature indicating devices are to be installed in the liquid and vapour piping systems, in cargo ~~refrigerating~~ refrigeration installations ~~and in the inert gas systems as detailed in this Chapter~~.

13.1.~~3~~2 Centralization of Control Equipment and Indicators ~~(*IGC Code* 13.1.3)~~

(Omitted)

13.1.~~4~~3 Calibration and Test of Measuring Instruments ~~(with reference to *IGC Code* 13.1.4)~~

Instruments are to be capable of being tested to ensure reliability in the working conditions and recalibrated at regular intervals. Test procedures for instruments and the intervals between recalibration are to be in accordance with manufacturer's recommendations.

13.2 Level Indicators for Cargo Tanks (*IGC Code* 13.2)

13.2.1 General

Each cargo tank is to be fitted with ~~at least one~~ liquid level gauging device(s), ~~designed to operate at pressures not less than the *MARVS* of the cargo tank and at temperatures within the cargo operating temperature range~~ arranged to ensure that a level reading is always obtainable whenever the cargo tank is operational. ~~Where only one liquid level gauge is fitted, it is to be so arranged that any necessary maintenance can be carried out while the cargo tank is in service.~~ The device(s) is to be designed to operate throughout the design pressure range of the cargo tank and at temperatures within the cargo operating temperature range. The liquid level gauges are to be of type approved by the Society.

13.2.2 Arrangement of Liquid Level Gauge

Where only one liquid level gauge is fitted, it is ti be arranged so that it can be maintained in an operational condition without the need to empty or gas-free the tank.

13.2.~~2~~3 Types of Level Indicators

Cargo tank liquid level gauges may be of the following kinds subject to any special requirement for particular cargoes shown in column "**g**" in the table of **Chapter 19** **of this Part**:

((1) to (4) are omitted.)

~~**13.2.3 Sighting Ports**~~

~~Sighting ports with a suitable protective cover and situated above the liquid level with an internal scale may be allowed by the Society as a secondary means of gauging for cargo tanks having a design vapour pressure not higher than 0.07*MPa*.~~

~~**13.2.4 Tubular Gauge Glasses**~~

~~Tubular gauge glasses are not to be fitted. Gauge glasses of the robust type as fitted on high-pressure boilers and fitted with excess flow valves may be allowed by the Society for deck tanks, subject to any provisions of **Chapter 17**.~~

13.3 Overflow Control (*IGC Code* 13.3)

13.3.1 General ~~(with reference to *IGC Code* 13.3.1)~~

Except as provided in **13.3.~~2~~4**, each cargo tank is to be fitted with a high liquid level alarm operating independently of other liquid level indicators and giving an audible and visual warning when activated.

13.3.2 Protection

(Omitted)

13.3.3 Emergency Shutdown Valve

The emergency shutdown valve referred to in **5.~~6.1~~5** and **~~5.6.3~~18.3** may be used for this purpose. If another valve is used for this purpose, the same information as referred to in **~~5.6.4~~18.3.1-2(1)(c)** is to be available on board. The level detecting devices used for high liquid level alarms and overflow control systems are to be of type approved by the Society.

13.3.~~2~~4 Omission if Automatic Shutoff ~~(*IGC Code* 13.3.2)~~

(Omitted)

13.3.5 Installation and Function Test

The position of the sensors in the tank is to be capable of being verified before commissioning. At the first occasion of full loading after delivery and after each dry-docking, testing of high-level alarms is to be conducted by raising the cargo liquid level in the cargo tank to the alarm point.

13.3.~~3~~6 Level Alarms with Electrical Circuits ~~(*IGC Code* 13.3.3)~~

~~Electrical circuits, if any, of level alarms are to be capable of being tested prior to loading.~~ All elements of the level alarms, including the electrical circuit and the sensor(s), of the high, and overfill alarms, are to be capable of being functionally tested. Systems are to be tested prior to cargo operation in accordance with **18.4.5-2**.

13.3.7 Override

Where arrangements are provided for overriding the overflow control system, they are to be such that inadvertent operation is prevented. When this override is operated, continuous visual indication is to be given at the relevant control station(s) and the navigation bridge.

13.4 Pressure <u>Monitoring</u> ~~Gauges~~ (*IGC Code* 13.4)

13.4.1 Pressure Gauges and Alarms of Cargo Tanks

The vapour space of each cargo tank is to be provided with a ~~pressure~~ <u>direct reading</u> gauge<u>.</u> ~~which is to incorporate an indicator in~~ <u>Additionally, an indirect indication is to be provided at</u> the control position required by **13.1.~~3~~<u>2</u>**. <u>Maximum and minimum allowable pressures are to be clearly indicated.</u>

<u>13.4.2 Pressure Alarms of Cargo Tanks</u>

~~In addition, a~~<u>A</u> high-pressure alarm and, if vacuum protection is required, a low-pressure alarm, are to be provided on the navigati~~ng~~<u>on</u> bridge <u>and at the control position required by **13.1.2**</u>. ~~Maximum and minimum allowable pressures are to be marked on the indicators.~~ The alarms are to be activated before the set pressures are reached.

<u>13.4.3 High-Pressure Alarm</u>

For cargo tanks fitted with ~~pressure relief valves~~ <u>PRVs</u>, which can be set at more than one set pressure in accordance with **8.2.~~6~~<u>7</u>**, high-pressure alarms are to be provided for each set pressure.

13.4.~~2~~<u>4</u> Pressure ~~Gauges~~ <u>Indication</u> of Discharge Line and Manifolds

Each cargo pump discharge line and each liquid and vapour cargo manifold are to be provided with at least one pressure ~~gauge~~ <u>indicator</u>.

13.4.~~3~~<u>5</u> Pressure ~~Gauges~~ <u>Indication</u> between Stop Valves and Hose Connection

Local-reading manifold pressure ~~gauges~~ <u>indication</u> are to be provided to indicate the pressure between ~~stop~~ <u>ship's manifold</u> valves and hose connections to the shore.

13.4.~~4~~<u>6</u> Pressure ~~Gauges~~ <u>Indication</u> of Hold Spaces and Interbarrier Spaces

Hold spaces and interbarrier spaces without open connection to the atmosphere are to be provided with pressure ~~gauges~~ <u>indication</u>.

<u>13.4.7 Indicating of Pressure Indication</u>

<u>All pressure indications provided are to be capable of indicating throughout the operating pressure range.</u>

13.5 Temperature Indicating Devices (*IGC Code* 13.5)

13.5.1 General

Each cargo tank is to be provided with at least two devices for indicating cargo temperatures, one placed at the bottom of the cargo tank and the second near the top of the tank, below the highest allowable liquid level. The ~~temperature indicating devices are to be marked to show the~~ lowest temperature for which the cargo tank has been ~~approved by the Society~~ <u>designed, as shown on the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk, is to be clearly indicated by means of a sign on or near the temperature indicating devices</u>.

<u>13.5.2 Design of Temperature Indicating Devices</u>

<u>The temperature indicating devices are to be capable of providing temperature indication across the expected cargo operating temperature range of the cargo tanks.</u>

13.5.3 Thermowells

Where thermowells are fitted, they are to be designed to minimize failure due to fatigue in normal service.

13.6 Gas Detection Requirements (*IGC Code* 13.6)

13.6.1 Application

Gas detection equipment is to be installed to monitor the integrity of the cargo containment, cargo handling and ancillary systems, in accordance with this **13.6**.

13.6.~~7~~2 Gas Detection and Alarms ~~(*IGC Code* 13.6.7)~~

A permanently installed system of gas detection and audible and visual alarms are to be ~~provided for~~ fitted in:

~~(1) cargo pump rooms;~~
~~(2) cargo compressor rooms;~~
(1) all enclosed cargo and cargo machinery spaces (including turrets compartments) containing gas piping, gas equipment or gas consumers;
~~(4) cargo control rooms unless designated as gas-safe;~~
(~~5~~2) other enclosed or semi-enclosed spaces ~~in the cargo area~~ where cargo vapours may accumulate, including hold spaces and interbarrier spaces for independent tanks other than type *C* tanks;
(~~7~~3) air-locks.
(4) spaces in gas-fired internal combustion engines, referred to in **16.7.3-3**;
(~~6~~5) ventilation hoods and gas ducts ~~where~~ required by **Chapter 16 of this Part**; and
(6) cooling/heating circuits, as required by **7.8.4**;
(7) inert gas generator supply headers; and
(~~3~~8) motor rooms for cargo handling machinery;

13.6.~~1~~3 ~~General~~Gas Detection Equipment ~~(*IGC Code* 13.6.1)~~

Gas detection equipment are to be designed, installed and tested in accordance with recognized standards acceptable to the Society and are to be suitable for the ~~gases~~ cargoes to be carried is to be provided in accordance with column "**f**" in **Table N19.1**.

13.6.4 Oxygen Deficiency Monitoring Equipment

Where indicated in column "**f**" in **Table N19.1** ships certified for carriage of non-flammable products, oxygen deficiency monitoring are to be fitted in cargo machinery spaces and cargo tank hold spaces. Furthermore, oxygen deficiency monitoring equipment is to be installed in enclosed or semi-enclosed spaces containing equipment that may cause an oxygen-deficient environment such as nitrogen generators, inert gas generators or nitrogen cycle refrigerant systems.

13.6.~~9~~5 Gas Detection Equipment for Toxic Products ~~(with reference to *IGC Code* 13.6.9)~~

In the case of products which are toxic or both toxic and flammable, ~~the Society,~~ except when column "**i**" in **Table N19.1** refers to **1~~7.9~~5.3**, ~~may authorize the use of~~ portable equipment can be used for detection of the toxic products as an alternative to a permanently installed system.

13.6.~~12~~6 Gas Detection for Toxic Gases ~~(with reference to *IGC Code* 13.6.12)~~

(Omitted)

13.6.~~8~~7 Capability of Gas Detection ~~(*IGC Code* 13.6.8)~~

~~The gas detection equipment is to be capable of sampling and analysing from each sampling head location sequentially at intervals not exceeding 30 *min*, except that in the case of gas detection for the ventilation hoods and gas ducts referred to in **13.6.7(6)** sampling is to be continuous. Common sampling lines to the detection equipment are not to be fitted.~~

Permanently installed gas detection is to be of the continuous detection type, capable of immediate response. Where not used to activate safety shutdown functions required by **13.6.9** and **Chapter 16 of this Part**, sampling type detection may be accepted.

13.6.8 Design of Sampling Type Gas Detection Equipment

When sampling type gas detection equipment is used, the following requirements are to be met:

(1) the gas detection equipment is to be capable of sampling and analysing for each sampling head location sequentially at intervals not exceeding 30 min;

(2) individual sampling lines from sampling heads to the detection equipment are to be fitted; and

~~13.6.3 Pipe Runs from Sampling Heads (*IGC Code* 13.6.3)~~

(3) Pipe runs from sampling heads are not to be led through ~~gas-safe~~ non-hazardous spaces except as permitted by **13.6.~~5~~9**.

13.6.9 Location of Gas Detection Equipment

The gas detection equipment may be located in a non-hazardous space, provided that the detection equipment such as sample piping, sample pumps, solenoids and analysing units are located in a fully enclosed steel cabinet with the door sealed by a gasket. The atmosphere within the enclosure is to be continuously monitored. At gas concentrations above 30% lower flammable limit (LFL) inside the enclosure, the gas detection equipment is to be automatically shut down.

13.6.10 Design of Sample Pipe

Where the enclosure cannot be arranged directly on the forward bulkhead, sample pipes are to be of steel or equivalent material and be routed on their shortest way. Detachable connections, except for the connection points for isolating valves required in **13.6.11** and analysing units, are not permitted.

13.6.~~5~~11 Location of Gas Detection Equipment ~~(*IGC Code* 13.6.5)~~

~~Gas detection equipment may be located in the control position required by **13.1.3**, on the navigating bridge or at other suitable locations. When such equipment is located in a gas-safe space the following conditions are to be met:~~

~~(1) gas-sampling lines are to have shutoff valves or an equivalent arrangement to prevent cross-communication with gas-dangerous spaces; and~~

~~(2) exhaust gas from the detector is to be discharged to the atmosphere in a safe location.~~

When gas sampling equipment is located in a non-hazardous space, a flame arrester and a manual isolating valve are to be fitted in each of the gas sampling lines. The isolating valve is to be fitted on the non-hazardous side. Bulkhead penetrations of sample pipes between hazardous and non-hazardous areas are to maintain the integrity of the division penetrated. The exhaust gas is to be discharged to the open air in a safe location.

13.6.~~2~~12 Positions of Fixed Sampling Heads ~~(*IGC Code* 13.6.2)~~

In every installation, the number and the positions of ~~fixed sampling~~ detection heads are to be determined with due regard to the ~~density~~ size and layout of the ~~vapours~~ compartment, the compositions and densities of the products intended to be carried and the dilution resulting from compartment purging or ventilation and stagnant areas.

13.6.~~4~~13 Location of Alarms from Gas Detection Equipment ~~(*IGC Code* 13.6.4)~~

~~Audible and visual~~ Any alarms ~~from the~~ status within a gas detection ~~equipment, if~~ system required by this section are to initiate an audible and visible alarm: ~~, are to be located on the navigating bridge, in the control position required by **13.1.3**, and at the gas detector readout location.~~

(1) on the navigation bridge;

(2) at the relevant control station(s) where continuous monitoring of the gas levels is recorded; and

(3) at the gas detector readout location.

13.6.~~11~~14 Gas Detection of Spaces Required to be Inerted ~~Cargo Containment Systems Other than Independent Tanks (*IGC Code* 13.6.11)~~

In the case of flammable products, ~~where cargo containment systems other than independent tanks are used,~~ the gas detection equipment provided for hold spaces and interbarrier spaces that are required to be ~~provided with a permanently installed gas detection system~~ inerted are to be capable of measuring gas concentrations of 0% to 100% by volume. ~~The detection equipment, equipped with audible and visual alarms, is to be capable of monitoring from each sampling head location sequentially at intervals not exceeding 30 *min*.~~

13.6.15 Design of Sample Pipe

Alarms are to be activated when the vapour concentration by volume reaches the equivalent of 30% ~~of the lower flammable limit~~ LFL in air. ~~or such other limit as may be approved by the Society in the light of particular cargo containment arrangements. Common sampling lines to the detection equipment are not to be fitted.~~

13.6.16 Alarm for Membrane Containment Systems

For membrane containment systems, the primary and secondary insulation spaces are to be able to be inerted and their gas content analysed individually. The alarm in the secondary insulation space is to be set in accordance with **13.6.15**, that in the primary space is set at a value as deemed appropriate by the Society.

13.6.~~10~~17 Alarms for the Spaces Listed in 13.6.~~7~~2 ~~(*IGC Code* 13.6.10)~~

For ~~the~~ other spaces listed in **13.6.~~7~~2**, alarms are to be activated ~~for flammable products~~ when the vapour concentration reaches 30% LFL and safety functions required by **Chapter 16 of this Part** are to be activated before the vapour concentration reaches 60% LFL ~~of the lower flammable limit~~. The crankcases of internal combustion engines that can run on gas are to be arranged to alarm before 100% LFL.

13.6.~~6~~18 Test of Gas Detection Equipment ~~(with reference to *IGC Code* 13.6.6)~~

Gas detection equipment is to be so designed that it may readily be tested. ~~Suitable equipment and span gas for~~ T~~t~~esting and calibration are to be carried ~~on board~~ out at regular intervals. Suitable equipment for this purpose is to be carried on board and be used in accordance with the manufacturer's recommendations. ~~Where practicable,~~ P~~p~~ermanent connections for such test equipment are to be fitted.

13.6.~~13~~19 Portable Gas Detection Equipment ~~(*IGC Code* 13.6.13)~~

Every ship is to be provided with at least two sets of portable gas detection equipment ~~acceptable to the Society and suitable for the products to be carried~~ that meet the requirement of **13.6.3** or an acceptable national or international standard.

13.6.~~14~~20 Measurement of Oxygen Levels ~~(*IGC Code* 13.6.14)~~

(Omitted)

13.7 Additional Requirements for Containment Systems Requiring a Secondary Barrier (*IGC Code* 13.7)

13.~~1.2~~7.1 Integrity of Barriers ~~Detection of Leakage from Primary Barrier (*IGC Code* 13.1.2)~~

(Omitted)

13.7.2 Temperature Indication Devices

~~13.5.4 Arrangement and Number of Temperature Indicating Devices~~

1 The number and position of temperature indicating devices are to be ~~to the satisfaction of the Society~~ appropriate to the design of the containment system and cargo operation requirements.

~~13.5.2 Temperature Indicating Devices of Hull Structure when a Cargo if Carried at a Temperature Lower than -55°C~~

2 When a cargo is carried in a cargo containment system with a secondary barrier at a temperature lower than -55°C, temperature indicating devices are to be provided within the insulation or on the hull structure adjacent to cargo containment systems. The devices are to give readings at regular intervals and, where applicable, audible warning of temperatures approaching the lowest for which the hull steel is suitable.

~~13.5.3 Temperature Indicating Devices of Cargo Tanks when a Cargo is Carried at a Temperature Lower than -55°C~~

3 If cargo is to be carried at temperatures lower than -55°C, the cargo tank boundaries, if appropriate for the design of the cargo containment system, are to be fitted with a sufficient number of temperature indicating devices to verify that unsatisfactory temperature gradients do not occur. ~~as follows:~~

~~(1) A sufficient number of devices to establish that an unsatisfactory temperature gradient does not occur.~~

4~~(2)~~ For the purposes of design verification and determining the effectiveness of the initial cooldown procedure on a single or series of similar ships, ~~On~~ one tank ~~a number of~~ is to be fitted with devices in excess of those required in **13.7.2-1** ~~(1) in order to verify that the initial cool down procedure is satisfactory~~. These devices may be ~~either~~ temporary or permanent~~. When~~ and only need to be fitted to the first ship, when a series of similar ships is built.~~, the second and successive ships need not comply with the requirements of this subparagraph.~~

13.8 Automation systems (*IGC Code* 13.8)

13.8.1 Application

The requirements of this section are to apply where automation systems are used to provide instrumented control, monitoring/alarm or safety functions required by this Rules.

13.8.2 Design of Automation Systems

Automation systems are to be designed, installed and tested in accordance with recognized standards deemed appropriate by the Society.

13.8.3 Design of Hardware

Hardware is to be capable of being demonstrated to be suitable for use in the marine environment by testing in accordance with **18.7, Part D of the Rules**.

13.8.4 Design of Software

Software is to be designed and documented for ease of use, including testing, operation and maintenance.

13.8.5 Interface

The user interface is to be designed such that the equipment under control can be operated in a safe and effective manner at all times.

13.8.6 Safeguard

Automation systems are to be arranged such that a hardware failure or an error by the operator does not lead to an unsafe condition. Adequate safeguards against incorrect operation are to be provided.

13.8.7 Redundancy

Appropriate segregation is to be maintained between control, monitoring/alarm and safety functions to limit the effect of single failures. This is to be taken to include all parts of the automation systems that are required to provide specified functions, including connected devices and power supplies.

13.8.8 Protection of Software

Automation systems are to be arranged such that the software configuration and parameters are protected against unauthorized or unintended change.

13.8.9 Management of Software

A management of change process is to be applied to safeguard against unexpected consequences of modification. Records of configuration changes and approvals are to be maintained on board.

13.8.10 Design of Integrated System

Processes for the development and maintenance of integrated systems are to be in accordance with recognized standards deemed appropriate by the Society. These processes are to include appropriate risk identification and management.

13.9 System integration (*IGC Code* 13.9)

13.9.1 Design

Essential safety functions are to be designed such that risks of harm to personnel or damage to the installation or the environment are reduced to a level acceptable to the Administration, both in normal operation and under fault conditions. Functions are to be designed to fail-safe. Roles and responsibilities for integration of systems are to be clearly defined and agreed by relevant parties.

13.9.2 Design of Subsystem

Functional requirements of each component subsystem are to be clearly defined to ensure that the integrated system meets the functional and specified safety requirements and takes account of any limitations of the equipment under control.

13.9.3 Risk Assessment

Key hazards of the integrated system are to be identified using appropriate risk-based techniques.

13.9.4 Reversionary Control

The integrated system is to have a suitable means of reversionary control.

13.9.5 Protection of Functionality of Other Parts

Failure of one part of the integrated system is not to affect the functionality of other parts, except for those functions directly dependent on the defective part.

13.9.6 Effectiveness of Operation

Operation with an integrated system is to be at least as effective as it would be with individual stand-alone equipment or systems.

13.9.7 Demonstration

The integrity of essential machinery or systems, during normal operation and fault conditions, is to be demonstrated.

13.~~7~~10 Operating Requirements

13.~~7~~10.1 Application

The provisions in **13.~~7~~10** are not related to surveys necessary ~~the conditions~~ for the maintenance of classification, but indicate those matters ~~for~~ which ~~examinations~~ are ~~required but the conditions~~ to be strictly observed by the ~~ship owner~~ shipowner or the~~,~~ ship master ~~or~~ as well as all other persons ~~who may concern with~~ responsible for the ship's operation.

13.~~7~~10.2 Calibration and Test of Instruments (*IGC Code* 13.1.~~4~~3)

Instruments are to be tested to ensure reliability in the working conditions and recalibrated at regular intervals. Test procedures for instruments and the intervals between recalibration are to be ~~approved by the Administration~~ in accordance with manufacturer's recommendations.

13.~~7~~10.3 Overflow Control (with reference to *IGC Code* 13.3.~~1~~3)

During loading, whenever the use of these valves specified in **13.3.~~1~~3** may possibly create a potential excess pressure surge in the loading system, ~~the port state authority may agree to~~ alternative arrangements such as limiting the loading rate~~, etc~~ are to be used.

13.~~7.5~~10.4 Gas Detection Equipments for Toxic Products (with reference to *IGC Code* 13.6.~~9~~5)

If the portable equipment for detection of toxic products specified in **13.6.~~9~~5** is used before personnel enter the spaces listed in **13.6.~~7~~2** and at 30 *min* intervals while they remain therein.

13.~~7.6~~10.5 Gas Detection for Toxic Gases (with reference to *IGC Code* 13.6.~~12~~6)

Gas from the spaces specified in **13.6.~~12~~6** is to be sampled and analysed from each sampling head location ~~by means of fixed or portable equipment at intervals not exceeding 4*h* and in any event before personnel enter the space and at 30 *min* intervals while they remain therein~~.

13.~~7.4~~10.6 Test of Gas Detection Equipment (with reference to *IGC Code* 13.6.~~6~~18)

Testing and calibration are to be carried out at regular intervals by the equipment specified in **13.6.~~6~~18**.

13.~~8~~11 Additional Requirements

13.~~8~~11.1 Installation of Gas Detection Equipment

Installation of gas detection equipment of the sampling type located outside ~~gas dangerous zones~~ non-hazardous spaces is to conform to the requirements in otherwise specified in addition to those specified in this Part.

Chapter 14 has been amended as follows.

Chapter 14 PERSONNEL PROTECTION

14.1 Protective Equipment (*IGC Code* 14.1)

1 ~~For the protection of crew members who are engaged in loading and discharging operations, the ship is to be provided on board with suitable protective equipment consisting of, special gloves with long sleeves, suitable footwear, and coveralls of which the materials are suitable for the characteristic of the product, and tight-fitting goggles or face shields or both. The protective clothing and equipment should cover all skin so that no part of the body is unprotected.~~ Suitable protective equipment, including eye protection to a recognized national or international standard, is to be provided for protection of crew members engaged in normal cargo operations, taking into account the characteristics of the products being carried.

2 Personal protective and safety equipment required in this chapter is to be kept in suitable, clearly marked lockers located in readily accessible places.

14.2 First-aid Equipment (*IGC Code* 14.2)

14.2.1 Stretcher

A stretcher that is suitable for hoisting an injured person from spaces below deck is to be kept in a readily accessible location.

14.2.2 Medical First-aid Equipment

The ship is to have onboard medical first-aid equipment, including oxygen resuscitation equipment, based on the requirements of the "*Medical First Aid Guide* (*MFAG*)" for the cargoes listed on the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk.

14.~~2~~3 Safety Equipment (*IGC Code* 14.~~2~~3)

14.~~2~~3.1 Number of Safety Equipment

Sufficient, but not less than ~~two~~ three complete sets of safety equipment is to be provided in addition to the ~~firemen~~firefighter's outfits required by **11.6.1** ~~each permitting personnel to enter and work in a gas-filled space, is to be provided~~. Each set is to provide adequate personal protection to permit entry and work in a gas-filled space. This equipment is to take into account the nature of the cargoes, listed on the International Certificate of Fitness for the Carriage of Liquified Gases in Bulk.

14.~~2~~3.2 Composition of Safety Equipment

~~One~~ Each complete set of safety equipment is to consist of:

(1) one self-contained positive pressure air-breathing apparatus incorporating full face mask, not using stored oxygen~~,~~ and having a capacity of at least 1,200*l* of free air. Each set is to be compatible with that required by **11.6.1**;

(2) protective clothing, boots~~,~~ and gloves ~~and tight-fitting goggles~~ to a recognized standard;

(3) steel-cored rescue line with belt; and
(4) explosion-proof lamp.

14.~~2~~3.3 Supply of Spare Compressed Air

An adequate supply of compressed air is to be provided and to consist ~~either~~ of:

(1) ~~the equipment consisting of:~~
~~(a)~~ at least one ~~set of~~ fully charged spare air bottle~~s~~ for each breathing apparatus required by **14.~~2~~3.1**~~:~~;
(~~b~~2) a~~n~~ ~~special~~ air compressor of adequate capacity capable of continuous operation, suitable for the supply of high-pressure air of ~~the required purity~~breathable quality; and
(~~c~~3) a charging manifold capable of dealing with sufficient spare breathing apparatus air bottles for the breathing apparatus required by ~~(b)~~**14.3.1**~~; or~~.
~~(2) fully charged spare air bottles with a total free air capacity of at least 6,000*l* for each breathing apparatus required by **14.2.1**~~.

~~14.2.4 Additional Air Supply System~~

~~In stead of the equipment required by **14.2.3**, the Society may accept a low-pressure air line system with hose connection suitable for use with the breathing apparatus required by **14.2.1**. This system is to provide sufficient high-pressure air capacity to supply, through pressure reduction devices, enough low-pressure air to enable two men to work in a gas-dangerous space for at least 1 *hour* without using the air bottles of the breathing apparatus. .Means are to be provided for recharging the fixed air bottles and the breathing apparatus air bottles from a special air compressor suitable for the supply of high-pressure air of the required purity.~~

~~14.2.5 Storage Room~~

~~Protective equipment required in **14.1** and safety equipment required in **14.2.1** are to be kept in suitable, clearly marked lockers located in readily accessible places.~~

~~14.3 First-aid Equipment (*IGC Code* 14.3)~~

~~14.3.1 Stretcher~~

~~A stretcher which is suitable for hoisting an injured person from spaces below deck is to be kept in a readily accessible location.~~

~~14.3.2 Medical First-aid Equipment~~

~~The ship is to have on board medical first-aid equipment, including oxygen resuscitation equipment and antidotes for cargoes to be carried, as deemed appropriate by the Society.~~

14.4 Personnel Protection Requirements for Individual Products (*IGC Code* 14.4)

14.4.1 Application

~~Provision~~Requirements of ~~**14.4**~~this section are ~~applicable~~to apply to ships carrying products for which those paragraphs are listed in column "***i***" in the **Table N19.1**.

14.4.2 Respiratory for Emergency Escape Purposes etc.

1 Suitable ~~R~~respiratory and eye protection ~~suitable~~ for emergency escape purposes ~~are~~is to be provided for every person on board, subject to the following (1) ~~and~~to (~~2~~3).

(1) ~~Respiratory protection is subject to the followings.~~

~~(a)~~ filter type respiratory protection is unacceptable;~~ and~~

(~~b~~2) self-contained breathing apparatus is ~~normally~~ to have at least a duration of service of ~~at least~~ 15*min*~~.~~; and

(~~2~~3) ~~E~~emergency escape respiratory protection is not to be used for fire-fighting or cargo handling purposes and is to be marked to that effect.

~~**2** Two additional sets of the above respiratory and eye protection are to be permanently located in the navigating bridge.~~

14.4.3 Decontamination Shower and Eyewash Stations

One or more ~~S~~suitably marked decontamination showers and eyewash stations are to be available on deck ~~in convenient locations~~, taking into account the size and layout of the ship. The showers and eyewashes are to be operable in all ambient conditions.

14.4.4 Protective Clothing

The protective clothing required under **14.3.2(2)** is to be gastight.

~~14.4.4 Additional Safety Equipment~~

~~In ships of a cargo capacity of 2,000m^3 and over, two complete sets of safety equipment are to be provided in addition to the equipment required by **11.6.1** and **14.2.1**. At least three spare charged air bottles are to be provided for each self-contained air-breathing apparatus required in this paragraph.~~

~~14.4.5 Refuge in an Emergency~~

~~The accommodation area to the satisfaction of the Society is to be arranged and required equipment is to be provided to protect personnel against the effects of a major cargo release.~~

~~14.4.6 Cargo Control Rooms for Highly Dangerous Products~~

~~For certain highly dangerous products, cargo control rooms are to be of the gas-safe type only.~~

14.5 Operating Requirements

14.5.1 Application

The provisions in **14.5** are not related to surveys necessary~~the conditions~~ for the maintenance of classification, but indicate those matters ~~for~~ which ~~examinations~~ are ~~required but the conditions~~ to be strictly observed by the shipowner~~,~~or the ship master as well as~~or~~all other persons ~~who may concern with~~responsible for the ship's operation.

14.5.2 Maintenance of Compressed Air Equipment (*IGC Code* 14.~~2.6~~1.3)

The compressed air equipment required in **14.~~2~~3** is to be inspected at least once a month by a responsible officer~~,~~ and the inspection recorded in the ship's log-book. The equipment is to be inspected and tested by a~~n expert~~ competent person at least once a year.

Chapter 15 has been amended as follows.

Chapter 15 FILLING LIMITS FOR CARGO TANKS

15.1 Definitions (related to *IGC Code* 15.1)

15.1.1 Filling Limit (*FL*)

Filling limit (*FL*) means the maximum liquid volume in a cargo tank relative to the total tank volume when the liquid cargo has reached the reference temperature.

15.1.2 Loading Limit (*LL*)

Loading limit (*LL*) means the maximum allowable liquid volume relative to the tank volume to which the tank may be loaded.

15.1.3 Reference Temperature

Reference temperature means (for the purposes of this chapter only):

(1) when no cargo vapour pressure/temperature control, as referred to in **Chapter 7** of this Part, is provided, the temperature corresponding to the vapour pressure of the cargo at the set pressure of the *PRV*s; and

(2) when a cargo vapour pressure/temperature control, as referred to in **Chapter 7** of this Part, is provided, the temperature of the cargo upon termination of loading, during transport or at unloading, whichever is the greatest.

15.1.4 Ambient Design Temperature

Ambient design temperature for unrestricted service means sea temperature of 32°C and air temperature of 45°C. However, lesser values of these temperatures may be accepted by the Society for ships operating in restricted areas or on voyages of restricted duration, and account may be taken in such cases of any insulation of the tanks. Conversely, higher values of these temperatures may be required for ships permanently operating in areas of high-ambient temperature.

15.2 General Requirements (related to *IGC Code* 15.2)

The maximum filling limit of cargo tanks is to be so determined that the vapour space has a minimum volume at reference temperature allowing for:

(1) tolerance of instrumentation such as level and temperature gauges;

(2) volumetric expansion of the cargo between the *PRV* set pressure and the maximum allowable rise stated in **8.4**; and

(3) an operational margin to account for liquid drained back to cargo tanks after completion of loading, operator reaction time and closing time of valves, see **5.5** and **18.3.1-2(1)(d)**.

15.3 Default Filling Limit (related to *IGC Code* 15.3)

15.3.1 Default Filling Limit

The default value for the filling limit (*FL*) of cargo tanks is 98% at the reference temperature. Exceptions to this value are to meet the requirements of **15.4**.

15.4 Determination of Increased Filling Limit (related to *IGC Code* 15.4)

15.4.1 A Filling Limit Greater than the Limit of 98%

1 A filling limit greater than the limit of 98% specified in **15.3** may be permitted under the trim and list conditions specified in **8.2.17**, providing:

(1) no isolated vapour pockets are created within the cargo tank;

(2) the *PRV* inlet arrangement is to remain in the vapour space; and

(3) allowances need to be provided for:

- (a) volumetric expansion of the liquid cargo due to the pressure increase from the *MARVS* to full flow relieving pressure in accordance with **8.4.1**;
- (b) an operational margin of minimum 0.1% of tank volume; and
- (c) tolerances of instrumentation such as level and temperature gauges.

2 In no case is a filling limit exceeding 99.5% at reference temperature to be permitted.

15.5 Maximum Loading Limit (related to *IGC Code* 15.5)

15.5.1 Maximum Loading Limit

The maximum loading limit (*LL*) to which a cargo tank may be loaded is to be determined by the following formula:

$$LL = FL\frac{\rho_R}{\rho_L}$$

where:

LL = loading limit as defined in **15.1.2**, expressed in percentage;

FL = filling limit as specified in **15.3** or **15.4** expressed in percentage;

ρ_R = relative density of cargo at the reference temperature; and

ρ_L = relative density of cargo at the loading temperature.

15.5.2 Maximum Loading Limit in Type *C* Tanks

The Society may allow type *C* tanks to be loaded according to the formula in **15.5.1** with the relative density ρ_R as defined below, provided that the tank vent system has been approved in accordance with **8.2.18**:

ρ_R = relative density of cargo at the highest temperature that the cargo may reach upon termination of loading, during transport, or at unloading, under the ambient design temperature conditions described in **15.1.4**.

This paragraph does not apply to products requiring a type 1*G* ship.

15.6 Information to be Provided to the Master

15.6.1 Document Specifing Maximum Allowable Loading Limits (*IGC Code* 15.6)

1 A document is to be provided to the ship, specifying the maximum allowable loading limits for each cargo tank and product, at each applicable loading temperature and maximum reference temperature. The information in this document is to be approved by the Administration or the Society.

2 Pressures at which the *PRV*s have been set are also to be stated in the document.

15.7 Operation Conditions

15.7.1 Application

The provisions in **15.7** are not related to surveys necessary for the maintenance of classification, but indicate those matters which are to be strictly observed by the shipowner or the ship master as well as all other persons responsible for the ship's operation.

15.7.2 Copy of document specifing maximum allowable loading limits (related to *IGC Code* 15.6.3)

A copy of the document in **15.6.1** is to be permanently kept on board by the master.

~~15.1 General (with reference to *IGC Code* 15.1)~~

~~15.1.1 Filling Plan(with reference to *IGC Code* 15.1)~~

~~No cargo tanks should have a higher filling limit (*FL*) than 98% at the reference temperature, except as permitted by **15.1.3**.~~

~~15.1.2 Loading Limit~~

~~The maximum loading limit (*LL*) to which a cargo tank may be loaded should be determined by the following formula:~~

$$\cancel{LL = FL\frac{\rho_R}{\rho_L}}$$

~~*LL* : loading limit expressed in percent which means the maximum allowable liquid volume relative to the tank volume to which the tank may be loaded~~

~~*FL* : filling limit as specified in **15.1.1** and **15.1.3**~~

~~ρ_R : relative density of cargo at the reference temperature~~

~~ρ_L : relative density of cargo at the loading temperature and pressure~~

~~15.1.3 Filling Limits Higher than 98%~~

~~The Administration may allow a higher filling limit than the limit of 98% specified in **15.1.1** at the reference temperature, taking into account the shape of the tank, arrangements of pressure relief valves, accuracy of level and temperature gauging and the difference between the loading temperature and the temperature corresponding to the vapour pressure of the cargo at the set pressure of the pressure relief valves, provided the conditions specified in **8.2.17** are maintained.~~

~~15.1.4 Reference Temperature~~

~~For the purpose of this Chapter only, "reference temperature" means:~~

~~(1) the temperature corresponding to the vapour pressure of the cargo at the set pressure of the pressure relief valves when no cargo vapour pressure/temperature control as referred to in **Chapter 7** is provided. However, where relevant vent systems for tank type *C* (excepting type 1*G* ships) are approved by the Society in accordance with **8.2.18**, the maximum temperature of the cargo upon termination of loading, during transport, or unloading under the ambient temperature condition specified in **7.1.2** may be used as mentioned temperature.~~

~~(2) the temperature of the cargo upon termination of loading, during transport, or at unloading, whichever is the greatest, when a cargo vapour pressure/temperature control as referred to in **Chapter 7** is provided. If this reference temperature would result in the cargo tank becoming liquid full before the cargo reaches a temperature corresponding to the vapour pressure of the cargo at the set pressure of the relieving system required in **8.2**, an additional pressure relieving system complying with **8.3** is to be fitted.~~

~~15.2 Information to be Provided to the Master~~

~~15.2.1 Application~~

~~The provisions in **15.2** are not the conditions for maintenance of classification for which examinations are required but the conditions to be observed by the ship owner, ship master or other persons who may concern with the ship operation.~~

~~15.2.2 List of Loading Limits (*IGC Code* 15.2)~~

~~The maximum allowable loading limits for each cargo tank are to be indicated for each product which may be carried, for each loading temperature which may be applied and for the applicable maximum reference temperature, on a list to be approved by the Administration. Pressures at which the pressure relief valves, including those valves required by **8.3**, have been set are also to be stated on the list. A copy of the list is to be permanently kept on board by the master.~~

Chapter 16 has been amended as follows.

Chapter 16 USE OF CARGO AS FUEL

16.1 General (*IGC Code* 16.1)

16.1.1 General

Except as provided for in **16.9**, ~~M~~methane (LNG) is the only cargo whose vapour or boil-off gas may be utilized in machinery spaces of category **A**, and, in ~~such~~these spaces, it may be utilized only in systems such as boilers, inert gas generators, internal combustion engines, gas combustion unit and gas turbines.

~~16.1.2 Other Use of Boil-off Gas~~

~~These provisions do not preclude the use of gas fuel for auxiliary services in other locations, provided that such other services and locations are to be subject to special consideration by the Society.~~

16.2 Use of Cargo Vapour as Fuel (*IGC Code* 16.2)

This section addresses the use of cargo vapour as fuel in systems such as boilers, inert gas generators, internal combustion engines, gas combustion units and gas turbines.

16.2.1 Fuel Systems Supplying LNG

For vaporized LNG, the fuel supply system is to comply with the requirements of **16.4.1**, **16.4.2** and **16.4.3**.

16.2.2 LNG Gas Consumers

For vaporized LNG, gas consumers are to exhibit no visible flame and are to maintain the uptake exhaust temperature below 535°C.

16.3~~2~~ Arrangement of Spaces Containing Gas Consumers~~Machinery Spaces of Category A~~ (*IGC Code* 16.3~~2~~)

16.3~~2~~.1 Mechanical Ventilation System

Spaces in which gas consumers are located~~fuel is utilized~~ are to be fitted with a mechanical ventilation system that is arranged to avoid areas where gas may accumulate, taking into account the density of the vapour and potential ignition sources~~and are to be arranged in such a way as to prevent the formation of dead spaces. Such ventilation is to be particularly effective in the vicinity of electrical equipment and machinery or of other equipment and machinery which may generate sparks~~. ~~Such a~~The ventilation system is to be separated from those ~~intended for~~serving other spaces.

16.3~~2~~.2 Gas Detectors

Gas detectors are to be fitted in these spaces, particularly ~~in the zones~~ where air circulation is reduced. The gas detection system is to comply with the requirements of **Chapter 13** of this Part.

16.3~~2~~.3 Electrical Equipment located in the Double Wall Pipe and Duct

Electrical equipment located in the double wall pipe or duct specified in **16.4.3~~3.1~~** is to comply with the requirements of **Chapter 10** of this Part~~be of the intrinsically safe type~~.

16.3.4 Vents and Bleed Lines

All vents and bleed lines that may contain or be contaminated by gas fuel are to be routed to a safe location external to the machinery space and be fitted with a flame screen.

16.4~~3~~ Gas Fuel Supply (*IGC Code* 16.4~~3~~)

16.4~~3~~.1 General~~Gas Fuel Piping~~

1 The requirements of this section are to apply to gas fuel supply piping outside of the cargo area. ~~Gas f~~Fuel piping is not to pass through accommodation spaces, service~~s~~ spaces, electrical equipment rooms or control stations. The routeing of the pipeline is to take into account potential hazards, due to mechanical damage, in areas such as stores or machinery handling areas.~~Gas fuel piping may pass through or extent into other spaces provided they fulfill one of the following:~~

~~(1) the gas fuel piping is to be a double wall piping system with the gas fuel contained in the inner pipe. The space between the concentric pipes is to be pressurized with inert gas at a pressure greater than the gas fuel pressure. Suitable alarms are to be provided to indicate a loss of inert gas pressure between the pipes; or~~

~~(2) the gas fuel piping is to be installed within a ventilated pipe or duct. The air space between the gas fuel piping and inner wall of this pipe or duct is to be equipped with mechanical exhaust ventilation having a capacity of at least 30 air changes per hour. The ventilation system is to be arranged to maintain a pressure less than the atmospheric pressure. The fan motors are to be placed outside the ventilated pipe or duct. The ventilation outlet is to be placed in a position where no flammable gas-air mixture may be ignited. The ventilation is to always be in operation when there is gas fuel in the piping. Continuous gas detection is to be provided to indicate leaks and to shut down the gas fuel supply to the machinery space in accordance with **16.3.10**. The master gas fuel valve required by **16.3.7** is to close automatically, if the required air flow is not established and maintained by the exhaust ventilation system.~~

2 Provision is to be made for inerting and gas-freeing that portion of the gas fuel piping systems located in the machinery space.

16.4.2~~3.2~~ Leak detection~~Countermeasure against Gas Leak~~

~~If a gas leak occurs, the gas fuel supply is not to be restored until the leak has been found and repaired. Instructions to this effect are to be placed in a prominent position in the machinery spaces.~~Continuous monitoring and alarms are to be provided to indicate a leak in the piping system in enclosed spaces and shut down the relevant gas fuel supply.

16.4.3 Routeing of Fuel Supply Pipes

Fuel piping may pass through or extend into enclosed spaces other than those mentioned in **16.4.1**, provided it fulfils one of the following conditions:

(1) it is of a double-wall design with the space between the concentric pipes pressurized with inert gas at a pressure greater than the gas fuel pressure. The master gas fuel valve, as required by **16.4.6**, closes automatically upon loss of inert gas pressure; or

(2) it is installed in a pipe or duct equipped with mechanical exhaust ventilation having a capacity of at least 30 air changes per hour and is arranged to maintain a pressure less than the atmospheric pressure. The mechanical ventilation is in accordance with **Chapter 12** of this Part,

as applicable. The ventilation is capable of being always in operation when there is fuel in the piping and the master gas fuel valve, as required by **16.4.6**, closes automatically if the required air flow is not established and maintained by the exhaust ventilation system. The inlet or the duct may be from a non-hazardous machinery space, and the ventilation outlet is in a safe location.

16.4.4 Requirements for Gas Fuel with Pressure greater than 1 *MPa*

1 Fuel delivery lines between the high-pressure fuel pumps/compressors and consumers are to be protected with a double-walled piping system capable of containing a high pressure line failure, taking into account the effects of both pressure and low temperature. A single-walled pipe in the cargo area up to the isolating valve(s) required by **16.4.6** is acceptable.

2 The arrangement in **16.4.3(2)** may also be acceptable providing the pipe or trunk is capable of containing a high pressure line failure, according to the requirements of **16.4.7** and taking into account the effects of both pressure and possible low temperature and providing both inlet and exhaust of the outer pipe or trunk are in the cargo area.

~~16.3.3 Terminal of Double Wall Piping System~~

~~The double wall piping system or the ventilated pipe or duct provided for the gas fuel piping is to terminate at the ventilation hood or casing required by **16.3.4**.~~

~~16.3.4 Ventilation Hood or Casing~~

~~A ventilation hood or casing is to be provided for the areas occupied by flanges, valves, etc., and for the gas fuel piping, at the gas fuel utilization units, such as boilers, diesel engines or gas turbines. If this ventilation hood or casing is not served by the exhaust ventilation fan serving the ventilated pipe or duct as specified in **16.3.1(2)**, then it is to be equipped with an exhaust ventilation system and continuous gas detection is to be provided to indicate leaks and to shut down the gas fuel supply to the machinery space in accordance with **16.3.10**. The master gas fuel valve required by **16.3.7** is to close automatically if the required air flow is not established and maintained by the exhaust ventilation system. The ventilation hood or casing is to be installed or mounted to permit the ventilating air to sweep across the gas utilization unit and be exhausted at the top of the ventilation hood or casing.~~

~~16.3.5 Ventilation Inlet and Discharge Outlet~~

~~The ventilation inlet and discharge for the required ventilation systems are to be respectively from and to a safe location.~~

16.4.5~~3.6~~ Gas Consumer Isolation~~Valves of Gas Utilization Units~~

The supply piping of each gas consumer unit is to be provided with gas fuel isolation by automatic double block and bleed, vented to a safe location, under both normal and emergency operation. The automatic valves are to be arranged to fail to the closed position on loss of actuating power. In a space containing multiple consumers, the shutdown of one is not to affect the gas supply to the others.~~Each gas utilization unit is to be provided with a set of three automatic valves. Two of these valves are to be in series in the gas fuel pipe to the consuming equipment. The third valve is to be in a pipe that vents, to a safe location in the open air, that portion of the gas fuel piping that is between the two valves in series. These valves are to be arranged so that failure of the necessary forced draught, loss of flame on boiler burners, abnormal pressure in the gas fuel supply line, or failure of the valve control actuating medium will cause the two gas fuel valves which are in series to close automatically and the vent valve to open automatically. Alternatively, the function of one of the valves in series and the vent valve can be incorporated into one valve body so arranged~~

~~that, when one of the above conditions occurs, flow to the gas utilization unit will be blocked and the vent opened. The three shut-off valves are to be arranged for manual reset.~~

~~16.3.7 Provision of Master Gas Fuel Valve~~

~~A master gas fuel valve that can be closed from within the machinery space is to be provided within the cargo area. The valve is to be arranged so as to close automatically if leakage of gas is detected, or loss of ventilation for the duct or casing or loss of pressurization of the double wall gas fuel piping occurs.~~

16.4.6 Spaces Containing Gas Consumers

1 It is to be possible to isolate the gas fuel supply to each individual space containing a gas consumer(s) or through which fuel gas supply piping is run, with an individual master valve, which is located within the cargo area. The isolation of gas fuel supply to a space is not to affect the gas supply to other spaces containing gas consumers if they are located in two or more spaces, and it is not to cause loss of propulsion or electrical power.

2 If the double barrier around the gas supply system is not continuous due to air inlets or other openings, or if there is any point where single failure will cause leakage into the space, the individual master valve for the space is to operate under the following circumstances:

(1) automatically by:
- (a) gas detection within the space;
- (b) leak detection in the annular space of a double-walled pipe;
- (c) leak detection in other compartments inside the space, containing single-walled gas piping;
- (d) loss of ventilation in the annular space of a double-walled pipe; and
- (e) loss of ventilation in other compartments inside the space, containing single-walled gas piping; and

(2) manually from within the space, and at least one remote location.

3 If the double barrier around the gas supply system is continuous, an individual master valve located in the cargo area may be provided for each gas consumer inside the space. The individual master valve is to operate under the following circumstances:

(1) automatically by:
- (a) leak detection in the annular space of a double-walled pipe served by that individual master valve;
- (b) leak detection in other compartments containing single-walled gas piping that is part of the supply system served by the individual master valve; and
- (c) loss of ventilation or loss of pressure in the annular space of a double-walled pipe; and

(2) manually from within the space, and at least one remote location.

16.4.7~~3.8~~ Piping and Ducting Construction~~Welding and Non-destructive Testing for Gas Fuel Piping in Machinery Spaces~~

Gas fuel piping in machinery spaces is to comply with **5.1~~2~~** to **5.9~~5~~**, as ~~far as found~~ applicable. The piping is to, as far as practicable, have welded joints. Those parts of the gas fuel piping~~,~~ ~~which~~that are not enclosed in a ventilated pipe or duct according to **16.4.3~~3.1~~**, and are on the ~~open deck~~weather decks outside the cargo area, are to have full penetration ~~butt welded~~butt-welded joints and are to be fully radiographed.

~~16.3.9 Inerting and Gas-freeing System for Gas Fuel Piping in Machinery Space~~

~~Provision is to be made for inerting and gas-freeing that portion of the gas fuel piping system located in the machinery space.~~

16.4.8~~3.10~~ ~~Alarm and Shut-down by~~ Gas Detection

Gas detection systems provided in accordance with the requirements of this Chapter~~**16.3.1** and **16.3.4**~~ are to ~~comply with **13.6.2** and **13.6.4** through **13.6.8** as applicable; they are to~~ activate the alarm at 30% LFL~~of the lower flammable limit~~ and shut down the master gas fuel valve ~~referred to in~~required by **16.4.6~~3.7~~** ~~before the gas concentration reaches~~at not more than 60% LFL~~of the lower flammable limit~~(See **13.6.17**).

16.5~~4~~ Gas Fuel Plants and Related Storage Tanks~~Gas Make-up Plant and Related Storage Tanks~~ (*IGC Code* 16.5~~4~~)

16.5~~4~~.1 Provision of Gas Fuel~~Arrangement~~

All equipment (heaters, compressors, vaporizers, filters, etc.) for ~~making up~~conditioning the ~~gas~~cargo and/or cargo boil off vapour for its use as fuel, and ~~the~~any related storage tanks, are to be located in the cargo area ~~in accordance with **3.1.5(4)**~~. If the equipment is in an enclosed space, the space is to be ventilated according to **12.1** and be equipped with a fixed fire-extinguishing system, according to **11.5**, and with a gas detection system according to **13.6**, as applicable.

16.5~~4~~.2 Remote Stops~~Compressors~~

1 All rotating equipment utilized for conditioning the cargo for its use as fuel is to be arranged for manual remote stop from the engine-room. Additional remote stops are to be located in areas that are always easily accessible, typically cargo control room, navigation bridge and fire control station.~~The compressors are to be capable of being remotely stopped from a position which is always and easily accessible, and also from the engine-room. In addition, the compressors are to be capable of automatically stopping when the suction pressure reaches a certain value depending on the set pressure of the vacuum relief valves of the cargo tanks. The automatic shut-down device of the compressors is to have a manual resetting. Volumetric compressors are to be fitted with pressure relief valves discharging into the suction line of the compressor. The size of the pressure relief valves are to be determined in such a way that, with the delivery valve kept closed, the maximum pressure does not exceed by more than 10% the maximum working pressure. The requirements of **5.6.1(3)** apply to these compressors.~~

2 The fuel supply equipment is to be automatically stopped in the case of low suction pressure or fire detection. Unless expressly provided otherwise, the requirements of **18.10** need not apply to gas fuel compressors or pumps when used to supply gas consumers.

16.5~~4~~.3 Heating and Cooling Mediums~~Degassing Tank~~

If the heating or cooling medium for the gas fuel ~~evaporator or heater~~conditioning system is returned to spaces outside the cargo area, ~~it is to first go through a degassing tank. The degassing tank is to be located in the cargo area. P~~provisions are to be made to detect and alarm the presence of ~~gas~~cargo/cargo vapour in the medium~~tank~~. ~~The~~Any vent outlet is to be in a safe position and fitted with an effective flame screen of an approved type.

16.5~~4~~.4 Piping and Pressure Vessels

Piping ~~and~~or pressure vessels fitted in the gas fuel ~~conditioning~~supply system are to comply with **Chapter 5** of this Part.

16.6~~5~~ Special Requirements for Main Boilers (*IGC Code* 16.6~~5~~)

~~16~~.6~~5~~.1 Arrangements~~Uptake~~

1 Each boiler is to have a separate exhaust uptake.

~~16.5.2 Forced Draught System~~

2 ~~A system suitable to ensure the~~Each boiler is to have a dedicated forced draught system~~in the boilers is to be provided~~. A crossover between boiler force draught systems may be fitted for emergency use providing that any relevant safety functions are maintained.~~The particulars of such a system are to be to the satisfaction of the Society.~~

~~16.5.3 Combustion Chambers~~

3 Combustion chambers and uptakes of boilers are to be designed to prevent any accumulation of gaseous fuel~~of suitable form such as not to present packets where gas may accumulate~~.

16.6.2~~5.4~~ Combustion Equipment~~Burner System~~

1 The burner systems are to be of dual type, suitable to burn either: oil fuel or gas fuel alone, or oil and gas fuel simultaneously. ~~Only oil fuel is to be used during manoeuvring and port operations unless automatic transfer from gas to oil burning is provided in which case the burning of a combination of oil and gas or gas alone may be permitted provided the system is demonstrated to the satisfaction of the Society. It is to be possible to change over easily and quickly from gas fuel operation to oil fuel operation. Gas nozzles are to be fitted in such a way that gas fuel is ignited by the flame of the oil fuel burner. A flame scanner is to be installed and arranged to assure that gas flow to the burner is cut off unless satisfactory ignition has been established and maintained. On the pipe of each gas burner a manually operated shut-off valve is to be fitted. An installation is to be provided for purging the gas supply piping to the burners by means of inert gas or steam, after the extinguishing of these burners.~~

2 Burners are to be designed to maintain stable combustion under all firing conditions.

3 An automatic system is to be fitted to change over from gas fuel operation to oil fuel operation without interruption of the boiler firing, in the event of loss of gas fuel supply.

4 Gas nozzles and the burner control system are to be configured such that gas fuel can only be ignited by an established oil fuel flame, unless the boiler and combustion equipment is designed and approved by recognized organization to light on gas fuel.

16.6.3 Safety

1 There are to be arrangements to ensure that gas fuel flow to the burner is automatically cut-off, unless satisfactory ignition has been established and maintained.

2 On the pipe of each gas-burner, a manually operated shut-off valve is to be fitted.

3 Provisions are to be made for automatically purging the gas supply piping to the burners, by means of an inert gas, after the extinguishing of these burners.

4 The automatic fuel changeover system required by **16.6.2-3** is to be monitored with alarms to ensure continuous availability.

~~16.5.5 Alarm Devices~~

~~Alarm devices are to be fitted in order to monitor a possible decrease in liquid fuel oil pressure or a possible failure of the related pumps.~~

~~**16.5.6 Purge System**~~

5 Arrangements are to be made that, in case of flame failure of all operating burners ~~for gas or oil or for a combination thereof~~, the combustion chambers of the boilers are automatically purged before relighting. ~~Arrangements are also to be made to enable the boilers to be manually purged.~~

6 Arrangements are to be made to enable the boilers to be manually purged.

16.7~~6~~ Special Requirements for Gas-fired Internal Combustion Engines ~~and Gas-fired Turbines~~ (*IGC Code* 16.7~~6~~)

Dual fuel engines are those that employ gas fuel (with pilot oil) and oil fuel. Oil fuels may include distillate and residual fuels. Gas only engines are those that employ gas fuel only.~~Special provisions for gas-fuelled internal combustion engines and for gas turbines will be considered by the Society in each case.~~

16.7.1 Arrangements

1 When gas is supplied in a mixture with air through a common manifold, flame arrestors are to be installed before each cylinder head.

2 Each engine is to have its own separate exhaust.

3 The exhausts are to be configured to prevent any accumulation of unburnt gaseous fuel.

4 Unless designed with the strength to withstand the worst case overpressure due to ignited gas leaks, air inlet manifolds, scavenge spaces, exhaust system and crank cases are to be fitted with suitable pressure relief systems. Pressure relief systems are to lead to a safe location, away from personnel.

5 Each engine is to be fitted with vent systems independent of other engines for crankcases, sumps and cooling systems.

16.7.2 Combustion Equipment

1 Prior to admission of gas fuel, correct operation of the pilot oil injection system on each unit is to be verified.

2 For a spark ignition engine, if ignition has not been detected by the engine monitoring system within an engine specific time after opening of the gas supply valve, this is to be automatically shut off and the starting sequence terminated. It is to be ensured that any unburnt gas mixture is purged from the exhaust system.

3 For dual-fuel engines fitted with a pilot oil injection system, an automatic system is to be fitted to change over from gas fuel operation to oil fuel operation with minimum fluctuation of the engine power.

4 In the case of unstable operation on engines with the arrangement in **-3** above when gas firing, the engine is to automatically change to oil fuel mode.

16.7.3 Safety

1 During stopping of the engine, the gas fuel is to be automatically shut off before the ignition source.

2 Arrangements are to be provided to ensure that there is no unburnt gas fuel in the exhaust gas system prior to ignition.

3 Crankcases, sumps, scavenge spaces and cooling system vents are to be provided with gas detection (See **13.6.17**).

4 Provision is to be made within the design of the engine to permit continuous monitoring of possible sources of ignition within the crank case. Instrumentation fitted inside the crankcase is to be in accordance with the requirements of **Chapter 10** of this Part.
5 A means is be provided to monitor and detect poor combustion or misfiring that may lead to unburnt gas fuel in the exhaust system during operation. In the event that it is detected, the gas fuel supply is to be shut down. Instrumentation fitted inside the exhaust system is to be in accordance with the requirements of **Chapter 10** of this Part.

16.8 Special Requirements for Gas Turbine (*IGC Code* 16.8)

16.8.1 Arrangements

1 Each turbine is to have its own separate exhaust
2 The exhausts is to be appropriately configured to prevent any accumulation of unburnt gas fuel.
3 Unless designed with the strength to withstand the worst case overpressure due to ignited gas leaks, pressure relief systems are to be suitably designed and fitted to the exhaust system, taking into consideration explosions due to gas leaks. Pressure relief systems within the exhaust uptakes are to be lead to a non-hazardous location, away from personnel.

16.8.2 Combustion Equipment

An automatic system is to be fitted to change over easily and quickly from gas fuel operation to oil fuel operation with minimum fluctuation of the engine power.

16.8.3 Safety

1 Means are to be provided to monitor and detect poor combustion that may lead to unburnt gas fuel in the exhaust system during operation. In the event that it is detected, the gas fuel supply is to be shut down.
2 Each turbine is to be fitted with an automatic shutdown device for high exhaust temperatures.

16.9 Alternative Fuels and Technologies (*IGC Code* 16.9)

16.9.1 Alternative Fuels and Technologies

1 If acceptable to the Administration, other cargo gases may be used as fuel, providing that the same level of safety as natural gas in this Part is ensured.
2 The use of cargoes identified as toxic products is not to be permitted.
3 For cargoes other than *LNG*, the fuel supply system is to comply with the requirements of **16.4.1**, **16.4.2**, **16.4.3** and **16.5**, as applicable, and is to include means for preventing condensation of vapour in the system.
4 Liquefied gas fuel supply systems are to comply with **16.4.5**.
5 In addition to the requirements of **16.4.3(2)**, both ventilation inlet and outlet are to be in a non-hazardous area external to the machinery space.

16.10 Operating Requirements

16.10.1 Application

The provisions in **16.10** are not related to surveys necessary for the maintenance of classification but indicate those matters which are to be strictly observed by the shipowner or ship master as well as all other persons responsible for the ship's operation.

16.10.2 Mechanical Ventilation of Fuel Piping (related to *IGC Code* 16.4.3)

Mechanical ventilation of pipes or ducts in which fuel piping is installed is to always be in operation when there is fuel in the piping.

16.10.3 Manual Purging of Boilers (related to *IGC Code* 16.6.3)

Combustion chambers of boilers are to be manually purged as needed in consideration of the provisions in **16.6.3**.

Chapter 17 has been amended as follows.

Chapter 17 SPECIAL REQUIREMENTS

17.1 (Omitted)

17.2 Materials of Construction (*IGC Code* 17.2)

17.2.1 Materials of Construction

Materials which may be exposed to cargo during normal operations are to be resistant to the corrosive action of the gases. In addition, the following materials of construction for cargo tanks, and associated pipelines, valves, fittings and other items of equipment <u>normally in direct contact with the cargo liquid or vapour</u> are not to be used for certain products as specified in column "**i**" in **Table N19.1**.
((1) to (6) are omitted.)

17.3 Independent Tanks (*IGC Code* 17.3)

17.3.1 (Omitted)

17.3.2 Type C Independent Tanks

Products are to be carried in type *C* independent tanks and the provisions of **7.1.~~3~~<u>2</u>** apply. The design pressure of the cargo tank is to take into account any padding pressure or vapour discharge unloading pressure.

17.4 Refrigeration Systems

17.4.1 Indirect System (*IGC Code* 17.4.1)

Only the indirect system described in **7.~~2.4(2)~~<u>3.1(2)</u>** is to be used.

17.4.2 Carriage of Products Forming Dangerous Peroxides (*IGC Code* 17.4.2)

For a ship engaged in the carriage of products which readily form dangerous peroxides, recondensed cargo is not to be allowed to form stagnant pockets of uninhibited liquid. This may be achieved either by:

(1) using the indirect system described in **7.~~2.4(2)~~<u>3.1(2)</u>** with the condenser inside the cargo tank; or

(2) using the direct system or combined system described in **7.~~2.4(1)~~<u>3.1(1)</u>** and **(3)** respectively, or the indirect system described in **7.~~2.4(2)~~<u>3.1(2)</u>** with the condenser outside the cargo tank, and designing the condensate system to avoid any places in which liquid could collect and be retained. Where this is impossible inhibited liquid is to be added upstream of such a place.

17.4.3 (Omitted)

17.5 ~~Deck Cargo Piping~~ Cargoes Requiring Type 1G Ship (*IGC Code* 17.5)

17.5.1 (Omitted)

~~17.9 Permanently Installed Toxic Gas Detectors (*IGC Code* 17.9)~~

17.~~9.1~~5.2 Gas Sampling

Gas sampling lines is not to be led into or through ~~gas-safe spaces~~ non-hazardous areas. Alarms referred to in **13.6.~~7~~2** are to be activated when the vapour concentration reaches the threshold limiting value.

17.~~9.2~~5.3 Alternative of Using Portable Equipment

The alternative of using ~~of~~ portable gas detection equipment in accordance with **13.6.~~9~~5** is not to be permitted.

17.5.4 Location of Cargo Control Room

Cargo control rooms are to be located in a non-hazardous area and, additionally, all instrumentation is to be of the indirect type.

17.5.5 Location of Protected Space

Personnel are to be protected against the effects of a major cargo release by the provision of a space within the accommodation area that is designed and equipped to the satisfaction of the Society.

17.5.6 Access to Cargo Area

Notwithstanding the requirements in **3.2.4-3**, access to forecastle spaces is not to be permitted through a door facing the cargo area, unless airlock in accordance with **3.6** is provided.

17.5.7 Access to Control Rooms and Machinery Spaces

Notwithstanding the requirements in **3.2.7**, access to control rooms and machinery spaces of turret systems is not to be permitted through doors facing the cargo area.

17.6 (Omitted)

17.7 (Omitted)

17.8 (Omitted)

17.~~10~~9 Flame Screen on Vent Outlets (*IGC Code* 17.~~10~~9)

17.~~10~~9.1 Flame Screen on Vent Outlets

Cargo tank vent outlets are to be provided with readily renewable and effective flame screens or safety heads of an approved type when carrying a cargo referenced to this Section. Due attention is to be paid in the design of flame screen and vent heads to the possibility of the blockage of these devices by the freezing of cargo vapour or by icing up in adverse weather conditions. ~~Ordinary protection screens are to be provided on board to fit after removal of the flame screens.~~ Flame screens are to be removed and replaced by protection screens, in accordance with **8.2.15**, when carrying cargoes not referenced to this section.

17.~~11~~10 Maximum Allowable Quantity of Cargo per Tank (with reference to *IGC Code* 17.~~11~~10)

17.~~11~~10.1 Maximum Allowable Quantity of Cargo per Tank

When carrying a cargo referenced to **17.1~~1~~0**, the quantity of the cargo is to be planned not to exceed 3,000m^3 in any one tank.

17.~~12~~11 ~~Submerged Electric~~ Cargo Pumps and Discharge Arrangements (with reference to *IGC Code* 17.1~~2~~1)

17.~~12~~11.1 Inerting of Vapour Spaces

(Omitted)

~~17.15 Diethyl Ether and Vinyl Ethyl Ether (*IGC Code* 17.5)~~

17.~~15.1~~11.2 Discharging of Cargo

(Omitted)

17.~~15.2~~11.3 Inert Gas Displacement for Discharging of Cargo

(Omitted)

17.~~13~~12 Ammonia (*IGC Code* 17.~~13~~12)

17.~~13~~12.1 General

Anhydrous ammonia may cause stress corrosion cracking in containment and process systems made of carbon manganese steel or nickel steel. To minimize the risk of this occurring, measures detailed in **17.1~~3~~2.2** to **17.1~~3~~2.8** are to be taken as appropriate.

17.~~13~~12.2 Provisions to use Carbon Manganese Steel

(Omitted)

17.~~13~~12.3 Heat Treatment for Carbon Manganese Steels with Higher Yield Properties

If carbon manganese steels with higher yield properties are used other than those specified in **17.~~13~~12.2**, the completed cargo tanks, piping, etc. are to be given a post weld stress relief heat treatment.

17.~~13~~12.4 Heat Treatment for Process Pressure Vessels

Process pressure vessels and piping of the condensate part of the refrigeration system are to be given a post-weld stress relief heat treatment when made of materials mentioned in **17.~~13~~12.1**.

17.~~13~~12.5 Mechanical Properties of the Welding Consumables

(Omitted)

17.~~13~~12.6 Unsuitable Materials to use

Nickel steel containing more than 5% nickel and carbon manganese steel not complying with the requirements of **17.1~~3~~2.2** and **17.1~~3~~2.3** are particularly susceptible to ammonia stress corrosion cracking and are not to be used for containment and piping systems for the carriage of this product.

17.~~13~~12.7 Provisions to use Nickel Steel Containing not more than 5% Nickel

Nickel steel containing not more than 5% nickel may be used provided the carriage temperature complies with the requirements specified in **17.1~~3~~2.2(3)**.

17.~~13~~12.8 Dissolved Oxygen Content

(Omitted)

Table N17.1 (Omitted)

17.~~14~~13 Chlorine

17.~~14~~13.1 Cargo Containment System (with reference to *IGC Code* 17.~~14~~13.1)

(-1 is omitted.)

2 The tank design vapour pressure is not to be less than 1.35*MPa* (*See also* **7.1.~~3~~2** *and* **17.3.2**).

(-3 to -5 are omitted.)

17.~~14~~13.2 Cargo Piping Systems (*IGC Code* 17.~~14~~13.2)

1 Cargo discharge is to be performed by means of compressed chlorine vapour from shore, dry air or another acceptable gas or fully submerged pumps. Cargo discharge compressors on board ships are not to be used for this. The pressure in the vapour space of the tank during discharging is not to exceed 1.05*MPa* gauge. ~~Cargo discharge compressors on board ships are not to be accepted by the Society.~~

(-2 is omitted.)

3 Relief valves of the cargo piping system are to discharge to the absorption plant ~~(*See also* **8.2.16**)~~, and the flow restriction created by this unit is to be taken into account when designing the relief valve system (*see* **8.4.3** and **8.4.4**).

17.~~14~~13.3 Materials (*IGC Code* 17.~~14~~13.3)

(Omitted)

17.~~14~~13.4 Instrumentation, Safety Devices (with reference to *IGC Code* 17.~~14~~13.4)

(-1 and -2 are omitted.)

3 A gas detecting system is to be provided capable of monitoring chlorine concentrations of at least 1 *ppm* by volume. ~~Suction~~ Sample points are to be located:

The gas detection system is to be provided with an audible and visual alarm with a set point of 5

ppm.
((1) to (4) are omitted.)
(5) on deck at the forward end, in the middle and at the after end of the cargo area. ~~(~~This is ~~O~~only required to be used during cargo handling and gasfreeing operations.~~)~~
(-4 is omitted.)

17.~~14~~13.5 Personnel Protection (*IGC Code* 17.~~14~~13.5.1)
1 The ~~enclosed~~ space required by **~~14.4.5~~17.5.5** is to be easily and quickly accessible form the ~~open~~ whether deck and from accommodation spaces by means of air locks, and is to be capable of being rapidly closed gastight. ~~Access to this space from the deck and from the accommodation spaces is to be by means of an air-lock.~~
2 One of the decontamination showers required by **14.4.3** is to be located near the weather deck airlock to the space.
3 The space referred to in **-1** is to be so designed as to accommodate the entire crew of the ship and to be provided with a source of uncontaminated air for a period of not less than 4 *hours*. ~~One of the decontamination showers required by **14.4.3** is to be located near the air-lock to the space.~~
~~**2** A compressor and the necessary equipment for filling the air bottles are to be provided.~~
~~3~~4 One set of oxygen therapy equipment is to be carried in the refuge space referred to in **-1.**

17.~~14~~13.6 Filling Limits for Cargo Tanks (with reference to *IGC Code* 17.~~14~~13.6)
1 The requirements of **15.1.~~4~~3(2)** do not apply when it is intended to carry chlorine.
(-2 is omitted.)

17.~~16~~14 Ethylene Oxide

17.~~16~~14.1 Application (*IGC Code* 17.~~16~~14.1)
For the carriage of ethylene oxide the requirements of **17.~~20~~18** apply, with the additions and modifications as given in this section.

17.~~16~~14.2 Use of Deck Tanks (with reference to *IGC Code* 17.~~16~~14.2)
(Omitted)

17.~~16~~14.3 Materials (*IGC Code* 17.~~16~~14.3)
(Omitted)

17.~~16~~14.4 Cleaning of Tanks (with reference to *IGC Code* 17.~~16~~14.4)
(Omitted)

17.~~16~~14.5 Discharging (*IGC Code* 17.~~16~~14.5)
Ethylene oxide is to be discharged only by deepwell pumps or inert gas displacement. The arrangement of pumps is to comply with **17.~~20.5-3~~18.5**.

17.~~16~~14.6 Temperature Control (with reference to *IGC Code* 17.~~16~~14.6)
(Omitted)

17.~~16~~14.7 Set Pressure of Relief Valves (*IGC Code* 17.~~16~~14.7)
(Omitted)

17.~~16~~14.8 Nitrogen Concentration in the Vapour Space (with reference to *IGC Code* 17.~~16~~14.8)

System of the protective padding of nitrogen gas as required by **17.~~20.15~~18.14** is to be such that the nitrogen concentration in the vapour space of the cargo tank will at not time be less than 45% by volume.

17.~~16~~14.9 Inerting of Cargo Tanks (with reference to *IGC Code* 17.~~16~~14.9)

A system is to be provided to inert the cargo tanks with nitrogen.

17.~~16~~14.10 Operation of Water Spray System (*IGC Code* 17.~~16~~14.10)

The water spray system required by **17.~~20.17~~18.29** and that required by **11.3** is to operate automatically in a fire involving the cargo containment system.

17.~~16~~14.11 Emergency Jettisoning Arrangement (*IGC Code* 17.~~16~~14.11)

(Omitted)

17.~~17~~15 ~~Isopropylamine and Monoethylamine~~ Separate piping systems ~~(*IGC Code* 17.17)~~

17.~~17~~15.1 Separation of Piping Systems (*IGC Code* 17.15)

Separate piping systems, as defined in **1.1.4(43)**, are to be provided.

17.~~18~~16 Methyl Acetylene-Propadiene Mixtures

17.~~18~~16.1 Stabilization for Transport (with reference to *IGC Code* 17.1~~8~~6.1)

The requirements in **17.1~~8~~6** are applicable to methyl acetylene-propadiene mixtures that are suitably stabilized for transport.

17.~~18~~16.2 Examples of Acceptable Stabilized Compositions (*IGC Code* 17.1~~8~~6.2)

(Omitted)

17.~~18~~16.3 Other Compositions (with reference to *IGC Code* 17.1~~8~~6.3)

A ship carrying other compositions than those specified in **17.1~~8~~6.2** is to be to the satisfaction of the Society.

17.~~18~~16.4 Refrigeration System (*IGC Code* 17.1~~8~~6.4)

~~A ship carrying methyl acetylene-propadiene mixtures is to preferably have an indirect refrigeration system as specified in **7.2.4(2)**. Alternatively, a ship not provided with indirect refrigeration may utilize direct vapour compression refrigeration subject to pressure and temperature limitations depending on the composition.~~ If a ship has a direct vapour compression refrigeration system, this is to comply with the following requirements, subject to pressure and temperature limitations depending on the composition. For the example compositions given in **17.1~~8~~6.2**, the following features are to be provided:

((1) and (2) are omitted.)

(3) The relief valve required by **(2)(c)** is to vent to a mast meeting the requirements of ~~**8.2.9**,~~ **8.2.10**, **8.2.1~~3~~1** and **8.2.14~~5~~** and is not to relieve into the compressor suction line.

((4) is omitted.)

17.~~18~~16.5 Segregation of Piping Systems (*IGC Code* 17.1~~8~~6.5)

The piping system, including the cargo refrigeration system, for tanks to be loaded with methyl acetylene-propadiene mixtures is to be either independent (as defined in **1.1.4(27)**) or separate (as defined in **1.1.4(43)**) from piping and refrigeration systems for other tanks. This segregation applies to all liquid and vapour vent lines and any other possible connections, such as common inert gas supply lines.

17.~~19~~17 Nitrogen ~~(*IGC Code* 17.19)~~

17.~~19~~17.1 Effect of High Oxygen Concentrations (*IGC Code* 17.17)

(Omitted)

17.~~20~~18 Propylene Oxide and Mixtures of Ethylene Oxide-Propylene Oxide with Ethylene Oxide Content of not more than 30% by Weight

17.~~20~~18.1 General (with reference to *IGC Code* 17.~~20~~18.1)

The provisions of **17.~~20~~18** are applicable to acethylene-free products.

17.~~20~~18.2 Cargo Tanks

1 (with reference to *IGC Code* 17.~~20.2.2~~18.3)
(Omitted)

2 (with reference to *IGC Code* 17.~~20.2.3~~18.4)
(Omitted)

3 (with reference to *IGC Code* 17.~~20.2.4~~18.5)
(Omitted)

4 (*IGC Code* 17.~~20.2.5~~18.6)
(Omitted)

5 (with reference to *IGC Code* 17.~~20.2.6~~18.7)
(Omitted)

17.~~20~~18.3 Valves, Flanges, Fittings, etc. (*IGC Code* 17.~~20.3~~18.8 to 11)

(Omitted)

17.~~20~~18.4 Filling and Discharge Piping (*IGC Code* 17.~~20.4~~18.12)

(Omitted)

17.~~20~~18.5 Loading and Discharging of Products (with reference to *IGC Code* 17.~~20.5~~18.13 to 15)

(Omitted)

17.~~20~~18.6 Ventilation of Cargo Tanks (*IGC Code* 17.~~20.6~~18.16)

(Omitted)

17.~~20~~18.7 Cargo Hoses (*IGC Code* 17.~~20.7~~18.17)

(Omitted)

17.~~20~~18.8 Monitoring of Hold Spaces (*IGC Code* 17.~~20.8~~18.18)

Hold spaces are to be monitored for these products. Hold spaces surrounding type *A* and *B* independent tanks are also to be inerted and monitored for oxygen. The oxygen content of these spaces is to be maintained below 2% by volume. Portable sampling equipment is satisfactory.

17.~~20~~18.9 Disconnection of Shorelines (*IGC Code* 17.~~20.9~~18.19)

(Omitted)

17.~~20~~18.10 Maximum Design Pressure of Cargo Tanks (*IGC Code* 17.~~20.10~~18.20)

(Omitted)

17.~~20~~18.11 Design Vapour Pressure (*IGC Code* 17.~~20.11~~18.21)

Tanks for the carriage of propylene oxide with a design vapour pressure of less than 0.06*MPa* and tanks for the carriage of ethylene oxide-propylene oxide mixtures with a design vapour pressure of less than 0.12*MPa* are to have a cooling system to maintain the cargo below the reference temperature. For reference temperature see **15.1.~~4(1)~~3**.

17.~~20~~18.12 Set Pressure of Pressure Relief Valves (*IGC Code* 17.~~20.12~~18.22)

(Omitted)

17.~~20~~18.13 Separation of Cargo Piping Systems ~~(*IGC Code* 17.20.13.1)~~

1 (with reference to *IGC Code* 17.18.23)

(Omitted)

2 (with reference to *IGC Code* 17.~~20.13.2~~18.24)

(Omitted)

~~**17.20.14 List of Maximum Allowable Tank Loading Limits (with reference to *IGC Code* 17.20.14)**~~

~~A copy of the list is to be permanently kept on board.~~

17.~~20.15~~18.14 Padding Nitrogen Gas (with reference to *IGC Code* 17.~~20.15~~18.27)

(Omitted)

17.~~20.16~~18.15 Oxygen Content of Vapour Space (with reference to *IGC Code* 17.~~20.16~~18.28)

(Omitted)

17.~~20.17~~18.16 Water Spray System (with reference to *IGC Code* 17.~~20.17~~18.29 to 31)

1 A water spray system of sufficient capacity is to be provided to blanket effectively the area surrounding the loading manifold, the exposed deck piping associated with product handling and the tank domes. The arrangement of piping and nozzles is to be such as to give a uniform distribution rate of 10l/m^2 per minute. The arrangement is to ensure that any spilled cargo is washed away.

2 The water spray system is to be capable ~~to both~~ of local and remote manual operation ~~and the arrangement is to ensure that any spilled~~ in case of a fire involving the cargo containment system ~~is washed away~~. Remote manual operation are to be arranged such that remote starting of pumps supplying water spray system and remote operation of any normally closed valves in the system can be carried out from a suitable location outside the cargo area, adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the areas protected.

17.~~21~~19 Vinyl Chloride (with reference to *IGC Code* 17.~~21~~19)

17.~~21~~19.1 Consideration for Carriage of Product

In cases where polymerization of vinyl chloride is prevented by addition of an inhibitor, **17.8** is applicable. In cases where no ~~or insufficient~~ inhibitor has been added, or the inhibitor concentration is insufficient, any inert gas used for the purposes of **17.6** is to contain not more oxygen than 0.1% by volume. A system is to be provided to analyse inert gas samples from the tanks and piping before loading is started. When vinyl chloride is carried, ~~the tanks are to be able to maintain~~ a positive pressure is always to be maintained in the tanks and~~, also~~ during ballast voyages between successive carriages.

17.20 Mixed *C*4 Cargoes (with reference to *IGC Code* 17.20)

17.20.1 Carriage of Mixed Cargoes

Cargoes that may be carried individually under the requirements of this Rule, notably butane, butylenes and butadiene, may be carried as mixtures subject to the provisions of this section. These cargoes may variously be referred to as “Crude *C*4”, “Crude butadiene”, “Crude steam-cracked *C*4”, “Spent steam-cracked *C*4”, “*C*4 stream”, “*C*4 raffinate”, or may be shipped under a different description. In all cases, the material safety data sheets (MSDS) are to be consulted as the butadiene content of the mixture is of prime concern as it is potentially toxic and reactive. While it is recognized that butadiene has a relatively low vapour pressure, if such mixtures contain butadiene they are to be regarded as toxic and the appropriate precautions applied.

17.20.2 Application of Inhibitor

If the mixed *C*4 cargo shipped under the terms of this section contains more than 50% (mole) of butadiene, the inhibitor precautions in **17.8** are to apply.

17.20.3 Liquid Expansion Coefficient of Mixed Cargoes

Unless specific data on liquid expansion coefficients is given for the specific mixture loaded, the filling limit restrictions of **Chapter 15 of this Part** are to be calculated as if the cargo contained 100% concentration of the component with the highest expansion ratio.

17.21 Carbon Dioxide: High Purity (with reference to *IGC Code* 17.21)

17.21.1 Triple Point

The set pressure for the alarms and automatic actions described in this section are to be set to at least 0.05 *MPa* above the triple point for the specific cargo being carried. The "triple point" for pure carbon dioxide occurs at 0.5 *MPa* gauge and -54.4°*C*.

17.21.2 Relief Valve

There is a potential for the cargo to solidify in the event that a cargo tank relief valve, fitted in accordance with **8.2**, fails in the open position. To avoid this, a means of isolating the cargo tank safety valves is to be provided and the requirements of **8.2.9(2)** do not apply when carrying this carbon dioxide. Discharge piping from safety relief valves is to be designed so they remain free from obstructions that could cause clogging. Protective screens are not to be fitted to the outlets of relief valve discharge piping, so the requirements of **8.2.15** do not apply.

17.21.3 Discharge Piping

Discharge piping from safety relief valves are not required to comply with **8.2.10**, but is to be designed so they remain free from obstructions that could cause clogging. Protective screens are not to be fitted to the outlets of relief valve discharge piping, so the requirements of **8.2.15** do not apply.

17.21.4 Pressure Monitoring

Cargo tanks are to be continuously monitored for low pressure when a carbon dioxide cargo is carried. An audible and visual alarm is to be given at the cargo control position and on the bridge. If the cargo tank pressure continues to fall to within 0.05 *MPa* of the "triple point" for the particular cargo, the monitoring system is to automatically close all cargo manifold liquid and vapour valves and stop all cargo compressors and cargo pumps. The emergency shutdown system required by **18.3** may be used for this purpose.

17.21.5 Materials for Cargo Tank and Cargo Piping System

All materials used in cargo tanks and cargo piping system are to be suitable for the lowest temperature that may occur in service, which is defined as the saturation temperature of the carbon dioxide cargo at the set pressure of the automatic safety system described in **17.21.1**.

17.21.6 Continuous Monitoring

Cargo hold spaces, cargo compressor rooms and other enclosed spaces where carbon dioxide could accumulate are to be fitted with continuous monitoring for carbon dioxide build-up. This fixed gas detection system replaces the requirements of **13.6**, and hold spaces are to be monitored permanently even if the ship has type *C* cargo containment.

17.22 Carbon Dioxide: Reclaimed Quality

17.22.1 Carbon Dioxide: Reclaimed Quality (with reference to *IGC Code* 17.22)

The requirements of **17.21** also apply to this cargo. In addition, the materials of construction used in the cargo system are also to take account of the possibility of corrosion, in case the reclaimed quality carbon dioxide cargo contains impurities such as water, sulphur dioxide, etc., which can cause acidic corrosion or other problems.

17.~~22~~23 Operating Requirements

17.~~22~~23.1 Application

The provisions in **17.2~~2~~3** are not related to surveys necessary ~~the conditions~~ for the maintenance of classification, but indicate those matters ~~for~~ which ~~examinations~~ are ~~required but the conditions~~ to be strictly observed by the ~~ship owner~~ shipowner or the~~,~~ ship master ~~or~~ as well as all other persons ~~who may concern with~~ responsible for the ship's operation.

17.~~22~~23.2 Refrigeration Systems (with reference to *IGC Code* 17.4.3)

(Omitted)

17.~~22~~23.3 Exclusion of Air from Vapour Spaces (with reference to *IGC Code* 17.~~1~~6)

(Omitted)

17.~~22~~23.4 Inhibition (with reference to *IGC Code* 17.8)

Care is to be taken to ensure that the cargo is sufficiently inhibited to prevent self-reaction (e.g. polymerization or dimerization) at all times during the voyage. Ships are to be provided with a certificate specified in **17.8.1**.

17.~~22~~23.5 Flame Screens on Vent Outlets (with reference to *IGC Code* 17.~~10~~9)

~~Ordinary protection screens are to be fitted after removal of the flame screens required in **17.10**~~ Flame screens are to be removed and replaced by protection screens, in accordance with **8.2.15**, when carrying cargoes not referenced to **17.9**.

17.~~22~~23.6 Maximum Allowable Quantity of Cargo per Tank (*IGC Code* 17.~~11.1~~10)

When carrying a cargo referenced to **17.~~11~~10**, the quantity of the cargo is not to exceed 3,000m^3 in any one tank.

17.~~22~~23.7 ~~Submerged Electric~~ Cargo Pumps and Discharge Arrangements (*IGC Code* 17.1~~2~~1)

(Omitted)

17.~~22~~23.8 Ammonia (with reference to *IGC Code* 17.1~~3~~2)

1 Liquid ammonia is never to be sprayed into a tank containing air as there is a risk of creating a static electrical charge which could cause ignition.

2 To minimize the risk of stress corrosion cracking occurring when ammonia is carried at a temperature above -20°C (vapour pressure 0.19*MPa*), the oxygen content of the vapour space in pressure vessels and in pipelines made of carbon-manganese steel (and other steels which require special consideration) is to be reduced to the minimum practicable before liquid ammonia is introduced.

3 The master is to be provided with documentation confirming **17.12.2(4)**.

17.~~22~~23.9 Chlorine

1 (with reference to *IGC Code* 17.1~~4~~3.1.6)
(Omitted)

2 (with reference to *IGC Code* 17.1~~4~~3.4.2)
(Omitted)

3 (*IGC Code* 17.1~~4~~3.6.2)
(Omitted)

17.~~22~~23.10 Ethylene Oxide

1 (*IGC Code* 17.1~~6~~4.2)
(Omitted)

2 (*IGC Code* 17.1~~6~~4.4)
(Omitted)

3 (*IGC Code* 17.1~~6~~4.8)
The protective padding of nitrogen gas as required by **17.~~20.15~~18.14** is to be such that the nitrogen concentration in the vapour space of the cargo tank will at no time be less than 45% by volume.

4 (*IGC Code* 17.1~~6~~4.9)
(Omitted)

17.~~22~~23.11 Methyl Acetylene-Propadiene Mixtures

1 (*IGC Code* 17.1~~8~~6.1)
(Omitted)

2 (*IGC Code* 17.1~~8~~6.3)
(Omitted)

17.~~22~~23.12 Propylene Oxide and Mixtures of Ethylene Oxide-Propylene Oxide with Ethylene Oxide Content of not more than 30% by Weight (with reference to *IGC Code* 17.~~20~~18)

1 (*IGC Code* 17.~~20~~18.1)
Products transported under the provisions of **17.~~20~~18** are to be acetylene-free.

2 (*IGC Code* 17.~~20~~18.2~~.1~~)
(Omitted)

3 (*IGC Code* 17.~~20.2.2~~18.3)
(Omitted)

4 (*IGC Code* 17.~~20.2.3~~18.4)
(Omitted)

5 (*IGC Code* 17.~~20.2.4~~18.5)
(Omitted)

6 (*IGC Code* 17.~~20.2.6~~18.7)
(Omitted)

7 (with reference to *IGC Code* 17.~~20.5.1~~18.13)
(Omitted)

8 (*IGC Code* 17.~~20.5.2~~18.14)
(Omitted)

9 (*IGC Code* 17.~~20.5.3~~18.15)
(Omitted)

10 (*IGC Code* 17.~~20.13.2~~18.24)
The products referred to **17.~~20~~18** are to be transported only in accordance with cargo handling plans that have been approved by the Administration. Each intended loading arrangement is to be shown on a separate cargo handling plan. Cargo handling plans are to be show the entire cargo piping system and the locations for installation of blank flanges needed to meet the above piping separation requirements. A copy of each approved cargo handling plan is to be kept on board the ship. The international Certificate of Fitness for the Carriage of Liquefied Gases in Bulk is to be endorsed to include reference to the approved cargo handling plans.

11 (*IGC Code* 17.~~20.13.3~~18.25)
(Omitted)

12 (*IGC Code* 17.~~20.14~~18.26)
The maximum allowable ~~tank~~ loading limits for each ~~cargo~~ tank are to be indicated for each loading temperature which may be applied, in accordance with **15.5**~~and for the applicable maximum reference temperature, on a list to be approved by the Administration~~. ~~A copy of the list is to be permanently kept on board by the master.~~

13 (with reference to *IGC Code* 17.~~20.15~~18.27)
(Omitted)

14 (*IGC Code* 17.~~20.16~~18.28)
(Omitted)

15 (with reference to *IGC Code* 17.~~20.17~~18.29)
In addition to **17.~~20.17~~18.5**, a water hose with pressure to the nozzle, when ambient temperatures permit, is to be connected ready for immediate use during loading and unloading operations.

17.~~22~~23.13 Vinyl Chloride (*IGC Code* 17.~~21~~19)

In cases where polymerization of vinyl chloride is prevented by addition of an inhibitor, **17.8** is applicable. In cases where no ~~or insufficient~~ inhibitor has been added, or the inhibitor concentration is insufficient, any inert gas used for the purposes of **17.6** is to contain not more oxygen than 0.1% by volume. Before loading is started, inert gas samples from the tanks and piping are to be analysed. When vinyl chloride is carried, a positive pressure is always to be maintained in the tanks~~, also~~ and during ballast voyages between successive carriages.

17.23.14 Carbon Dioxide: High Purity

Uncontrolled pressure loss from the cargo can cause "sublimation" and the cargo will change from the liquid to the solid state. The precise "triple point" temperature of a particular carbon dioxide cargo is to be supplied before loading the cargo, and will depend on the purity of that cargo, and this is to be taken into account when cargo instrumentation is adjusted.

17.23.15 Carbon dioxide: Reclaimed Quality

The requirements of **17.23.14** also apply to this cargo.

Chapter 18 has been amended as follows.

Chapter 18 OPERATING REQUIREMENTS

18.1 General~~Operation Manual~~ (*IGC Code* 18.1)

18.1.1 General

1 Those involved in liquefied gas carrier operations are to be made aware of the special requirements associated with, and precautions necessary for, their safe operation.

2 A copy of *IGC Code*, or national regulations incorporating the provisions of *IGC Code*, are to be on board every ship covered by this Part.

~~Operation manual approved by the Society is to be provided on board. This operation manual is to include the information specified in **18.2**.~~

18.2 Cargo Operations Manuals (*IGC Code* 18.2)

18.2.1 Cargo Operations Manuals

1 The ship is to be provided with copies of suitably detailed cargo system operation manuals approved by the Society such that trained personnel can safely operate the ship with due regard to the hazards and properties of the cargoes that are permitted to be carried.

2 The content of the manuals is to include, but not be limited to:

(1) overall operation of the ship from dry-dock to dry-dock, including procedures for cargo tank cooldown and warm-up, transfer (including ship-to-ship transfer), cargo sampling, gas-freeing, ballasting, tank cleaning and changing cargoes;

(2) cargo temperature and pressure control systems;

(3) cargo system limitations, including minimum temperatures (cargo system and inner hull), maximum pressures, transfer rates, filling limits and sloshing limitations;

(4) nitrogen and inert gas systems;

(5) firefighting procedures: operation and maintenance of firefighting systems and use of extinguishing agents;

(6) special equipment needed for the safe handling of the particular cargo;

(7) fixed and portable gas detection;

(8) control, alarm and safety systems;

(9) emergency shutdown systems;

(10) procedures to change cargo tank pressure relief valve set pressures in accordance with **8.2.8** and **4.13.2-3**; and

(11) emergency procedures, including cargo tank relief valve isolation, single tank gas-freeing and entry and emergency ship-to-ship transfer operations.

18.3 Cargo Emergency Shutdown (ESD) System (*IGC Code* 18.10)

18.3.1 Cargo Emergency Shutdown (ESD) System

1 General

(1) A cargo emergency shutdown system is to be fitted to stop cargo flow in the event of an emergency, either internally within the ship, or during cargo transfer to ship or shore. The design of the ESD system is to avoid the potential generation of surge pressures within cargo transfer pipe work (see **-2(1)(d)**).

(2) Auxiliary systems for conditioning the cargo that use toxic or flammable liquids or vapours are to be treated as cargo systems for the purposes of ESD. Indirect refrigeration systems using an inert medium, such as nitrogen, need not be included in the ESD function.

(3) The ESD system is to be activated by the manual and automatic initiations listed in **Table 18.1**. Any additional initiations are only to be included in the ESD system if it can be shown that their inclusion does not reduce the integrity and reliability of the system overall.

(4) Ship's ESD systems are to incorporate a ship-shore link in accordance with recognized standards.

(5) A functional flow chart of the ESD system and related systems is to be provided in the cargo control station and on the navigation bridge.

2 ESD valve requirements

(1) General

(a) The term ESD valve means any valve operated by the ESD system.

(b) ESD valves are to be remotely operated, be of the fail-closed type (closed on loss of actuating power), be capable of local manual closure and have positive indication of the actual valve position. As an alternative to the local manual closing of the ESD valve, a manually operated shut-off valve in series with the ESD valve is to be permitted. The manual valve is to be located adjacent to the ESD valve. Provisions are to be made to handle trapped liquid should the ESD valve close while the manual valve is also closed.

(c) ESD valves in liquid piping systems are to close fully and smoothly within 30 *seconds* of actuation. Information about the closure time of the valves and their operating characteristics is to be available on board, and the closing time is to be verifiable and repeatable.

(d) The closing time of the valve referred to in **13.3.1** to **13.3.3** (i.e. time from shutdown signal initiation to complete valve closure) is not to be greater than:

$$\frac{3600U}{L_R} \quad (second)$$

where:

U : ullage volume at operating signal level (m^3);

L_R : maximum loading rate agreed between ship and shore facility (m^3/h).

The loading rate is to be adjusted to limit surge pressure on valve closure to an acceptable level, taking into account the loading hose or arm, the ship and the shore piping systems, where relevant.

(2) Ship-shore and ship-ship manifold connections

One ESD valve is to be provided at each manifold connection. Cargo manifold connections not being used for transfer operations are to be blanked with blank flanges rated for the design pressure of the pipeline system.

(3) Cargo system valves

If cargo system valves as defined in section **5.5** are also ESD valves within the meaning of

18.3.1, then the requirements of **18.3.1** are to apply.

3 ESD system controls

(1) As a minimum, the ESD system is to be capable of manual operation by a single control on the bridge and either in the control position required by **13.1.2** or the cargo control room, if installed, and no less than two locations in the cargo area.

(2) The ESD system is to be automatically activated on detection of a fire on the weather decks of the cargo area and/or cargo machinery spaces. As a minimum, the method of detection used on the weather decks is to cover the liquid and vapour domes of the cargo tanks, the cargo manifolds and areas where liquid piping is dismantled regularly. Detection may be by means of fusible elements designed to melt at temperatures between 98°C and 104°C, or by area fire detection methods.

(3) Cargo machinery that is running is to be stopped by activation of the ESD system in accordance with the cause and effect matrix in **Table 18.1**.

(4) The ESD control system is to be configured so as to enable the high-level testing required in **13.3.5** to be carried out in a safe and controlled manner. For the purpose of the testing, cargo pumps may be operated while the overflow control system is overridden. Procedures for level alarm testing and re-setting of the ESD system after completion of the high-level alarm testing is to be included in the operation manual required by **18.2.1**.

4 Additional shutdowns

(1) The requirements of **8.3.1(1)** to protect the cargo tank from external differential pressure may be fulfilled by using an independent low pressure trip to activate the ESD system, or, as minimum, to stop any cargo pumps or compressors.

(2) An input to the ESD system from the overflow control system required by **13.3** may be provided to stop any cargo pumps or compressors' running at the time a high level is detected, as this alarm may be due to inadvertent internal transfer of cargo from tank to tank.

5 Pre-operations testing

Cargo emergency shutdown and alarm systems involved in cargo transfer are to be checked and tested before cargo handling operations begin.

Table N18.1 – ESD functional arrangements

	Pumps		Compressor systems				Valves	Link
Initiation ↓ Shutdown action →	Cargo pumps/ cargo booster pumps	Spray/ stripping pumps	Vapour return compressors	Fuel gas compressors	Reliquefaction plant***, including condensate return pumps, if fitted	Gas combustion unit	ESD valves	Signal to ship/ shore link****
Emergency push buttons (see **18.3.1-3(1)**)	○	○	○	b	○	○	○	○
Fire detection on deck or in compressor house* (see **18.3.1-3(2)**)	○	○	○	○	○	○	○	○
High level in cargo tank (see **13.3.2** and **13.3.3**)	○	○	○	a b	a c	a	f	○
Signal from ship/shore link (see **18.3.1-1(4)**)	○	○	○	b	c	N/A	○	N/A
Loss of motive power to ESD valves**	○	○	○	b	c	N/A	○	○
Main electric power failure (“blackout”)	g	g	g	g	g	g	○	○
Level alarm override (see **13.3.7**)	d	d e	○	a	a	a	○	○

Notes:

1) SYMBOL

a: These items of equipment can be omitted from these specific automatic shutdown initiators, provided the equipment inlets are protected against cargo liquid ingress.

b: If the fuel gas compressor is used to return cargo vapour to shore, it is to be included in the ESD system when operating in this mode.

c: If the reliquefaction plant compressors are used for vapour return/shore line clearing, they are to be included in the ESD system when operating in that mode.

d: The override system permitted by **13.3.7** may be used at sea to prevent false alarms or shutdowns. When level alarms are overridden, operation of cargo pumps and the opening of manifold ESD valves are to be inhibited except when high-level alarm testing is carried out in accordance with **13.3.5** (*see* **18.3.1-3(4)**).

e: Cargo spray or stripping pumps used to supply forcing vaporizer may be excluded from the ESD system only when operating in that mode.

f: The sensors referred to in **13.3.2** may be used to close automatically the tank filling valve for the individual tank where the sensors are installed, as an alternative to closing the ESD valve referred to in **18.3.1-2(2)**. If this option is adopted, activation of the full ESD system is to be initiated when the high-level sensors in all the tanks to be loaded have been activated.

g: These items of equipment are to be designed not to restart upon recovery of main electric power and without confirmation of safe conditions.

*: Fusible plugs, electronic point temperature monitoring or area fire detection may be used for this purpose on deck.

**: Failure of hydraulic, electric or pneumatic power for remotely operated ESD valve actuators.

***: Indirect refrigeration systems which form part of the reliquefaction plant do not need to be included in the ESD function if they employ an inert medium such as nitrogen in the refrigeration cycle.

****: Signal need not indicate the event initiating ESD.

○: Functional requirement.

2) ABBREVIATIONS

N/A: Not applicable.

18.4~~2~~ Operating Requirements

18.4~~2~~.1 Application

The provisions in **18.4~~2~~** are not ~~the conditions~~ related to surveys necessary for the maintenance of classification, but indicate those matters ~~for~~ which ~~examinations~~ are ~~required but the conditions~~ to be strictly observed by the ship-owner~~,~~ or the ship master ~~or~~ as well as all other persons ~~who may concern with~~ responsible for the ship operation.

18.4~~2~~.2 Cargo Information (*IGC Code* 18.3~~1~~)

1 Information is to be on board and available to all concerned~~,~~ in the form of a cargo information data sheet(s) giving the necessary data for the safe carriage of cargo. Such information is to include, for each product carried:

(1) a full description of the physical and chemical properties necessary for the safe carriage and containment of the cargo;
(2) reactivity with other cargoes that are capable of being carried on board in accordance with the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk;
(3~~2~~) the actions to be taken in the event of cargo spills or leaks;
(4~~3~~) counter-measures against accidental personal contact;
(5~~4~~) fire-fighting procedures and fire-fighting media;
~~(5) procedures for cargo transfer, gas-freeing, ballasting, tank cleaning and changing cargoes;~~
(6) special equipment needed for the safe handling of the particular cargo; and
~~(7) minimum allowable inner hull steel temperatures; and~~
(7~~8~~) emergency procedures.

2 The physical data supplied to the master, in accordance with the **-1(1)** above, is to include information regarding the relative cargo density at various temperatures to enable the calculation of cargo tank filling limits in accordance with the requirements of **Chapter 15**.~~Products required to be inhibited are to be refused if the certificate required by **17.8** is not supplied.~~

3 Contingency plans in accordance with the **-1(3)** above, for spillage of cargo carried at ambient temperature, are to take account of potential local temperature reduction such as when the escaped cargo has reduced to atmospheric pressure and the potential effect of this cooling on hull steel.~~A copy of the *IGC Code* or national regulations incorporating the provisions of the *IGC Code* is to be on board every ship.~~

18.4~~2~~.3 ~~Compatibility~~ Suitability for Carriage (*IGC Code* 18.4~~2~~)

1 The master is to ascertain that the quantity and characteristics of each product to be loaded are within the limits indicated in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk and in the Loading and Stability Information booklet ~~provided for~~required by in **2.2.~~2~~3** and that products are listed in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk as required under section ~~**3**~~**4** of the Certificate.

2 Care is to be taken to avoid dangerous chemical reactions if cargoes are mixed. This is of particular significance in respect of;

(1) tank cleaning procedures required between successive cargoes in the same tank; and
(2) simultaneous carriage of cargoes ~~which~~that react when mixed. This is to be permitted only if the complete cargo systems including, but not limited to, cargo pipework, tanks, vent systems and refrigeration systems are separated as defined in **1.1.4(43)**.

3 Where products are required to be inhibited, the certificate required by **17.8** is to be supplied before departure, otherwise the cargo is not to be transported.

18.4.4 Carriage of Cargo at Low Temperature (*IGC Code* 18.5)

When carrying cargoes at low temperatures:

(1) the cooldown procedure laid down for that particular tank, piping and ancillary equipment is to be followed closely;

(2) loading is to be carried out in such a manner as to ensure that design temperature gradients are not exceeded in any cargo tank, piping or other ancillary equipment; and

(3) if provided, the heating arrangements associated with the cargo containment systems are to be operated in such a manner as to ensure that the temperature of the hull structure does not fall below that for which the material is designed.

18.4.5 Cargo Transfer Operations (*IGC Code* 18.6)

1 A pre-cargo operations meeting is to take place between ship personnel and the persons responsible at the transfer facility. Information exchanged is to include the details of the intended cargo transfer operations and emergency procedures. A recognized industry checklist is to be completed for the intended cargo transfer and effective communications are to be maintained throughout the operation.

2 Essential cargo handling controls and alarms are to be checked and tested prior to cargo transfer operations.

18.4~~2~~.6~~4~~ Personnel Training (*IGC Code* 18.7~~3~~)

~~**1** Reference is made to the provisions of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, and in particular to the "Mandatory minimum requirements for the training and qualifications of masters, officers and ratings of liquefied gas tankers" - regulation V/3, Chapter V of the Annex to that Convention and to resolution 12 of the International Conference on Training and Certification of Seafarers, 1978.~~

1~~2~~ Personnel is to be adequately trained in the operational and safety aspects of liquefied gas carriers as required by the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended, the International Safety Management Code and the *Medical First Aid Guide (MFAG)*. As a minimum:~~Personnel involved in cargo operations are to be adequately trained in handling procedures.~~

(1)~~**3**~~ All personnel are to be adequately trained in the use of protective equipment provided on board and have basic training in the procedures, appropriate to their duties, necessary under emergency conditions~~.~~; and

(2)~~**4**~~ Officers are to be trained in emergency procedures to deal with conditions of leakage, spillage or fire involving the cargo~~, based on *MEDICAL FIRST AID GUIDE FOR USE IN ACCIDENTS INVOLVING DANGEROUS GOODS (MFAG)* and the related requirements of Part A and B of *STCW Code*,~~ and a sufficient number of them is to be instructed and trained in essential first aid for the cargoes carried.

18.4~~2~~.7~~5~~ Entry into Enclosed Spaces (*IGC Code* 18.8~~4~~)

1 Under normal operational circumstances, ~~P~~personnel are not to enter cargo tanks, hold spaces, void spaces~~, cargo handling spaces~~ or other enclosed spaces where gas may accumulate, unless~~:~~

~~(1)~~ the gas content of the atmosphere in such space is determined by means of fixed or portable equipment to ensure oxygen sufficiency and the absence of toxic atmosphere~~; or~~

~~(2) personnel wear breathing apparatus and other necessary protective equipment and the entire operation is under the close supervision of a responsible officer.~~

2 If it is necessary to gas-free and aerate a hold space surrounding a type *A* cargo tank for routine inspection, and flammable cargo is carried in the cargo tank, the inspection is to be conducted when the tank contains only the minimum amount of cargo "heel" to keep the cargo tank cold. The hold is to be re-inerted as soon as the inspection is completed.

3~~2~~ Personnel entering any space designated as a hazardous area~~gas-dangerous~~ on a ship carrying flammable products are not to introduce any potential source of ignition into the space unless it has been certified gas-free and is maintained in that condition.

~~**3** Following attentions are to be paid to operations in and near an internal insulation tank.~~

~~(1) For internal insulation tanks, special fire precautions are to be taken in the event of hot work carried out in the vicinity of the tanks. For this purpose, gas absorbing and de-absorbing characteristics of the insulation material is to be taken into account.~~

~~(2) For internal insulation tanks, repairs are to be carried out in accordance with the procedures provided for in paragraph **4.4.7-6**.~~

~~18.2.6 Carriage of Cargo at Low Temperature (*IGC Code* 18.5)~~

~~When carrying cargoes at low temperatures:~~

~~(1) if provided, the heating arrangements associated with cargo containment systems are to be operated in such a manner as to ensure that the temperature does not fall below that for which the material of the hull structure is designed;~~

~~(2) loading is to be carried out in such a manner as to ensure that unsatisfactory temperature gradients do not occur in any cargo tank, piping, or other ancillary equipment; and~~

~~(3) when cooling down tanks from temperatures at or near ambient, the cool-down procedure laid down for that particular tank, piping and ancillary equipment are to be followed closely.~~

~~18.2.7 Protective Equipment (*IGC Code* 18.6)~~

~~Personnel are to be made aware of the hazards associated with the cargo being handled and are to be instructed to act with care and use the appropriate protective equipment as mentioned in **14.2.2** during cargo handling.~~

~~18.2.8 Systems and Controls (*IGC Code* 18.7)~~

~~Cargo emergency shutdown and alarm systems involved in cargo transfer are to be tested and checked before cargo handling operations begin. Essential cargo handling controls are also to be tested and checked prior to transfer operations.~~

~~18.2.9 Cargo Transfer Operations (*IGC Code* 18.8)~~

~~**1** Transfer operations including emergency procedures are to be discussed between ship personnel and the persons responsible at the shore facility prior to commencement and communications maintained throughout the transfer operations.~~

~~**2** The closing time of the valve referred to in **13.3.1** (i.e. time from shutdown signal initiation to complete valve closure) is not to be greater than:~~

$$\cancel{\frac{3600U}{LR}\ (s)}$$

~~where:~~

~~U : ullage volume at operating signal level (m^3)~~

~~LR : maximum loading rate agreed between and shore facility (m^3/h).~~

~~The loading rate is to be adjusted to limit surge pressure on valve closure to an acceptable level taking into account the loading hose or arm, the ship and the shore piping systems where relevant.~~

18.4.8 Cargo Sampling (*IGC Code* 18.9)

1 Any cargo sampling are to be conducted under the supervision of an officer who is to ensure that protective clothing appropriate to the hazards of the cargo is used by everyone involved in the operation.

2 When taking liquid cargo samples, the officer is to ensure that the sampling equipment is suitable for the temperatures and pressures involved, including cargo pump discharge pressure, if relevant.
3 The officer is to ensure that any cargo sample equipment used is connected properly to avoid any cargo leakage.
4 If the cargo to be sampled is a toxic product, the officer is to ensure that a "closed loop" sampling system as defined in **1.1.4(14)** is used to minimize any cargo release to atmosphere.
5 After sampling operations are completed, the officer is to ensure that any sample valves used are closed properly and the connections used are correctly blanked.

18.4.9 Hot Work on or Near Cargo Containment Systems (*IGC Code* 18.11)

Special fire precautions are to be taken in the vicinity of cargo tanks and, particularly, insulation systems that may be flammable or contaminated with hydrocarbons or that may give off toxic fumes as a product of combustion.

18.4~~2~~.10 Additional Operating Requirements (*IGC Code* 18.12~~9~~)

Additional operating requirements will be found in the following paragraphs of this Chapter:

1.2, **2.8,** **3.9**, **5.14,** **7.9~~7.3~~**,**8.5** ~~**8.6**~~, **13.10~~13.7~~**, **14.5**, **15.7~~15.2~~** and **17.23~~17.22~~**.

Chapter 19 has been amended as follows.

Chapter 19 MINIMUM REQUIREMENTS
(~~with reference~~related to *IGC Code* Chapter 19)

19.1 General

19.1.1 Application

The requirements of columns "**c**" to "**g**" and "**i**" of **Table N19.1** are applied to ships depending on the products to be carried according to the provisions which refer to **Table N19.1** in each previous chapter. The symbols of each column are as follows:

(1) Products (column **a**): the names of products are identical with those given in the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in bulk. The product name is to be used in the shipping document for any cargo offered for bulk shipments. Any additional name may be included in brackets after the product name.

(2) UN Numbers (column **b**): ~~The UN numbers as listed in **Table N19.1** are intended for information only.~~(Deleted)

(3) Ship type (column **c**): ~~*See* **2.1.2**.~~
    Ship type 1*G*: (**2.1.2(1)**)
    Ship type 2*G*: (**2.1.2(2)**)
    Ship type 2*PG*: (**2.1.2(3)**)
    Ship type 3*G*: (**2.1.2(4)**)

(4) Independent tank type *C* required (column **d**): Type *C* independent tank (**4.23**) ~~"-" means not required this tank type~~.

(5) Tank environmental c~~C~~ontrol ~~of vapour space within cargo tanks~~ (column **e**): ~~"-" means no special requirements.~~
    Inert: Inerting (**9.4**)
    Dry: Drying (**17.7**)
    - : No special requirements under this Part

(6) Vapour detection ~~required~~ (column **f**):
    F :~~-~~Flammable vapour detection
    T :~~-~~Toxic vapour detection
    ~~*O* -Oxygen analyser~~
    F + *T* :~~-~~Flammable and toxic vapour detection
    A : Asphixiant

(7) Gauging (column **g**): ~~Types permitted are follows;~~
    I :~~-~~Indirect or closed~~, as described in~~ (**13.2.~~2~~3(1)** and **(2)**)
    ~~*C* -Indirect, or closed, as described in **13.2.2(1)**, **(2)** and **(3)**~~
    R :~~-~~Indirect, closed or restricted~~, as described in~~ (**13.2.~~2~~3(1)**, **(2)**, **(3)** and **(4)**)
    C : Indirect or closed (**13.2.3(1), (2) and (3)**)

(8) *MFAG* numbers (column **h**): ~~MFAG numbers are provided for information on the emergency procedures to be applied in the event of an incident with the products covered by this Part of the Rules. Where any of the products listed are carried at low temperature from which frostbite may occur, MFAG No. 620 is also applicable.~~(Deleted)

(9) Special requirements (column **i**): The paragraph in "( )" ~~is indicated~~indicates the paragraph of *IGC Code*. When specific reference is made to **Chapters 14** and/or **17** of this Part, these requirements are to be additional to the requirements in any other column.

19.1.2 Gas Mixtures Containing Acethylenes

Unless otherwise specified, gas mixtures containing less than 5% total acetylenes may be transported with no further requirements than those provided for the major components.

Table N19.1 Summary of Minimum Requirements

a	b	c	d	e	f	g	h	i
Product name	~~UN number~~(Deleted)	Ship type	Independent tank type C required	Control of vapour space within cargo_tanks	Vapour detection	Gauging	~~MFAG table No.~~ (Deleted)	Special requirements
Acetaldehyde	~~1089~~	*2G/2PG*	-	Inert	*F+T*	*C*	~~300~~	14.4.3 (14.4.3), 14.3.3(1)~~4.4~~ (14.3.3.1~~4.4~~), 17.4.1 (17.4.1),17.6.1(1) & 17.23~~22~~.3(1) (17.6.1)
Ammonia, anhydrous	~~1005~~	*2G/2PG*	-	-	*T*	*C*	~~725~~	~~14.4.2 (14.4.2), 14.4.3 (14.4.3),~~ 14.4.~~4~~ (14.4.~~4~~), 17.2.1(1) (17.2.1),17.12~~13~~ & 17.23~~22~~.8 (17.12~~13~~)
Butadiene(all isomers)	~~1010~~	*2G/2PG*	-	-	*F+T*	*C~~R~~*	~~310~~	14.4(14.4), 17.2.1(2) (17.2.2), 17.4.2 (17.4.2), 17.4.3 & 17.23~~22~~.2 (17.4.3),17.6~~.1~~ & 17.23~~22~~.3 (17.6), 17.8~~.1~~ & 17.23~~22~~.4 (17.8)
Butane(all isomers)	~~1011~~	*2G/2PG*	-	-	*F*	*R*	~~310~~	
Butane-propane mixture~~s~~	~~1011/ 1978~~	*2G/2PG*	-	-	*F*	*R*	~~310~~	
Butylenes (all isomers)	~~1012~~	*2G/2PG*	-	-	*F*	*R*	~~310~~	
Carbon dioxide(high purity)	~~-~~	*3G*	~~Yes~~-	-	*A~~-~~*	*R~~C~~*	~~-~~	17.21 (17.21)
Carbon Dioxide(Reclaimed quality)		*3G*	-	-	*A*	*R*		17.22 (17.22)
Chlorine	~~1017~~	1*G*	Yes	Dry	*T*	*I*	~~740~~	14.4 (14.4), 17.3.2 (17.3.2), 17.4.1 (17.4.1), 17.5 (17.5), 17.7 (17.7),17.9 & 17.23.5(17.9), 17.13~~14~~ & 17.23~~22~~.9 (17.13~~14~~)
Diethyl ether*	~~1155~~	*2G/2PG*	-	Inert	*F+T*	*C*	~~330~~	14.4.2 (14.4.2), 14.4.3 (14.4.3), 17.2.1(6) (17.2.6), 17.3.1 (17.3.1),17.6.1(1) & 17.23~~22~~.3(1) (17.6.1), 17.9~~10~~ & 17. 23~~22~~.5 (17.9~~10~~),17.10~~11~~ & 17. 23~~22~~.6 (17.10~~11~~), 17.11.2&17.23.7 (17.11.2), 17.11.3 & 17.23.7 (17.11.3)~~&17.15 (17.15)~~
Dimethylamine	~~1032~~	*2G/2PG*	-	-	*F+T*	*C*	~~320~~	14.4.~~2~~ (14.4.~~2~~),~~14.4.3 (14.4.3), 14.4.4 (14.4.4),~~ 17.2.1(1) (17.2.1)
Dimethyl ~~e~~Ether	-	*2G/2PG*	-	-	*F+T*	*C*	-	
Ethane	~~1961~~	*2G*	-	-	*F*	*R*	~~310~~	
Ethyl C~~c~~hloride	~~1037~~	*2G/2PG*	-	-	*F+T*	*C~~R~~*	~~340~~	
Ethylene	~~1038~~	*2G*	-	-	*F*	*R*	~~310~~	

Table N19.1 Summary of Minimum Requirements (continued)

a	b	c	d	e	f	g	h	i
Product name	~~UN number~~(Deleted)	Ship type	Independent tank type C required	Control of vapour space within cargo tanks	Vapour detection	Gauging	~~MFAG table No.~~ (Deleted)	Special requirements
Ethylene oxide	~~1040~~	1*G*	Yes	Inert	*F+T*	*C*	~~365~~	14.4.~~2~~ (14.4.~~2~~), ~~14.4.3 (14.4.3), 14.4.4 (14.4.4), 14.4.6 (14.4.6),~~17.2.1(2) (17.2.2), 17.3.2 (17.3.2), 17.4.1 (17.4.1), 17.5 (17.5), 17.6.1(1) & 17.23~~22~~.3(1) (17.6.1), 17.14~~16~~ & 17.23~~22~~.10 (17.14~~16~~)
Ethylene oxide-propylene oxide mixtures with ethylene oxide content of not more than 30% by weight*	~~2938~~	2*G*/2*PG*	-	Inert	*F+T*	*C*	~~365~~	14.4.3 (14.4.3), 17.3.1 (17.3.1), 17.4.1 (17.4.1),17.6.1(1) & 17.23~~22~~.3(1) (17.6.1), 17.9~~10~~ & 17.23~~22~~.5 (17. 9~~10~~),17.10~~11~~ & 17. 23~~22~~.6 (17. 10~~11~~), 17.18~~20~~ & 17.23~~22~~.12 (17.18~~20~~)
Isoprene(all isomers)*	~~1218~~	2*G*/2*PG*	-	-	*F*	*R*	~~310~~	14.4.3 (14.4.3), 17.8 & 17. 23~~22~~.4 (17.8), 17. 9~~10~~ & 17. 23~~22~~.5 (17. 9~~10~~),17.11.1~~12~~ & 17. 23~~22~~.7 (17. 11.1~~12~~)
Isoprene (part refined)*		2*G*/2*PG*	-	-	*F*	*R*		14.4.3 (14.4.3), 17.8 & 17.23.4 (17.8),17.9 & 17.23.5 (17.9), 17.11.1 & 17.23.7 (17.11.1)
Isopropylamine*	~~1221~~	2*G*/2*PG*	-	-	*F+T*	*C*	~~320~~	14.4.2 (14.4.2), 14.4.3 (14.4.3), 17.2.1(4) (17.2.4), 17.9~~10~~ & 17.23~~22~~.5 (17.9~~10~~),17.10~~11~~ & 17.23~~22~~.6 (17.10~~11~~), 17.11.1~~12~~ & 17.23~~22~~.7 (17.11.1~~12~~), 17.15~~17~~ (17.15~~17~~)
Methane(LNG)	~~1972~~	2*G*	-	-	*F*	*C*	~~620~~	
Methyl acetylene-propadiene mixtures	~~1060~~	2*G*/2*PG*	-	-	*F*	*R*	~~310~~	17.16~~18~~ & 17.23~~22~~.11 (17.16~~18~~)
Methyl bromide	~~1062~~	1*G*	Yes~~-~~	-	*F+T*	*C*	~~345~~	14.4 (14.4), 17.2.1(3) (17.2.3), 17.3.2 (17.3.2), 17.4.1 (17.4.1), 17.5 (17.5)~~, 17.9 (17.9)~~
Methyl chloride	~~1063~~	2*G*/2*PG*	-	-	*F+T*	*C*	~~340~~	17.2.1(3) (17.2.3)
Mixed C4 Cargoes		2*G*/2*PG*	-	-	*F+T*	*C*		14.4 (14.4), 17.2.1(2) (17.2.2), 17.4.2(17.4.2), 17.4.3 & 17.23.2 (17.4.3), 17.6 & 17.23.3 (17.6), 17.20 (17.20)
M~~e~~onoethylamine*	~~1036~~	2*G*/2*PG*	~~Yes~~-	-	*F+T*	*C*	~~320~~	14.4.~~2~~ (14.4.~~2~~), ~~14.4.3 (14.4.3), 14.4.4 (14.4.4),~~ 17.2.1(1) (17.2.1),17.3.1 (17.3.1), 17.9~~10~~ & 17.23~~22~~.5 (17.9~~10~~), 17.10~~11~~ & 17.23~~22~~.6 (17.10~~11~~),17.11.1~~12~~ & 17.23~~22~~.7 (17.11.1~~12~~), 17.15~~17~~ (17.15~~17~~)
Nitrogen	~~2040~~	3*G*	-	-	*A*~~*O*~~	*C*	~~620~~	17.17~~19~~ (17.17~~19~~)

Table N19.1 Summary of Minimum Requirements (continued)

a	b	c	d	e	f	g	h	i
Product name	~~UN number~~(Deleted)	Ship type	Independent tank type C required	Control of vapour space within cargo_tanks	Vapour detection	Gauging	~~MFAG table No.~~ (Deleted)	Special requirements
Pentane~~s~~ (all isomers)*	~~1265~~	2*G*/2*PG*	-	-	*F*	*R*	~~310~~	~~14.4.4 (14.4.4),~~ 17.9~~10~~ & 17.23~~22~~.5 (17.9~~10~~), 17.11~~12~~ & 17.23~~22~~.7 (17.11~~12~~)
Pentene (all isomers)*	~~1265~~	2*G*/2*PG*	-	-	*F*	*R*	~~310~~	~~14.4.4 (14.4.4),~~ 17.9~~10~~ & 17.23~~22~~.5 (17.9~~10~~), 17.11~~12~~ & 17.23~~22~~.7 (17.11~~12~~)
Propane	~~1978~~	2*G*/2*PG*	-	-	*F*	*R*~~*C*~~	~~310~~	
Propylene	~~1077~~	2*G*/2*PG*	-	-	*F*	*R*	~~310~~	
Propylene oxide*	~~1280~~	2*G*/2*PG*	-	Inert	*F+T*	*C*	~~365~~	14.4.3 (14.4.3), 17.3.1 (17.3.1), 17.4.1 (17.4.1),17.6.1(1) & 17.23~~22~~.3(1) (17.6.1),17.9~~10~~ & 17.23~~22~~.5 (17.9~~10~~), 17.10~~11~~ & 17.23~~22~~.6 (17.10~~11~~), 17.18~~20~~ & 17.23~~22~~.12 (17.18~~20~~)
Refrigerant gases (see **notes**)	-	3*G*	-	-	-	*R*	~~350~~	
Sulphur dioxide	~~1079~~	1*G*	Yes	Dry	*T*	*C*	~~635~~	14.4 (14.4), 17.3.2 (17.3.2), 17.4.1 (17.4.1), 17.5 (17.5), 17.7 (17.7)~~, 17.9 (17.9)~~
Vinyl chloride	~~1086~~	2*G*/2*PG*	-	-	*F+T*	*C*	~~340~~	14.4.2 (14.4.2), 14.4.3 (14.4.3), 17.2.1(2) (17.2.2), 17.2.1(3) (17.2.3),17.3.1 (17.3.1), 17.6~~.1~~ & 17.23~~22~~.3 (17.6), 17.19~~21~~ & 17.23~~22~~.13 (17.19~~21~~)
Vinyl ethyl ether*	~~1302~~	2*G*/2*PG*	-	Inert	*F+T*	*C*	~~330~~	14.4.2 (14.4.2), 14.4.3 (14.4.3), 17.2.1(2) (17.2.2), 17.3.1 (17.3.1),17.6.1(1) & 17.23~~22~~.3(1) (17.6.1), 17.8 & 17.23~~22~~.4 (17.8),17.9~~10~~ & 17.23~~22~~.5 (17.9~~10~~), 17.10~~11~~ & 17.23~~22~~.6 (17.10~~11~~), 17.11.2 & 17.23.7 (17.11.2), 17.11.3 &17.23.7 (17.11.3)~~17.15 (17.15)~~
Vinylidene chloride*	~~1303~~	2*G*/2*PG*	-	Inert	*F+T*	*C*~~*R*~~	~~340~~	14.4.2 (14.4.2), 14.4.3 (14.4.3), 17.2.1(5) (17.2.5),17.6.1(1) & 17.23~~22~~.3(1) (17.6.1), 17.8 & 17.23~~22~~.4 (17.8),17.9~~10~~ & 17.23~~22~~.5 (17.9~~10~~), 17.10~~11~~ & 17.23~~22~~.6 (17.10~~11~~)
Other liquefied gases having same hazard of the products listed above	Requirements provided individually by the Society in accordance with characters of cargoes.							

Notes:

Refrigerant gases: Non-toxic and non-flammable gases ~~such as:~~

~~dichlorodifluoromethane (1028)~~

~~dichloromonofluoromethane (1029)~~

~~dichlorotetrafluoroethane (1958)~~

~~monochlorodifluoromethane (1018)~~

~~monochlorotetrafluoroethane (1021)~~

~~monochlorotrifluoromethane (1022)~~

*: This cargo is covered also by **Part S**.

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 July 2016.

2. Notwithstanding the amendments to the Rules, the current requirements may apply to ships the keels of which were laid or which were at *a similar stage of construction* before the effective date.

(Note) The term "*a similar stage of construction*" means the stage at which the construction identifiable with a specific ship begins and the assembly of that ship has commenced comprising at least 50 *tonnes* or 1% of the estimated mass of all structural material, whichever is the less.

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part N Ships Carrying Liquefied Gases in Bulk

GUIDANCE

2016 AMENDMENT NO.1

Notice No.39 30th June 2016

Resolved by Technical Committee on 28th July 2015 / 5th February 2016

Notice No.39 30th June 2016
AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Guidance for the survey and construction of steel ships" has been partly amended as follows:

Part N SHIPS CARRYING LIQUEFIED GASES IN BULK

Amendment 1-1

N6 MATERIALS OF CONSTRUCTION

N6.3 Welding and Non-destructive Testing

N6.3.7 Non-destructive Testing

1 For the purpose of the requirements in **6.3.7-1, Part N of the Rules**, the following requirements **(1)** to **(3)** are to be complied with.

Sub-paragraph (2) has been amended as follows.

(2) The following requirements **(a)** through **(b)** are to apply as the testing procedures and acceptance criteria for the non-destructive tests referred to in the requirements in **6.3.7-1(3), Part N of the Rules**:

(a) Radiographic test<u>ing</u> is to comply with the requirements specified in **11.4.5**, **Part D** of the Rules. <u>The requirements specified in **D11.4.5-2(2)**, however, are not to be applied.</u>

((b) to (d) are omitted.)

EFFECTIVE DATE AND APPLICATION (Amendment 1-1)

1. The effective date of the amendments is 30 June 2016.

Amendment 1-2

N1 has been amended as follows.

N1 GENERAL

N1.1 General

N1.1.5 Definitions

1 Cargo area

"Cargo area" extended by the requirements in **3.3.2~~1-2~~, Part N of the Rules** is, for example, as shown in **Fig. N1.1.5-1**.

2 Hazardous area

The electrical installation in "hazardous area" referred to in **1.1.5(23), Part N of the Rules** is to comply with **Chapter 10, Part N of the Rules.**

~~2~~3 Hold space

"Hold space" in the requirements in **1.1.5(~~17~~25), Part N of the Rules** includes the peripheral compartments of cargo tanks in the case of integral tanks. (*See* **Fig. N1.1.5-2**)

~~3~~4 Independent

The "provisions available for the potential connection to other systems" referred to in **1.1.5(~~18~~27), Part N of the Rules** includes the blank flanges.

~~4~~5 Interbarrier space

"Interbarrier space" referred to in **1.1.5(29~~0~~), Part N of the Rules** means the peripheral compartments of the cargo tanks in the case of integral tanks. (*See* **Fig. N1.1.5-2**)

Fig. N1.1.5-1

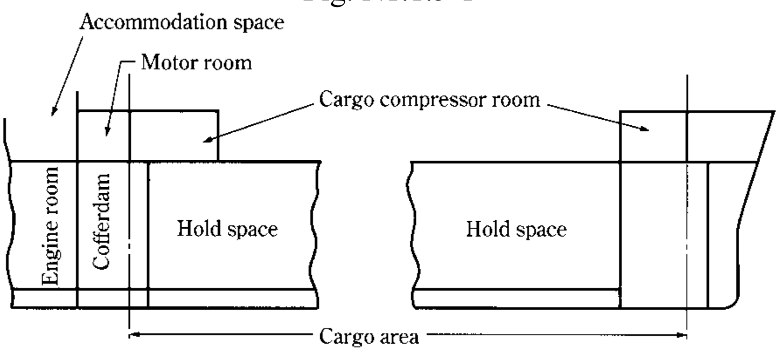
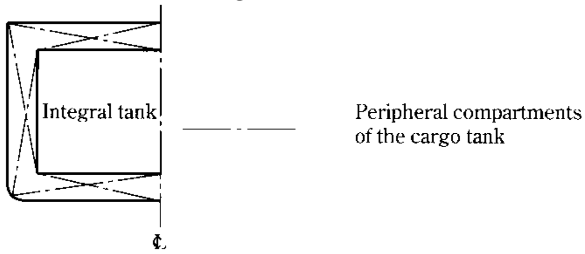


Fig. N1.1.5-2



N2 has been amended as follows.

N2 SHIP SURVIVAL CAPABILITY AND LOCATION OF CARGO TANKS

N2.1 General

N2.1.1 General

1 Reference is, to be made to the Guidelines for Uniform Application of the Survival Requirements of the Bulk Chemical Code and the Gas Carrier Code (*IMO MSC* /*Circ*. 286) for the damage stability calculation carried out to verify the compliance with survival requirements specified in **2.~~9~~7, Part N of the Rules**.

2 In the damage stability calculation, no consideration may be taken for the evaporation of cargo in the intact cargo tanks due to failure of the thermal insulation located within the extent of damage.

N2.2 ~~Solid Ballast and Stability Information~~ Freeboard and Stability

N2.2.~~1~~2 Solid Ballast

1 In case where solid ballast is arranged under unavoidable reasons to ensure stability of the ship, the distance between such solid ballast and the cargo tank is to be not less than 760*mm* at any point.

2 The solid ballast is to be of concrete blocks and similar materials which can be fitted securely to the hull structure of the ship. No solid ballast consisting of scrap iron in bulk, etc. is accepted.

N2.2.~~2~~3 Stability Information

The items relating to the survival capability of the ship to be entered in the stability information specified in **2.2.~~2~~3, Part N of the Rules** are to include, at least, the following **(1)** through **(5)**:

(1) Data relative to loading and distribution of cargo and ballast necessary to ensure compliance with damage survival requirements.

(2) Data relative to the ship's survival capabilities.

(3) Plan showing the damage control procedures (describing the locations of fittings necessary for the damage control such as closing appliances and valves, and list of instructions for their controls)

(4) Data relating to the effects of free surface or liquid heeling moments of cargo tanks at all stages of filling.

(5) Example calculations and standard blank forms to facilitate calculations (which are useful for verifying compliance with the survival requirements in an intact condition of the ship).

N2.2.~~3~~4 Stability Instruments

1 The wording "performance standards recommended by the *IMO*" specified in **2.2.~~3~~4-1, Part N of the Rules** refers to the following **(1)** to **(3)**:

(1) Chapter 4, Part B of *IMO resolution MSC*.267(85) "*International Code on Intact Stability, 2008* (*2008 IS Code*)"

(2) Section 4, Annex to "*Guidelines for the Approval of Stability Instruments*" (*MSC*.1/*Circ*.1229)

(3) The technical standards provided in Part 1 of "*Guidelines for Verification of Damage Stability Requirements for Tankers*" (*MSC*.1/*Circ*.1461)

2 In applying the requirements in **2.2.~~3~~4-4, Part N of the Rules**, reference is to be made to the operational guidance provided in Part 2 of "*Guidelines for Verification of Damage Stability Requirements for Tankers*" (*MSC*.1/*Circ*.1461).

~~N2.3 Shipside Discharges below the Freeboard Deck~~

~~N2.3.1 Overboard Discharge Pipes~~

~~**1** The requirements of **2.3.1, Part N of the Rules** don't apply to the overboard discharge pipes from the superstructure and deckhouse located on or above the second deck on freeboard deck.~~

~~**2** In applying the requirements in **2.3.1, Part N of the Rules**, the following requirements **(1)** to **(3)** are to be complied with:~~

~~(1) The scupper pipes within the superstructure are to be in accordance with the requirements in **D13.4.1-1**.~~

~~(2) The inboard side open ends of scupper pipes are to be in accordance with the requirements in **D13.4.1-2**.~~

~~(3) The direct overboard discharge pipes of top side tanks are to be in accordance with the requirements in **13.4.1-4** and **-5, Part D of the Rules**.~~

~~N2.4 Conditions of Loading~~

N2.2.5~~4.1~~ Conditions of Loading

To ensure the compliance with the survival requirements in **2.~~9~~7, Part N of the Rules** for "all anticipated conditions of loading and variations in draught and trim" specified in **2.2.5~~4.1~~, Part N of the Rules** at least one or combination of the following **(1)** to **(3)** are to be taken for the draught up to the summer water load line:

(1) Carry out damage stability calculations for all anticipated conditions of loading.

(2) Provide manual or calculating machine capable of carrying out the required damage stability calculations. When calculating machine is provided, suitable means of redundancy is to be provided for possible failure of the machine.

(3) Provide diagrams permitting to verify compliance with the survival requirements on the basis of the data in intact condition of the ship. (e.g. *KG* values)

N2.~~5~~3 Damage Assumptions

N2.~~5~~3.2 Other Damage

For the purpose of the requirements in **2.~~5~~3.2(2), Part N of the Rules**, the transverse bulkheads assumed to remain intact in the requirements in **2.~~8~~6.1(4)** to **(6), Part N of the Rules** may also be assumed that they remain free from local damages.

N2.~~6~~4 Location of Cargo Tanks

N2.~~6~~4.1 Location of Cargo Tanks

For the purpose of the requirements in **2.~~6~~4.1, Part N of the Rules**, the extent of damage is to be measured to the primary barrier.

N2.~~6~~4.3 Suction Wells

The suction wells are not to be installed less than ~~760~~800*mm* from the shell plating.

N2.~~7~~5 Flooding Assumptions

N2.~~7~~5.1 General

1 Conditions that are anticipated to cause more severe results are to be selected of all anticipated conditions of loading, and consideration is to be given to the following **(1)** through **(8)** in making calculation according to **2.~~7~~5.1, Part N of the Rules**:

(1) Tanks in way of the assumed damage filled with liquid at increments of about 25% between empty and the maximum weight of liquid, or liquids, intended to be carried in the particular tanks under consideration.

(2) The distribution of liquids in the adjacent tanks concerned which will give the most severe result, taking trim into account.

(3) A number of draughts over the operating range, up to and including the tropical freeboard mark. The fresh water freeboards need not be considered.

(4) The effect of damage involving the machinery space and adjacent tanks containing liquids over a number of draughts as in **(3)**.

(5) The ship in either the departure or the arrival condition, whichever will give the most severe result.

(6) The ship without trim and a sufficient number of trims covering the operating range, in order to permit interpolation.

(7) Where the assumed damage causes the ship to trim by the stern, condition having the largest allowable trim by the stern, consistent with operational requirements.

(8) Where the assumed damage causes the ship to trim by the bow, condition having the largest allowable trim by the bow, consistent with operational requirements.

2 The free surface effects of intact cargo tanks in the damage stability calculation are to be computed for the actual angle of heel caused by assumed damage and for each angle of heel within the stability limit.

3 In calculating the effect of free surface of consumable liquids, it is to be assumed that, for each type of liquid, at least one transverse pair or a single centreline tank has maximum free surface, and the tank or combination of tanks to be taken into account are to be those where the effect of free surfaces is the greatest; in each tank the centre of gravity of the contents is to be taken at the centre of volume of the tank. The remaining tanks are to be assumed either completely empty or completely filled, and the distribution of consumable liquids among these tanks is to be such as to obtain the greatest possible height above the keel for the centre of gravity.

4 In calculating free surface effects given in the preceding **-3**, the requirements specified in the preceding **-2** are to be complied with.

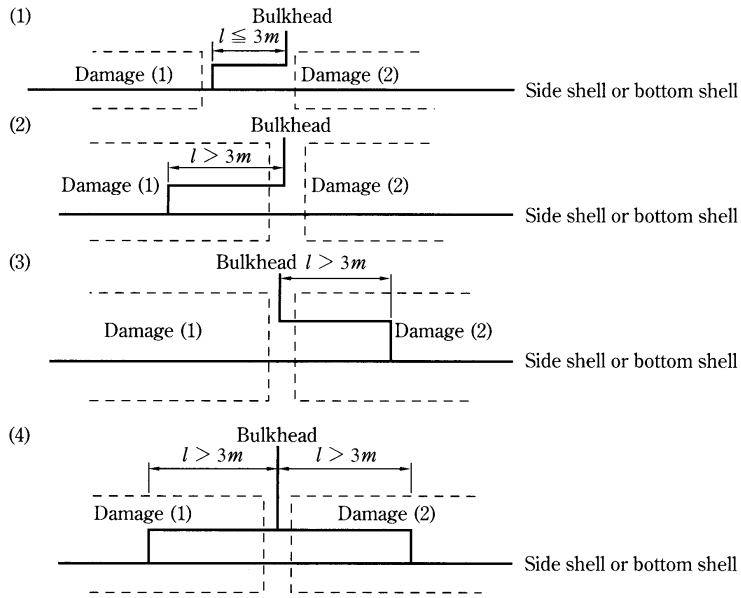
N2.~~7~~5.2 Permeability

For the purpose of the requirements in **2.~~7~~5.2, Part N of the Rules**, the Society may approve a lesser permeability in consideration of volume of the insulations etc. provided within the compartment.

N2.~~7~~5.4 Damage of Transverse Bulkhead

In applying the requirements for damage of transverse bulkhead specified in **2.~~7~~5.4, Part N of the Rules**, the extent of damage when the transverse bulkhead is stepped or recessed, are for example, as shown in **Fig. N2.~~7~~5.4**.

Fig. N2.~~7~~5.4



N2.~~7~~5.6 Equalization Arrangements

1 The equalization arrangements specified in **2.~~7~~5.6, Part N of the Rules** are to be made operable from a readily accessible place in the damaged condition before using the equalization arrangement.

2 The righting arm curve of the ship without using the equalization arrangement referred to in the preceding **-1** is to be determined in accordance with the requirements in **2.~~7~~5.3, Part N of the Rules**, but calculation in this case is to be made assuming that the cross-levelling pipe is closed or this equalization arrangement is not effectively functioning.

3 The cross sectional area of the cross-levelling pipe used for the equalization arrangement referred to in the preceding **-1** is to satisfy the value obtained from the following equation:

$$A \geq 7.5\frac{V}{\sqrt{H}}\left(cm^2\right)$$

where:

A : cross sectional area of cross-levelling pipe (cm^2)

V : estimated flooding volume in flooded compartment (cm^3)

H : height from the draught line before flooding to the centre line of pipe (m)

4 "Ducts of large cross-sectional area" referred to in **2.~~7~~5.6, Part N of the Rules** are to satisfy both of the following equations:

$$A \geq 150\frac{V}{\sqrt{H}}\left(cm^2\right)$$

$A \geq 2Sh\left(cm^2\right)$

where:

V : value obtained by the preceding **-3**

H : height obtained by the preceding **-3** to the centre of duct

S : frame distance (*cm*). However, in case of longitudinal framing system, *S* may be obtained from the following equation but not to be less than $61cm$:

$S = 45 + 0.2L_f\,(cm)$

$h = B/15(cm)$

N2.~~7~~5.7 Progressive Flooding

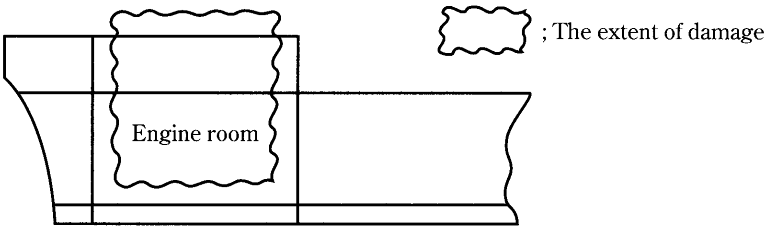
The "arrangements are to be such that progressive flooding cannot thereby extend" referred to in the requirements in **2.~~7~~5.7, Part N of the Rules** may be such as a stop valve operable from the exposed deck and accommodation space, etc. provided outside the extent of damage. In this case, any part of operating systems is to effectively function for assumed damage.

N2.~~7~~5.8 Buoyancy of Superstructure

1 For the purpose of **2.~~7~~5.8, Part N of the Rules**, the longitudinal extent of damage to superstructures above a machinery space located aft is to be the same as the longitudinal extent of the side damage to the machinery space specified **2.~~8~~6.1, Part N of the Rules**. (*See* **Fig. N2.~~7~~5.8**)

2 The sliding watertight doors specified in **2.~~7~~5.8(2), Part N of the Rules** are to be remotely operable from a readily accessible place in case of damage. Further, the openings of weathertight accepted within the minimum range of residual stability are to be capable of being securely closed at final equilibrium.

Fig. N2.~~7~~5.8



N2.8 Standard of Damage

N2.~~8~~6.1 General

1 For the purpose of the standard of damage specified in **2.~~8~~6.1, Part N of the Rules**, damage assumed to have sustained within $0.3L_f$ or thereabout from the stem are to be in accordance with the following requirements **(1)** and **(2)**:

(1) For bottom damage for $0.3L_f$ from the forward perpendicular and afore (according to **Table N2.2, Part N of the Rules**), such damage may not be considered beyond the point of $0.3L_f$ from the forward perpendicular.

(2) For cases of bottom damage which is applied to damage sustained in areas after the point of 0.3 L_f from the forward perpendicular (according to **Table N2.2, Part N of the Rules**), such damage is to be considered up to the point corresponding to ~~0.3 L_f - 5.0*m*~~ 0.3 L_f - 1/3 $L_f^{2/3}$ or 0.3 L_f - 14.5*m*, whichever is greater, from the forward perpendicular.

N2.~~9~~7 Survival Requirements

N2.~~9~~7.1 Survival Requirements

1 For the purpose of the requirements of **2.~~9~~7.1-2(1), Part N of the Rules**, openings specified in the following **(1)**, **(2)** and **(3)** may be regarded as watertight flash deck openings.

(1) Openings protected by tank covers with strength equivalent to deck plating.

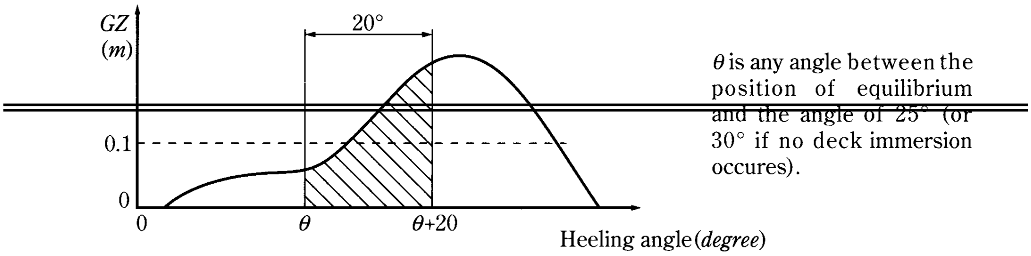
(2) Openings for cargo containment systems on the weather decks sealed with effectively packing of non-combustible material complied with the requirements in **3.2.33, Part R of the Rules** or equivalent and of sufficient strength.

(3) Sounding pipe with closing head.

2 For the purpose of **2.~~9~~7.1-3(1), Part N of the Rules**, openings capable of being closed weathertight whose immersion are accepted within the required range of residual stability are to be closed securely at final equilibrium after flooding. Openings which are unable to be closed by remote control are to be provided at the place readily accessible at the final equilibrium. However, the requirement may not apply to float type airpipes with automatic closing systems in water.

~~**3** For the purpose of **2.9.1-3(1), Part N of the Rules**, the righting lever curve may be considered to satisfy the requirements within the range of residual stability between the position of equilibrium and the angle or 25° (or 30° if no deck immersion occurs) further through 20° from any arbitrary angle of heel within the residual stability range. (*See* **Fig. N2.9.1**)~~

~~Fig. N2.9.1~~



N3 has been amended as follows.

N3 SHIP ARRANGEMENTS

N3.1 Segregation of the Cargo Area

N3.1.1 Segregation of the Hold Space

1 “~~The h~~ Hold spaces are to be located forward of machinery spaces of category *A*” referred to in **3.1.1, Part N of the Rules** means to be located forward of the forward bulkhead (including the stepped or recessed portions) in machinery spaces of category *A*. (*See* **Fig. N3.1.1**)

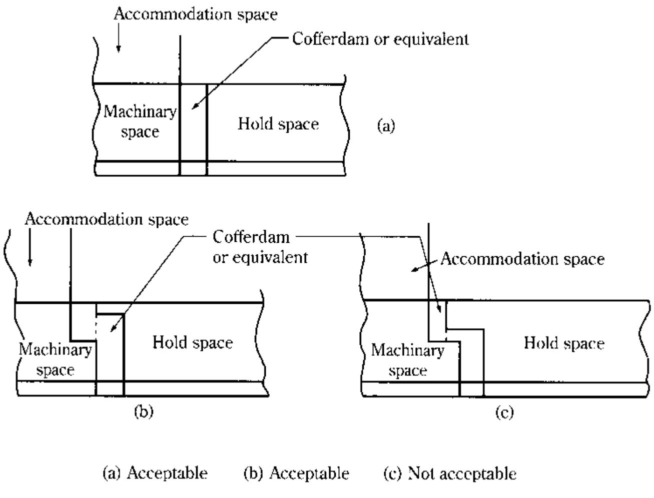
~~**2** Where machinery spaces of category *A* are located forward of hold spaces, which “deemed necessary by the Society for the safety or navigation of the ship” specified in the requirements in **3.1.1, Part N of the Rules**, the following requirements **(1)** and **(2)** are to be complied with:~~

~~(1) The requirements for fire protection and fire extinguishing for the machinery spaces of category *A* specified in **Part R of the Rules** are to be complied with.~~

~~(2) The requirements for periodically unmanned machinery spaces specified in **Part D**, **Part H** and **Part R of the Rules** are to be complied with. Further, the Society may give additional requirements when deemed necessary.~~

~~3~~2 For the purpose of the requirements in **3.1.1, Part N of the Rules,** ~~H~~hold spaces are neither to be located forward of the collision bulkhead nor aftward of the aft peak bulkhead.

Fig. N3.1.1



N3.1.2 In Case of a Cargo Containment System Not Requiring a Complete or Partial Secondary Barrier

1 “If there is no source of ignition or fire hazard” referred to in the requirements in **3.1.2, Part N of the Rules** means those compartments such as ballast tanks, fresh water tanks, cofferdams, fuel oil tanks, cargo service spaces where there is no source of ignition and is not normally entered by persons, cargo pump rooms and cargo compressor rooms, etc.

2 The packing used for bolted watertight manholes fitted on the boundaries of ballast tanks, cofferdams, fuel oil tanks, which are required to be segregated by single *A*-0 class divisions, may not be of non-combustible material.

N3.1.3 In Case of a Cargo Containment System Requiring a Complete or Partial Secondary Barrier

"If there is no source of ignition or fire hazard" referred to in the requirements in **3.1.3, Part N of the Rules** means the compartments specified in **N3.1.2-1**.

~~N3.1.5 Segregation of Cargo Piping~~

~~**1** For the purpose of the requirements in **3.1.5(1), Part N of the Rules**, combinations of a screw-down check valve and a check valve or of a spectacle flange and a stop valve are to be provided at the inter-connections of cargo or cargo vapour lines and inert gas lines necessary for the operation. (*See* **Fig. N3.1.5**)~~

~~**2** The screw-down check valve specified in the preceding **-1** may be replace with a combination of check valve and stop valve. Further, the spectacle flange may be replaced with a spool piece.~~

~~**3** "Vertical trunkway" referred to in the requirements in **3.1.5(3), Part N of the Rules** is to comply with the following requirements **(1)** through **(7)**:~~

~~(1) The access opening in the vertical trunkway is to comply with the requirements in **3.5.3, Part N of the Rules**.~~

~~(2) The bilge discharge system in the vertical trunkway is to comply with the requirements in **3.7.1-2** and **3.7.2, Part N of the Rules**.~~

~~(3) Vent system complying with the requirements in **8.2.2, Part N of the Rules** is to be provided.~~

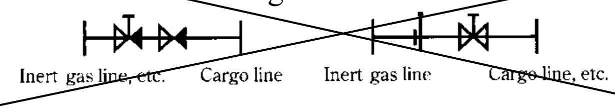
~~(4) Inerting system complying with the requirements in **9.2.2, Part N of the Rules** is to be provided.~~

~~(5) The electrical installations within the vertical trunkway are to comply with the requirements in **10.2.3-1, Part N of the Rules**.~~

~~(6) Ventilation system complying with the requirements in **12.2, Part N of the Rules** is to be provided.~~

~~(7) Gas detecting system complying with the requirements in **13.6.7, Part N of the Rules** is to be provided.~~

~~Fig. N3.1.5~~



~~N3.1.6 Emergency Cargo Jettisoning Piping System~~

~~For the purpose of the requirements in **3.1.6, Part N of the Rules**, the emergency cargo jettisoning piping system is to comply with the requirements in **3.8.3** and **3.8.7, Part N of the Rules**.~~

N3.1.7 Openings for Cargo Containment System

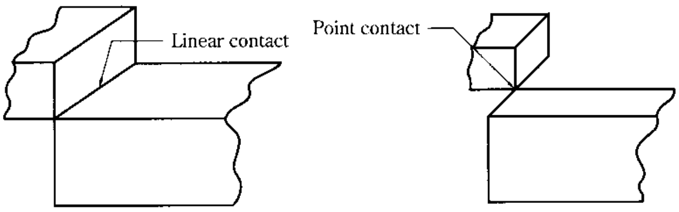
"~~The a~~ Arrangements for sealing the weather decks in way of openings for cargo containments systems" referred to in **3.1.7, Part N of the Rules** means the arrangements complying with the requirements in **20.2.1**, **20.2.2**, **20.2.3**, and **20.2.5-4.(3), Part C of the Rules**.

N3.2 Accommodation, Service and Machinery Spaces and Control Stations

N3.2.1 Segregation of Hold Spaces Requiring a Secondary Barrier

"To be so located as to avoid the entry of gas from the hold space to such spaces through a single failure of a deck or bulkhead" referred to in **3.2.1, Part N of the Rules** means that boundaries of the compartment are so arranged as not to make linear contact or point contact with hold spaces. (*See* **Fig. N3.2.1**)

Fig. N3.2.1



N3.2.2 Location of Air Intakes and Openings

Compliance with the requirements in **3.2.4**, **3.8.4**, **8.2.11~~0~~** and **12.1.5~~6~~, Part N of the Rules** would also ensure compliance with the requirement in **3.2.2**. Air outlets are subject to the same requirements as air inlets and air intakes.

N3.2.4 Arrangements of Entrances, Air Inlets and Openings

1 "Windows and sidescuttles...... they are so designed that a rapid and efficient gas and vapour tightening of the wheelhouse can be ensured" referred to in **3.2.4-2, Part N of the Rules** means those fitted with packing and clamping devices. These windows and sidescuttles are to be subject to hose tests or other suitable tests acceptable to the Society to verify their gas-tightness.

2 In case where clear view screens are provided in wheelhouse within the restricted area specified in **3.2.4-1, Part N of the Rules**, additional clamping devices are to be provided to the clear view screen or alternative arrangement of closing the window to make it gastight when the screen is not in rotating motion is to be made.

3 The requirements in **3.2.4, Part N of the Rules** may not apply to ships dedicated to the carriage of cargo which require neither (*F*) nor (*T*) in column "*f*" of **Table N19.1** in **Chapter 19, Part N of the Rules**.

4 In cases where it is impossible or impractical to satisfy the requirements specified in **3.2.4, Part N of the Rules**, entrances, air inlets and openings facing cargo areas may be provided subject to no sources of ignition in a hazardous area as defined in **1.1.5(~~15~~23), Part N of the Rules**. In such cases, explosion-protected electrical equipment complying with IEC 60092-502 is not regarded as a source of ignition.

N3.2.6 Closing Devices of Air Intakes, Outlets and Other Openings

1 For the purpose of the requirements in **3.2.6, Part N of the Rules**, closing devices for air intakes and openings are to have suitable gas-tightness where steel made fire protection flaps without gaskets are not accepted.

2 For the purpose of the requirements in **3.2.6, Part N of the Rules**, the closing devices in ships intended to carry toxic products the following requirements **(1)** and~~through~~ **(2~~4~~)** are to be complied with:

(1) The requirements in the ~~preceding~~ **-1** above are to be complied with.

~~(2) The compartments required to have closing means operable from inside are to be as follows:~~
~~(a) radio rooms and navigating rooms~~
~~(b) mess rooms and galleys~~
~~(c) cabins, lavatories and hospitals~~
~~(3) Internal closing is not required for such compartments not normally manned as listed below.~~
~~(a) deck stores~~
~~(b) forecastle stores~~
~~(c) engine room casings and steering gear compartments~~
~~(d) workshops~~
~~(e) cargo control rooms located within the cargo area~~

(2~~4~~) When internal closing is required, this is to include both ventilation intakes and outlets.

N3.3 ~~Cargo Pump Rooms and Cargo Compressor Rooms~~ Cargo Machinery Spaces and Turret Compartments

N3.3.1 Location

~~1~~ For the purpose of the requirements in **3.3.1, Part N of the Rules**, where ~~cargo pump rooms and compressor rooms~~ cargo machinery spaces are permitted to be fitted at the after end of the aftermost hold space or at the forward, the arrangements are, for example, as shown in **Fig. N3.3.1-1**.

~~2 For the purpose of the requirements in **3.3.1-1, Part N of the Rules**, the arrangement that cargo pump rooms and cargo compressor rooms are located below the exposed deck is not accepted.~~

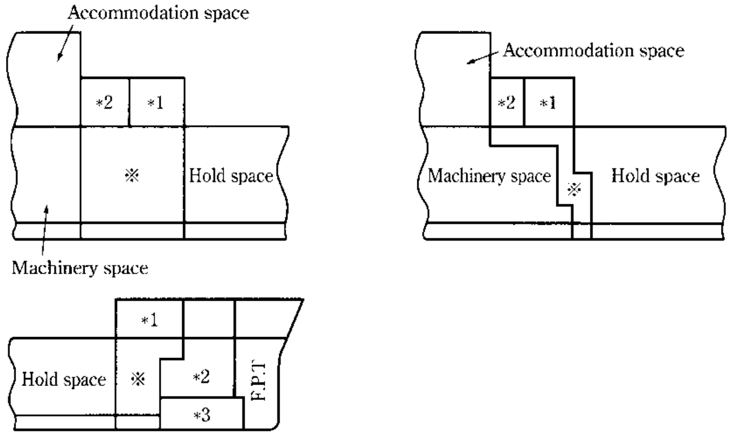
N3.3.2 Extension of the Limits of the Cargo Area

~~3~~ The compartments within the cargo area extended according to the requirements in **3.3.2~~1-2~~, Part N of the Rules** may not be regarded as hazardous ~~gas-dangerous~~ area as far as the following requirements **(1)** and **(2)** are complied with. (*See* **Fig. N3.3.2-1~~1-2~~**) However, consideration is to be given to the requirements in **3.3.3~~1-3~~, Part N of the Rules**.

(1) The access holes and air vents to the compartment are to have no openings to hazardous ~~gas-dangerous~~ areas.

(2) The compartment is not to fall under any compartments specified in **4.2.3-3** and **-4, Part H of the Rules**.

Fig. N3.3.1-1



Notes:

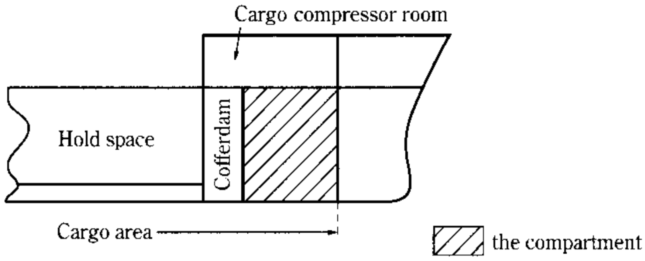
*1: ~~Cargo pump and cargo compressor room~~ Cargo machinery space

*2: Motor room

*3: Bow thruster room

※: It may be ballast tanks or void spaces as well as cofferdams or fuel oil tanks

Fig. N3.3.2-1~~1-2~~



N3.3.3 Bulkheads of the Cargo Machinery Spaces

~~4~~ The requirements in **3.3.3~~1-3~~, Part N of the Rules** are also to apply to cases where cargo area is not extended according to the requirements in **3.3.2~~1-2~~, Part N of the Rules**.

N3.3.4~~2~~ Cargo Compressors and Cargo Pumps ~~Gastight Seal of Shaft~~

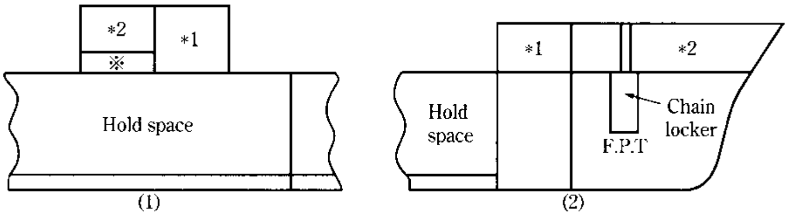
1 Shaft seals such as those manually feeding grease periodically are not considered as ensuring ~~the~~ "~~other means of ensuring the permanence of the gas seal~~ effective gastight segregation of the two spaces" referred to in **3.3.4~~2~~, Part N of the Rules**.

2 The shaft seals required in **3.3.4~~2~~, Part N of the Rules** are to be provided outside cargo pump rooms and cargo compressor rooms.

3 The arrangement of motor rooms housing electric motors driving cargo pumps and cargo compressors referred to in **3.3.4~~2~~, Part N of the Rules** is to be as, for example, shown in **Fig. N3.3.4~~2~~**(1). If the arrangement can not be complied with the above requirement in case of such as a small ship, it may be as, for example, shown in **Fig. N3.3.4~~2~~**(2), where the openings of compartments such as chain lockers considered as the source of ignition are provided in the motor rooms, however, the openings are to be closed by steel watertight covers fitted with warning signs stating that "the openings are to be always kept closed. If opened, the motor room is to be sufficiently ventilated."

4 The "motor rooms" referred to in the ~~preceding~~ **-3** above is to be arranged in ~~gas-safe space~~ a non-hazardous area.

Fig. N3.3.4~~2~~



Notes:
*1: Cargo pump and cargo compressor room
*2: Motor room
※: Cofferdam. It is to be needed for the hold space having secondary barrier.

N3.3.6~~3~~ ~~Access and Discharge of~~ Drainage

Drain plugs provided on the casing walls of the compartment for draining onto the exposed deck may be accepted, as the “Suitable arrangements...... to deal with drainage” referred to in **3.3.~~3~~6, Part N of the Rules**.

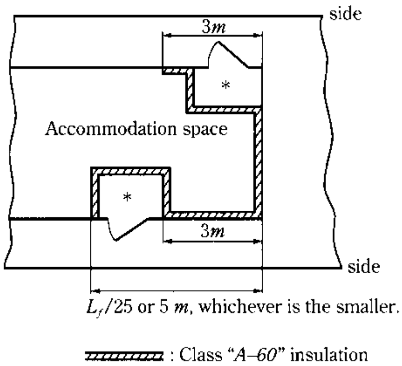
N3.4 Cargo Control Rooms

N3.4.1 Location

1 The boundaries where “*A*-60” class insulation is required according to the requirements in **3.4.1(~~2~~3), Part N of the Rules** are to be as, for example, shown in **Fig. N3.4.1**. The ceilings and floors of the cargo control room, asterisked in the drawing, are also to be applied with “*A*-60” class insulation.

2 The above requirements **-1** applies to other compartments (safety equipments locker, cargo equipment locker, etc.) than cargo control rooms, whose entrances, air inlets and openings are not applicable to the requirement of **3.2.4, Part N of the Rules**, too.

Fig. N.3.4.1



N3.4.3 Source of Ignition

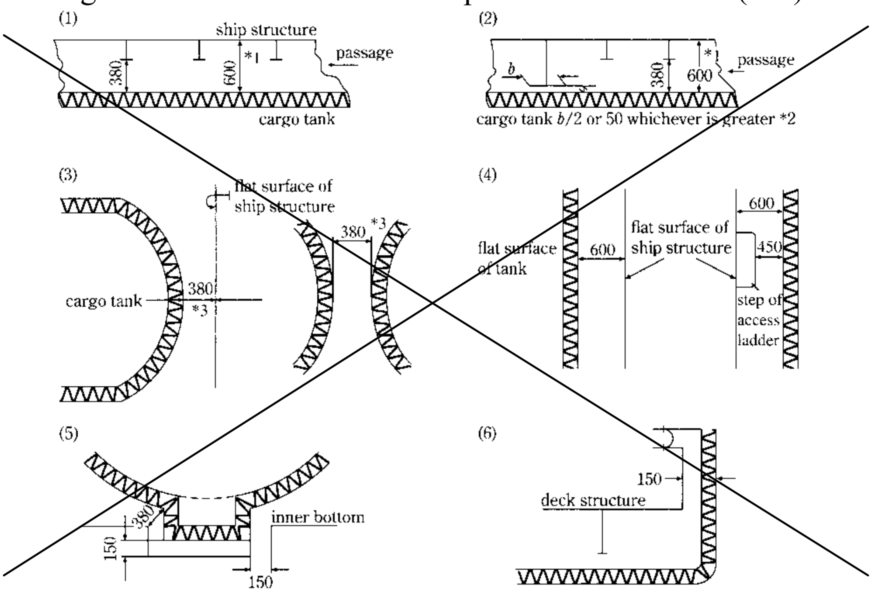
For the purpose of the requirements in **3.4.3, Part N of the Rules**, the electrical installations in the cargo control room are to comply with the requirements in **10.2.3~~1.4~~** and **10.2.4~~1.5~~, Part N of the Rules** depending on the location of the room. The cargo control room is to be provided with mechanical ventilation complying with the requirements in **12.1, Part N of the Rules**.

N3.5 Access to Spaces in the Cargo Area

~~N3.5.1 Access for Inspection of Inner Hull~~

~~The minimum clearance for inspection required in the requirement of **3.5.1, Part N of the Rules** are to be as shown in **Fig. N3.5.1**(1) through (6).~~

~~Fig N3.5.1 Access for Inspection of Insulation (*mm*)~~



~~Notes:~~

~~*1: This distance between the surface to be inspected and the surface to which above structural elements are fitted, e.g. deck, bulkhead or shell, should be at least 450*mm* in case of a curved tank surface(e.g. in case of C-tank).~~

~~*2: Where the surveyor does not require to pass between the surface to be inspected and any part of the structure.~~

~~*3: Where the surveyor does not require to pass between that curved surface, a smaller distance than 380*mm* may be accepted taking into account the curved surface.~~

~~Notes:~~

~~1) If necessary for inspection, fixed or portable staging should be installed. This staging should not impair the distances required above (1) to (4).~~

~~2) If fixed or portable ventilation ducting has to be fitted in compliance with **1.2.2, Part N of the Rules**, such ducting should not impair the distances required above (1) to (4).~~

~~3) If there is no suction well, notwithstanding figure (5) above, the distance between the cargo tank sump and the inner bottom may be reduced to 50 *mm*.~~

N3.5.2 Access for Inspection of Insulation

1 According to the requirements in **3.5.2, Part N of the Rules**, neither visual inspection may be required on one side of the insulation in hold spaces of membrane tanks and semi-membrane tanks nor apply the requirements in **3.5.3, Part N of the Rules**.

N3.5.3 Access to Hold Spaces, etc.

~~**1**~~ The details of minimum opening size required in **3.5.3(1)(b)** and **(c), Part N of the Rules** are to be as shown in **Fig. N3.5.3**.

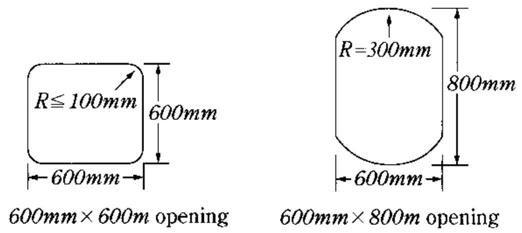
~~**2** In applying the requirements in **3.5.3(1)(b), Part N of the Rules**, type *C* independent tanks are to have access holes from exposed spaces with a diameter not less 600*mm*.~~

~~**3** In case where those tanks can not be provided with the access holes specified in the preceding **-1**, due to strength reasons in ships with L_f not more than 70*m*, they may be replaced with circular~~

~~holes with a diameter not less than 500*mm* or oval holes with equivalent open area. However, they are to be sufficient to allow entry by a personnel wearing protective clothing and to allow unconscious personnel to be removed from the space.~~

4 The requirements of **3.5.3(1)(b)** and **(c), Part N of the Rules** do not apply to spaces separated from hold spaces for independent tanks not requiring a secondary barrier ~~described in **4.7.1(2)(b), Part H of the Rules**~~.

Fig. N3.5.3 Opening Details



N3.5.4 Access to ~~Gas-safe Spaces~~ Non-hazardous Areas

"Open weather deck" referred to in the requirements of **3.5.4, Part N of the Rules** means the exposed part of the uppermost continuous deck within the cargo area.

N3.6 Air-locks

N3.6.1 Location of Gastight Doors

For the purpose of the requirements in **3.6.1, Part N of the Rules**, the steel doors for air-lock are to be verified for their gastightness by hose tests or other means considered appropriate by the Society, as necessary.

N3.6.2 Design and Arrangement of the Ventilation

"recognized standards acceptable to the Society" referred to in the requirements in **3.6.2, Part N of the Rules** means *IEC* 60092-502:1999.

N3.6.4 Maintenance of Overpressure in the Protected Space

For the purpose of the requirements in **3.6.4, Part N of the Rules**, maintenance of overpressure in spaces protected by air-locks is to be by the pressure differential sensing devices provided within the compartment, but alternatively, either of the following method **(1)** or **(2)** may be employed:

(1) The following means are considered acceptable alternatives to differential pressure sensing devices in spaces having a ventilation rate not less than 30 air changes per hour:
   (a) monitoring of current or power in the electrical supply to the ventilation motors; or
   (b) air low sensors in the ventilation ducts.

(2) In spaces where the ventilation rate is less than 30 air changes per hour and where one of the means specified in the ~~preceding~~ **(1)** above is fitted, in addition to the alarms required by **3.6.3, Part N of the Rules**, the arrangements are to be made to de-energize electrical equipment which is not of the certified safe type, if more than one air-lock door is moved from the closed position.

N3.6.5 Electrical Equipments in the Protected Space

For the purpose of the requirements in **3.6.5, Part N of the Rules**, electrical equipment of certified safe type is to be selected in accordance with the classification of hazardous areas adjoining to airlock spaces, gas and vapour.

~~N3.6.5 Ventilation~~

~~**1** For the purpose of the requirements in **3.6.5, Part N of the Rules**, the ventilating fans and their air intakes are to be provided in the gas-safe space. However, the ventilating fans may not comply with the requirements in **12.1, Part N of the Rules**. Protection screens of not more than 13*mm*×13*mm* square mesh is to be fitted in outside openings of ventilation ducts.~~

~~**2** For the purpose of the requirements in **3.6.5, Part N of the Rules**, verification of maintenance of pressure in spaces protected by air-locks is to be by, for example, monitoring of current in electrical supply to the ventilation motors, air flow sensors in the ventilation ducts or pressure differential sensing devices. The standard ventilation rate in the air-lock space is 8 air changes per hour.~~

N3.7 Bilge, Ballast and ~~Fuel~~ Oil Fuel Arrangements

N3.7.1 Drainage Arrangements ~~of Hold Spaces~~ Not Requiring a Secondary Barrier

1 For the purpose of the requirements in **3.7.1~~-1~~, Part N of the Rules**, the drainage arrangements of hold spaces are to be of bilge pumps and bilge pipings provided within the cargo area complying with the requirements in **13.5, Part D of the Rules**, or to be of bilge suction system by eductors. In the case of bilge eductors, those capacity and arrangement are to comply with the requirements in **13.5.4-2, Part D of the Rules**.

2 Where eductors are provided in accordance with the ~~preceding~~ **-1** above, stop valves are to be provided in driving water lines at the aft end of the cargo area, and the branch lines of the driving water line are to be fitted with screw-down check valves.

3 For the purpose of the requirements in **3.7.1~~-1~~, Part N of the Rules**, means to detect gas leakage in hold spaces, when the hold spaces are not inerted, may be of sounding pipes specified in **13.8, Part D of the Rules**. When hold spaces are inerted, the requirements in ~~**-4**~~**N3.7.2** are to be complied with.

N3.7.2 Drainage Arrangements Requiring a Secondary Barrier

~~**4**~~ For the purpose of the requirements in **3.7.2~~1-2~~, Part N of the Rules**, the drainage arrangements of hold spaces are to comply with the requirements in ~~the preceding~~ **N3.7.1-1** and **-2**. The means of detecting gas leakage in hold spaces is to be of the level alarm system of closed type complying with the requirements in **13.2.3~~2~~(3), Part N of the Rules**. In case where the sounding pipes are provided together with gas leakage detector, an automatic closing head is to be fitted at the each of upper end of the sounding pipes.

N3.7.3~~2~~ Drainage System of Interbarrier Spaces

For the purpose of the requirements in **3.7.3~~2~~, Part N of the Rules**, the drainage arrangements for dealing with any leakage into the hold or interbarrier spaces are to comply with the following requirements **(1)** through **(3)**:

(1) In case where estimation of leakage of liquid cargo is not carried out, the capacity of the drainage arrangements is to comply with the requirements in **13.5, Part D of the Rules**.

(2) The drainage arrangements to deal with the leaked cargo may commonly serve as those required in **3.7.2~~1-2~~, Part N of the Rules**.
(3) The piping system of the drainage arrangements of leaked cargo is to comply with the requirements in **Chapter 5, Part N of the Rules**. The water-driven eductor is not accepted as such arrangement.

N3.7.5~~4~~ Connection to Pumps in the Machinery Spaces

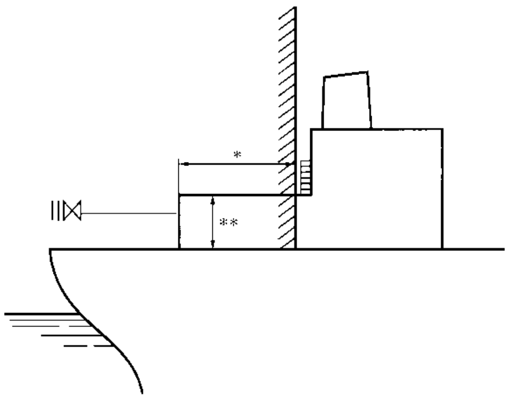
The requirement relating to pump vents of **3.7.5-3~~4~~, Part N of the Rules** ~~does not apply~~ applies only to pumps in the machinery spaces led to ballast tanks, fuel oil tanks and ~~gas-safe~~ non-hazardous spaces.

N3.8 Bow ~~or~~and Stern Loading and Unloading Arrangements

N3.8.4 Arrangements of Entrance, Air Inlets and Openings

For the purpose of application of the requirements in **3.8.4, Part N of the Rules**, the arrangements of air ~~intakes~~ inlets and openings are, for example, not to be provided within the shadowed range in **Fig. N3.8.4**.

Fig. N3.8.4



Notes:

* = L_f/25 or 3*m*, whichever is the greater, but need not exceed 5*m*.

** = To be of the standard height of superstructure, prescribed in the 1966 International Load Line Convention or more

N4 has been deleted and new Chapter 4 has been added as follows.

N4 CARGO CONTAINMENT

N4.3 Functional Requirements

N4.3.2 Environmental Condition

The standard used for the "North Atlantic environmental conditions and relevant long-term sea state scatter diagrams" referred to in the requirements in **4.3.2**, **Part N of the Rules** is to be *IACS* Reccommendation No. 34 "Standard Wave Data".

N4.3.5 Corrosion Allowances, etc.

1 The corrosion allowance "where there is no environmental control around the cargo tank, such as inerting" referred to in the requirements in **4.3.5**, **Part N of the Rules**, in the case of steel, is to be 1*mm*. Except for tanks carrying cargoes containing considerable amounts of impurities or corrosive substances such as chroline and sulfa dioxide, no corrosion allowance may be required for aluminum alloys and stainless steel.
2 For the purpose of the requirements in **4.3.5**, **Part N of the Rules**, no corrosion allowance may be required for the internal surface of pressure vessels including the Type *C* independent tank except for the case where corrosive substances are to be loaded. For the exterior surface where there is no environmental control around the cargo tank such as inerting or where there is no protection by suitable insulation materials having the approved vapour barrier, the corrosion allowance for steel is to be the smaller of 1*mm* or 1/6 of the required thickness excluding the corrosion allowance. Paint or other thin coatings are not to be credited as protection.
3 In case where no corrosion allowance is considered for cargo tanks protected by insulation according to the requirements in **4.3.5, Part N of the Rules**, the air-tightness of the vapour barrier of insulation structure is to have been verified. This air-tightness is to be verified in the test of insulation specified in the requirements in **4.19.3, Part N of the Rules**.

N4.3.6 Inspection/Survey Plan

With respect to the wording "An inspection/survey plan for the cargo containment system" specified in the requirements in **4.3.6**, **Part N of the Rules,** reference is to be made to the special requirements for ships carrying liquefied gases in bulk specified in **Chapters 3** to **5**, **Part B of the Rules** as applicable to surveys for cargo containment systems in addition to requirements specified in this Part.

N4.5 Secondary Barriers in relation to Tank Types

The conditions for approving partial secondary barrier for the semi-membrane tanks specified in Note 2 of **Table N4.1**, in **4.5**, **Part N of the Rules** are to be in accordance with the following **(1)** through **(6)**:

(1) Detailed stress analysis is to be carried out. Wave loads as the design load are to be assumed in details according to the requirements in **4.14.1**, **Part N of the Rules**. The results of stress analysis are to be verified for the accuracy by measuring the stresses at time of pressure tests on a real ship or model test.
(2) The results of stress analysis under the requirements in the preceding **(1)** are not to exceed the allowable stress specified in the requirements in **4.22.3-1(1)**, **Part N of the Rules**.

(3) The requirements in **N4.22.2(6)**, **(7)** and **(9)** are to be complied with.
(4) Cargo tanks are to be subjected to buckling analysis depending on their structural type whereby it is to be verified that they have sufficient strength against buckling.
(5) Repair procedures for cargo tanks are to be established. On the fatigue strength and crack propagation analysis in case such repair procedures have been applied, assessments are to be carried out by applying the requirements in **N4.22.2(6)** and **(7)** correspondingly.
(6) The hull structure adjacent to cargo tanks is to be subjected to strength analysis compatible with the case of cargo tanks. In addition to carrying out detailed stress analysis by the method of which accuracy has been verified by stress measurements, etc., it is to be verified that the strength is sufficient through the fatigue strength analysis and crack propagation analysis done by applying the requirements in **4.22.4**, **Part N of the Rules** correspondingly.

N4.6 Design of Secondary Barriers

N4.6.1 Hull Structure Acting as a Secondary Barrier

1 For the purpose of requirements in **4.6.1(2)**, **Part N of the Rules**, thermal stress analysis is to be carried out for the calculation condition in case of cargo leakage specified in the requirements in **4.19.1(1)** and **(2)**, **Part N of the Rules**.
2 The combined stress of the maximum membrane stress or the maximum bending stress obtained in the analysis of the preceding **-1** and the static stress created by the static load specified in the requirements in **4.13**, **Part N of the Rules** is not to exceed 90% of the yield stress of the material.
3 In the ship designed under the same design temperature and loading conditions of similar ships where it is verified that the thermal stress is sufficiently small, the Society may accept omission of the analysis referred to in the preceding **-1**.

N4.6.2 Standards of Secondary Barrier

1 For the purpose of the requirements in **4.6.2**, **Part N of the Rules**, the secondary barriers of non-metal material are to conform to the following requirements **(1)** to **(3)**:
(1) Compatibility with the cargo is to have been verified, and to have necessary mechanical properties at the cargo temperature under the atmospheric pressure.
(2) A model test may be required to prove that the secondary barrier has effective performance when the Society deems it necessary.
(3) For welded joints, welding procedure tests and production test are to be conducted. The test plans for the above are to have been approved by the Society beforehand.

2 For the purpose of the requirements in **4.6.2(1)**, **Part N of the Rules**, no special analysis of the complete secondary barrier for verifying that "it is capable of containing any envisaged leakage of liquid cargo for a period of 15 *days*" may be carried out except for cases where the Society deems it specially necessary.
3 In principal, Openings such as manholes are not to be provided in secondary barriers.
4 For the purpose of the requirements in **4.6.2(4)**, **Part N of the Rules**, the test procedure where visual inspection of the secondary barrier is not possible is to be in accordance with the following requirements **(1)** to **(3)**:
(1) The inspection method of the secondary barrier and its criteria relating to the performance to act as the secondary barrier are to be verified for their effectiveness through model test.
(2) The secondary barrier is to be verified by model test for the required performance. This model test is to be capable of verifying that the secondary barrier can maintain the necessary performance throughout the life of the ship.

(3) When sufficient data to prove the effectiveness and reliability relative to the preceding **(1)** and **(2)** are submitted to the satisfaction of the Society, this model test may be omitted.

5 For the purpose of the requirements in **4.6.2(6), Part N of the Rules**, the extent of the secondary barrier is, at least, to cover the surface of leaked liquid cargo corresponding to a static heel angle of 30°.

6 The "surface of leaked liquid cargo" referred to in the preceding **-5** means a surface of fully leakage of fully loaded cargo for the complete second barrier, and of liquid cargo determined in accordance with the requirements in **4.7.2**, **Part N of the Rules** for the partial secondary barriers.

7 For spaces outside the extent of the secondary barriers specified in the preceding **-5**, the hull structures are to be protected against splashes of leaked cargo by the spray shields specified in the requirements in **4.7.1**, **Part N of the Rules**, or the extent of the secondary barrier is to be suitably extended.

N4.7 Partial Secondary Barriers and Primary Barrier Small Leak Protection System

N4.7.1 General

The spray shield specified in the requirements in **4.7.1**, **Part N of the Rules** is to have been verified by test that it has satisfactory performance to act as the shield.

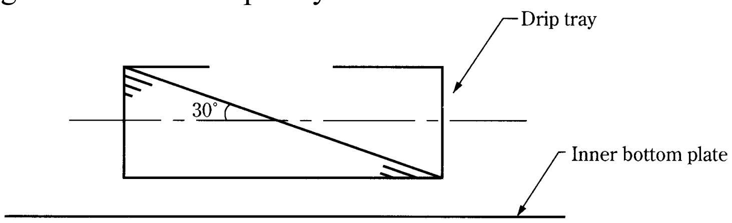
N4.7.2 Partial Secondary Barriers

For the purpose of the requirements in **4.7, Part N of the Rules**, the protection of the inner bottom plating at the lower part of cargo tanks is to conform to the following requirements **(1)** and **(2)**:

(1) According to the requirements in **4.6.1**, **Part N of the Rules**, the inner bottom plating is to act as the secondary barrier.

(2) In case where a drip tray is provided as a secondary barrier for example as shown in **Fig. N4.7.2**, with consideration so as not to allow the leaked liquid cargo to overflow from the secondary barrier, no protection may be required. However, where no such consideration is taken, the inner bottom plating is to be protected by insulation materials.

Fig. N4.7.2 Drip Tray to Protect the inner Bottom Plate



N4.8 Supporting Arrangements

N4.8.1 General

1 In spaces between the refrigerated tanks and supports, suitable insulation materials are to be provided so that hull structure might not be cooled excessively through the supporting structures according to the requirement of **4.10.1**, **Part N of the Rules**.

2 The analysis of supporting structures against the load conditions specified in the requirements in **4.13.9** and **4.14.1, Part N of the Rules** is to be done while giving considerations to the following conditions **(1)** and **(2)**:

(1) A condition where static load by the weight of cargo tank containing the cargo at a static heel angle of 30° and the static sea water pressure without dynamic pressure due to waves is imposed.

(2) A condition where load by the weight of cargo tank containing the cargo with the acceleration caused by ship motions specified in the requirements in **4.14.1**, **Part N of the Rules** and the dynamic sea water pressure due to waves are imposed. Such dynamic sea water pressure due to waves may be determined by the requirements in **C31.1.3**.

3 The results of analysis for the conditions indicated in the preceding **-2** are not to exceed the allowable stress determined depending upon the type of cargo tank. Further, sufficient safety factor against the critical buckling stress is to be considered.

N4.13 Functional Loads

N4.13.2 Internal Pressure

For the purpose of the requirements in **4.13.2-2**, **Part N of the Rules**, when a design vapour pressure either higher or lower than 45°C is employed, the ambient temperature is to be of the highest atmospheric temperature of the sea area which is the permanent trade area of the ship obtained from the weather data covering a long period.

N4.13.4 Thermally Induced loads

1 For the purpose of the requirements in **4.13.4-1, Part N of the Rules**, arrangements for cooling down are to be provided so as not to cause excessive stress on the tank structures. Further, where cargo with temperature lower than 0°C but not lower than -55°C is carried, such installations for cooling down are also to be provided.

2 The arrangements shown in the preceding **-1** are to be such that safety in cooling down using the arrangements has been proved by records of cargo tanks of similar design or cooling down operation is performed at a rate not exceeding the safe temperature reduction curve which has been proved by thermal stress analysis.

3 The installations shown in the preceding **-1** are to be also capable of performing cooling down at time when excessive thermal loads may be anticipated due to splashing of the residual cargo liquid in ballast passage of the ship under heavy weather as well as at time of cargo loading.

4 For the purpose of the requirements in **4.13.4-2, Part N of the Rules**, no thermal stress analysis may be required for cargo tanks with design temperature of -10°C or upward, in general. In cargo tanks with design temperature at -55°C or below, the structural strength is to be verified through thermal stress analysis by taking into account the vertical temperature distribution at time of cooling down and partial cargo loading, and when necessary, the temperature distribution in the direction of the plate thickness of plating of full loaded tanks.

5 For tanks other than those specified in the preceding **-4**, the Society may request thermal stress analysis of the cargo tank by taking into account the constraining condition of the cargo tank by tank supporting structure in case where the tank supporting system is special, and thermal analysis in consideration of the effect of materials with different coefficients of thermal expansion in case where such materials are used.

6 In the cases referred to in the preceding **-4** and **-5** where the type of tank supporting system is special, the Society may request thermal analysis on the tank supporting structure itself.

N4.13.5 Vibration

For the purpose of the requirements in **4.13.5**, **Part N of the Rules**, the cargo tank plates and stiffeners are to have such scantlings as not to be caused harmful effects by resonance with the vibrations of exciting sources such as propeller and main engine. The natural frequencies of the cargo tanks and stiffeners used in the above assessment are to be the minimum values in a state in contact with cargo liquid.

N4.13.8 Test Loads

1 For the purpose of the requirements in **4.13.8**, **Part N of the Rules**, in the case of type *B* and *C* independent tanks, that their stress levels under the pressure tests are to be confirmed that they are within the stress range specified in the **4.22.6** and **4.23.6**, **Part N of the Rules**.

2 The cargo tanks other than those indicated in the preceding **-1**, are to be verified in strength undergoing the enough analysis required for each tank type in considering the internal pressure distribution at the time of the pressure test. However, when the detailed analysis is carried out, the preceding **-1** may apply.

N4.13.9 Static Heel Loads

1 For the purpose of the requirements in **4.13.9**, **Part N of the Rules**, the added mass due to hull damage or flooding may not be considered.

2 For the purpose of the requirements in **4.13.9, Part N of the Rules**, the strength assessment in way of supports of type C independent tanks made of carbon manganese steel is to be in accordance with the following **(1)** through **(3)**:

(1) The following criterion for the allowable stresses in way of supports may be used:

$$\sigma_e = \sqrt{(\sigma_n + \sigma_b)^2 + 3\tau^2} \le \sigma_a$$

where:

σ_e =equivalent stress (N/mm^2), to be calculated over the full extent of the stiffening ring for a sufficient number of load cases as defined in **4.13.9, Part N of the Rules**.

σ_n = normal stress (N/mm^2) in the circumferential direction of the stiffening ring

σ_b = bending stress (N/mm^2) in the circumferential direction of the stiffening ring

τ = shear stress (N/mm^2) in the stiffening ring

σ_a =allowable stress (N/mm^2), to be taken as the smaller of the values:

$0.57R_m$ or $0.85R_e$

R_m and R_e as defined in **4.18.1(3), Part N of the Rules**.

(2) The following assumptions are to be made for the stiffening rings:

(a) The stiffening ring is to be considered as a circumferential beam formed by web, face plate, doubler plate, if any, and associated shell plating. The effective width of the associated plating is to be taken as the following i) and ii):

i) For cylindrical shells:

An effective width (*mm*) not greater than $0.78\sqrt{rt}$ on each side of the web. A doubler plate, if any, may be included within that distance.

where:

r = mean radius of the cylindrical shell (*mm*)

t = shell thickness (*mm*)

ii) For longitudinal bulkheads (in the case of lobe tanks):

The effective width is to be determined according to established standards. A value of $20t_b$ on each side of the web may be taken as a guidance value.

where:

t_b = bulkhead thickness (*mm*).

(b) The stiffening ring is to be loaded with circumferential forces, on each side of the ring, due to the shear stress, determined by the bi-dimensional shear flow theory from the shear force of the tank.

(3) The following **(a)** through **(c)** are to be taken into account:

(a) Elasticity of support material (intermediate layer of wood or similar material)

(b) Change in contact surface between tank and support, and of the relevant reactions, due to the following i) and ii)

i) thermal shrinkage of tank

ii) elastic deformations of tank and support material.

The final distribution of the reaction forces at the supports is not to show any tensile forces.

(c) Buckling strength of stiffening rings

N4.14 Environmental Loads

N4.14.1 Loads due to Ship Motion

The "ships for restricted service" referred to in **4.14.1-5, Part N of the Rules** means those ships with notations "*Coasting Service*" or "*Smooth Water Service*" affixed. In this case, the dynamic load may be determined by the results of calculation of ship motions carried out on the basis of the data on sea and weather conditions at the navigating area which are considered appropriately by the Society.

N4.14.3 Sloshing Loads

1 For the purpose of the requirements in **4.14.3, Part N of the Rules**, sloshing loads are to be determined in such a way that assessments are made by model experiment for each type of cargo tanks. For cargo tanks where partial filling is intended, data concerning the resonant period of the hull and natural period of the liquids are to be available on board the ship for avoiding the danger of resonance.

2 Notwithstanding the requirements in the preceding **-1**, in the type C independent tank in ships with L_f not exceeding 90m, consideration for structural strength of cargo tanks due to sloshing loads may not be necessary. For tanks partial filling is intended, however, sufficient consideration is to be taken for the installation of equipments in cargo tanks such as cargo piping and cargo pump, against impact loads due to sloshing.

N4.18 Design Conditions

N4.18.1 Ultimate Design Condition

For the purpose of the requirements in **4.18.1(3), Part N of the Rules**, the values of R_e and R_m when the strength of welds is less than that of the parent metal as in the case of 9% nickel steel are to be of the required values of mechanical properties of the weld metal. For welded joints of aluminium alloys 5083-*O* and 5083/5183 and 9% nickel steel, the values of R_e and R_m may be modified in consideration of the increase in the yield stress and tensile stress at low temperature after taking into account the welding procedure employed.

N4.18.2 Fatigue Design Condition

1 For the purpose of the requirements in **4.18.2-5, Part N of the Rules**, the stress due to fatigue load may be generally determined by using the cumulative probability curve as shown in **Fig. N4.18.2**.

2 When the fatigue strength analysis specified in the requirements in **4.22.4, Part N of the Rules** is carried out using the frequency distribution of cyclic stress shown in the preceding **-1**, the number of representative stress (σ_i) is to be eight, and σ_i and its number of repetition n_i may be obtained from the following equation:

$$\sigma_i = \frac{17-2i}{16}\sigma_{max}$$

$$n_i = 0.9 \times 10^i$$

where:

$i = 1, 2, \ldots, 8$

σ_{max}: Stress induced by the predicted maximum dynamic load (half amplitude)

3 For the purpose of **4.18.2-6(3), Part N of the Rules**, the fatigue load used in the calculation of propagation speed of fatigue cracks is, as a rule, to be the predicted maximum load value that can occur at the most severe period in the trade area specified. In case where analysis is made by using the load frequency distribution given in **Fig. N4.4 in Part N of the Rules**, the number of representative stress (σ_i) is to be set at five and σ_i and its number of repetition n_i may be obtained from the following equations:

$$\sigma_i = \frac{5.5-i}{5.3}\sigma_{max}$$

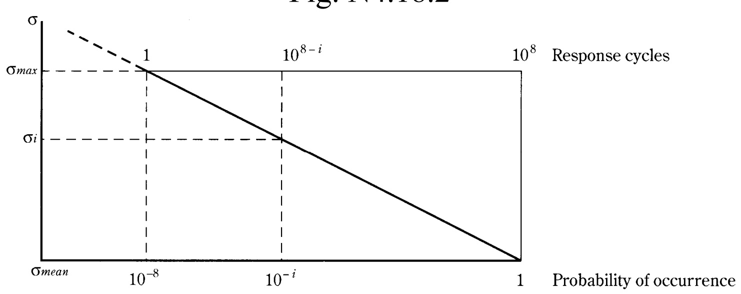
$$n_i = 1.8 \times 10^i$$

where:

$i = 1, 2, \ldots, 5$

σ_{max}: Stress created by the predicted maximum load

Fig. N4.18.2



N4.19 Materials

N4.19.1 Materials forming Ship Structure

For the purpose of the requirements in **4.19.1-1, Part N of the Rules**, the calculation conditions in computing the temperature of hull structures are to be in accordance with the following **(1)** through **(4)**:

(1) The loading condition of the ship for the calculation is to be full-loaded condition.

(2) At the upright cargo leakage is to be considered for the calculation in accordance with the following **(a)** through **(d)**. However, no leakage may be considered for integral tanks and type *C* independent tanks.

(a) It is to be assumed that the failure of all cargo tanks located between transverse watertight bulkheads are caused. However, in case where the cross section of the ship is divided into more than one compartments by longitudinal bulkheads of the ship, it is to be assumed that the failure of all cargo tanks within each such compartment are caused.
(b) It is to be assumed that the locations of the failure of the cargo tank cover all conceivable ones.
(c) It is to be assumed that only the liquid cargo leaks out where the cargo tank, supports and hull remain intact without involving any deflections or fracture.
(d) For cargo tanks where the complete secondary barrier is required according to the requirements in **4.5, Part N of the Rules**, it is to be assumed that the leakage of liquid cargo occurs instantaneously and the levels of residual liquid cargo in damaged cargo tank and the leaked liquid level in the hold space reach the same level instantaneously.

(3) The boundary conditions of the calculation model are to be in accordance with the following requirements **(a)** through **(i)**:
(a) The temperature of the compartment adjacent to hold spaces is to be determined by heat transmission calculation. The atmosphere of the compartment which is adjacent to the compartment contiguous to hold space may be taken as a still air at 0°C. In the case of machinery space, it may be assumed as a still air at 5°C.
(b) It is to be assumed that there is no radiation of sun beam.
(c) The structures in hold space such as insulation materials and supports are to be assumed that they do not absorb liquid cargo.
(d) It is to be assumed that the gas and liquid within the same compartment are at the same temperature.
(e) At time of damage to the cargo tank, the gaseous phase in the cargo tank and that in hold spaces are to be assumed to have a pressure equals to the atmospheric pressure.
(f) It is to be assumed that there is no transfer of gases within the insulation materials.
(g) It is to be assumed that there is no influence of moisture.
(h) The ship is to be assumed to stay upright.
(i) It is to be assumed that there is no influence of paints.

(4) The calculation conditions in heat transmission calculation are to be in accordance with the following requirements **(a)** through **(h)**:
(a) Temperature distribution and heat transmission are to be dealt with as the phenomena in a steady state. No transient condition may be considered.
(b) Sea water is to be assumed to have a density of 1,025kg/m^3 and a coagulation point of -2.5°C with physical properties compatible with those of fresh water for other items.
(c) The liquid cargo is to be assumed to have uniform temperature distribution.
(d) The heat transfer coefficients at various boundaries can be computed by using the numeral values given in **Table N4.19.1**, but calculation may be carried out by using empirical equations given in the heat transfer engineering data which has been made public. In this case, heat transfer due to radiation is also to be taken into account.
(e) The substance for which temperature distribution is investigated is to be assumed to be of homogeneous one without directivity.
(f) Frames may be dealt with as fins.
(g) In case where hold spaces located forward and afterward the hold space under study are in the same conditions, they may be treated as a two-dimensional problem.
(h) The temperature of structural members is to be represented by the temperature at their half thickness, and for individual members, the following requirements **i)** through **iv)** are to be complied with:
i) The temperature of those frames fitted to plates is to be assumed to be the same as

the temperature of the plates, but when the temperature distribution of the frame in the direction of depth is known, the area mean of the temperature distribution may be taken.

ii) The temperature of web frames supporting frames or plates is to be the temperature at their half depth for webs, and the temperature of face plates for these.

iii) The temperature of members connecting the inner shell and outer shell, e.g., brackets and girders is to be of the mean of the temperature of the inner shell and that of the outer shell.

iv) The temperature of brackets is to be the temperature at their centroid.

Table N4.19.1 The Heat Transfer Coefficient at Various Boundaries

Boundaries			Heat transfer coefficients ($W/m^2 \cdot {}^\circ C$)
Still gas	↔	Hull or liquid	5.8
Still sea water	↔	Hull	116.3
Cargo vapour	↔	Hull attached to air	11.6

2 For the purpose of the requirements in **4.19.1-3**, **Part N of the Rules**, brackets, panel breakers on such as girders, tripping brackets and docking brackets provided to prevent buckling of structural members may be excluded from the application of the requirements.
3 Notwithstanding the requirements in the preceding **-2**, for longitudinal strength members and stiffeners in deep tanks and watertight bulkheads among those shown above the requirements apply.

N4.19.2 Materials of Primary and Secondary Barriers

When the design temperature of a material falls under the higher temperature range than the specified one for the material in **Table N6.3** and **Table N6.4**, **Part N of the Rules**, the impact test temperature given in **Table N6.1** to **Table N6.4**, **Part N of the Rules** correspondingly to the design temperature may be used instead of the impact test temperature depending on the material. For example, in the case of 2.25%*Ni* steel pipes used at the design temperature of -45°C, the impact test temperature may be -50°C, while in the case of 3.5%*Ni* steel plates used at the design temperature of -61°C, the impact test temperature may be -70°C.

N4.19.3 Thermal Insulation and Other Materials used in Cargo Containment Systems

1 For the purpose of the requirements in **4.19.3-1, Part N of the Rules**, insulation materials of independent tanks and integral tanks are to be free from generating harmful defects that degrade the insulation performance even under such conditions of service that can actually take place in insulation structure including forced deflection and thermal expansion and contraction.
2 The performance referred to in the preceding **-1** is to be verified in the insulation procedure test specified in **-3** as necessary.
3 For the purpose of the requirements in **4.19.3-2, Part N of the Rules**, tests and inspection specified in the following **(1)** and **(2)** are to be carried out.

(1) The insulation materials are to be approved in accordance with the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**". In the above, tests and inspection are to be conducted according to the procedures on the manufacture, storage, handling and product quality control established by the manufacturer.

(2) The inspection for insulation work is to include the following items of tests and inspections **(a)** to **(c)**:

(a) Insulation procedure test

For insulation system and insulation procedure without previous records, tests are to be conducted in accordance with the test plan approved by the Society. The test may be conducted at the manufacturer of insulation materials or shipyard as necessary.

(b) Insulation production test
In accordance with the test plan approved by the Society in advance, tests are to be conducted to verify the work control, working environment control and product quality control during insulation procedure.

(c) Completion inspection
After the insulation work is completed, inspection is to be conducted for dimensions, shape, appearance, etc. in accordance with the procedures already approved by the Society, and in addition, the insulation performance is also to be verified in the test specified in **4.20.3-5, Part N of the Rules**.

4 For the purpose of the requirements in **4.19.3-2, Part N of the Rules**, the properties of insulation materials are, in general, to be verified by the tests given in **Table N4.19.3**.

5 In addition to complying with the requirements in the preceding **-4**, property verification test may be requested by the Society depending on the insulation system.

6 If the material, which has been approved according to the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**", satisfies the performance requirements and such performance is considered to serve the purpose, the tests referred to in the preceding **-4** may be omitted.

7 For insulation materials to which the requirements in the preceding **-4** to **-6** do not apply, the following requirements **(1)** and **(2)** are to be complied with:

(1) For insulation materials used for supports of independent tanks, the requirements given in the column of membrane tank and semi-membrane tank in **Table N4.19.3** apply.

(2) For insulation materials provided in cargo tanks to which no provision of insulation is required according to the requirements in **4.10.1, Part N of the Rules**, data on the necessary properties of those specified in **4.19.3-2, Part N of the Rules** depending on the insulation system is to be submitted to the Society.

Table N4.19.3 Properties of Insulation Material for Cargo Tank Types

No.	Ensuring items		Integral tank	Membrane/ Semi-membrane tank	Type A/B independent tank	Type C independent tank	Note
1	Compatibility with the cargo			○[1]	○[1]		
2	Solubility in the cargo			○[1]	○[1]		
3	Absorption of the cargo		□	○[1]	○[1]		
4	Shrinkage			○[1]	○[1]		
5	Ageing		□	○	○[1]	□	
6	Closed cell content		△	△	△	△	applied only to closed cell material
7	Density		○	○	○	○	
8	Mechanical properties	Bending strength	○	○	○	○	
		Compress strength		○			
		Tensile strength	○	○	○	○	
		Shearing strength	○	○			
9	Thermal expansion		□	○	○[2]	○[2]	
10	Abrasion			○			
11	Cohesion		□	△	△[1]	□	applied to cohered material
12	Thermal conductivity		○	○	○	○	
13	Resistance to vibration		△	△	△[1]		refer to **4.19.3-7, Part N of the Rule**
14	Resistance to fire and flame spread		○	○	○	○	
15	Resistance to fatigue failure			○			
16	Resitance to crack propagation			△			

Remarks:

○: Items to be verified through verification test for properties.

△: Items to be verified through verification test where deemed necessary depending on the insulation material.

□: Items for which preparation of data on the properties is desirable.

Notes:

1) Necessary when the insulation material acts as spray shield specified in the requirements in **4.7.1, Part N of the Rules**. In other cases, data on the properties is to be prepared.

2) Not generally required for cargo tanks where the design temperature exceeds -10°C.

N4.20 Construction Processes

N4.20.1 Weld Joint Design

1 The "dome-to-shell connections" referred to in the requirements in **4.20.1, Part N of the Rules** are applicable to tanks with *MARVS* is 0.07*MPa* or below, and the connections mean ordinary cargo pipes or other penetrations of equivalent size sufficiently small when compared with the size of dome.

2 In welding of the penetrations referred to in the preceding **-1** full penetration type welding may not be required, but are to have proper grooves. In this case, all the weld lines for penetrations of pipes with outside diameter exceeding 100*mm*, and the partial weld lines for those with outside diameter of 100*mm* or below, are to be subjected to non-destructive test as appropriate.

3 The "very small process pressure vessels" referred to in the requirements in **4.20.1-2(1), Part N of the Rules** means pressure vessels which are so small that it is difficult to remove their backing strip.

N4.20.3 Testing

1 For the purpose of the requirements in **4.20.3-2, Part N of the Rules**, in case where leakage of cargo tanks can not be inspected in the hydraulic test or hydrostatic test or hydropneumatic test according to the requirements in **4.21** to **4.26, Part N of the Rules**, the tightness test of cargo tanks is to be conducted separately. This test is to be of the airtightness test conducted at a pressure of *MARVS* or more of the cargo tank.

2 With respect to the requirements of **4.20.3-3, Part N of the Rules**, it is to be verified that secondary barriers keep a specific level of tightness required in the system design in accordance with an appropriate procedures. However, low differential pressures tests are not to be considered an acceptable test for the tightness of secondary barriers. For cargo containment systems with glued secondary barriers, tests for verification of the tightness are to be carried out before and after initial cool down and related values obtained in the tests are to be recorded for the use as reference for periodical surveys. If the verification results do not satisfy acceptance criteria approved in advance, an investigation is to be carried out and additional testing such as thermographic or acoustic emissions testing is to be carried out.

3 For the purpose of the requirements in **4.20.3-4, Part N of the Rules**, in case where stress measurements of the cargo tank previously built which can be regarded as the tank of the same design manufactured at the same shipyard had resulted in good agreement with design stress levels, provision of instrumentation of independent tanks stress levels for tanks subsequently built may be omitted.

4 In accordance with the requirements in **4.20.3-5** and **5.13.2-5, Part N of the Rules** the following tests **(1)** and **(2)** are to be conducted in the attendance of the Surveyor to verify the performance of the cargo containment installations and cargo handling equipment:

(1) Gas trial
 On items given in **Table N4.20.3-1**, tests are to be conducted to verify the performance of the cargo containment system, cargo handling equipment and instrumentation using a suitable quantity of the cargo after the completion of all the construction work. However, for cargo tanks with a design temperature of 0°C or more, omission of this test may be accepted if substitution is made by the operating test with the substituting medium to verify the requirements given in **Table N4.20.3-1** except for the case where the tank is of the first cargo tank manufactured by the manufacturer of cargo tanks.

(2) Cargo full loading test
 On items given in **Table N4.20.3-2**, tests are to be conducted after completion of all the construction work to verify that the cargo containment installations, cargo handling equipment and instrumentation satisfy the design conditions under the fully loaded condition of cargo. However, for this test, the attendance of the Surveyor may be omitted for ships, other than those carrying liquefied methane (*LNG*) in bulk, whose cargo containment and cargo transfer installations can be regarded as of the same specification of those which have previously been built and tested at the same shipyard.

5 The kinds of real liquid cargo and gas used in the gas trial and cargo full loading test specified in the preceding **-4** are to be such that reproduction of the most severe conditions of those design conditions of the cargo containment system, the transfer installations and the reliquefaction system, etc. and consideration is to be given to the following requirements **(1)** and **(2)**:

(1) The verification relative to design temperatures is to be made by reproducing the condition that the cargo on the basis of which design temperature has been determined is cooled down as close to the design temperature as practicable.

(2) For design conditions basing on the corrosivity or extreme toxicity, omission of verification through the use of these cargoes in gas trial may be accepted in case where experimental data and information to prove the compliance of the construction and equipment including

structural materials have been submitted to the Society.

6 The quantities of the real cargo and vapour used in the gas trial and cargo full loading test referred to in the preceding **-4** are to be sufficient to conducting the tests specified in **-4**.

7 The cargo full loading test to capacity specified in the preceding **-4(2)** may be conducted simultaneously with the gas trial indicated in the preceding **-4(1)**.

8 The cold spot inspection of cargo tanks specified in **4.20.3-7, Part N of the Rules** is to be carried out during the cargo full loading test to capacity specified in the preceding **-4** for the membrane tank, semi-membrane tank, internal insulation tank, and when necessary, independent tank.

Table N4.20.3-1 Test Items at the Gas Trial

Test item	◎:Attendance of the Surveyor ○:Submission of the record	Inspection Equipment	Survey item
1. Drying test	○	・ Inert gas generator (*IGG*)	・Dew point ・Change of dryness in cargo tanks and hold spaces
2. Inerting test	○	・ Inert gas generator	・Operation of the inert gas generator ・Measuring of atmosphere in cargo tanks
3. Inert gas purge test using cargo vapour	○	・Cargo vapourizer ・Compressor	・Change of O_2/temperature of cargo vapour in cargo tanks ・Quantity of cargo vapour (or liquid) supply ・Capacity of the vapourizer ・Capacity of the compressor
4. Cool-down test	◎/○	・Spray pump ・Compressor ・Cargo piping ・ Temperature indicators for cargo tank ・Spray piping	・ Temperature curve of cargo tanks ・Inspection of hold spaces/condition of insulation of tanks[1] (after cool-down) ・Cooling condition of spray piping ・Cooling condition of cargo piping ・Capacity of spray pump ・Cargo consumption ・Capacity of Compressor (property of return gas) ・Temperature/pressure in cargo tank ・Shrinkage of cargo tank[2]
5. Loading test of cargo liquid	◎/○	・Compressor ・Cargo piping related for loading ・Level gauge/temperature indicator	・Temperature/pressure level in cargo tanks ・Temperature/pressure in hold spaces ・ Temperature/pressure of cargo liquid/gas at manifolds ・Service condition of cargo piping
6. Operation test of cargo pump	◎/○	・All cargo pumps	・Discharge pressure/current of cargo pumps ・Liquid level/pressure in cargo tanks ・Stripping
7. Operation test of pressure/ temperature control system	◎/○	・Depend on the type of controls	・Depend on the type of controls

Notes:

1) The Society may approve omission in consideration of quality control status and manufacturing records of insulation materials.

2) To be verified only in case of independent tanks.

Table N4.20.3-2 Survey Items of Full Loading Test

	Survey items
1. At loading operation 1)	• Continuous loading rate • Proper operation of gas detection systems 4) • Proper operation of cargo control and monitoring systems such as level gauging equipment, temperature sensors, pressure gauges, cargo pumps, compressors and cargo heat exchangers 4) • Proper operation of over-flow control systems 5) • Proper operation of nitrogen generating plants or inert gas generators and pressure control systems for insulation, interbarrier and annular spaces 4) • Proper operation of cofferdam heating systems, if fitted 4) • Proper operation of reliquefaction plants, if fitted 4) • Proper operation of equipment fitted for the burning of cargo vapours 4) • On-deck cargo piping system • Topping off process for cargo tanks including proper operation of high level alarms
2. After full loading or during voyage 2)	• Cargo tanks and supports • Hull adjacent to cargo tanks (cold spot) • Insulation capacity of cargo tanks and supports (cold spot) • Atmosphere in hold spaces • Capacity of pressure/temperature indicator
3. At discharging operation 3)	• Emergency shutdown system testing prior to commencement of unloading • Discharging rate • Conditions of related installations such as those listed in 1. • On membrane vessels, verification that the readings of the cofferdam and inner hull temperature sensors are not below the allowable temperature for the selected grade of steel • On-deck cargo piping system • Other operation of discharging • Submission/Survey of related records such as cold spot examination records 6), cargo logs, operation logs of installations related to cargo operations and alarm reports where no attendance during the cargo loaded voyage of 2.

Notes:

1) Priority is to be given to latter stages of loading (approximately last 6 *hours*).
2) May be exempted from the presence of Surveyors. In such cases, each survey item is to be recorded in order that the Surveyors can check this record.
3) Priority is to be given to the commencement of unloading (approximately first 4-6 *hours*).
4) Overall inspection may be accepted where an installation are not in operation.
5) In case where implementation is difficult, the verification of operation may be made by suitable other method.
6) Surveyors are to check the sampling of cold spot records, if possible.

N4.21 Type *A* Independent Tanks

N4.21.2 Structural Analysis

For the purpose of the requirements in **4.21.2-2, Part N of the Rules**, the following **(1)** to **(3)** are to be considered for loads and ship deflections.

(1) Ship deflections due to longitudinal bending moment in waves and longitudinal still water bending moment.

(2) Ship deflections due to horizontal bending moment in waves and twisting moment, when necessary due to type of supporting structures.

(3) Internal pressure specified in the requirements in **4.28.1, Part N of the Rules**.

N4.21.3 Ultimate Design Condition

1 The "classical analysis procedures" referred to in the requirements in **4.21.3-1, Part N of the Rules** means the beam theory where the type of stress to be assessed is the combined stress of bending stress and axial stress.

2 For the purpose of the requirements in **4.21.3-1, Part N of the Rules**, the allowable stress for the equivalent stress σ_c when detailed stress calculations are made on primary members is to be as given in **Table N4.21.3**.

3 For the purpose of the requirements in **4.21.3-2, Part N of the Rules**, the corrosion allowance may be reduced or may not be required in accordance with the requirements in **4.3.5, Part N of the Rules**. In structures where the membrane or axial force due to internal pressure can not be neglected, the calculation equation specified in **Chapter 14, Part C of the Rules** may be used after suitable modification.

4 In case where no corrosion allowance specified in **4.3.5, Part N of the Rules** is required in accordance with the preceding **-3**, stiffeners may have section modulus more than 1/1.2 of one required in **14.2.3, Part C of the Rules**.

Table N4.21.3 Allowable Stresses for the Primary Equivalent Stress

Ferrite steels	Austenic steels	Aluminium alloys
$0.79R_e$	$0.84R_e$	$0.79R_e$
$0.53R_m$	$0.42R_m$	$0.42R_m$

Note:
For each member, the smaller of the above values is to be used with R_e and R_m as specified in **4.18.1(3), Part N of the Rules**.

N4.21.5 Testing

1 For the purpose of the requirements in **4.21.5** and **4.22.6, Part N of the Rules**, the hydrostatic or hydropneumatic test of cargo tanks is to be conducted by simulating the actual load conditions (static load + dynamic load) in accordance with the following requirements **(1)** and **(2)**:

(1) Test of cargo tanks
Hydrostatic-hydropneumatic test is to simulate the static pressure of cargo, acceleration by ship motions and internal pressure including the vapour pressure by water head and pneumatic pressure. (*See* **Fig. N4.21.5-1**, **Fig. N4.21.5-2**, and **Fig. N4.21.5-3**)

(2) Load test of supporting structures
Hydraulic test is to simulate the cargo weight and the load created by the acceleration due to ship motions solely by the weight of water. (*See* **Fig. N4.21.5-4**)

2 All tests specified in the preceding **-1(1)** and **(2)** may be conducted individually.

3 In the case of the cargo tank of supports which can be regarded as those of the same type manufactured at the same manufacturing plant, implementation of the second and subsequent tests of cargo tanks and supports specified in the preceding **-1(2)** may be omitted when deemed acceptable by the Society.

Fig. N4.21.5-1
Simulating the Internal Pressure
Distribution of Rectangular Tank

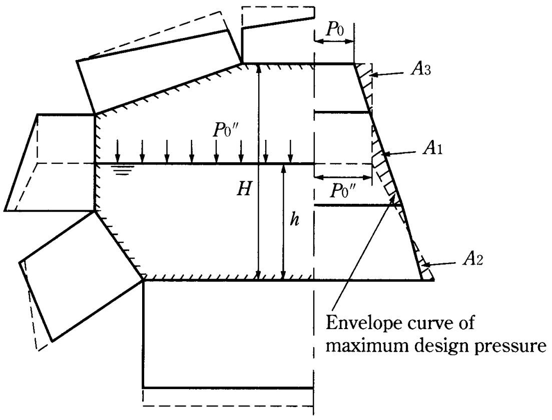


Fig. N4.21.5-2
Simulating the Internal Pressure
Distribution of Spherical Tank

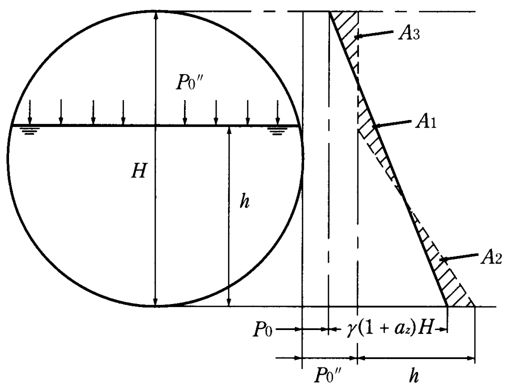


Fig. N4.21.5-3
Simulating the Internal Pressure
Distribution at Pressure Discharge

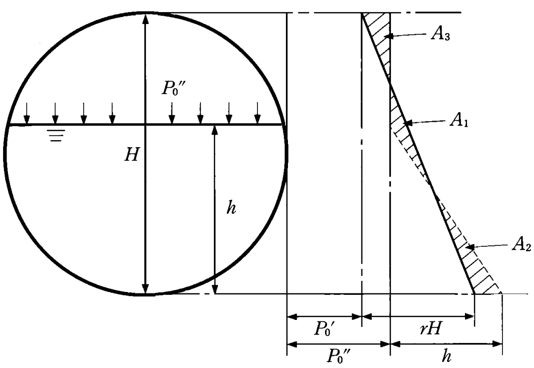
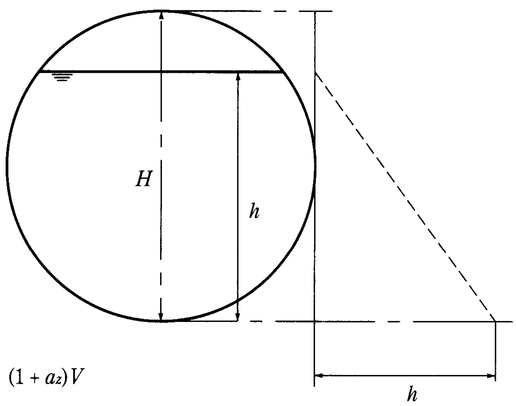


Fig. N4.21.5-4
Simulating the Loading Condition
of Support Structure



$v \geqq \gamma\ (1 + a_z)V$

v : Cargo tank volume for water pressure h

V: Cargo tank volume for water pressure H

Notes:

Explanatory notes on symbols in **Fig.N4.21.5-1** to **Fig. N4.21.5-4**

——:maximum loading condition which is predicted to actually encounter

- - - -: pressure testing condition simulating as far as practicable (P_0'' and h are to be chosen so that $P_0'' > P_0$ or $P_0'' > P_0'$ and $A_2+A_3>A_1$ as far as practicable)

H : depth of tank

h : water head

γ : specific gravity of cargo

a_z : maximum vertical acceleration (non-dimensional)

P_0 : design vapour pressure at ordinary passage

P_0' : design vapour pressure during pressurized unloading in port

P_0'' : air pressure

N4.22 Type *B* Independent Tanks

N4.22.2 Structural Analysis

In applying the requirements in **4.22.2, Part N of the Rules**, the following requirements **(1)** through **(9)** are to be complied with:

(1) The cargo tank structure is to be analyzed by three-dimensional frame structural analysis method or finited element method. The model for the analysis is to include concerned hull structures and support construction considering ship deflections and local deflections of hull due to vertical, horizontal and twisting moments.

(2) The strength members of cargo tanks are to be computed in details by the finite element method. In case where compatible results can be obtained, however, the frame structural analysis method may be used in replacement therewith.

(3) In the preceding **(1)** and **(2)**, dynamic loads necessary for the calculation of interactions between the hull and cargo tanks are, as a rule, to be determined by long-term distribution in accordance with the requirements in **4.14.1**, **4.18.2** and **4.22.2-3, Part N of the Rules** where the most probable largest load in terms of the probability of occurrence as deemed appropriate by the Society is to be used. The dynamic stress (σ_{dyn}) due to such loads are to be evaluated for their phase difference according to the requirements in **4.17.3, Part N of the Rules**, and the total stress including dynamic stress is to be the sum of such dynamic stress and static stress (σ_{st}). However, the load within cargo tanks may be considered as the internal pressure specified in the requirements in **4.28.1-2, Part N of the Rules** by using the value of long-term distribution of acceleration computed by direct calculation according to the requirements in **4.14.1**, **4.18.2** and **4.22.2-3, Part N of the Rules**.

(4) The scantlings of cargo tank plates and stiffeners fitted to tank plates are to the satisfaction of the Society in consideration of the stress distribution and the mode of stress.

(5) In case where bulkheads are provided in cargo tanks, the scantlings of bulkhead plates and stiffeners fitted to the bulkhead plates are to the satisfaction of the Society.

(6) The strength members in cargo tanks are to be subjected to fatigue strength analysis for both the base metal and welded joints of high stress regions and stress concentration regions. *S-N* curves are to be plotted by experiment by the taking into account the following **(a)** through **(f)**.
   - (a) Shape and size of test specimen
   - (b) Stress concentration and notch sensitivity
   - (c) Mode of stress
   - (d) Mean stress
   - (e) Welding conditions
   - (f) Ambient temperature

(7) Relative to the design standards for the secondary barrier, the crack propagation analysis specified in the requirements in **4.22.2-1, Part N of the Rules** is to be carried out to verify that the assumed initial cracks would not reach the critical crack length in a period of 15 *days* or for the particular voyage. The rate of cargo leakage is to be computed on the basis of the crack length obtained by this analysis.

(8) It is to be verified that the cargo tank plates and associated structural members have sufficient strength against compressive buckling, tripping buckling of stiffeners, shearing buckling, and bending buckling of tripping brackets.

(9) The accuracy in stress analysis is to be verified by model tank test or pressure measurements taken at time of pressure tests on a real ship in accordance with the requirements in **4.20.3-4**, **Part N of the Rules**.

N4.22.3 Ultimate Design Condition

For the purpose of the requirements in **4.22.3-1**, **Part N of the Rules**, the allowable stress for the primary stress of the prismatic Type *B* independent tanks is to be in accordance with the requirements in **4.22.3-1(1)**, **Part N of the Rules**.

N4.23 Type *C* Independent Tanks

N4.23.1 Design Basis

For the purpose of the requirements in **4.23.1**, **Part N of the Rules**, for the scantlings, shapes and reinforcements of openings of cargo tanks against internal pressure in cargo tanks, the requirements for Group 1 Pressure Vessels in **Chapter 10**, **Part D of the Rules** apply.

N4.23.3 Ultimate Design Condition

The "calculations using accepted pressure vessel buckling theory" referred to in the requirements in **4.23.3-2, Part N of the Rules** means calculations based on standards such as *JIS*, *ASME*, etc. P_4 among design external pressure P_e is to be the value computed by applying the requirements in **10.2**, **18.2** and **19.2, Part C of the Rules** corresponding to the location of the tanks.

N4.23.6 Testing

1 The "pressure vessels other than simple cylindrical and spherical pressure vessels" referred to in the requirements in **4.23.6-1, Part N of the Rules** means those cylindrical or spherical pressure vessels with supporting structures of well proved records. In tanks of special shape having supporting structures likely to cause excessive bending stress or bicylindrical shape tanks, the stress levels are to be verified by strain measurement through prototype test.

2 "Where necessary" referred to in the requirements in **4.23.6-4, Part N of the Rules** means a case in which the shipbuilding berth or hull structure can not withstand the hydrostatic load when cargo tanks are illed with water to the tank top level and another case in which a large load exceeding the design load is imposed on the structural members of the tank or adjacent structures by conducting the hydrostatic test.

3 For the purpose of the requirements in **4.23.6-6, Part N of the Rules**, the leakage test is to be of the air-tightness test conducted at a pressure of *MARVS* or more of the pressure vessel.

N4.24 Membrane tanks

N4.24.1 Design Basis

In case where the design vapour pressure is made higher than 0.025*MPa* in accordance with the provision to the requirements in **4.24.1-4**, **Part N of the Rules**, this vapour pressure is to be taken into account when model test specified in **4.24.8-1**, **Part N of the Rules** is conducted. In this case, special consideration is to be given to stress concentration for the welding and construction details of the adjacent hull structure.

N4.24.2 Design Considerations

1 For the purpose of the requirements in **4.24.2-1**, **Part N of the Rules**, in the assessments of plastic deformations and fatigue of the membrane and thermal insulation materials, all static and dynamic stresses and thermal stress specified in **4.11** to **4.15**, **Part N of the Rules** are to be taken into account.

2 In the assessments referred to in the preceding **-1**, verification is to be made through fatigue tests on a model combining the elements of the tank, second barrier, insulation structure and tank supporting structure considering the dimensional effects on real tank and the effects of dispersions in materials and fabrication accuracy as an integral part of the test specified in **4.24.8-1**, **Part N of the Rules**.

N4.24.3 Loads and Load Combinations

The assessments of loss of tank integrity referred to in the requirements in **4.24.3, Part N of the Rules** are to be made in accordance with the following requirements **(1)** and **(2)**:

(1) For overpressure and negative pressure in the interbarrier space, collapse test is to be conducted on a prototype model of the membrane to verify its ultimate strength.

(2) For sloshing loads, impact load experiment is to be carried out on a prototype model of the membrane to verify its strength when the Society considers necessary.

N4.24.4 Structural Analyses

For the purpose of the requirements in **4.24.4-2, Part N of the Rules**, the hull structure adjacent to membrane tanks is to comply with the requirements in **Chapter 14, Part C of the Rules** and, in addition, the stress in the hull structure is to be restricted in consideration of the structural strength of membrane tanks, if necessary. The allowable stresses of the membrane, membrane supporting structures and insulation materials are to be determined in each case according to the mechanical properties of materials, records of construction, product specifications and levels of product quality control practice.

N4.24.8 Design Development Testing

Tests specified in the requirements in **4.24.8-1**, **Part N of the Rules**, are to be conducted on a model in combination of the primary barrier, insulation structure and second barrier. Test object and testing procedure are to be determined for each type of tank in each case.

N4.24.9 Testing

1 The "hydrostatically tested as deemed appropriate by the Society" referred to in the requirements in **4.24.9-1**, **Part N of the Rules** means the hydraulic test according to the requirements in **2.1.5**, **Part B of the Rules**. In this case, hydraulic pressure may be applied from hull structures such as ballast tanks and cofferdams.

2 The leakage test for the "all hold structure supporting the membrane" referred to in the requirements in **4.24.9-2**, **Part N of the Rules** is to be in accordance with the testing procedure applicable to general hull structures as specified in **2.1.5(1)**, **Part B of the Rules**.

N4.25 Integral Tanks

N4.25.1 Design Basis

In case where the design vapour pressure is made higher than 0.025*MPa* in accordance with the provision to the requirements in **4.25.1-2(1)**, **Part N of the Rules**, special consideration is to be given to stress concentration for the welding and detailed construction of cargo tanks.

N4.25.3 Ultimate Design Condition

The allowable stresses specified in **4.25.3-2**, **Part N of the Rules** are to be those specified in **C31.1.3**.

N4.25.5 Testing

For the purpose of the requirements in **4.25.5**, **Part N of the Rules**, the hydraulic test of integral tanks is to conform to the requirements in **2.1.5**, **Part B of the Rules**. However, for tanks whose design *MARVS* exceeds 0.025 *MPa* or specific gravity of the cargo exceeds 0.6, the test may be such as to conform to the requirements specified in **N4.21.5-1** correspondingly.

N4.26 Semi-membrane Tanks

N4.26.1 Design Basis

1 For the purpose of the requirements in **4.26.1-3, Part N of the Rules**, stress analysis is to be carried out on the structural members of cargo tanks in consideration of the loads specified in the requirements in **4.3, Part N of the Rules**. In this case, the requirements in **4.22.3-1, Part N of the Rules** apply correspondingly to the allowable stress.

2 For stress analysis referred to in the preceding **-1**, the Society may request model test to verify the accuracy in such stress analysis or stress measurements at time of pressure test of cargo tanks when the Society deems it necessary.

N4.28 Guidance Notes for Chapter 4

N4.28.1 Guidance to Detailed Calculation of Internal Pressure for Static Design Purpose

1 As the "Equivalent calculation procedures" referred to in the requirements in **4.28.1-3, Part N of the Rules**, the following **(1)** to **(3)** may be based upon:

(1) In the case of square tanks, the water head at arbitrary point j on the tank plate is to be obtained from the following equations:

$$h_j = h_{j\cdot st} + h_{j\cdot dyn} \quad (MPa)$$

$$h_{j\cdot st} = \frac{P_0 + \rho z_j}{1.02\times 10^5} (MPa)$$

$$h_{j\cdot dyn} = \frac{\rho\sqrt{(x_j a_x)^2 + (y_j a_y)^2 + (z_j a_z)^2}}{1.02\times 10^5}$$

where:

P_0 and ρ: As specified in **4.28.1, Part N of the Rules**.

a_x, a_y and a_z: As specified in **4.28.2, Part N of the Rules**

x_j, y_j and z_j (m): As specified in **Fig. N4.28.1-1**

(2) In the case of spherical tanks, pressure $P(\Phi,\Theta)$ at arbitrary point on the tank plate is to be obtained from the following equations:

(a)

$$P(\Phi,\Theta) = P(\Phi,\Theta)_{st} + P(\Phi,\Theta)_{dyn} \quad (MPa)$$

$$P(\Phi,\Theta)_{st} = P_0 + \frac{\rho R(1-\cos\Phi)}{1.02\times 10^5} \quad (MPa)$$

$$P(\Phi,\Theta)_{dyn} = \sqrt{P_1^2 + P_2^2 + P_3^2} \quad (MPa)$$

$$P_1 = \frac{\rho R\left(\sqrt{1+a_x^2} - a_x \sin\Phi \cos\Theta - 1\right)}{1.02\times10^5} \ (MPa)$$

$$P_2 = \frac{\rho R\left(\sqrt{1+a_y^2} - a_y \sin\Phi \sin\Theta - 1\right)}{1.02\times10^5} \ (MPa)$$

$$P_3 = \frac{\rho R a_z (1-\cos\ \Phi)}{1.02\times10^5} \quad (MP_a)$$

where:

P_0, ρ, a_x, a_y and a_z: As specified in the preceding **-1**

R : Inner radius of sphere (m)

Φ and Θ : As specified in **Fig. N4.28.1-2**

(b) Notwithstanding the value specified in the preceding **(a)**, the value of P is not to be made less than the following value:

$$P(\Phi,\Theta)_{min} = P_0 + \frac{\rho R(1+a_z)(1-\cos\Phi)}{1.02\times10^5} (MPa)$$

where:

P_0, ρ, R and a_z: As specified in the preceding **(1)**.

(3) In the case of cylindrical tank arranged horizontally along the longitudinal direction of the ship, pressure $P(x_j,\Phi)$ at an arbitrary point on the tank plate is to be obtained from the following equation:

(a)

$$P(x_j,\Phi) = P(x_j,\Phi)_{st} + P(x_j,\Phi)_{dyn} \ (MPa)$$

$$P(x_j,\Phi)_{st} = P_0 + \frac{\rho R(1-\cos\Phi)}{1.02\times10^5} \ (MPa)$$

$$P(x_j,\Phi)_{dyn} = \sqrt{P_1^2 + P_2^2 + P_3^2} \ (MPa)$$

$$P_1 = \frac{\rho x_j a_x}{1.02\times10^7} \ (MPa)$$

$$P_2 = \frac{\rho R\left(\sqrt{1+a_y^2} - a_y \sin\Phi - 1\right)}{1.02\times10^5} \ (MPa)$$

$$P_3 = \frac{\rho R a_z (1-\cos\Phi)}{1.02\times10^5} (MPa)$$

where:

P_0, ρ, a_x, a_y and a_z: As specified in the preceding **(2)**

R : Inner radius of cylinder (m)

Φ and x_j: As specified in **Fig. N4.28.1-3**

(b) Notwithstanding the value specified in the preceding **(a)**, the value of P is not to be made less than the following value:

$$P(x_j,\Phi)_{min} = P_0 + \frac{\rho R(1+a_z)(1-\cos\Phi)}{1.02\times10^5} (MPa)$$

Fig. N4.28.1-1

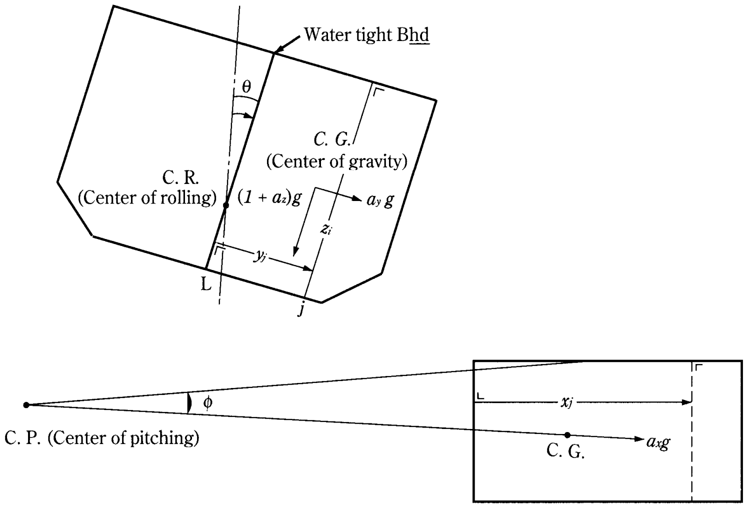


Fig. N4.28.1-2

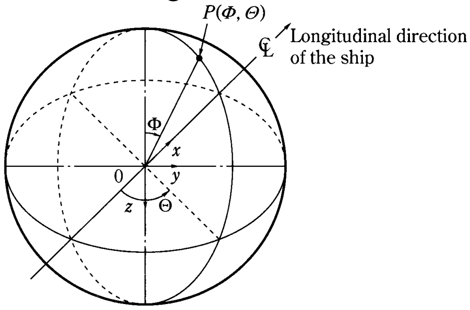
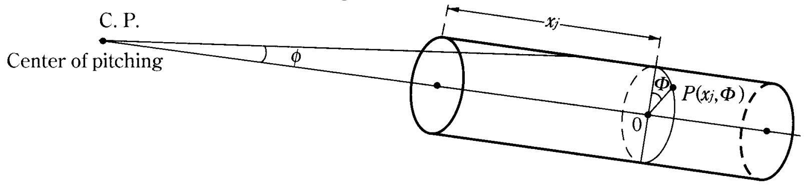


Fig. N4.28.1-3



N5 has been amended as follows.

N5 PROCESS PRESSURE VESSELS AND LIQUID, VAPOUR, AND PRESSURE PIPING SYSTEMS

N5.1 General

~~N5.1.1 Process Pressure Vessels~~

~~**1** For the purpose of the requirements in **5.1.1, Part N of the Rules**, "process pressure vessels" means the pressure vessels used for cargo operation, cooling, processing of boil-off gases and temporarily containing the cargo inside where heat exchangers are included. They, however, do not include those pressure vessels for refrigerant without containing cargo and parts of cargo pumps, compressors and valves subjected to internal pressure.~~

~~**2** Of those process pressure vessels referred to in the preceding **-1**, for the process pressure vessels that are not used for cargo storage, only the requirements in **4.4.6-1** and **-2**, **4.5.1-6**, **4.5.2**, **4.9.3**, **4.10.1**, **4.10.2**, **4.10.9**, **4.10.10(3)**, **4.10.11**, **4.10.18** and **4.11.1, Part N of the Rules** apply.~~

~~N5.2 Cargo and Process Piping~~

N5.1.1~~2.1~~ General

1 For the purpose of the requirements in **5.1.1~~2.1-1~~, Part N of the Rules**, "product and process piping" means the piping used for cargo operations, cooling, heating, processing and disposing of boil-off gases which can~~having a~~ possibly~~ility of~~ come~~ming~~ into contact with the cargo. ~~The r~~Refrigerant piping which does not directly come into contact with the cargo is not included.

2 For the product and process piping referred to in the ~~preceding~~ **-1** above, in addition to the requirements in ~~**5.2 to 5.5**~~**Chapter 5, Part N of the Rules** ~~and~~, the requirements in~~,~~ **Part D of the Rules** apply where deemed~~considered as~~ necessary by the Society.

~~**3** For the purpose of the requirements in **5.2.1-3, Part N of the Rules**, for piping with design temperature lower than -5°C, the following requirements **(1)** to **(3)** are to be complied with to protect the hull structure.~~

~~(1) The branches of the piping are to be insulated for thermally separating them from the hull structure. However, in case where the materials of hull structures comply with the requirements given in **Table N6.5, Part N of the Rules** against the temperature obtained by heat transmission calculation in consideration of the design temperature of the piping, these requirements may be dispensed with.~~

~~(2) As a means of protection for hull structures against cargo leakage from the piping, drain pans or equivalent manufactured from the materials specified in **Table N6.2**, **Table N6.3** and **Table N6.4, Part N of the Rules** having sufficient capacity are to be arranged according to the design temperature of the piping at all locations where liquid leakage is likely.~~

~~(3) Drain pans or equivalent indicated in the preceding **(2)** are to be provided below all flange joints of liquid piping with design temperature not exceeding -55°C located outside the cargo tanks. However, in case where the arrangement is made in such a way that the hull structures do not reach dangerous temperature even in case of leakage from flanges, these requirements may be dispensed with.~~

~~**4** The materials of drain pans referred to in the preceding **-3(2)** and **(3)** may be made such that they comply with the requirements of *JIS* or recognized standards and are suitable for the design temperature of the piping system.~~

~~**5** For the purpose of the requirements in **5.2.4-4, Part N of the Rules**, the electrical bonding is to conform to the requirements of **2.1.4, Part H of the Rules** and the resistance between the cargo tanks/process plant/piping systems and the hull of the ship is to be not greater than 1 *M*Ω. However, where provided with bonding straps, the measurement of the resistance for the places may be dispensed with. In case where electrical bondings are necessary for cargo tanks and secondary barriers, such bondings are to be provided at readily accessible places.~~

~~**6** The "suitable means" referred to in the requirements in **5.2.1-5, Part N of the Rules** means the residual liquid discharging piping led to cargo tank, liquid cargo line or other drain tank.~~

~~**7** "All pipelines or components which may be isolated in a liquid full condition" referred to in the requirements in **5.2.1-6, Part N of the Rules** means, for example, those pipelines given in the following **(1)** and **(2)**.~~

~~(1) Pipeline between two adjacent stop valves.~~

~~(2) Pipeline between stop valve and compressor or pump likely to be liquid full. However, where the relief valve mounted on the compressor or pump is in effective condition, this requirement may be dispensed with.~~

~~**8** For the pipeline indicated in the preceding **-7**, a relief valve is to be provided irrespective of its design pressure. This relief valve is to be of approved ones in accordance with the requirements in the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".~~

~~**9** The "means to detect and dispose of any liquid cargo which may flow into the vent system" referred to in the requirements in **5.2.1-7, Part N of the Rules** means the following **(1)** and **(2)** (*See* **Fig. N5.2.1**):~~

~~(1) As a means to dispose of the liquid cargo, a tank with a capacity larger than those determined in the following **(a)** to **(c)** is to be provided. The material of the disposition tank is to be of equivalent to the liquid cargo piping or higher grade, and in the case of pressurized cargo tanks, consideration is to be given to the temperature drop due to expansion and evaporation.~~

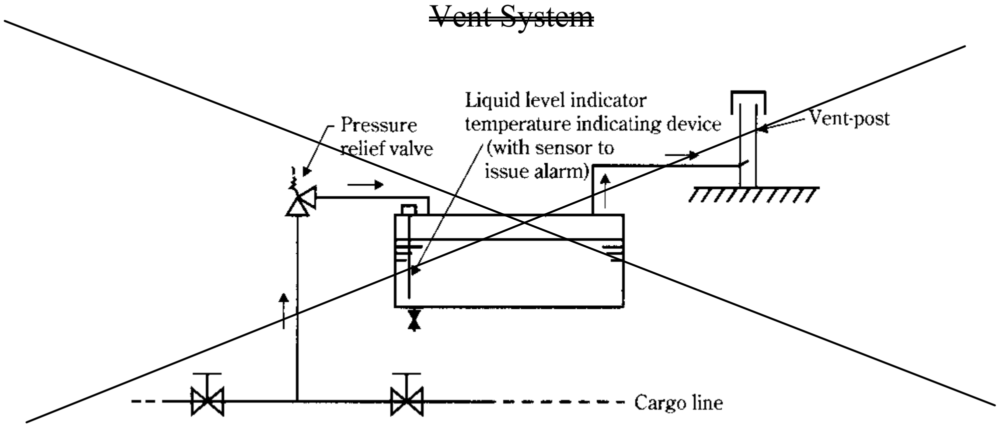
~~(a) By assuming possible state of liquid full condition that may actually take place, the quantity of liquid cargo to be covered is to be determined.~~

~~(b) Due to heat input from the fire, the quantity of expansion for the quantity of liquid indicated in **(a)** above to rise from the initial temperature (normally, the minimum design temperature of the pipeline) to the temperature of vapour saturation at the set pressure of the relief valve is to be obtained and on the basis of which the quantity of the liquid to the disposition tank is to be determined.~~

~~(c) By giving consideration to the back pressure of the vent pipeline, the liquid phase quantity in the disposition tank of the inflow quantity obtained in the preceding **(b)** is to be computed to obtain the capacity.~~

~~(2) As a means for detecting liquid cargo, a level sensor or temperature sensor in case of low temperature cargo tanks, and a level sensor in case of pressure cargo tanks, are to be provided in the disposition tank and to issue alarm when the sensor functions.~~

~~Fig. N5.2.1 Example Means to Detect and Dispose of any Liquid Cargo which may Flow into the Vent System~~



N5.1.2 Process Pressure Vessels

1 For the purpose of the requirements in **5.1.2, Part N of the Rules**, "process pressure vessels" refers to the following means the pressure vessels: those used for cargo operations and cargo cooling; those used for the processing, etc. of boil-off gases; and those used for the temporary internal storage of cargo. The above includes heat exchangers, however, does not include pressure vessels used for refrigerants which are not being carried as cargo as well as the pressure receiving parts of cargo pumps, compressors and valves.

2 Of the process pressure vessels referred to in the **-1** above, only the requirements in **4.23.2**, **4.23.3-2**, **4.23.3-1**, **4.3.5**, **4.19.2**, **4.20.1**, **4.23.6**, **4.20.3-2**, and **4.23.7, Part N of the Rules** apply to process pressure vessels not used for cargo storage.

N5.2 System Requirements

N5.2.2 Arrangements: General

1 The wording "precautions to ensure that cargo or cargo vapour cannot enter other piping systems through the interconnections" specified in **5.2.2-1(1), Part N of the Rules** means providing combinations of a screw-down check valve and a check valve or of a spectacle flange and a stop valve at the inter-connections of the cargo or cargo vapour lines and inert gas lines necessary for the operation. (*See* **Fig. N5.2.2-1**)

2 The screw-down check valve specified in the **-1** above may be replaced with a combination of a check valve and stop valve. Furthermore, the spectacle flange may be replaced with a spool piece.

3 "Vertical trunkway" specified in **5.2.2-1(3), Part N of the Rules** is to comply with the following **(1)** to **(7)**:

(1) The access opening in the vertical trunkway is to comply with the requirements in **3.5.3, Part N of the Rules**;

(2) The bilge discharge system in the vertical trunkway is to comply with the requirements in **3.7.2**, **3.7.2** and **3.7.4, Part N of the Rules**;

(3) A vent system which complies with the requirements in **8.2.2, Part N of the Rules** is to be provided for the vertical trunkway;

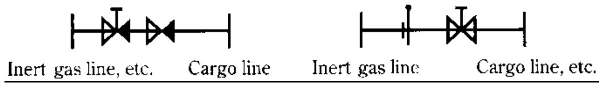
(4) An inerting system which complies with the requirements in **9.2.2, Part N of the Rules** is to be provided for the vertical trunkway;

(5) The electrical installations in the vertical trunkway are to comply with the requirements in **4.2.4, Part H of the Rules**, as applicable;

(6) A ventilation system which complies with the requirements in **12.2, Part N of the Rules** is to be provided in the vertical trunkway; and

(7) A gas detecting system which complies with the requirements in **13.6.2, Part N of the Rules** is to be provided for the vertical trunkway

Fig. N5.2.2-1



4 The wording "suitable means to relieve the pressure and remove liquid cargo" specified in **5.2.2-2, Part N of the Rules** means a residual liquid discharging piping led to the cargo tank, liquid cargo line or another drain tank.

5 The wording "means are provided to detect and dispose of any liquid cargo that may flow into the vent system" specified in **5.2.2-4, Part N of the Rules** requires that the following **(1)** and **(2)** (*See* **Fig. N5.2.2-2**) be complied with:

(1) A means to dispose of liquid cargo such as a tank with a capacity larger than those determined in accordance with following **(a)** to **(c)** is to be provided. The material of the disposition tank is to be equivalent to the liquid cargo piping or of a higher grade, and in the case of pressurized cargo tanks, consideration is to be given to temperature drops due to expansion and evaporation.

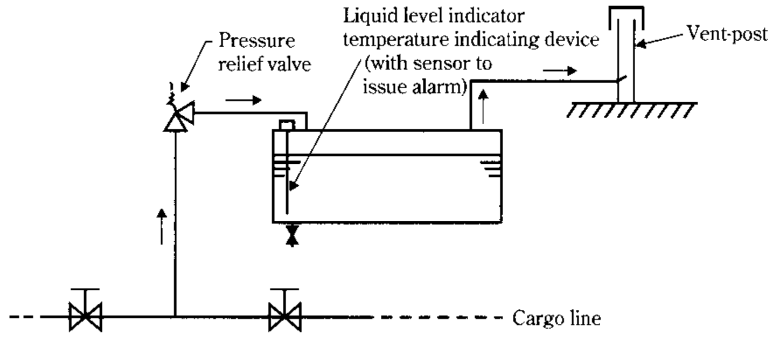
  (a) By assuming the possible state of liquid full condition that may actually take place, the quantity of liquid cargo to be covered is to be determined;

  (b) Due to heat input from fire, the quantity of expansion for the quantity of liquid indicated in **(a)** above to rise from the initial temperature (normally, the minimum design temperature of the pipeline) to the temperature of vapour saturation at the set pressure of the relief valve is to be obtained and used to determine the quantity of the liquid for the disposition tank; and

  (c) By giving consideration to the back pressure of the vent pipeline, the liquid phase quantity in the disposition tank of the inflow quantity obtained in the **(b)** above is to be computed to obtain the capacity.

(2) As a means for detecting liquid cargo, a level sensor or temperature sensor, in the case of low temperature cargo tanks, and a level sensor, in the case of pressure cargo tanks, are to be provided in the disposition tank and are to issue alarms when the sensor functions.

Fig. N5.2.2-2 Example of Means to Detect and Dispose of Liquid Cargo Which May Flow into Vent Systems



N5.3 Arrangements for Cargo Piping outside the Cargo Area

N5.3.1 Emergency Cargo Jettisoning

For the purpose of the requirements in **5.3.1, Part N of the Rules**, emergency cargo jettisoning piping systems are to comply with the requirements in **5.10**, **5.3.3(3)** and **3.8.6, Part N of the Rules**.

~~N5.2.2 Scantlings Based on Internal Pressure~~

~~For the purpose of the requirements in **5.2.2, Part N of the Rules**, the following requirements **(1)** through **(4)** are to be complied with:~~

~~(1) The joint efficiency of electric-resistance welded pipes where non-destructive testing for full length of weld lines is not conducted is to be 0.85.~~

~~(2) For methane, propane, butane, butadiene and propylene cargoes, the corrosion allowance is to be 0.3*mm* for carbon-*Mn* steel and 0*mm* for stainless steel and aluminium alloys. Where effective corrosion control are taken for the interior of carbon-*Mn* steel pipes, the corrosion allowance may be 0.15*mm*.~~

~~(3) In addition to the preceding **(2)**, for carbon-*Mn* steel pipes arranged on open deck without any effective external corrosion-control means, 1.2*mm* is to be added to the required corrosion allowance.~~

~~(4) The negative manufacturing dimensional deviation in pipe thickness is, except for expressly provided otherwise, to be in accordance with the requirements in **4.1.7**, **4.2.7**, **4.3.7**, **4.4.7** and **4.5.7, Part K of the Rules**.~~

N5.4~~2.3~~ Design Pressure

N5.4.2 Design Pressure

1 For the purpose of the requirements in **5.4.2~~2.3-2~~, Part N of the Rules**, where design vapour temperatures higher or lower than 45°C are~~is~~ used~~employed~~, the requirements in **N4.13.2~~2.6~~** apply.

2 The "relief valve on a pipeline system" referred to in the requirements in **5.4.2~~2.3-2~~(~~6~~5), Part N of the Rules** means ~~the~~ one which is approved in accordance with the requirements in ~~the~~ **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

~~N5.2.4 Permissible Stress~~

~~**1** The "value deemed appropriate by the Society" referred to in the requirements in **5.2.4-2, Part N of the Rules** means the value given in column F of **Table D12.6(2), Part D of the Rules** for carbon-*Mn* steel, and the value corresponding to Schedule 10*S* for stainless steel. However, for steel pipes provided with effective corrosion control or those not arranged under corrosive environment, the value may be reduced to the extent acceptable to the Society with a limitation of 1*mm*. Further, the value for pipes in cargo tanks and pipes having open ends may also be reduced to the extent acceptable to the Society.~~

~~**2** The cases where increase in pipe size is required according to the requirements in **5.2.4-3, Part N of the Rules** are the cases in which such becomes necessary on the basis of the results of stress analysis specified in the requirements in **5.2.5, Part N of the Rules**, and in which suitable supports and means to absorb structural expansion and contraction can not be arranged due to convenience of on-deck piping, etc.~~

~~**3** As a presumption for the condition indicated in the preceding **-2**, the supports for piping are to be so arranged as to prevent exertion of the own weight of the pipe on valves or other fittings and to prevent generation of excessive vibration.~~

~~**4** For the purpose of the requirements in **5.2.4-4, Part N of the Rules**, fittings are to comply with the following requirements **(1)** and **(2)**:~~

~~(1) Valves, flanges and other fittings are to comply with the requirements of *JIS* for their type and size.~~

~~(2) The design pressure of bellows type expansion joints to be used in vapour piping may be taken 0.2*MPa* for those provided on pipelines with open ends, and 0.5*MPa* for those provided on other pipelines.~~

~~N5.2.5 Stress Analysis~~

~~**1** For the purpose of the requirements in **5.2.5, Part N of the Rules**, the calculation conditions and allowable stress in the stress analysis are to be in accordance with the following requirements **(1)** through **(5)** as standard:~~

~~(1) As temperature condition, a state uniformly cooled down to the design temperature is to be considered. As the reference temperature (thermal stress = 0), 15°C is to be regarded as standard.~~

~~(2) Loading conditions are to be in accordance with the following requirements **(a)** through **(b)**:~~

~~(a) As internal pressure, the design pressure specified in the requirements in **5.2.3, Part N of the Rules** is to be considered.~~

~~(b) The own weight of pipelines, when can not be neglected, is to be considered including its acceleration.~~

~~(c) As forced displacement, the forced strains corresponding to allowable sagging moment and hogging moment for the hull are to be considered.~~

~~(d) As thermal load, one which can be determined according to the condition indicated in the preceding **(1)** is to be considered.~~

~~(3) Support conditions are to be as deemed appropriate by the Society depending on the construction, arrangement and materials of the pipe supports.~~

~~(4) Allowable stresses are to be as deemed appropriate by the Society depending on the calculation method and materials of pipelines.~~

~~(5) Insulation materials are to be considered to give no contribution at all to the strength of the pipeline.~~

~~**2** According to the requirements in **5.2.5, Part N of the Rules**, stress analysis may be required for pipings with the design temperature higher -110°C where the following **(1)** to **(3)** are relevant:~~

~~(1) Where suitable supports or means to absorb structural expansion and contraction can not be arranged due to convenience of on-deck piping arrangement.~~

~~(2) Where new supporting method or new means to absorb expansion and contraction are used.~~

~~(3) Other cases where the Society deems necessary.~~

~~N5.2.6 Materials~~

~~**1** For the purpose of the requirements in **5.2.6-1, Part N of the Rules**, the materials of pipings, valves and fittings are to comply with the relevant requirements in **Chapter 6, Part N of the Rules**, and at the same time, to conform to the relevant requirements in **Part K of the Rules**. However, for materials used in pipings as specified in the following **(1)** through **(4)**, those conforming to *JIS* or other standards as deemed appropriate by the Society may be used where they comply with the requirements in **Chapter 6, Part N of the Rules**.~~

~~(1) Pipes, valves and pipe fittings used for cargo piping and process piping with the design pressure not exceeding 1*MPa* and design temperature of 0°C or more.~~

~~(2) Valves and pipe fittings used for cargo piping and process piping with the design pressure not exceeding 3*MPa* and design temperature of 0°C or more and nominal diameter less than 100*A*.~~

~~(3) Pipes, valves and pipe fittings used for accessory piping or instrumentation piping with diameter not exceeding 25*mm* irrespective of the design pressure and design temperature.~~

~~(4) Open-ended pipes provided inside and outside cargo tanks other than menbrane and semi-menbrane tanks with the design temperature of -55°C or higher.~~

~~**2** Notwithstanding the requirements in the preceding **-1**, the piping having open ends not coming to contact with the liquid cargo led from the pressure relieving valves of cargo tanks and cargo piping or process piping with the design temperature of -55°C or higher may not be made of the steel for low temperature services specified in **Table N6.4**, **Chapter 6, Part N of the Rules**. Further, its material may be such as to comply with *JIS* or other standards as deemed appropriate by the Society.~~

~~**3** For the purpose of the requirements in **5.2.6-2, Part N of the Rules**, the insulation applied on the short pipes with a melting point lower than 925°C fitted to the cargo tank, except for the minimum range of area necessary for inspection and maintenance of pipe flanges, is to be protected according to the requirements specified in **N4.9.6(2)**. Further, the insulation materials for cargo piping and other piping are to conform to the requirements in **N4.9.7-4(2)**.~~

~~N5.3 Type Tests on Piping Components~~

~~N5.3.1 Requirements of Type Tests~~

~~**1** For the purpose of the requirements in **5.3.1(1), Part N of the Rules**, those valves which are relevant to the following **(1)** or **(2)** are to be approved in accordance with the requirements in the Guidance for Survey and Construction of Equipment and Fittings for Ships Carrying Liquefied Gases in Bulk.~~

~~(1) All valves used for the cargo and process piping with the design temperature lower than -55°C.~~

~~(2) Those valves used for accessory piping or instrumentation piping of the design temperature lower than -55°C with an outside diameter exceeding 25*mm* and normally come to contact with the cargo.~~

~~**2** For the purpose of the requirements in **5.3.1(2), Part N of the Rules**, all bellows type expansion joints provided on all cargo piping including the cargo liquid/vapour piping provided both inside and outside the tanks, and vent piping with open ends are to be of the approved ones in accordance with the requirements of the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**."~~

~~N5.4 Piping Fabrication and Joining Details~~

~~N5.4.1 Application~~

~~According to the requirements in **5.4.1, Part N of the Rules**, the requirements specified in **5.4.2** to **5.4.6, Part N of the Rules** may be modified in accordance with the following **(1)** and **(3)**:~~

~~(1) For pipes provided inside the cargo tanks with open end excluding pump discharging pipings, the following requirements **(a)** to **(c)** apply:~~

~~(a) Butt welded joints with backing strips, sleeve joints and screw joints may be used in all cases.~~

~~(b) Slip-on and socket welded joints may be used in all cases.~~

~~(c) Non-destructive testing for butt welded joints may be omitted.~~

~~(2) For pipes with open ends provided outside the cargo tanks are to conform to the requirements specified in the preceding **(1)(a)** and **(b)**, and in addition, the non-destructive testing for butt welded joints may be reduced to 10% sampling.~~

~~(3) For pump discharging pipes provided inside the cargo tanks, butt weld joints and sleeve joints may be used in all cases subject to in accordance with the preceding requirements **(1)(b)** and **(c)**.~~

~~N5.4.2 Connection of Pipes without Flanges~~

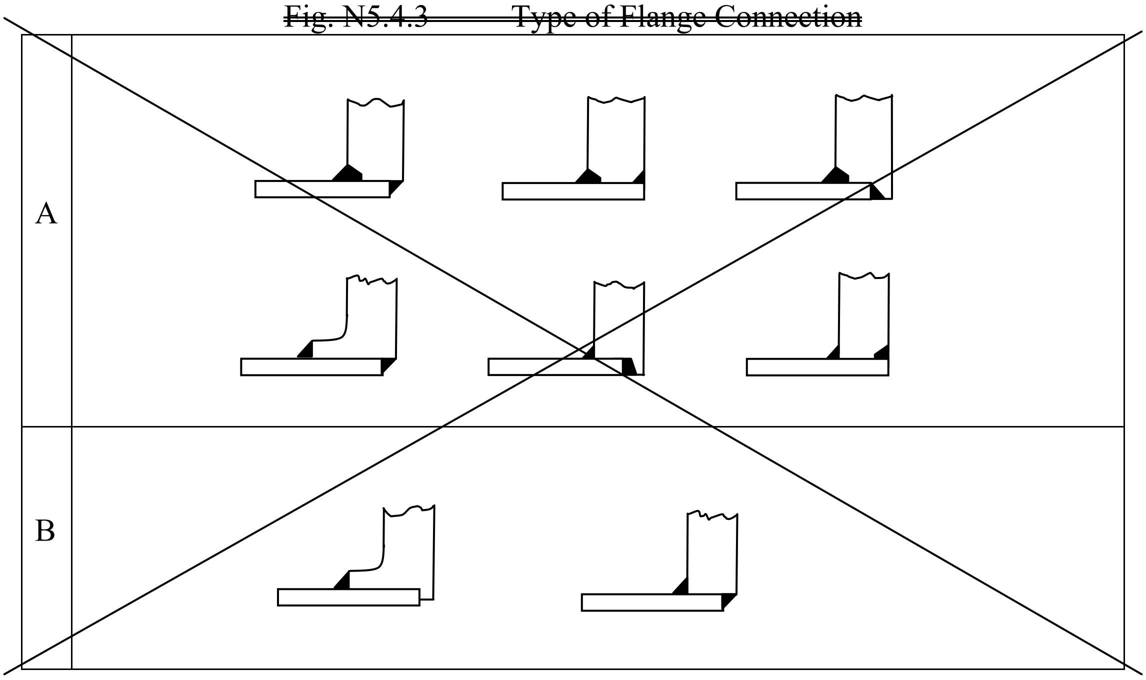
~~**1** The "screwed couplings" referred to in the requirements in **5.4.2(3), Part N of the Rules** are to conform to the requirements of *JIS B* 0203 or equivalent.~~

~~**2** The "as deemed appropriate by the Society" referred to in the requirements in **5.4.2(3), Part N of the Rules** means those cases where a positive means to prevent couplings from rotating is provided.~~

~~N5.4.3 Flange Connection~~

~~For the purpose of the requirements in **5.4.3-2, Part N of the Rules**, flange connections are to conform to *JIS* or other standards as deemed appropriate by the Society for their type, manufacturing and testing. The term "slip-on flanges" here refers to the type described in **A** of **Fig. N5.4.3**, and "socket welded flanges" refers to the type described in **B** of **Fig. N5.4.3**.~~

~~Fig. N5.4.3 Type of Flange Connection~~



~~N5.4.6 Welding, Post-weld Heat Treatment and Non-destructive Testing~~

~~**1** For the purpose of the requirements in **5.4.6-2, Part N of the Rules**, the post-weld heat treatment of pipes with thickness not exceeding 10*mm* may be omitted except for those required in the requirements in **11.6.4, Part D of the Rules**.~~

~~**2** For the purpose of the requirements in **5.4.6-3, Part N of the Rules**, the radiographic testing method and the judgement for acceptance are to conform to the requirements in **11.6.5-1, Part D of the Rules**.~~

~~**3** The "special approval of the Society" referred to the requirements in **5.4.6-3(1), Part N of the Rules** means the case where well-documented quality assurance procedures and records are available to enable the Society to assess the ability of the manufacturer to produce satisfactory welds consistently.~~

~~**4** The "other non-destructive tests" referred to in **5.4.6-3(2), Part N of the Rules** means the ultrasonic testing, and depending on use of pipes, magnetic particle testing or liquid penetrant testing, and the testing procedures are to conform to the requirements in **D11.4.6-2**.~~

~~N5.5 Testing of Piping~~

~~N5.5.1 Application~~

~~For the purpose of the requirements in **5.5.1, Part N of the Rules**, for pipes within the cargo tank and pipes with open ends, the hydraulic test and leak test specified in the requirements in **5.5.2** and **5.5.3, Part N of the Rules** may be omitted. However, the hydraulic test specified in the requirements in **5.5.2, Part N of the Rules** is to be conducted for pipes without open ends and discharging pipes provided inside the cargo tanks.~~

~~N5.5.3 Leak Test~~

~~For the purpose of the requirements in **5.5.3, Part N of the Rules**, the leak test of pipelines is to be conducted at a pressure of 90% of the design pressure of the pipings. The test pressure may be modified, when test is conducted with a liquid of high leak detecting ability.~~

~~N5.5.4 Test under Operating Condition~~

~~For the purpose of the requirements in **5.5.4, Part N of the Rules**, the test is to be conducted according to the requirements in **N4.10.14**.~~

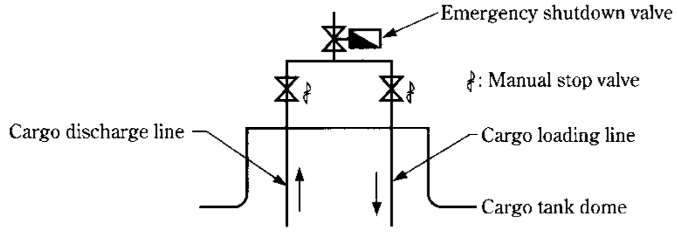
N5.5~~6~~ Cargo System Valve~~ing~~ Requirements

N5.5.2~~6.1~~ ~~Stop Valves~~ Cargo Tank Connections

1 For the purpose of the requirements in **5.5.2-1~~6.1(1)~~** and **~~(2)~~-2, Part N of the Rules**, no expansion joints are to be provided between the cargo tank and stop valves fitted to the cargo tank. ~~To~~The wording "valves are to provide full closure and are to be capable of local manual operation~~be capable of local manual operation and provide full closure~~" ~~referred to~~specified in the requirements ~~means~~requires that the stop valves ~~is~~be fitted with manual operated closing means.

2 For the purpose of the requirements in **5.5.2-2~~6.1(2)~~, Part N of the Rules**, the duplicated provisions of manual stop valve and emergency shutdown valve may be made in such a way as shown in **Fig. N5.5.2~~6.1~~**.

Fig. N5.5.2~~6.1~~ Duplicate Provisions of Stop Valve Emergency Shutdown



N5.5~~6~~.3 Cargo ~~Hose~~Manifold Connections

1 The "transfer connections not ~~used~~ in use~~transfer operations~~" ~~referred to in the requirements~~specified in **5.5.3-1~~6.3~~, Part N of the Rules** means those not used for cargo operation, for example, hose connection used for gas free operation. In this case, stop valve and blank flange are to be provided at the connection.

2 For the purpose of the requirements in **5.5~~6~~.3, Part N of the Rules**, the connection between the cargo hose connection and shore line is to be electrically bonded.

~~N5.6.4 Emergency Shutdown Valves~~

~~**1** The emergency shutdown valves specified in **5.6.4-1, Part N of the Rules** are to be in accordance with the following requirements **(1)** to **(5)**:~~

~~(1) In case where there is no cargo control room and no remote control of cargo operation is carried out, one of the remote control locations of the emergency shutdown valves is to be in the wheelhouse.~~

~~(2) The "fail-closed type" referred to in the requirement of the Rules is, for example, one of given in the following **(a)** and **(b)**:~~

~~(a) The type in which the hydraulic or pneumatic pressure is solely used in valve opening motion, and the valve closing motion including the case of fail-closure is effected by spring or weight.~~

~~(b) Where valve diameter is so large that both opening and closing motions of the valve are hydraulically or pneumatically effected, the operating oil or air in the fail-closure operation is to be supplied from a specially provided accumulator and the system setup is to comply with the following requirements **i)** to **iii)**:~~

~~i) The valve operating cylinder may be used for both ordinary motion and fail-closure motion, but the hydraulic or pneumatic line from the special accumulator for fail-closure operation to the valve operating cylinder is not to serve commonly with those for ordinary valve operation. Further, no stop valve is to be provided on the hydraulic or pneumatic line for fail-closure.~~

~~ii) The capacity of a special accumulator for fail-closure operation is to be sufficient to operate, at least, twice all the emergency shutdown valves. However, when a special accumulator is connected to the emergency shutdown valves of the same type provided on both sides of the ship, it may be made in such a way that the emergency shutdown valves on one side is operated twice.~~

~~iii) Alarm is to be given in the event of loss of hydraulic or pneumatic pressure for ordinary valve motion and activation of fail-closure operation.~~

~~(3) To "be capable of local manual closing operation" referred to in the requirements of the Rules means the one which can be directly manually closed, and in addition those shutdown by manual release of hydraulic pressure or pneumatic pressure or shutdown by manual pump.~~

~~(4) The requirement of "fully close under all service conditions within 30 *sec* of actuation" referred to in the requirements of the Rules may not apply to the manual emergency shutdown valves given in the preceding **(3)**.~~

~~(5) No stop valve is to be provided on the hydraulic or pneumatic line for closing the emergency shutdown valve.~~

~~**2** The confirmation of whether emergency shutdown valves are open or closed by valve handle position is not regarded to be an indicator complying with **5.6.4-2, Part N of the Rules**.~~

~~N5.7 Ship's Cargo Hoses~~

~~N5.7.1 General~~

~~For the purpose of the requirements in **5.7, Part N of the Rules**, the cargo hoses carried by the ship are to be of approved ones in accordance with the requirements of the **Annex 1 "GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK"**.~~

N5.5.6 Relief Valves

1 The wording "all pipelines or components which may be isolated in a liquid full condition" specified in **5.5.6, Part N of the Rules** means, for example, those pipelines given in the following **(1)** and **(2)**.

(1) Pipelines between two adjacent stop valves; and

(2) Pipelines between a stop valve and a compressor or pump likely to be liquid full. However, where the relief valve mounted on the compressor or pump is in effective condition, this requirement may be dispensed with.

2 For the pipelines indicated in the **-1** above, a relief valve is to be provided irrespective of its design pressure. This relief valve is to be of approved ones in accordance with the requirements in the **Annex 1 "GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK"**.

N5.6~~8~~ Cargo Transfer Arrangements~~Methods~~

N5.6~~8~~.1 Means of Cargo Transfer ~~Cargo Transfer Installations~~

1 For the purpose of the requirements in **5.6~~8~~.1, Part N of the Rules**, when the cargo transfer methods are of the submerged pumps or by deep well pumps, standby cargo pump or the cargo transfer installations according to ~~the requirements in~~ **5.~~8~~6.2, Part N of the Rules** are to be provided.

2 The standby cargo pump referred to in the ~~preceding~~ **-1** above may be such as to conform to the following requirements:

(1) Where two sets or more cargo pumps are provided in one cargo tank, the provision of standby cargo pump may be omitted even when both of them are normally subjected to simultaneous operation. Where cargo tank of such a construction that it is separated by a bulkhead and connecting holes or bulkhead valve with remote control are not provided, each such tank separated by the bulkhead is to be regarded as one cargo tank.

(2) The stripping pump may be regarded as a standby pump.

(3) The eductor may be regarded as a standby pump. In this case, however, care is to be taken so that even when cargoes of different kinds are carried simultaneously, the driving fluid is available at all times.

3 The cargo pumps specified in ~~the requirements in~~ **5.~~6~~8.1, Part N of the Rules** are to be approved in accordance with the requirements of the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

N5.~~6~~8.2 Cargo Transfer by Gas Pressurization

1 The "transfer of cargo by gas pressurization" ~~referred to in the requirements~~specified in **5.~~6~~8.2, Part N of the Rules** means, for example, ~~to~~ pressurizing~~e~~ the cargo tank with cargo vapour pressurized by cargo compressor or cargo heater.

2 The compressor specified~~referred to~~ in the ~~preceding~~ **-1** above is to be approved in accordance with the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

N5.6.5 Cargo Sampling Connections

For the purpose of **5.6.5, Part N of the Rules**, two valves on the sample inlet are, in general, to be located at least 500 *mm* apart from each other, except where a smaller distance is permitted by the Society.

N5.7 Installation Requirements

N5.7.2 Precautions against Low Temperatures

1 For the purpose of **5.7.2, Part N of the Rules**, for piping with design temperature lower than -5°C, the following requirements **(1)** to **(3)** are to be complied with to protect the hull structure.

(1) The branches of the piping are to be insulated for thermally separating them from the hull structure. However, in cases where the materials of hull structures comply with the requirements given in **Table N6.5, Part N of the Rules** for the temperature obtained by heat transmission calculations in consideration of the design temperature of the piping, these requirements may be dispensed with.

(2) As a means of protection for hull structures against cargo leakage from piping, drain pans or their equivalent manufactured from the materials specified in **Table N6.2**, **Table N6.3** and **Table N6.4, Part N of the Rules** having sufficient capacity are to be arranged according to the design temperature of the piping at all locations where liquid leakage is likely.

(3) Drain pans or equivalent indicated in the **(2)** above are to be provided below all flange joints of liquid piping with design temperature not exceeding -55°C located outside the cargo tanks. However, in cases where the arrangement is made in such a way that the hull structures do not reach dangerous temperature even in case of leakage from flanges, these requirements may be dispensed with.

2 The materials of drain pans referred to in the **-1(2)** and **(3)** above may be made such that they comply with the requirements of *JIS* or recognized standards and are suitable for the design temperature of the piping system.

N5.7.4 Bonding

For the purpose of the requirements in **5.7.4, Part N of the Rules**, the electrical bonding is to conform to the requirements of **2.1.4, Part H of the Rules** and the resistance between the cargo tanks/process plant/piping systems and the hull of the ship is to be not greater than 1 $M\Omega$. However, where provided with bonding straps, the measurement of the resistance for the places may be dispensed with. In cases where electrical bonding is necessary for cargo tanks and secondary barriers, such bonding is to be provided at readily accessible places.

N5.8 Piping Fabrication and Joining Details

N5.8.1 General

According to the requirements in **5.8.1, Part N of the Rules**, the following **(1)** to **(3)** may be applied to pipes in cargo tanks and pipes with open ends.

(1) For pipes provided inside the cargo tanks with open ends, excluding pump discharge piping, the following requirements **(a)** and **(b)** apply:
   (a) Butt welded joints with backing strips, sleeve joints and screw joints may be used in all cases.
   (b) Slip-on and socket welded joints may be used in all cases.

(2) Pipes with open ends provided outside the cargo tanks are to conform to the requirements specified in the **(1)(a)** and **(b)** above.

(3) For pump discharging pipes provided inside the cargo tanks, butt weld joints and sleeve joints may be used in all cases in accordance with the requirements **(1)(b)** and **(c)** above.

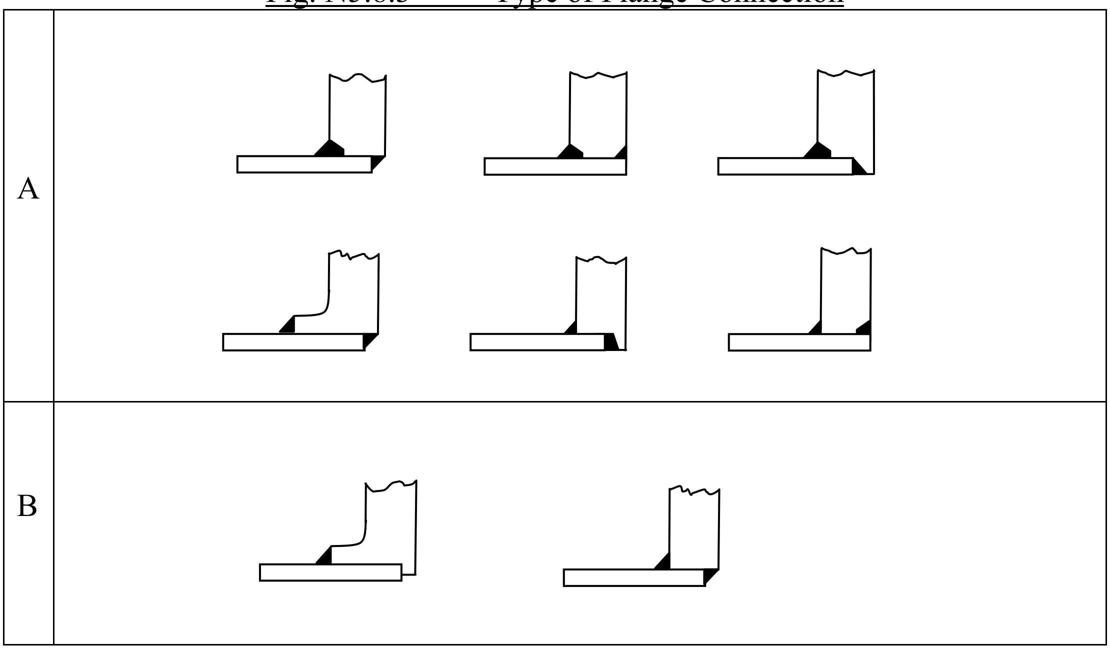
N5.8.2 Direct Connections

The "screwed couplings" specified in **5.8.2(3), Part N of the Rules** are to conform to the requirements of *JIS B* 0203 or the equivalent.

N5.8.3 Flanged Connections

For the purpose of **5.8.3-2, Part N of the Rules**, flange connections are to conform to *JIS* or other standards deemed appropriate by the Society for their type, manufacturing and testing. The term "slip-on flanges" here refers to the type described in **A** of **Fig. N5.8.3**, and "socket welded flanges" refers to the type described in **B** of **Fig. N5.8.3**.

Fig. N5.8.3 Type of Flange Connection



N5.9 Welding, Post-weld Heat Treatment and Non-destructive Testing

N5.9.2 Post-weld Heat Treatment

For the purpose of **5.9.2, Part N of the Rules**, the post-weld heat treatment of pipes with wall thickness not exceeding 10 *mm* may be omitted except for those required by the requirements in **11.6.4, Part D of the Rules**.

N5.9.3 Non-destructive Testing

1 For the purpose of **5.9.3, Part N of the Rules**, the radiographic testing method and the judgement for acceptance are to conform to the requirements in **D11.6.5-1** and **-2**.

2 The wording "procedures approved by the Society" specified in **5.9.3(2), Part N of the Rules** requires that well-documented quality assurance procedures and records are available to enable the Society to assess the ability of the manufacturer to produce satisfactory welds consistently.

3 The "other non-destructive tests" referred to in **5.9.3(3), Part N of the Rules** means, depending upon the use of the pipe, magnetic particle testing or liquid penetrant testing, and the testing procedures are to conform to the requirements in **D11.4.6-3** and **-4**.

N5.11 Piping System Component Requirements

N5.11.2 Pipe Wall Thickness

1 For the purpose of **5.11.2, Part N of the Rules**, the following requirements **(1)** to **(4)** are to be complied with:

(1) The joint efficiency of electric-resistance welded pipes where non-destructive testing for full length of weld lines is not conducted is to be 0.85;

(2) For methane, propane, butane, butadiene and propylene cargoes, the corrosion allowance is to be 0.3 *mm* for carbon-*Mn* steel and 0 *mm* for stainless steel and aluminium alloys. Where effective corrosion controls are taken for the interior of carbon-*Mn* steel pipes, the corrosion allowance may be 0.15 *mm*;

(3) In addition to the **(2)** above, for carbon-*Mn* steel pipes arranged on open decks without any effective external corrosion-control means, 1.2 *mm* is to be added to the required corrosion allowance; and

(4) The negative manufacturing dimensional deviation in pipe thickness is, except where expressly provided for otherwise, to be in accordance with the requirements in **4.1.7**, **4.2.7**, **4.3.7**, **4.4.7** and **4.5.7, Part K of the Rules**.

2 For the purpose of **5.11.2-3, Part N of the Rules** means the value given in column F of **Table D12.6(2), Part D of the Rules** for carbon-*Mn* steel, and the value corresponding to Schedule 10*S* for stainless steel. However, for steel pipes provided with effective corrosion control or those not arranged under corrosive environment, the value may be reduced to the extent acceptable to the Society with a limitation of 1*mm*. Furthermore, the value for pipes in cargo tanks and pipes having open ends may also be reduced to the extent acceptable to the Society.

3 For the purpose of **5.11.2-4, Part N of the Rules**, if necessary on the basis of the results of the stress analysis specified in **5.11.5, Part N of the Rules** or in cases where suitable supports and means to absorb structural expansion and contraction cannot be arranged due to the location of the on-deck piping, etc., the pipe size is to be increased.

4 As a presumption for the condition indicated in the **-3** above, the supports for piping are to be so arranged as to prevent exertion of the self-weight of the pipe onto valves or other fittings and to prevent the generation of excessive vibration.

N5.11.5 Stress Analysis

1 For the purpose of **5.11.5, Part N of the Rules**, the calculation conditions and allowable stress in the stress analysis are to be standardized in accordance with the following requirements **(1)** to **(5)**:

(1) As the temperature condition, a state uniformly cooled down to the design temperature is to be considered. As the reference temperature (thermal stress = 0), 15°C is to be regarded as standard.

(2) Loading conditions are to be in accordance with the following requirements **(a)** to **(d)**:

(a) As the internal pressure, the design pressure specified in the requirements in **5.2.4, Part N of the Rules** is to be considered.

(b) The self-weight of pipelines, when it cannot be neglected, is to be considered including its acceleration;

(c) As the forced displacement, the forced strains corresponding to the allowable sagging moment and hogging moment for the hull are to be considered.

(d) As the thermal load, one which can be determined according to the condition indicated in the **(1)** above is to be considered.

(3) Support conditions are to be as deemed appropriate by the Society depending upon the construction, arrangement and the materials used for pipe supports.

(4) Allowable stresses are to be as deemed appropriate by the Society depending upon the calculation method and materials used for pipelines.

(5) Insulation materials are to be considered to give no contribution at all to the strength of the pipeline.

2 For the purpose of **5.11.5, Part N of the Rules**, stress analysis may be required for piping with design temperatures higher than -110°C where the following **(1)** to **(3)** are relevant:

(1) Where suitable supports or means to absorb structural expansion and contraction cannot be arranged due to the location of on-deck piping arrangements;

(2) Where new supporting method or new means to absorb expansion and contraction are used; and

(3) Other cases deemed necessary by the Society.

N5.11.6 Flanges, Valves and Fittings

1 For the purpose of **5.11.6, Part N of the Rules**, fittings are to comply with the following requirements **(1)** and **(2)**:

(1) Valves, flanges and other fittings are to comply with the *JIS* requirements for their type and size; and

(2) The design pressure of bellows-type expansion joints to be used in vapour piping may be taken as 0.2 *MPa* for those provided on open-ended lines or pressure relief valve discharge lines, and the lower of 0.5 *MPa*, or 10 times the relief valve set pressure for those provided on other pipelines.

2 For the purpose of **5.11.6-4, Part N of the Rules**, expansion bellows are to be approved in accordance with the requirements of **Annex 1 "GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK"**.

N5.11.7 Ship's Cargo Hoses

For the purpose of **5.11.7, Part N of the Rules**, the cargo hoses carried by the ship are to be approved in accordance with the requirements of **Annex 1 "GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK"**.

N5.12 Materials

N5.12.1 Materials

1 For the purpose of **5.12.1, Part N of the Rules**, the materials used for piping, valves and fittings are to comply with the relevant requirements in **Chapter 6, Part N of the Rules**, and at the same time, to conform to the relevant requirements in **Part K of the Rules**. However, for materials used for the piping specified in the following **(1)** to **(4)**, those conforming to *JIS* or other standards deemed appropriate by the Society may be used where they comply with the requirements in **Chapter 6, Part N of the Rules**.

(1) Pipes, valves and pipe fittings used for cargo piping and process piping with design pressures not exceeding 1 *MPa* and design temperatures of 0°C or more.

(2) Valves and pipe fittings used for cargo piping and process piping with design pressures not exceeding 3 *MPa* and design temperatures of 0°C or more as well as nominal diameters less than 100 *A*.

(3) Pipes, valves and pipe fittings used for accessory piping or instrumentation piping with diameters not exceeding 25 *mm* irrespective of design pressure and design temperature.

(4) Open-ended pipes provided inside and outside cargo tanks, excluding membrane and semi-membrane tanks, with design temperatures of -55°C or higher.

2 Notwithstanding the requirements in the **-1** above, piping having open ends not coming into contact with the liquid cargo led from the pressure relieving valves of cargo tanks and cargo piping or process piping with design temperatures of -55°C or higher may not be made of steel used for low temperature services specified in **Table N6.4**, **Chapter 6, Part N of the Rules**. Furthermore, piping material may be such as to comply with *JIS* or other standards deemed appropriate by the Society.

N5.12.2 Materials having a Lower Melting Point

For the purpose of **5.12.2, Part N of the Rules**, the insulation applied to short pipes with a melting point lower than 925°C which are fitted to cargo tanks, excluding the minimum range of area necessary for the inspection and maintenance of pipe flanges, is to be protected according to **4.19.3-4, Part N of the Rules**. Furthermore, insulation materials for cargo piping and other piping are to conform to the requirements in **N4.19.3-6(2)** as well as **5.12.3-2, Part N of the Rules**.

N5.13 Testing Requirements

N5.13.1 Type Testing of Piping Components

1 For the purpose of **5.13.1-1, Part N of the Rules**, those valves which are relevant to the following **(1)** or **(2)** are to be approved in accordance with the requirements in **Annex 1 "GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK"**.

(1) All valves used for the cargo and process piping with design temperatures lower than -55°C.

(2) Those valves used for accessory piping or instrumentation piping with design temperatures lower than -55°C and outside diameters exceeding 25 *mm* which normally come into contact with the cargo.

2 For the purpose of **5.13.1-2, Part N of the Rules**, all bellows-type expansion joints provided for all cargo piping, including the cargo liquid/vapour piping, provided both inside and outside tanks as well as vent piping with open ends are to be approved in accordance with the requirements of the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

N5.13.2 System Testing Requirements

1 For the purpose of **5.13.2-3, Part N of the Rules**, the leak test of piping systems are to be conducted at a pressure which are 90% of the design pressure of the piping. Test pressures, however, may be modified when the test is conducted using a liquid which has high leak detecting ability.

2 For the purpose of **5.13.2-5, Part N of the Rules**, tests are to be conducted according to the requirements in **N4.20.3-4** to **-7**.

N6 has been deleted and new N6 has been added as follows.

N6 MATERIALS OF CONSTRUCTION AND QUALITY CONTROL

N6.2 Scope and General Requirements

N6.2.3 Properties after Post-welded Heat Treatment

For the purpose of the requirements in **6.2.3**, **Part N of the Rules**, when post-weld heat treatment is carried out, the properties of the base material are to be in accordance with the requirements given in **Table N6.1** to **Table N6.4**, **Part N of the Rules** in the heat treated condition or equivalent condition whether such post-weld heat treatment is regarded in **6.6.2** or **5.9.2**, **Part N of the Rules** or not. welding procedure qualification tests and production weld tests specified in the requirements in **6.3**, **Part N of the Rules** are to satisfy the requirements in **6.5.3-5** and **6.5.5**, **Part N of the Rules** in the heat treated condition.

N6.3 General Test Requirements and Specifications

N6.3.1 Tensile Test

For the purpose of the requirements in **6.3.1-2**, **Part N of the Rules**, the required values of tensile strength, yield stress and elongation of a material are to be in accordance with the requirements in **Part K of the Rules** applicable to the material.

N6.3.2 Toughness Test

The wording "To be in accordance with Recognized Standard" referred to in the requirements given **6.3.2-1**, **Part N of the Rules** means to refer to **note (6) of Table K4.28**.

N6.3.4 Section Observation and Other Testing

The wording "To be carried out as deemed appropriate by the Society" referred to in the requirements given **6.3.4**, **Part N of the Rules** means to refer to, for welding procedure tests of the cargo tanks and process pressure vessels, **N6.5.3-1(2)**.

N6.4 Requirements for Metallic Materials

N6.4.1 General Requirements for Metallic Materials

1 For the purpose of the requirements in **Table N6.1**, **Part N of the Rules**, the following requirements **(1)** to **(4)** are to be complied with:

(1) The use of the longitudinally or spirally welded pipes given in the Note 1 of the Table is to be in accordance with the relevant requirements in **Chapter 4**, **Part K of the Rules**.

(2) Fittings of Type *C* independent tanks and process pressure vessels with the design pressure not exceeding 3*MPa* and design temperature of 0°C or more and nominal diameter less than 100*A*.

(3) The controlled rolling as a substitution for normalizing may be of the temperature controlled rolling or Thermo-Mechanical Controlled Processing (*TMCP*).

(4) For materials with the thickness of greater than 40 *mm* and not more than 50 *mm*, the impact test is to be carried out at the temperature of -30°C.

2 The controlled rolling as a substitution for normalizing or tempering and quenching given in Note 4 of **Table N6.2**, **Part N of the Rules** may be of *TMCP*.

3 For the purpose of the requirements in **Table N6.3**, **Part N of the Rules**, the following requirements **(1)** to **(3)** are to be complied with:

(1) For the purpose of the requirements in Note 2 of the Table, aluminium alloy of 5083, austenitic stainless steel, 36%*Ni* steel and 9%*Ni* steel may be used at the design temperature up to -196°C.

(2) For the purpose of the requirements in Note 5 of the Table, the chemical composition limit of a material, if the material specified in **Part K of the Rules**, is to be in accordance with the relevant requirements in **Part K**.

(3) For the purpose of the requirements in Note 9 of the Table, the omission of the impact test given in Note 9 of this Table may generally be accepted for the austenitic stainless steel of the type referred to in the Table.

4 For the purpose of the requirements in **Table N6.4**, **Part N of the Rules**, the following requirements **(1)** through **(5)** are to be complied with:

(1) The use of vertically or spirally welded pipes given in Note 1 of the Table is to be in accordance with the requirements in the preceding **-1(1)**.

(2) The requirements for forgings and castings given in Note 2 of the Table are to be in accordance with the relevant requirements in the **Part K**, if specified.

(3) For the design temperature given in Note 3 of the Table lower than -165°C, the provision in the preceding **-3(1)** are to apply.

(4) The chemical composition limit given in Note 5 of the Table is to be in accordance with the requirements in the preceding **-3(2)**.

(5) The omission of the impact test given in Note 8 of this Table are to be in accordance with the requirements in the preceding **-3(3)**.

5 For the purpose of the requirements in **6.4.1(6)**, **Part N of the Rules**, the specifications of a certain type of material, if specified in **Part K of the Rules**, is to be in accordance with the relevant requirements in **Part K of the Rules**.

N6.5 Welding of Metallic Materials and Non-Destructive Testing

N6.5.1 General

1 The requirements in **6.5**, **Part N of the Rules** apply to independent tanks, semi-membrane tanks, process pressure vessels, integral tanks and piping. The requirements on membrane tanks, are to the satisfaction of the Society depending on the structural type of the tank.

2 For the purpose of the requirements in **6.5**, **Part N of the Rules**, the following requirements **(1)** and **(2)** are to be complied with.

(1) The impact test for welded joint may generally be omitted for austenitic stainless steels of types given in **Table N6.3** and **Table N6.4**, **Part N of the Rules**.

(2) The impact test for welded joint may generally be omitted for aluminum alloys of type 5083. In addition, additional tests may be required to verify the toughness of the material for aluminimum alloys other than type 5083.

N6.5.3 Welding Procedure Tests for Cargo Tanks, Process Pressure Vessels and Secondary Barriers

1 For the purpose of the requirements in **6.5.3-4**, **Part N of the Rules** the following requirements **(1)** and **(2)** are to be complied with:

(1) Longitudinal bend tests which are required in lieu of transverse bend tests in the case where the

base material and weld metal have different strength level are to be in accordance with the requirements in **4.2**, **Part M of the Rules**.

(2) For the purpose of the requirements in **6.5.3-4**, **Part N of the Rules**, for type *C* independent tanks and process pressure vessels, macroscopic and microscopic examinations and hardness tests are to be carried out according to the requirements in **Chapter 11**, **Part D of the Rules**. For other independent tanks, integral tank and semi-membrane tanks, macroscopic examinations are to be carried out according to the requirements in **Chapter 4**, **Part M of the Rules**.

2 For the purpose of the requirements in **6.5.3-5**, **Part N of the Rules**, the welding procedure qualification tests are also to be complied with the relevant requirements in **Chapter 4**, **Part M** and **Chapter 11**, **Part D of the Rules**.

3 For the purpose of the requirements in **6.5.3-5(1)**, **Part N of the Rules**, the transverse tensile strength of weld metal which has lower tensile strength than that of the parent metal is to be complied with the requirements in **4.2.5**, **Part M of the Rules**.

4 For the purpose of the requirements in **6.5.3-5(2)**, **Part N of the Rules**, bend tests are also to be complied with the requirements in **4.2.6**, **Part M of the Rules**.

5 For the purpose of the requirements in **6.5.3-5(3)**, **Part N of the Rules**, the test temperature of impact tests may be determined in accordance with the requirements in **N4.19.2**.

N6.5.4 Welding Procedure Tests for Piping

For the purpose of the requirements in **6.5.4**, **Part N of the Rules**, welding procedure qualification tests for pipes are also to be in accordance with the relevant requirements in **Chapter 11**, **Part D** and **Chapter 4**, **Part M of the Rules** are to be complied with.

N6.5.5 Production Weld Tests

1 Production weld tests are to be in accordance with the requirements specified in **6.5.5**, **Part N** and **Chapter 11**, **Part D of the Rules** and are also to comply with the following requirements:

(1) Application

When welding is made for independent tanks of ships carrying liquefied gases in bulk, the production weld tests are to be carried out for each position of welding in accordance with the following requirements, in addition to the welding procedure qualification tests specified in **Part M of the Rules**.

(a) Type *A* independent tanks

The production weld test is to be carried out on at least one test sample for every 50*m* of welding length of butt joints of principal structural members. However, consideration may be given for reduction of the number of test sample or omission of the production weld test taking into account the past records and the actual state of quality control system of the manufacturer.

(b) Type *B* independent tanks

The production weld tests are to be carried out on at least one test sample for every 50*m* of welding length of butt joints of principal structural members. However, the number of test sample may be reduced to one test sample for every 100*m* of welding length taking into account the past records and the actual state of quality control system of the manufacturer. In this case, however, at least one or more test specimens are to be selected for one tank.

(c) Type *C* independent tanks

The production weld tests are to be carried out on at least one test sample for every 30*m* of welding length of butt joints of principal structural members. However, the number of test sample may be reduced to one test sample for every 50*m* of welding length taking into account the past records and the actual state of quality control system of the manufacturer.

(2) Test procedure

(a) The production weld tests are to be carried out for every welding length specified in the above **(1)** for welded joints made under the same welding procedure, welding position and welding conditions.
(b) Test sample are, in principle, to be located on the same line as the welded joints of the body and to be welded at the same time of welding of the body.

(3) Kind of test
Kinds of the test are to be as given in **Table N6.5.5-1**.

(4) Test assemblies
The shape and size of test assemblies are to be as shown in **Fig. N6.5.5-1**. In cases of Type *A* and Type *B* independent tanks, tensile test may not be required.

(5) Test specimens
(a) The shape and size of tensile test specimens are to be of the *U*2*A* or *U*2*B* test specimen specified in **Table M3.1**, **Part M of the Rules**.
(b) The shape and size of bend test specimens are to be of the *UB*-1, *UB*-2 and *UB*-3 test specimens specified in **Table M3.2**, **Part M of the Rules**. For test specimens with a thickness exceeding 20*mm*, side bend test specimens are to be substituted for face bend and root bend test specimens.
(c) Impact test specimens are to be the *U*4 test specimen specified in **Table K2.5**, **Part K of the Rules**. In the impact test, one set of test specimens comprising three pieces are to be taken from every test assembly.
The test specimens are to be taken alternately from the position *A* and from a position among *B* through *E* where the lowest value is recorded in the welding procedure qualification test, shows in **Fig. M4.4**, **Part M of the Rules**. This means that one set of three test specimens are taken from a test assembly at the position *A*, thence other set of three test specimens are taken in the subsequent test assembly from the position among *B* through *E* where the lowest value is recorded, and this procedure is repeated.

(6) Tensile test
The tensile strength of weld metal is to be more than the specified value of the base metal. However, the tensile strength of weld metal which has lower tensile strength than that of the parent metal is to be complied with the requirements in **4.2.5**, **Part M of the Rules**.

(7) Bend test
(a) The bend test specimen is to be bent up to an angle of 180 *degrees* by a test jig with an inner radius of double the thickness of the test specimen.
(b) The results of the bend test are to be as free from cracks exceeding 3*mm* in length in any direction on the outer bent surface and from other significant defects.

(8) Impact test
The specified value for the impact test are as given in **Table M4.8**, **Part M of the Rules**.

2 For the purpose of the requirements in **6.5.5-1**, **Part N of the Rules**, the number of test specimens for production weld tests of secondary barriers may be reduced to the extent as deemed appropriate by the Society considering the experience of same welding procedures in past, workmanship and quality control. In general, intervals of production tests for secondary barriers may be approximately 200 *m* of butt weld joints and the tests are to be representative of each welding position.

3 For the purpose of the requirements in **6.5.5-5**, **Part N of the Rules**, number of test specimens for the production weld tests for integral tanks may be reduced to the same level as in the case of secondary barrier given in the preceding **-2**. Production weld tests for membrane tanks are left to the discretion of the Society depending on the construction system of the tank.

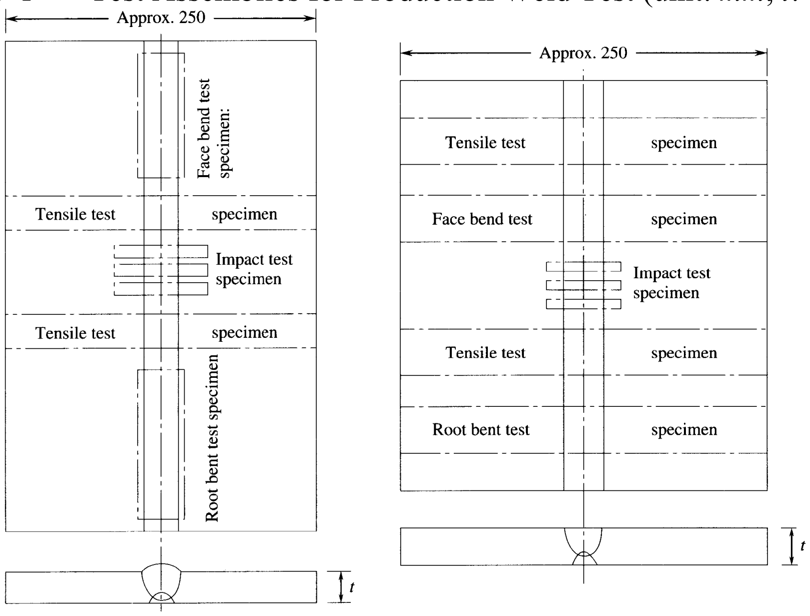
Table N6.5.5-1 Kind of Tests

Material	Kind of test
9% *Ni* steel	Tensile test, bend test and impact test
Austenitic stainless steel	Tensile test, bend test
Aluminium alloy(1)	Tensile test, bend test
Steel for low temperature service (excluding 9% *Ni* steel)	Tensile test, bend test and impact test

Note:

(1) For aluminimum alloys other than type 5083, additional tests may be required to verify the toughness of the material.

Fig. N6.5.5-1 Test Assemblies for Production Weld Test (unit: *mm*, *t*: thickness)



(a) For 9% *Ni* steel (b) For materials other than (a)

N6.5.6 Non-Destructive Testing

1 The following requirements **(1)** through **(4)** are to apply as the testing procedures and acceptance criteria for the non-destructive tests referred to in the requirements in **6.5.6-1**, **Part N of the Rules**:

(1) Radiographic testing is to comply with the requirements specified in **11.4.5**, **Part D** of the Rules. The requirements specified in **D11.4.5-2(2)**, however, are not to be applied.

(2) For ultrasonic tests, the requirements in **11.4.6-2**, **Part D of the Rules** apply correspondingly.

(3) For magnetic particle test, the requirements in **11.4.6-2**, **Part D of the Rules** apply correspondingly.

(4) For dye penetrant tests, the requirements in **11.4.6-2**, **Part D of the Rules** apply correspondingly.

2 Where ultrasonic tests are performed as a substitution for radiographic tests according to the requirements in **6.5.6-1**, **Part N of the Rules**, at least 10% of the whole testing objects are to be subjected to radiographic tests.

3 For the non-destructive tests specified in the requirements in **6.5.6-2**, **Part N of the Rules** for the remaining welds of tank plates of type *A* and *B* independent tanks and semi-membrane tanks other than butt welds, fillet welds of highly stressed parts of main structural members of cargo tanks are to be examined magnetic particle or dye penetrant tests given in **-1** above. Butt welds of highly stressed parts of main structural members such as face plates of girders are to be subjected to radiographic test given in **-1** above.

4 For the purpose of the requirements in **6.5.6-5(2)**, **Part N of the Rules**, the ultrasonic testing is to be conducted in the following cases **(1)** and **(2)**:

(1) In case where defect detection by radiographic testing fails and ultrasonic testing is considered additionally necessary.

(2) In case where ultrasonic testing is considered necessary for the quality control of essential structural members.

5 For the purpose of the requirements in **6.5.6-8**, **Part N of the Rules**, radiographic tests of secondary barriers where the hull structure acts as the secondary barrier are to be carried out for butt welded joints of the double bottom tank top platings and bulkhead platings in addition to the objects of inspections specified in **Annex M1.4.2-3(1) "GUIDANCE FOR NON-DESTRUCTIVE INSPECTIONS ON INTERNAL IMPERFECTIONS OF THE WELDED JOINTS OF HULL CONSTRUCTIONS"**. Acceptance criteria of radiographic tests are to be in accordance with the requirements specified in **Annex M1.4.2-3(1)**.

6 For the purpose of the requirements in **6.5.6-9**, **Part N of the Rules**, the welding inspection procedures and acceptance criteria for integral tanks are to comply with the requirements in **6.5.6-3**, **Part N of the Rules** correspondingly. The procedures and criteria for membrane tanks are to be to the satisfaction of the Society, depending on the structural type of the tanks.

N6.6 Other Requirements for Construction in Metallic Materials

N6.6.2 Independent Tank

1 For the purpose of the requirements in **6.6.2-1**, **Part N of the Rules**, the allowable dimensional deviations for the manufacture and fabrication are to conform to the requirements in **11.5.2**, **Part D of the Rules**, and in addition to the requirements in *JIS B* 8265 or recognized standards.

2 For the purpose of the requirements in **6.6.2-2**, **Part N of the Rules**, the stress relieving is to be in accordance with the following requirements **(1)** to **(3)**:

(1) The post-weld heat treatment is to comply with the requirements in **11.3**, **Part D of the Rules**.

(2) For 9% *Ni* steel, 5% *Ni* steel and aluminium alloy 5083-*O*, post-weld heat treatment may, in general, be omitted.

(3) For cargo tanks made of carbon steel and carbon manganese steel with the design temperature of -10°C or more, the requirements in **D11.5.3** may be based upon except for cargo tanks anticipated to carry chlorine, ammonia and toxic cargoes.

N6.6.5 Membrane Tanks

1 For the purpose of the requirements in **6.6.5**, **Part N of the Rules**, quality assurance procedure, welding control, design details, quality control of materials, construction method, inspection and standards of production testing of components for membrane tanks are to be developed during the prototype test specified in **4.24.8**, **Part N of the Rules** or another prototype test separately conducted for development of production procedure, and their effectiveness is to be verified. The relevant data is to be noted in the construction procedure manual for cargo tanks including the insulation construction of membrane tanks.

2 The construction procedure manual referred to in the preceding **-1** is to be approved by the Society after being verified through prototype test.

N7 has been amended as follows.

N7 CARGO PRESSURE/TEMPERATURE CONTROL

N7.1 ~~General~~ <u>Methods of Control</u>

~~**N7.1.1 Means of Control**~~

~~**1** Where diesel engines or boilers whereby methane is permitted to utilize as fuel are designed to use as the means to maintain the cargo tank pressure below the *MARVS* subject to the provisions of **7.1.1(2), Part N of the Rules**, the means of disposing of the excess of the boil-off vapours when these diesel engines or boilers do not operate is to be provided. Where a system specified in **7.1.1(1), Part N of the Rules** is use for the purpose of disposing of the boil-off vapours mentioned above, the subject diesel engines or boilers may be used as the alternative means to maintain the cargo pressure/temperature specified in **7.2.1, Part N of the Rules**.~~

~~**2** The "system allowing the product to warm up and increase in pressure" referred to in the requirements in **7.1.1(3), Part N of the Rules** is, in general, accepted for ships with limited area of service. The ambient design temperature and period of voyage as the design conditions of the system are to be to the satisfaction of the Society in consideration of the sea and weather conditions of the service area, and where necessary, possible extension of voyage for sheltering from heavy weather.~~

~~**N7.1.2 Design Requirement of the Systems**~~

~~**1** For the purpose of the requirements in **7.1.2, Part N of the Rules**, the cooling system is to comply with the following requirements **(1)** to **(3)**:~~

~~(1) For the refrigerating plant, the following requirements **(a)** and **(b)** are to be complied with:~~
- ~~(a) In the case of indirect system, the relevant requirements in **Chapter 5** and **Chapter 7 of the Rules for Cargo Refrigerating Installations** are to be complied with.~~
- ~~(b) In the case of the direct system, the following requirements **i)** through **vii)** are to be complied with:~~
  - ~~i) The construction of compressors is to be such that causes only a small amount of gas leakage and without sparks.~~
  - ~~ii) A relief valve or overpressure preventing device is to be provided on the discharge from the compressor. However, when overpressure is unlikely, this requirement may be dispensed with. The vent pipe of the relief valve of the compressor is to be led to the vent system specified in the requirements in **8.2.9, Part N of the Rules**.~~
  - ~~iii) A pressure gauge is to be provided on the discharge side of the compressor.~~
  - ~~iv) Means to avoid the entry of cargo liquid are to be provided cargo into the compressor.~~
  - ~~v) The requirements in **3.1.3**, **3.2.4**, **3.2.5**, **5.1.1** and **5.1.2 of the Rules for Cargo Refrigerating Installations** apply correspondingly.~~
  - ~~vi) The temperature of the cooling sea water used in the calculation of capacity of the refrigeration plant is to be the ambient sea water temperature specified in **7.1.2, Part N of the Rules**.~~
  - ~~vii) The compressors and heat exchangers are to be approved in accordance with the requirements of the **Annex 1 "GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK"**.~~

~~(2) For pressure vessels and pipings, the requirements in **5.1.1** and **5.2, Part N of the Rules** and **N5.1.1** and **N5.2.1-1** are to be complied with.~~

~~(3) For pressure relief valves, level gauges and other fittings, the relevant requirements in **Chapter 5**, **Chapter 8** and **Chapter 13, Part N of the Rules** apply correspondingly as necessary.~~
~~**2** The increments/decrements of design ambient temperature specified in the requirements in **7.1.2, Part N of the Rules** are to be in accordance with **N4.2.6**.~~

N7.1.~~3~~2 Design Requirement for Dangerous Cargoes

The "certain ~~highly dangerous~~ cargoes specified in **Chapter 17**" referred to in **7.1.~~3~~2, Part N of the Rules** means the cargoes to which **17.3.2, Part N of the Rules** apply as required in column "**i**" in **Table N19.1**, **Part N of the Rules**.

N7.2 Design of Systems

The increments/decrements of design ambient temperature specified in the requirements in **7.2, Part N of the Rules** are to be in accordance with **N4.13.2**.

N7.~~2~~3 ~~Refrigeration Systems~~ Reliquefaction of Cargo Vapours

N7.~~2.4~~3.1 ~~Type of Refrigeration System~~ General

1 The "~~certain cargoes specified in **Chapter 17**~~ requirements of **Chapters 17 and 19 of this Part** may preclude the use of one or more of these systems or may specify the use of a particular system" referred to in the requirements in **7.3.1~~2.4(1) and (3)~~, Part N of the Rules** means those ~~cargoes to~~ cases which the application of the provisions of **17.4.1, Part N of the Rules** is required in column "**i**" in **Table N19.1** in **Chapter 19**, **Part N of the Rules**.

2 For the purpose of the requirements in **7.3.1, Part N of the Rules**, the reliquefaction system is to comply with the following requirements **(1)** to **(3)**:

(1) For the refrigerating plant, the following requirements **(a)** and **(b)** are to be complied with:
- (a) In the case of indirect system, the relevant requirements in **Chapters 1, 3, 4** and **6 of the Rules for Cargo Refrigerating Installations** are to be complied with.
- (b) In the case of the direct system, the following requirements **i)** through **vii)** are to be complied with:
  - i) The construction of compressors is to be such that causes only a small amount of gas leakage and without sparks.
  - ii) A relief valve or overpressure preventing device is to be provided on the discharge from the compressor. However, when overpressure is unlikely, this requirement may be dispensed with. The vent pipe of the relief valve of the compressor is to be led to the vent system specified in the requirements in **8.2.10, Part N of the Rules**.
  - iii) A pressure gauge is to be provided on the discharge side of the compressor.
  - iv) Means to avoid the entry of cargo liquid are to be provided cargo into the compressor.
  - v) The requirements in **3.1.3**, **3.2.4**, **3.2.5**, **6.1.1** and **6.1.2 of the Rules for Cargo Refrigerating Installations** apply correspondingly.
  - vi) The temperature of the cooling sea water used in the calculation of capacity of the refrigeration plant is to be the ambient sea water temperature specified in **7.2, Part N of the Rules**.
  - vii) The compressors and heat exchangers are to be approved in accordance with the requirements of the **Annex 1 "GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK"**.

(2) For pressure vessels and pipings, the requirements in **5.1.1** and **5.2, Part N of the Rules** and **N5.1.1** and **N5.2.1-1** are to be complied with.
(3) For pressure relief valves, level gauges and other fittings, the relevant requirements in **Chapters 5**, **8** and **13, Part N of the Rules** apply correspondingly as necessary.

N7.~~2.5~~3.2 ~~Heat Exchange~~ Compatibility

For the purpose of the requirements in **7.~~2.5~~3.2, Part N of the Rules**, the compressors for the refrigerant and other equipment that directly handle the refrigerant are, as a rule, to be installed within the cargo area. However, in case where proper means of detecting the leakage of the cargo into the refrigerant and shutting-off the inflow of the leaked cargo to the spaces outside the cargo area after the detection of leakage is established depending on the possibility of cargo leakage into the refrigerant pipes within the heat exchangers, this requirement may be dispensed with.

N7.7 Segregation

~~N7.2.2 Requirement for Carrying Simultaneously Cargoes or Chemical Reaction~~

The "cargoes which may react chemically in a dangerous manner" referred to in **7.~~2.2~~7, Part N of the Rules** means those cargoes in combination as given in **Table N7.~~2.2~~7**. For other cargoes not given in this Table, except for those given in the notes of the Table, decision is to be taken in each case upon investigating the physical properties.

~~N7.2.1 Stand-by Unit and Heat Exchanger~~

~~**1** For the purpose of the requirements in **7.2.1, Part N of the Rules**, the stand-by unit of the refrigeration system and stand-by heat exchangers are to comply with the following requirements **(1)** through **(4)**:~~

~~(1) The stand-by refrigeration system referred to in the requirements of the Rules does not include heat exchanger.~~
~~(2) Where the whole necessary capacity is shared by multiple sets of units, the capacity of the stand-by unit may be made in such a way that it compensates the capacity of one unit having the largest capacity among others.~~
~~(3) Where the refrigeration plants are all driven by electric motors, electrical supply to the motors is to be fed from two or more generators.~~
~~(4) The piping of the stand-by heat exchangers may, for example, be made as given in **Fig. N7.2.1**. In this case, the total capacity of the heat exchangers including stand-by unit is to be 125% or more of the maximum requirement.~~

~~**2** Reliquefaction plant of methane (*LNG*) is to comply with the following requirements **(1)** and **(2)**:~~

~~(1) Mechanical refrigeration fitted as the primary system for cargo pressure control~~
~~(a) **7.2, Part N of the Rules** is to apply to refrigeration systems when fitted on *LNG* carriers, i.e. standby capacity is to be determined in accordance with **7.2.1, Part N of the Rules**. A stand-by *LNG*/refrigerant heat exchanger need not be provided and the fitted *LNG*/refrigerant heat exchanger will not be required to have 25% excess capacity over that for normal requirements. Other heat exchangers utilizing water cooling are to have a stand-by or have at least 25 % excess capacity.~~
~~(b) Unless an alternative means of controlling the cargo pressure/temperature is provided to the satisfaction of the Society, the stand-by unit affording spare capacity at least equal to the largest required single unit is to be fitted. For the purpose of complying with the above, a suitable alternative means of pressure/temperature control is to be following **i)** or **ii)**:~~

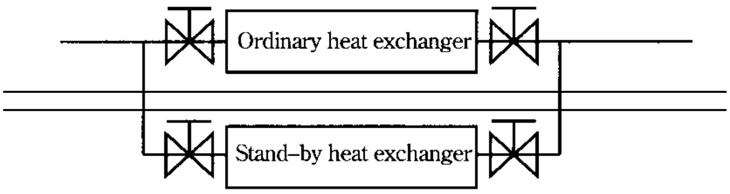
~~i) The auxiliary boiler capable of burning the boil-off vapours and disposing of the generated steam or an alternative waste heat system acceptable to the Society. Consideration may be given to systems burning only part of the boil-off vapour if it can be shown that *MARVS* will not be reached within a period of 21 *days*.~~

~~ii) Controlled venting of cargo vapours as specified in **7.3.2, Part N of the Rules**, if permitted by the Administrations concerned.~~

~~(2) Mechanical refrigeration fitted as the secondary system for cargo pressure control~~

~~Where a refrigeration plant is fitted as a means of disposing of excess energy as detailed in **7.1.1(2), Part N of the Rules**, no stand-by unit is required for the refrigeration plant.~~

~~Fig. N7.2.1 The Example Piping of the Stand-by Heat Exchanger~~



~~N7.2.3 Cooling Water~~

~~**1** "Any other essential service" referred to in the requirements in **7.2.3, Part N of the Rules** means water supply to equipment necessary for propulsion, discharge of bilges, ballasting/deballasting and fire services. The service for the water spray system specified in the requirements in **11.3, Part N of the Rules** is to be included therein.~~

~~**2** In case where the stand-by cooling pump is used for service common to that given in the preceding **-1**, the capacity of this pump is not to be less than the total capacity of the maximum cooling requirement and the necessary capacity for the particular service.~~

Table N7.~~2.2~~7 Cargoes Which May React Chemically in a Dangerous Manner

Group No.	Groups	Product name	Group No.							
			6	7	16	19	30	31	35	36
6	Ammonia	Ammonia, anhydrous	-		H	H				
7	Aliphatic amines	Dimenthylamine Monoethylamine		-	H	H				
16	Alkylene oxides	Propylene oxide	H	H	-					
19	Aldehydes	Acetaldehyde	H	H		-				
30	Olefines	Butadiene Ethylene Propylene Butylene Methyl acetylene -propadiene alxtures					-			
31	Paraffins	Butane Ethane Metthane (LNG) Propane						-		
35	Viny halides	Vinyl chloride							-	
36	Halogenated hydrocarbons	Ethyl chloride Methyl bromide Methyl chloride								-

Notes:

1. "*H*" in **Table** denotes possibility of dangerous reaction whereas blank column signifies no possibility of such reaction.
2. In general, chlorine and ethylene oxide are to be individually refrigerated or not carried together with other cargo.
3. Nitrogen has no danger of reacting with other cargo.

N8 has been amended as follows.

N8 CARGO TANK VENT SYSTEMS

N8.1 General

N8.1.1 General

For the purpose of the requirements in **8.1.1, Part N of the Rules**, the pressure relief~~ving~~ system of hold spaces is to be in accordance with the following requirements **(1)** and **(2)**:

(1) In hold spaces not regarded as the interbarrier space and environmental control within the space is required in accordance with the provisions in **9.2** and **9.3, Part N of the Rules**, one or more pressure relief systems of sufficient capacity are to be provided. The set pressure of those pressure relief systems is to be so set as not to exceed the design pressure of the cargo containment system and hull construction under the condition of dry air sealing or inerting. The location of the vent discharge outlet to which the ~~exhaust~~outlets from the pressure relief systems is lead is to be in accordance with the requirements in **13.6.4, Part D of the Rules**, and in addition, consideration is to be given so as not to cause the inert gas to accumulate on deck.

(2) The pressure relief system of hold spaces regarded as the interbarrier space or part thereof is to conform to the requirements in **N8.2.2**.

N8.2 Pressure Relief Systems

N8.2.2 Pressure Relief ~~System~~Devices for Interbarrier Spaces

1 The "pressure relief devices ~~to the satisfaction of the Society~~" referred to in the requirements in **8.2.2, Part N of the Rules** means PRVs~~pressure relief valves~~, rupture discs or equivalent, or two or more of them in combination are to be provided in each space to be covered. Interbarrier space pressure relief devices in the scope of this interpretation are emergency devices for protecting the hull structure from being unduly overstressed in case of a pressure rise in the interbarrier space due to primary barrier failure. Therefore such devices need not comply with the requirements of **8.2.10~~9~~** and **8.2.11~~10~~, Part N of the Rules**.

2 When only PRVs~~pressure relief valves~~ are provided as the pressure relief devices given in the preceding **-1**, the following requirements **(1)** and **(2)** are to be complied with:

(1) In case where the cargo tank is of the type *A* independent tank, semi-membrane tank provided with complete secondary barrier, membrane tank or integral tank, the following requirements **(a)** and **(b)** are to be complied with:
   (a) The capacity of the pressure relief system is to be sufficient to relieve the greater of the maximum supply capacity of the inerting system and dry air supply system or the estimated volume of cargo evaporation in an event of failure of the cargo tank.
   (b) PRVs~~Pressure relief valves~~ are to be in accordance with the requirements in **N8.2.5**.

(2) In case where the cargo tank is of the type *B* independent tank or semi-membrane tank provided with partial secondary barrier, the following requirements **(a)** and **(b)** are to be complied with:
   (a) The capacity of pressure relief device is to be in accordance with the preceding **(1)(a)**.
   (b) PRVs~~Pressure relief valves~~ may not be such as being approved in accordance with the requirements in **N8.2.5**. However, they are to be equivalent to those complying with the requirements for *PV* valves in **R11.6.1**.

3 When, as a pressure relief device referred to in the preceding **-1**, pressure valve and rupture disc are provided in combination, they are to conform to the following requirements **(1)** to **(3)** for the cargo tank types indicated in the preceding **-2(1)**:

(1) The capacity of the PRV~~pressure relief valve~~ is to be sufficient to relieve the maximum supply capacity of the inerting system.

(2) PRVs~~Pressure relief valves~~ are to be in accordance with the requirements in the preceding **-2(2)(b)**.

(3) The capacity of rupture disc is to be sufficient to relieve the volume of cargo evaporation in an event of failure of the cargo tank, and the construction is to be as deemed appropriate by the Society.

4 Size of pressure relief devices

(1) The combined relieving capacity of the pressure relief devices for interbarrier spaces surrounding type A independent cargo tanks where the insulation is fitted to the cargo tanks may be determined by the following formula:

$$Q_{sa} = 3.4 A_c \frac{\rho}{\rho_v} \sqrt{h} \quad (m^3/s)$$

where:

Q_{sa} = minimum required discharge rate of air at standard conditions of 273 K and 1.013 *bar*

A_c = design crack opening area (m^2)

$$A_c = \frac{\pi}{4} \delta l \quad (m^2)$$

δ = max crack opening width (m)

$$\delta = 0.2t \quad (m)$$

t = thickness (m) of tank bottom plating

l = design crack length (m) equal to the diagonal of the largest plate panel of the tank bottom.

h = max liquid height (m) above tank bottom plus $10 MARVS$

ρ = density of product liquid phase (kg/m^3) at the set pressure of the interbarrier space relief device

ρ_v = density of product vapour phase (kg/m^3) at the set pressure of the interbarrier space relief device and a temperature of 273 K

$MARVS$ = max allowable relief valve setting (*bar*) of the cargo tank.

(2) The relieving capacity of pressure relief devices of interbarrier spaces surrounding independent type B cargo tanks may be determined on the basis of the method given in **(1)** above, however, the leakage rate is to be determined in accordance with **4.7.2~~6-1.~~, Part N of the Rules**.

(3) The relieving capacity of pressure relief devices for interbarrier spaces of membrane and semimembrane tanks is to be evaluated on the basis of specific membrane/semi-membrane tank design.

(4) The relieving capacity of pressure relief devices for interbarrier spaces adjacent to integral type cargo tanks may, if applicable, be determined as for type A independent cargo tanks.

N8.2.4 Arrangement of PRVs~~Pressure Relief Valves~~

For the purpose of the requirements in **8.2.4, Part N of the Rules**, for the cargo tank with the design temperature lower than 0°C, it is to be verified through temperature distribution calculation, etc. that the valve would not freeze or it is provided with anti-freezing construction. In ships where the requirements in **Part I of the Rules** apply or ships regularly navigate through the sea of cold zone, the PRVs~~pressure relief valves~~ are to have satisfactory proved function under freezing condition or to be provided with heating system to prevent functional inability due to freezing.

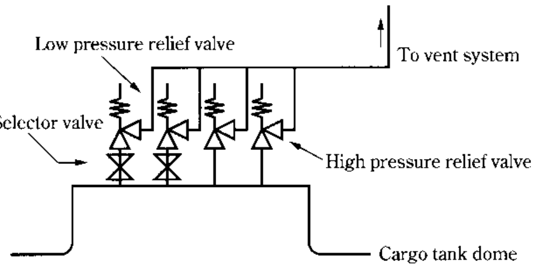
N8.2.5 Valve Testing~~Capacity of Pressure Relief Valves~~

For the purpose of the requirements in **8.2.5, Part N of the Rules**, PRVs~~pressure relief valves~~ to be provided in cargo tanks, cargo piping and interbarrier spaces, as necessary, are to be approved in accordance with the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

N8.2.7~~6~~ Changing ~~of~~ Set Pressure of PRVs~~Relief Valves~~

The means as "necessary, for isolating the valves not in use from the cargo tank" referred to in **8.2.7~~6~~, Part N of the Rules** means, for example, the arrangement as shown in **Fig. N8.2.7~~6~~**.

Fig. N.8.2.7~~6~~



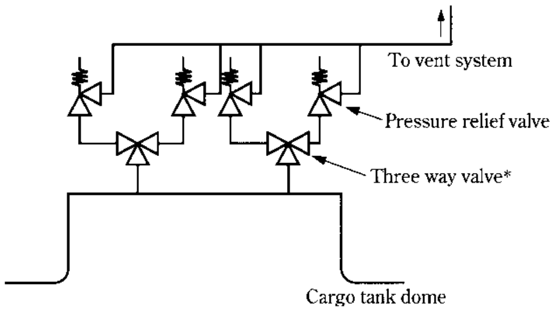
N8.2.9~~8~~ Means of Emergency Isolation of PRVs~~Stop Valves between Tanks and Pressure Relief Valves~~

1 For the purpose of the requirements in **8.2.9~~8~~, Part N of the Rules**, no stop valve is to be provided in the vent piping on the downstream of the PRV~~pressure relief valve~~.

2 The requirement "~~suitable arrangements~~to allow only one of the cargo tank installed PRVs to be isolated" specified~~referred to in the requirements~~ in **8.2.9(2)~~8(1)~~, Part N of the Rules** ~~means~~may be achieved, for example, by the arrangement shown in **Fig. N8.2.7,** the 3-way valve arrangement ~~through transfer of the 3-way valve as~~ shown in **Fig. N8.2.9~~8~~-1**,~~or~~ the arrangements ~~by~~with an interlocking stop valve ~~of interlocking type~~ as shown in **Fig. N8.2.9-2** or arrangements with balloons.

~~**3** The "suitably maintained spare valve" referred to in the requirements in **8.2.8(3), Part N of the Rules** means, for example, valves of the same type and capacity of valve I and valve II in the arrangement as shown in **Fig. N8.2.8-2**. In this case, if valve I and valve II are of the completely same type and capacity, only one set of such spare may be accepted.~~

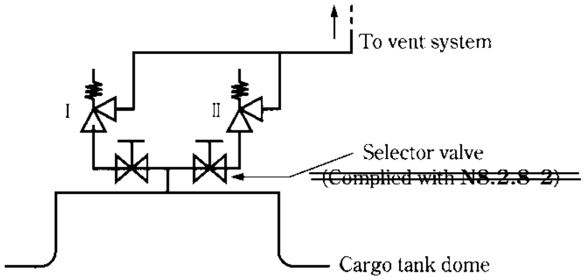
Fig. N8.2.9~~8~~-1



note:

*: 3-way valve in which the direction of opening is indicated where means are provided to prevent any intermediate valve position.

Fig. N8.2.9~~8~~-2

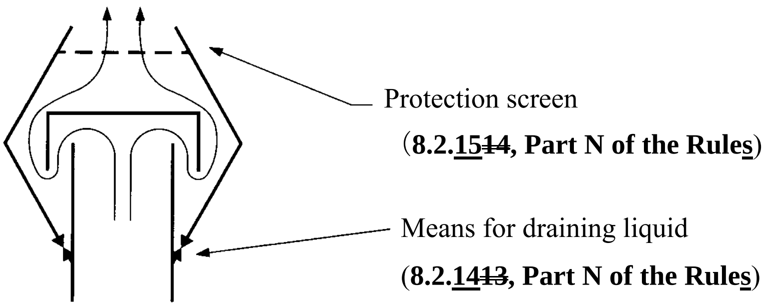


N8.2.10~~9~~ Venting Systems

1 ~~To "be so constructed that the discharge of gas will be directed upwards and so arranged as to minimize the possibility of water or snow entering the vent system" means~~An example of a construction complying with **8.2.10(1)** and **(2), Part N of the Rules** is ~~for example, as~~ shown in **Fig.N8.2.10~~9~~**.

2 For the purpose of the requirements in **8.2.10~~9~~, Part N of the Rules**, the height of the vent exits~~discharge outlet~~ is to be measured from the exposed deck at the place where the vent mast is provided.

Fig. N8.2.10~~9~~ Example of Construction of Vent ~~Discharge~~ Outlet



N8.2.11~~0~~ Arrangement of Vent Outlets~~Exits~~

For the purpose of the requirements in **8.2.11~~0~~, Part N of the Rules**, the distance to the vent ~~discharge~~ outlet is to be measured horizontally.

N8.2.12~~1~~ Arrangement of All Other Cargo Vent Outlets~~Exits~~

For the purpose of the requirements in **8.2.12~~1~~, Part N of the Rules**, the arrangements of ~~an~~other cargo vent piping~~discharge outlet are~~is to be in accordance with following requirements **(1)** ~~to~~and **(~~3~~2)**:

(1) ~~Vent discharge o~~Outlets from the gas fuel piping specified in **16.4.5~~3.6~~, Part N of the Rules** are to be in accordance with the requirements in **8.2.10~~9~~** and **8.2.11~~0~~, Part N of the Rules**.

 (a) The vent ~~discharge~~ outlets of PRV~~pressure relief valve~~ or rupture disc of interbarrier spaces of type *A* independent tank. However, when both PRV~~pressure relief valve~~ and rupture disc are provided in combination, only the vent discharge outlet for the PRV~~pressure relief valve~~ may be applied.

 (b) Vent ~~discharge~~ outlet from the gas fuel piping specified in **16.4.5~~3.6~~, Part N of the Rules**.

~~(2) Discharge outlets specified in the requirements in **16.3.5, Part N of the Rules** are to be arranged at a horizontal distance not less than 10 *m* from the nearest air intakes, discharge~~

~~outlets or openings to accommodation spaces, service spaces and control stations, or other gas-safe spaces.~~

(2~~3~~) Vent ~~discharge~~ outlets from PRVs~~pressure relief valves~~ or rupture discs of interbarrier spaces are to be installed in gas dangerous zones.

N8.2.13~~2~~ Pressure Relief Systems for Simultaneously Carrying ~~Incompatible~~ Cargoes which React in a Dangerous Manner ~~Simultaneously~~

The "separate pressure relief system" referred to in the requirements in **8.2.13~~2~~, Part N of the Rules** means the independent vent system including an independently provided PRV~~pressure relief valve~~. In this case, no specific requirement is provided on the distance between vent ~~discharge~~ outlets.

N8.2.14~~3~~ Means for Draining

For the purpose of the requirements in **8.2.14~~3~~, Part N of the Rules**, drain plugs or drain cocks are to be provided at places where drains are likely to accumulate.

~~N8.2.14 Protection Screens on Vent Outlets~~

~~The "protection screens" referred to in the requirements in **8.2.14, Part N of the Rules** means wire gauze of 13 *mm* × 13 *mm* mesh or below with suitable strength against falling objects.~~

N8.2.18 Adequacy of the Vent System~~Pressure Relief Systems~~

Adequacy of the vent system~~Pressure Relief Systems~~ specified in **8.2.18 of the Rules** is to be certified in accordance with the **Annex 5** "**GUIDANCE FOR THE EVALUATION OF THE ADEQUACY OF TYPE *C* TANK SYSTEMS**".

~~N8.3 Additional Pressure Relieving System for Liquid Level Control~~

~~N8.3.1 Requirement of Additional Pressure Relieving Systems~~

~~The words "to prevent the tank from becoming liquid full" contained in **8.3.1, Part N of the Rules** have the following meaning: At no time during the loading, transport or unloading of the cargo including fire conditions will the tank be more than 98% liquid full, except as permitted by the requirements in **15.1.3, Part N of the Rules**.~~

N8.3~~4~~ Vacuum Protection Systems

N8.3.1~~4.2~~ Fitting of Vacuum Protection Systems

1 For the purpose of the requirements in **8.3.1~~4.2~~(1), Part N of the Rules**, the means to stop all suction of the cargo liquid or cargo vapour may be by shutting off valves or stopping the equipment provided that they are automatically operated.

2 For the purpose of the requirements in **8.3.1~~4.2~~(2), Part N of the Rules**, the vacuum relief valve is to conform to the requirements in **8.2.5** and **8.2.6, Part N of the Rules** and to be approved in accordance with the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**". However, means as specified in the requirements in **8.3.1~~4.2~~(1) ~~or (3)~~, Part N of the Rules** are to be provided, and where vacuum relief valve adjusted to function at a pressure lower than such means is provided as an additional device, the requirements may be dispensed with for this vacuum relief valve as an additional means.

N8.3.2~~4.3~~ Requirement of Vacuum Relief Valves~~Protection Systems~~

For the purpose of the requirements in **8.3.2~~4.3~~, Part N of the Rules**, vacuum relief valves are to be in accordance with the following requirements **(1)** and **(2)**:

(1) Only for cases where vacuum relief valves adjusted to a set pressure lower than the operating pressure of the device specified in the requirements in **8.3.1~~4.2~~(1) ~~or (3)~~, Part N of the Rules**, are provided for additional means of the devices, it may be accepted to admit the air to be introduced into the tank even in case of flammable cargoes except for the cases specified in the relevant requirements in **Chapter 17, Part N of the Rules**.

(2) The air suction opening for the vacuum relief valve as an additional device indicated in the preceding **(1)** may be made in such a way that the requirements in **8.2.10~~9~~** and **8.2.11~~10~~, Part N of the Rules** do not apply. However, the requirements in **13.6.4, Part D of the Rules** are to be complied with, and the construction of the suction opening is, for example, to be as shown in **Fig. N8.2.10~~9~~**.

N8.4~~5~~ Sizing~~e~~ of Pressure Relieving Systems~~Valves~~

N8.4~~5~~.1 Sizing~~e~~ of PRVs~~Valves~~

For the purpose of the requirements in **8.4~~5~~.1(2), Part N of the Rules**, the fire exposure factor (F) is to be in accordance with the following requirements **(1)** ~~through~~to **(4)**:

(1) The insulation materials used at exposed spaces when F = 0.5 are to conform to the requirements in **~~N4.9.6(2)~~4.19.3-4, Part N of the Rules**.

(2) In the case of integral tanks, F = 0.1.

(3) The fire exposure factor of the tank which partially protrudes beyond the tank cover having the fire integrity equivalent to the deck and deck structure is to be of such a value as obtained by proportional distribution of cargo tank surface areas above and below the deck or tank cover.

(4) In case where hold spaces filled with dry air is accepted for semi-membrane tanks provided with partial secondary barriers in accordance with the requirements in **9.2.2~~-2~~, Part N of the Rules**, F = 0.2.

N9 has been amended as follows.

N9 ~~ENVIRONMENTAL~~ CARGO CONTAINMENT SYSTEM ATMOSPHERE CONTROL

N9.1 ~~Environmental~~ Atmosphere Control within the Cargo ~~Tanks and Cargo Piping~~ Containment Systems

N9.1.1 ~~Gas-free and Purge~~ Atmosphere Control Systems of Cargo Tanks

For the purpose of the requirements in **9.1.1, Part N of the Rules**, the design and arrangement of ~~gas freeing and purging piping~~ atmosphere control systems of cargo tanks are to be in accordance with the following requirements **(1)** and **(2)**:

(1) For installation of piping and fixing of pipe fittings in cargo tanks, sufficient consideration is to be taken for possible transient temperature differential.

(2) The effectiveness of replacement of cargo tank atmosphere is to be verified at time of gas trial given in **N4.20.3-4** to **-7~~10.14~~**.

~~N9.1.2 Monitoring of Purging and Gas-freeing~~

~~Gas sampling systems referred to in **9.1.2, Part N of the Rules** are to be in accordance with the following requirements:~~

~~**1** The arrangement of gas sampling points in cargo tanks is to be determined according to cargo properties, cargo tank construction and capacity as well as the abilities of gas freeing and purging systems; moreover, in cases where appropriate, the adequacy of the arrangement of gas sampling points is to be verified by performance tests. The locations of gas sampling points are, as standard, to be at the upper, middle and lower spaces of the cargo tank.~~

~~**2** At least two valves are to be used to isolate a gas sampling point. However, in cases where only gas (not liquid) is sampled at the sampling points, just a single valve may be acceptable.~~

~~**3** In cases where gas sampling systems are connected to cargo transfer lines and where two valves are provided in accordance with 2 above, the relief valves specified in **5.2.1-6, Part N of the Rules** are to be provided. However, in the cases where measures are taken to prevent the retention of cargo liquid between such valves and where the following is complied with, the fitting of relief valves may be omitted.~~

~~(1) Caution plates that show the procedures for gas sampling including how to operate both valves are to be provided at the operation position for gas sampling.~~

~~(2) Confirmation whether both valves are open or closed are to be taken at the operation position for gas sampling.~~

~~**4** For ships which **Column *f* of Table N19.1, Part N of the Rules** is applied according to the type of products to be carried and which are required to install toxic vapour detectors, the gas sampling system is to be of a closed-loop design to prevent cargo vapour from venting to the atmosphere.~~

~~**5** The closed-loop designed gas sampling systems specified in **-4** above is to be provided with two valves respectively on both the sample inlet side and return side.~~

N9.1.~~3~~2 Inerting of Cargo Tanks

For the purpose of the requirements in **9.1.2~~3~~, Part N of the Rules**, for cargo tanks carrying petroleum products, etc. the requirements in this Chapter apply, and in addition, the requirements specified in **R~~3.1.1-2~~1.2.1** are to be complied with.

N9.1.4 Monitoring of Atmosphere Change

Gas sampling points referred to in **9.1.4, Part N of the Rules** are to be in accordance with the following requirements:

1 The arrangement of gas sampling points in cargo tanks is to be determined according to cargo properties, cargo tank construction and capacity as well as the abilities of gas freeing and purging systems; moreover, in cases where appropriate, the adequacy of the arrangement of gas sampling points is to be verified by performance tests. The locations of gas sampling points are, as standard, to be at the upper, middle and lower spaces of the cargo tank.

2 At least two valves are to be used to isolate a gas sampling point. However, in cases where only gas (not liquid) is sampled at the sampling point, just a single valve may be acceptable.

3 In cases where gas sampling systems are connected to cargo transfer lines and where two valves are provided in accordance with **2** above, the relief valves specified in **5.5.6, Part N of the Rules** are to be provided. However, in the cases where measures are taken to prevent the retention of cargo liquid between such valves and where the following is complied with, the fitting of relief valves may be omitted.

(1) Caution plates that show the procedures for gas sampling including how to operate both valves are to be provided at the operation position for gas sampling.

(2) Confirmation whether both valves are open or closed are to be taken at the operation position for gas sampling.

4 For ships which **Column *f* of Table N19.1 of the Rules** is applied according to the type of products to be carried and which are required to install toxic vapour detectors, the gas sampling system is to be of a closed-loop design to prevent cargo vapour from venting to the atmosphere.

5 The closed-loop designed gas sampling systems specified in **4** above is to be provided with two valves respectively on both the sample inlet side and return side.

N9.2 ~~Environmental~~ Atmosphere Control within the Hold Spaces (Cargo Containment Systems ~~o~~Other than Type *C* Independent Tanks)

N9.2.1 ~~Environmental~~ Atmosphere Control, Requiring Full or Partial Secondary Barriers

1 For the purpose of the requirements in **9.2.1, Part N of the Rules**, even in cases where full secondary barrier is not required according to the requirements in **4.5~~7.3~~, Part N of the Rules**, if flammable gases are carried in type *A* independent tank, integral tank, membrane tank and semi-membrane tank, the requirements in **9.2.1, Part N of the Rules** apply correspondingly.

2 For the purpose of the requirements in **9.2.1, Part N of the Rules** even in cases where partial secondary barrier is not required according to the requirements in **4.5, Part N of the Rules**, if flammable gases are carried in type *B* independent tank, the requirements in **9.2.1** or **9.2.2, Part N of the Rules** apply correspondingly.

~~**2**~~**3** The "suitable dry inert gas" referred to in the requirements in **9.2.1, Part N of the Rules** means the inert gas of which dew point is controlled in accordance with **N9.4.1(4)**. Further, the "normal consumption for at least 30 *days*" referred to in the requirements in **9.2.1, Part N of the Rules** is to be given consideration for the effects of atmospheric pressure and temperature variations during the passage and additional consumption by gas detection, etc.

N9.2.2 ~~Environmental~~ Alternative Arrangements of Atmosphere Control, Requiring Partial Secondary Barriers

~~**1** For the purpose of the requirements in **9.2.2, Part N of the Rules**, even in cases where the provision of partial secondary barriers is not required according to the requirements in **4.7.3, Part N**~~

~~**of the Rules**, when flammable gases are carried by type *B* independent tank, the requirements in **9.2.2, Part N of the Rules** apply.~~
~~**2** The "suitable dry inert gas" and the "normal consumption for at least 30 *days*" referred to in the requirements in **9.2.2, Part N of the Rules** are to be as specified in **N9.2.1-2**.~~
~~**3**~~ In cases where dry air is introduced into the interbarrier spaces and hold spaces in accordance with **9.2.2, Part N of the Rules**, at least the following requirements **(1)** to **(3)** are to be complied with:

(1) Dew point of dry air is to be controlled according to **N9.4.1(4)**.

(2) On the supply piping of dry air, one stop valve is to be provided at the inlet into the space which is filled with dry air, and two non-return valves are to be provided within the cargo area side near the forward or aft end of the cargo area. However, one of the two non-return valves may be substituted by 3-in one set of valves as shown in **Fig. N9.2.2**.

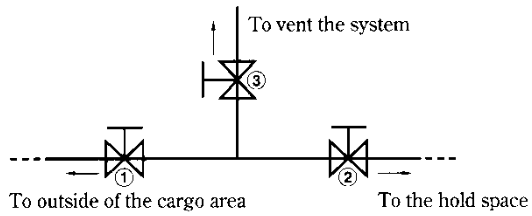
(3) Instrumentation is to be provided in accordance with the following requirements **(a)** to **(c)**:

  (a) At the outlet of the dry air supply system, pressure gauge and thermometer are to be provided.

  (b) One or more dew point meters as deemed appropriate by the Society are to be provided. However, in case where only one dew point meter is provided, a spare cell unit is to be provided.

  (c) At the outlet of the dry air supply system, interbarrier spaces and hold spaces, connections for dew point meter are to be provided.

Fig. N9.2.2



1) When dry air is being supplied, stop valves ① and ② are to be opened. Stop valves ③ is to be closed.
2) When dry air supply is stopped, stop valve ③ is to be opened, and stop valves ① and ② are to be closed.

N9.2.3 ~~Environmental~~ Atmosphere Control for Non-flammable Gases

1 The "suitable dry air or inert atmosphere" referred to in the requirements in **9.2.3, Part N of the Rules** means a state in which spaces are filled with the air with controlled dew point or inert gas according to the requirements in **N9.4.1(4)**. This inert gas system may not conform to the requirements in **9.4** and **9.5, Part N of the Rules**, but is to be provided with a storage system or generating system capable of making up a consumption for at least 30 *days*.
2 In case where dry air is introduced according to the ~~preceding~~ **-1** above, the requirements in **N9.2.2**~~**-3**~~ are to be complied with.

N9.3 Environmental Control of Spaces Surrounding Type *C* Independent Tanks

N9.3.1 Environmental Control of Spaces Surrounding Type *C* Independent Tanks

For the purpose of the requirements in **9.3, Part N of the Rules**, the environmental control of the compartment is to be in accordance with **N9.2.3**.

N9.4 Inerting

N9.4.1 Properties of Inert ~~g~~Gas and ~~i~~Its Supply

For the purpose of the requirements in **9.4.1, Part N of the Rules**, the following requirements **(1)** through **(4)** are to be complied with:

(1) For the inert gas supply piping, evaporator and heater, if necessary, are to be provided so that the compartment supplied with inert gas can be maintained at proper temperature and pressure and further, thermometer and pressure gauges are to be provided for monitoring.

(2) Where the inert gas is stored in inert gas bottles, the following requirements **(a)** through **(d)** are to be complied with:

(a) The inert gas bottles and piping are to be dealt with according to the following requirements **i)** to **iii):**

i) The material of the piping may be to the requirements of the standard as deemed appropriate by the Society.

ii) The gas bottle may be to the requirements of the National Standards notwithstanding the requirements in **Chapter 10, Part D of the Rules**.

iii) The hydraulic tests for pipes, valves and pipe fittings may be omitted.

(b) The location of installation of the bottles is to be as given in the following **i)** and **ii):**

i) The inert gas bottles are, as a rule, to be located in the storage room within the cargo area.

ii) The storage room of inert gas bottles is to be well ventilated so as not to allow leaked gas accumulate the room and be capable of being accessed from the exposed deck.

(c) The inert gas storage containers are to be so arranged to be safe against ship motions and vibrations, and are to be stored upright as far as practicable.

(d) The piping system, after assembly on board, is to be subjected to airtightness test at a pressure 1.25 *times* the maximum working pressure or more, and free flow test at a suitable pressure.

(3) Where the permanent storage tank installed on deck is used as the inert gas storage container, the requirements for the design, tests and inspection of the tank and the piping are to be in accordance with the relevant requirements specified for process pressure vessels and piping systems in **Chapter 4** and **Chapter 5, Part N of the Rules**. However, consideration may be given as appropriate depending on their service conditions.

(4) The dew point of dry inert gas is, in general, not exceed the minimum design temperature of the exposed surface of the insulation material of the cargo tank into the hold space and hull structural members of the space being inerted in normal condition.

N9.4.3 Storage of Inert Gas at Low Temperature

For the purpose of the requirements in **9.4.3, Part N of the Rules**, the thermal isolation between the hull structure and the storage tank, and where necessary, the inert gas supply piping is to be in accordance with **N5.7.2-1~~5.2.1-3~~**.

~~N9.4.4 Prevention of the Backflow of Cargo Vapour~~

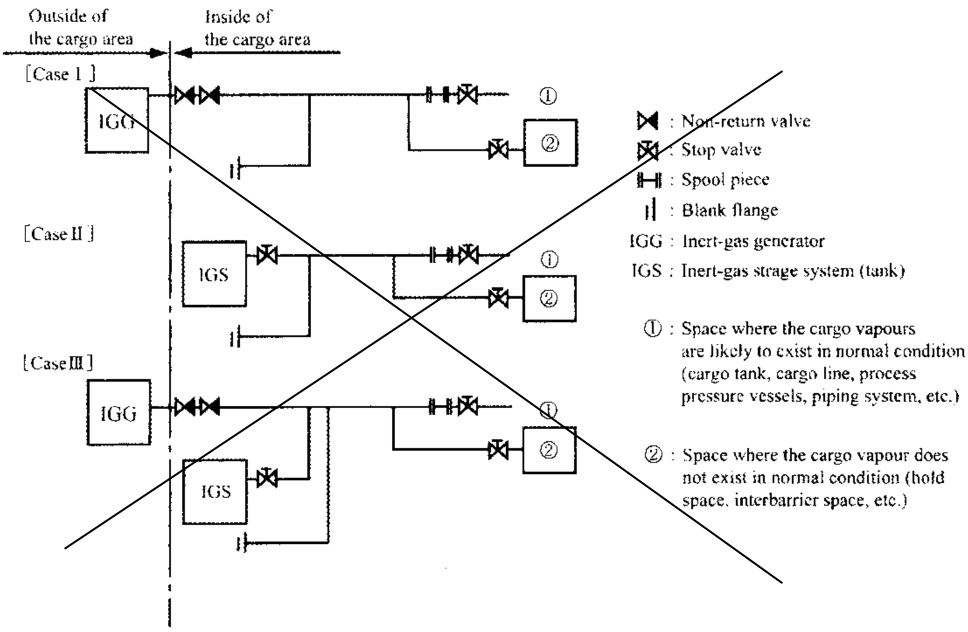
~~For the purpose of the requirements in **9.4.4, Part N of the Rules**, the arrangement to prevent the backflow of cargo vapour from entering the inert gas system is to be in accordance with **N3.1.5-1**. (*See* **Fig.N9.4.5**)~~

~~N9.4.5 Isolation of Spaces being Inerted~~

~~**1** For the purpose of the requirements in **9.4.5, Part N of the Rules**, the isolation of the spaces where the cargo vapours are likely to exist in normal condition (cargo tank, cargo line, process pressure vessels, piping system, etc.) from the inert gas system are to be in accordance with **N9.4.4**. (See **Fig.N9.4.5**)~~

~~**2** The isolation of the interbarrier spaces, hold spaces where the cargo vapour does not exist in normal condition and the outer side of double wall gas fuel piping specified in the requirements in **16.3.1(1), Part N of the Rules** from the inert gas system may be by a stop valve. (See **Fig.N9.4.5**)~~

~~Fig. N9.4.5~~



N9.5 Inert Gas Production on Board

N9.5.1 Inert Gas Production Equipment

(Omitted)

N10 ELECTRICAL INSTALLATIONS

Section N10.1 has been amended as follows.

N10.~~1~~2 General

N10.~~1.5~~2.4 Certified Safe Type Equipment

1 The wording "the satisfaction of the Society" in **10.~~1.5~~2.4**, **Part N of the Rules** mean that the explosion-protected electrical equipment complying with the requirements in **2.16, Part H of the Rules** and grouped into appropriate Apparatus Group and Temperature Class according to **Table N10.~~1.5~~2.4** or equivalent thereto for an environmental gas or vapours condition.

2 The wording "approved or certified one as the ~~certified~~ safe type" in **10.~~1.5~~2.4**, **Part N of the Rules** means one of the following: ~~that~~

(1) the explosion-protected electrical equipment approved by the Society in accordance with the requirements in **1.2.1-4, Part H of the Rules** or the equipment of a type which may not cause ignition of gases or vapours of the cargoes; or~~.~~

(2) The one evaluated and certified or listed by an accredited testing authority or notified body recognized by the Society.

Table N10.1.5 has been renumbered to Table N10.2.4.

Table N10.~~1.5~~2.4 Gases and Vapours Groups and Temperature Class

(Omitted)

Paragraph N10.2.6 has been added as follows.

N10.2.6 Electrical Generation and Distribution Systems

The wording "the standard deemed appropriate by the Society" given in **10.2.6, Part N of the Rules** means *IEC* 60812:2006.

N11 has been amended as follows.

N11 FIRE PROTECTION AND ~~FIRE~~ EXTINCTION

N11.1 Fire Safety Requirements

N11.1.1 General

(Omitted)

N11.1.2 Exclusion of Ignition Source

For the purpose of the requirements in **11.1.2, Part N of the Rules**, in the ~~gas-dangerous zones or~~ hazardous areas specified in the requirements in **1.1.5(~~15~~23), Part N of the Rules**, for ships carrying flammable substances, neither electrical equipment such as anchor windless nor openings of chain lockers which are regarded as sources of ignition are to be provided except for those approved under the relevant requirements in **Chapter 10, Part N of the Rules**.

N11.2 Fire ~~Water~~ Mains ~~Equipment~~ and Hydrants

N11.2.1 Fire Pump and Fire Main

For the purpose of the requirements in **11.2.1, Part N of the Rules**, the minimum pressure at fire hydrant of the fire main is to be not less than 0.5*MPa* (gauge) irrespective whether the fire pump and water main as used as part of water spray system or not.

N11.2.4 Nozzles

For the purpose of the requirements in **11.2.4, Part N of the Rules**, all nozzles ~~provided for fire-fighting~~ are to be in accordance with **10.2.3-3, Part R of the Rules**.

~~N11.2.5 Remote Control~~

~~In case of applying the requirements in 11.2.5, Part N of the Rules, at least one of fire pumps is to be capable of starting by remote control, and all valves provided between the fire pump and fire main are to be capable of being opened by remote control from the navigation bridge or other control stations outside the cargo area.~~

N11.2.5 Test after Installation

For the purpose of the requirements in **11.2.5, Part N of the Rules**, tightness tests are to be carried out with a pressure not less than the maximum working pressure.

N11.3 Water Spray System

N11.3.1 Area to be Covered

1 For the purpose of the requirements in **11.3.1(1), Part N of the Rules**, the area to be covered at the exposed tank dome is to include the areas where stop valves for cargo tanks and emergency shutdown valves specified in the requirements in **5.5~~6.3~~, Part N of the Rules** are fitted.

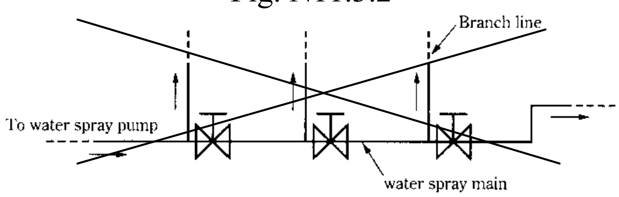
2 For the purpose of the requirements **11.3.1(~~3~~4), Part N of the Rules**, the area of the ~~manifold~~ load/unload connections is to include the areas where emergency shutdown valves specified in the requirements in **5.~~6~~5.3, Part N of the Rules** are fitted. Further, the "control valves" referred to in the requirements in **11.3.1(~~3~~4), Part N of the Rules** is to include stop valves for the transfer of cargo line to and from vapour line.
3 The "high fire risk items" referred to in the requirements in **11.3.1(~~4~~6), Part N of the Rules** are not to include the hydraulic machinery and electric motors (*See* **R2.3.1-7**). ~~Further, the "boundaries all facing the cargo area" referred to in the requirements in **11.3.1(4), Part N of the Rules** are not to include the ceiling of the compartment to be covered.~~

N11.3.2 Arrangement and Capacity

For the purpose of the requirements in **11.3.2, Part N of the Rules**, the following requirements **(1)** ~~to~~ and **(~~3~~2)** are to be complied with:

(1) The nozzles for protecting vertical surfaces are to be arranged per every two tiers for the end walls of the accommodation spaces, as standard.
~~(2) The intermediate valves fitted with the fire main are to be provided at the connections between the branch line and spray main for example, as shown in **Fig. N11.3.2**.~~
(~~3~~2) The water spray system is to be approved in accordance with the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

~~Fig. N11.3.2~~



N11.3.5~~4~~ Use for Other Services

For the purpose of the requirements in **11.3.5~~4~~, Part N of the Rules**, the ballast pump and bilge pump may be used commonly for the water spray system.

N11.3.8 Test after Installation

For the purpose of the requirements in **11.3.8, Part N of the Rules**, tightness tests are to be carried out with a pressure not less than the maximum working pressure.

N11.4 Dry Chemical Powder Fire-extinguishing Systems

~~N11.4.1 General~~

~~The "satisfactory to the Society" referred to in the requirements in **11.4.1, Part N of the Rules** means that the requirements in **N5.7.1** are complied with.~~

N11.4.1~~2~~ ~~Component of the Systems~~ General

~~For the purpose of the requirements in **11.4.2, Part N of the Rules**,~~ "Fixed dry chemical powder fire-extinguishing system approved by the Society" referred to in **11.4.1, Part N of the Rules** are to comply with "*Guidelines for the approval of fixed dry chemical powder* *fire-extinguishing systems for the protection of ships carrying liquefied gases in bulk*" (*MSC*.1/*Circ*.1315). ~~conform to the requirements in **11.4.2** to **11.4.6, Part N of the Rules**, and in addition they are to be approved in accordance with the **Annex 1 "GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK"**.~~

N11.4.3 Monitors and Hand Hose Lines, etc.

For the purpose of the requirements in **11.4.3, Part N of the Rules**, the ~~manifold~~ load/unload connection areas may be protected by only one monitor provided that it can be so fixed to protect the ~~manifold~~ load/unload connection area used for cargo operation even if there are ~~manifold~~ load/unload connections on both sides of the ship.

N11.4.5~~6~~ ~~Capacity of Dry Chemical Powder~~ Maximum Effective Distance of Hand Hose Lines

For the purpose of the requirements in **11.4.5~~6~~, Part N of the Rules**, when the areas to be covered are located higher than the installed positions of monitors and manual hose reels, the Society may request increase in the capacity of these monitors and manual hose reels depending on their arrangement.

N11.4.8 Test after Installation

For the purpose of the requirements in **11.4.8, Part N of the Rules**, tightness tests are to be carried out with a pressure not less than the maximum working pressure.

N11.5 ~~Cargo Compressor and Pump Rooms~~ Enclosed Spaces Containing Cargo Handling Equipment

N11.5.2 Fire-extinguishing System for the Ships Dedicated to the Carriage of a Restricted Number of Cargoes

The nitrogen gas fire extinguishing system is to conform to the requirements in **25.2.1, Part R of the Rules**, and in addition it is to be approved in accordance with the Guidance for Equipment and Fittings of Ships Carrying Liquefied Gases in Bulk.

N12 has been amended as follows.

N12 MECHANICAL VENTILATION IN THE CARGO AREA

N12.1 Spaces Required to be Entered during Normal Cargo Handling Operations

N12.1.4 Maintenance of Overpressure

"Recognized standards" referred to in **12.1.4, Part N of the Rules**, means *IEC* 60092-502:1999.

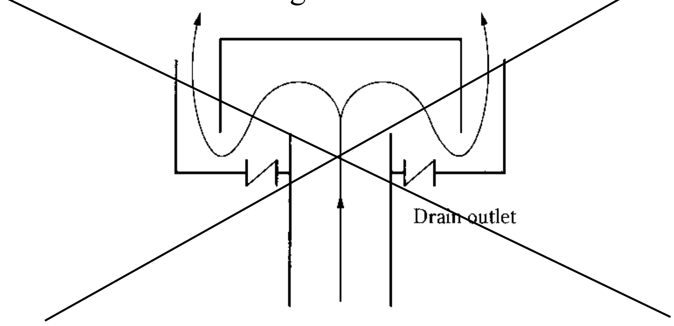
N12.1.5 Arrangement of Ventilation Ducts, Air Intakes and Outlets

1 "Recognized standards" referred to in **12.1.5, Part N of the Rules**, means *IEC* 60092-502:1999.

~~N12.1.6 Ventilation Exhaust Ducts from Gas-dangerous Spaces~~

~~For the purpose of the requirements in **12.1.6, Part N of the Rules**, the construction of ventilation exhaust ducts is, for example, to be as shown in **Fig. N12.1.6**.~~

~~Fig. N12.1.6~~



~~N12.1.7 Arrangement of Ventilation Intakes~~

2 For the purpose of the requirements in **12.1.~~7~~5, Part N of the Rules**, ~~ventilation~~ air intakes serving artificial ventilation systems are~~, at least,~~ to be in accordance with the following requirements **(1)** and **(2)**~~located in the gas-safe areas~~.

(1) Air intakes for hazardous area are to be taken from areas which, in the absence of the considered inlet, would be non-hazardous.

(2) Air intakes for non-hazardous area are to be taken from non-hazardous areas at least 1.5 *m* from the boundaries of any hazardous area.

3 For the purpose of the requirements in **12.1.5, Part N of the Rules**, exhaust outlets serving artificial ventilation systems are to be in accordance with the following requirements **(1)** and **(2)**.

(1) Exhaust outlets from hazardous area are to be located in an open area which, in the absence of the considered outlet, would be of the same or lesser hazard than the ventilated space.

(2) Exhaust outlets from non-hazardous area are to be located in a non-hazardous open area.

N12.1.7~~9~~ Construction of Ventilation Fans

For the purpose of the requirements in **12.1.7~~9~~, Part N of the Rules**, the following requirements **(1)** and **(2)** are to be complied with:

(1) Ventilation fans are to be of non-sparking type complied with the requirements of **R4.5.4-1(2)** as well as **12.1.7, Part N of the Rules**, and approved in accordance with the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**". For the purpose of the requirements, the openings of the ducts to which the ventilation fans are fitted are to be provided with protection screens of not more than 13 *mm* square mesh.
(2) The ventilation fans for motor rooms where electric motors to drive cargo compressors and cargo pumps are installed are to conform to the requirements in **12.1.7~~9~~, Part N of the Rules**, and in addition, to the following requirements **(a)** and **(b)**:
   (a) To have a ventilation capacity of not less th~~e~~an 30 air changes of the total volume of the motor room per hour.
   (b) Electric motors driving ventilation fans are to conform to the relevant requirements in **Chapter 10, Part N of the Rules** depending on the location of motors, and in addition, to the requirements for exterior-mounted type specified in **R19.3.4-2** when motors are installed in exposed spaces.

~~N12.1.10 Spare Parts~~

~~"Spare parts" referred to in the requirements in **12.1.10, Part N of the Rules** means one spare impeller for each type of fan.~~

N12.1.9~~11~~ Protection Screens of Ventilation Duct Openings

"Protection screens" referred to in the requirements in **12.1.9~~11~~, Part N of the Rules** means those with suitable strength against falling objects ~~given in **N8.2.14**~~.

N12.1.10 Design and Arrangement of the Ventilation

"Recognized standards" referred to in **12.1.10, Part N of the Rules**, means *IEC* 60092-502:1999.

N12.2 Spaces not Normally Entered

N12.2.1 Ventilation of ~~Hold~~ Enclosed Spaces

For the purpose of the requirements in **12.2.1, Part N of the Rules**, the ventilation of spaces not normally entered is to conform to the following requirements **(1)** and **(2)**:
(1) Natural ventilation alone is not accepted. ~~The mechanical ventilation system is to have a ventilation capacity of not less than eight air changes per hour when ventilation fans are provided in the permanently ducts, and not less than sixteen air changes per hour when no installed ducts are provided, as standard.~~
(2) Portable ventilation fans are to be in accordance with **N5.11.7~~.1~~**.

N13 has been amended as follows.

N13 INSTRUMENTATION AND AUTOMATION SYSTEMS ~~(GAUGING, GAS DETECTION)~~

N13.1 General

N13.1.~~3~~2 Centralization of Control Equipment and Indicators

For the purpose of the requirements in **13.1.~~3~~2, Part N of the Rules**, in case where control equipments and indicators are unable to be centralized in the cargo control room or other suitable places, they are to be provided in the wheelhouse.

N13.1.~~4~~3 Calibration and Test of Measuring Instruments

For the purpose of the requirements in **13.1.~~4~~3, Part N of the Rules**, tests and inspections of measuring instruments are to be in accordance with the following requirements **(1)** to **(3)**:

(1) Tests and inspections of measuring instruments during manufacture of each are to conform to the following requirements **(a)** to **(c)**:

  (a) Gas detection equipment~~s~~ are to be evaluated and certified or listed by an accredited testing authority or notified body recognized by the Society~~in accordance with the requirements in the **Chapter 7**, **Part 7** of **“Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use”**~~.

  (b) Level gauges are to be in accordance with the requirements in the **Chapter 4**, **Part 7** of **“Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use”**.

  (c) Pressure gauges and temperature indicating devices are to be in accordance with the requirements of the **Annex 1 “GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK”**.

((2) is omitted.)

(3) For retests and testing procedures of instrumentation after installation on board the ship, at least the following items are to be noted in the Operation Manual specified in the requirements in **18.1.1(3), Part N of the Rules**:

  ((a) to (f) is omitted.)

N13.2 Level Indicators for Cargo Tanks

N13.2.1 General

For the purpose of the requirements **13.2.1, Part N of the Rules**, the following requirements **(1)** and **(2)** are to be complied with:

(1) The performance and construction of level gauges are to be approved by the **Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

(2) With respect to t~~T~~he effectiveness ~~and number of units~~ of level gauges, ~~are to be in accordance with the following requirements **(a)** and **(b)**:~~

  ~~(a) Where only one level gauge is fitted, it is to be arranged so that any necessary maintenance, such as an overhaul, can be carried out while the cargo tank is in service.~~

  ~~(b)~~ ~~F~~for example, in case where gauging of levels is limited at high level and low level, such level is considered effective on condition that cargo is loaded within such range.

N13.2.2 Arrangement of Liquid Level Gauge

For the purpose of the requirements in **13.2.2**, **Part N of the Rules**, where only one level gauge is fitted, it is to be arranged so that any necessary maintenance, such as an overhaul, can be carried out while the cargo tank is in service.

N13.2.~~2~~3 Type of Level Indicators

For the purpose of the requirements in **13.2.~~2~~3, Part N of the Rules**, in case where the prospective cargoes are plural and the type of level gauges required in column **g** in **Table N19.1**, **Chapter 19, Part N of the Rules** is also plural where two or more level gauges are provided for each requirement (in the case shown in **N13.2.2~~1(2)(a)~~**, may be one), they may be multiplicate. However, for the type of level gauge for less severe requirements, warning sign stating that the level gauge is not to be used for other cargoes than the specified cargoes is to be posted.

~~N13.2.3 Sighting Ports~~

~~For the purpose of the requirements in **13.2.3, Part N of the Rules**, the construction and liquid-tight and gas-tight performance of the sighting ports are to be equivalent to the tank top plating and suitable protection steel covers are to be provided. For the purpose of the requirements in **13.2.1, Part N of the Rules**, the sighting ports are not to be regarded as level gauges required.~~

~~N13.2.4 Tubular Glass Gauge~~

~~Tubular glass gauges are to conform to the requirements in **13.2.4, Part N of the Rules**, and in addition, to the requirements in **9.9.8, Part D of the Rules**.~~

N13.3 Overflow Control

N13.3.1 General

For the purpose of the requirements in **13.3.1, Part N of the Rules**, ~~the following requirements **(1)** and **(2)** are to be complied with:~~

(1) ~~H~~high level alarm systems are to be in accordance with **R11.6.3-1**.

N13.3.2 Protection

~~(2)~~ For the purpose of the requirements in **13.3.2, Part N of the Rules**, ~~T~~the sensor for automatic closing of the loading valve for overflow control may be combined with those of level gauges required in **13.2.1, Part N of the Rules**.

N13.3.~~2~~4 Omission of Automatic Shutoff

The "maximum possible pressure during the loading operation" referred to in the requirements in **13.3.~~2~~4(2), Part N of the Rules** is to be considered as the maximum pressure generated by the discharge pressure of shore-based transfer pump and cargo vapour pressure.

N13.3.~~3~~6 Level Alarms with Electrical Circuits

~~To "be capable of being tested prior to loading" referred to in~~ For the purpose of the requirements in the requirements in **13.3.~~3~~6, Part N of the Rules**, ~~means~~ it is to be capable of verifying by test (for example, by buzzer test) that all alarm circuits are in normal working condition when verification through actual operation is impossible. However, a special attention is to be paid to those that can not be always monitored the breaking down of the circuit.

N13.4 Pressure Monitoring ~~Gauges~~

N13.4.~~1~~2 Pressure ~~Gauges and~~ Alarms of Cargo Tanks

For the purpose of the requirements in **13.4.~~1~~2, Part N of the Rules**, high pressure or low pressure alarms are to be in accordance with following requirements **(1)** to **(3)**:

(1) The low pressure alarm provided on the navigation bridge under the requirements in **13.4.~~1~~2, Part N of the Rules**, when the provision of vacuum relief valve is required by the provision in **8.4.2, Part N of the Rules**, is to be capable of issuing alarm at a suitable differential pressure between inside and outside of cargo tank, which is lower than the maximum design external pressure of the cargo tank.

(2) The alarm system specified in the requirements in **13.4.~~1~~2, Part N of the Rules** is to issue visible and audible alarms.

(3) Pressure gauges are to be approved in accordance with the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

N13.5 Temperature Indicating Devices

N13.5.1 General

~~1 The "lowest temperature for which the cargo tank has been approved by the Society" referred to in the requirements in **13.5.1, Part N of the Rules** means the lowest design temperature indicated together with the classification characters in the Register Book.~~

~~2~~ Temperature indicating devices are to have been approved in accordance with the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

N13.6 Gas Detection Requirements

N13.6.~~1~~3 ~~General~~Gas Detection Equipment

The wording "~~Gas detection equipment~~ recognized standards acceptable to the Society" in **13.6.~~1~~3**, **Part N** of the Rules means *IEC* 60079-29-1. ~~the equipment approved by the Society in accordance with **Chapter 7**, **Part 7** of **"Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use"** or the equipment which passed the test of the official organization deemed appropriate by the Society.~~

N13.6.~~9~~5 Gas Detection Equipment for Toxic Products

For the purpose of the requirements in **13.6.~~9~~5, Part N of the Rules**, the use of portable gas detecting equipment is to be in accordance with the following requirements **(1)** to **(3)**:

(1) At least two sets of portable gas detecting equipments are to be provided on board.

(2) In the case of the cargo expressed in "*F* + *T*" in column "**f**" of **Table N19.1**, **Chapter 19, Part N of the Rules**, the fixed type flammable gas detecting device specified in the requirements in **13.6.~~11~~14, Part N of the Rules** is to be provided additionally.

(3) In case where the equipments are composed of consumables such as detecting tubes, suitable spare parts such as detecting tubes are to be provided onboard in addition to the equipments specified in the preceding **(1)** by taking into account the shipboard work and the frequency of

carriage of the cargo. In the case of the detecting tube type, detecting tubes are to be provided for each kind of loadings cargos as above requirement, but two suction pumps for each type of the portable detection equipments may be enough.

N13.6.~~12~~6 Gas Detection for Toxic Gases

For the purpose of the requirements in **13.6.~~12~~6, Part N of the Rules**, the gas sampling pipes of hold spaces and interbarrier spaces dealing with toxic gas in case of portable gas detection equipment are to have openings at the upper part or lower part of the compartment in consideration of the cargo vapour density and automatic closing pipe heads are to be fitted at their top ends. In case where the sounding pipes specified in the requirements in **13.8, Part D of the Rules** can be used for the purpose in consideration of the cargo vapour density and the set pressure of the relief valve of the compartment, they may be used commonly therewith.

N13.6.~~2~~12 Positions of Fixed Sampling Heads

For the purpose of the requirements in **13.6.~~2~~12, Part N of the Rules**, the positions of fixed sampling heads are to be arranged where cargo vapours are liable to accumulate by taking into account the geometrical configurations of the compartment to be covered, construction and arrangement of the space within the compartment. In this case, the sampling heads are, as a rule, to be provided at least at two locations for each such compartment.

N13.6.~~11~~14Gas Detection of Spaces Required to be Inerted ~~for Cargo Containment Systems other than Independent Tanks~~

For the purpose of the requirements in **13.6.1~~1~~4, Part N of the Rules**, the gas detection equipment for hold spaces and interbarrier spaces required to be inerted ~~of cargo tanks other than independent tanks~~ are to be in accordance with the following requirements **(1)** and **(2)**:

(1) In the case of integral tanks, the requirements in **13.6.1~~1~~4, Part N of the Rules** do not apply. However, the requirements in **13.6.~~7(5)~~2(2), Part N of the Rules** apply to the hold space of this cargo containment system.

(2) The available measuring range of gas detector is to be ordinarily made under the graduation where the lower explosive limit is taken as 100% but the range may be changeable to measure gas concentration between 0% and 100% in volumetric percent if necessary.

N13.6.~~14~~20~~Instruments for~~ Measurement of Oxygen Levels

The "suitable instrument for the measurement of oxygen levels" referred to in the requirements in **13.6.~~14~~20, Part N of the Rules** means the one as given in **N5.~~7.1~~11.7** in a corresponding manner.

N13.7 Additional Requirements for Containment Systems Requiring a Secondary Barrier

N13.~~5~~7.2 Temperature Indicationng Devices ~~of Hull Structure when a Cargo is Carried at a Temperature Lower than -55°C~~

1 The word, "where applicable" referred to in the requirements in **13.~~5.2~~7.2-2, Part N of the Rules** means the case where provision is made for heating the structural hull members as specified in the requirements in **~~4.8.4~~19.1-5, Part N of the Rules**. At four points, at least, on double bottom tank top platings, the temperature sensors are to be provided.

~~**N13.5.3 Temperature Indicating Devices of Cargo Tanks when a Cargo is Carried at a Temperature Lower than -55°C**~~

2 For the purpose of the requirements in **13.~~5.3~~7.2-3, Part N of the Rules**, the temperature indicating devices for cases of carrying the cargo at a temperature lower than -55°*C* are to be in accordance with the following requirements **(1)** and **(2)**:

(1) In order to verify the cooling down or loading procedures according to the requirements in **N4.~~3.6~~13.4-1**, temperature indicating devices required in the provisions in **13.~~5.3(1)~~7.2-3, Part N of the Rules** are to be provided.

(2) The temperature sensors provided for verifying the cooling down procedure specified in the requirements in **13.~~5.3(2)~~7.2-4, Part N of the Rules** are to be arranged under considering the arrangement of spray nozzles and construction of cargo containment system. For the other cargo tanks which can be regarded as having the same construction and arrangements as the cargo tanks provided with above sensors, the temperature indicating devices specified in the requirements in **13.5.1**, and **13.~~5.3(1)~~7.2-3, Part N of the Rules** may only be provided.

N13.8 Automation systems

N13.8.2 Design of Automation Systems

The wording “recognized standards deemed appropriate to the Society” in **13.8.2**, **Part N** of the Rules means *IEC* 60092-504:2001.

N13.8.10 Design of Integrated System

The wording “recognized standards deemed appropriate to the Society” in **13.8.10**, **Part N** of the Rules means *ISO/IEC* 15288:2008 and *ISO* 17894:2005.

N13.9 System integration

N13.9.3 Risk Assessment

The wording “appropriate risk-based techniques” in **13.9.3**, **Part N** of the Rules means FTA, FMEA, FMECA, etc.

N13.~~8~~11 Additional Requirements

N13.~~8~~11.1 Installation of Gas Detection Equipment

The wording “the requirements otherwise specified” in **13.~~8~~11.1, Part N of the Rules** means those specified in **R4.5.10-2(1), Part R**.

N14 has been amended as follows.

N14 PERSONNEL PROTECTION

~~N14.3 First-aid Equipment~~

~~N14.3.2 Medical First-aid Equipment~~

~~With respect to the wording "medical first-aid equipment as deemed appropriate by the Society" specified in **14.3.2, Part N of the Rules**, reference is made to the "*MEDICAL FIRST-AID GUIDE FOR USE IN ACCIDENTS INVOLVING DANGEROUS GOODS (MFAG)*"~~

N14.4 Personnel Protection Requirements for Individual Products (*IGC Code* 14.4)

N14.4.3 Decontamination Shower and Eyewash Stations

Decontamination showers and eyewash stations are to be located in the vicinity of cargo manifolds, cargo pump rooms, etc. which are vulnerable to cargo splashes, and shielding walls are to be provided to prevent crew members from being sprayed by any additional cargo splashes during eye washing. The construction of a special locker for the storage of protective equipment provided in the cargo area is to comply with the requirement in **Chapter 19, Part C of the Rules**. The piping for decontamination showers and eyewash is to be permanent metal piping complying with the requirements in **Chapter 12, Part D of the Rules**, and it is also to be provided with thermal insulation or drain connections at suitable locations to prevent freeze damage.

N15 has been amended as follows.

N15 FILLING LIMITS FOR CARGO TANKS

N15.~~1~~4 ~~General~~ Determination of Increased Filling Limit

N15.4.1~~1.3~~ A Filling Limit ~~Higher~~ Greater than the Limit of 98%

For the purpose of the requirements in **15.4.1~~1.3~~, Part N of the Rules**, **IACS Rec. No.109** is to be referred for the filling limits. ~~are to be in accordance with the following requirements **(1)** and **(2)**:~~

~~(1) The "filling limit (FL)" means the maximum liquid volume in a cargo tank relative to the accepted tank volume when the liquid cargo has reached the reference temperature specified in the requirements in **15.1.4, Part N of the Rules**. In this case, the total volume of the cargo tank may include the volume of tank dome provided that either of the following conditions is satisfied:~~

~~(a) In applying the requirements in **4.3.2-2, Part N of the Rules**, consideration is given to the tank dome for determining Z_β.~~

~~(b) Tank dome is to be in accordance with **N4.3.2-2**.~~

~~(2) In case where the following conditions **(a)** and **(b)** are satisfied, the filling limit may be a value exceeding 98% within the limit not exceeding 99.5%:~~

~~(a) The maximum allowable filling limit results from the following formula:~~

$$\cancel{\left(\frac{V_{FL}}{V}\right)\times 100(\%)}$$

~~where:~~

~~V_{FL} : cargo tank volume to liquid level corresponding to the filling limit (m^3)~~

~~V : accepted total tank volume (m^3)~~

~~(b) Under conditions specified in **8.2.17, Part N of the Rules**, the suction funnels of the pressure relief valves are to remain well above the sloped liquid level for the expanded volume determined by following formula:~~

$$\cancel{V_{FL}\times\frac{100+\alpha_t}{100}\left(m^3\right)}$$

~~where:~~

~~α_t : the value as given by the following formula:~~

$$\cancel{\alpha_t=\sqrt{\alpha_1^2+\alpha_2^2+\alpha_3^2}\,(\%)}$$

~~α_1 : relative increase in liquid volume due to the tolerance of level gauges as given by the following formula:~~

$$\cancel{\alpha_1=\frac{dV}{dh}\left(\frac{h\times\Delta Z}{V}\right)(\%)}$$

~~where:~~

~~dV/dh : variation of tank volume per metre filling height at the filling height h (m^3/m)~~

~~h : filling height (m) at the filling limit FL to be investigated (FL>98%)~~

~~ΔZ : maximum total tolerance of level gauges (%)~~

~~V : as specified in the preceding (a)~~

~~α_2 : relative increase in liquid volume due to the tolerance of temperature gauges as given by the following formula:~~

$$\cancel{\alpha_2 = 100\left[1 - \left(\frac{T_c - T_L - \Delta T}{T_c - T_L}\right)^{0.26}\right](\%)}$$

~~where:~~

~~T_c :critical temperature of the product (K)~~

~~T_L : highest loading temperature of the product (K)~~

~~ΔT : maximum tolerance of temperature gauges (K)~~

~~α_3 : relative increase in liquid volume due to the difference between loading temperature and the temperature corresponding to the vapour pressure of the cargo at the set pressure of the pressure relief valves taking into account the accuracy of the cargo tank calibration as given by the following formula:~~

$$\cancel{\alpha_3 = \left(\frac{\rho_L}{\rho_R} - 1\right) \times \Delta a(\%)}$$

~~where:~~

~~ρ_L and ρ_R : cargo densities as defined in **15.1.2, Part N of the Rules**~~

~~Δa : accuracy of cargo tank calibration (%)~~

~~**N15.1.4 Reference Temperature**~~

~~The "cargo tank becoming liquid full" referred to in the requirements in **15.1.4(2), Part N of the Rules** is to be construed as given in **N8.3.1** in a corresponding manner.~~

N16 has been amended as follows.

N16 USE OF CARGO AS FUEL

N16.1 General

N16.1.1 General

1 The requirements for gas fuel diesel engines and gas fuel boilers are to be in accordance with **Annex 3** "**GUIDANCE FOR HIGH PRESSURE DUAL FUEL DIESEL ENGINES**" or **Annex 4** "**GUIDANCE FOR LOW PRESSURE DUAL FUEL DIESEL ENGINES**" and **Annex 2** "**GUIDANCE FOR DUAL FUEL BOILERS**" respectively.
2 The requirements for gas turbines are to be subject to the special consideration of the Society.

N16.3 Arrangement of Spaces Containing Gas Consumers

N16.3.4 Vents and Bleed Lines

The "flame screen" specified in **16.3.4, Part N of the Rules** is to be a type approved in accordance with the provisions of **Chapter 7, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

~~N16.5 Special Requirements for Main Boilers~~

~~N16.5.4 Burner System~~

~~**1** The "during manoeuvring and port operations" referred to the requirements in **16.5.4, Part N of the Rules** means the cases where the ship is engaged in the area of traffic congestion, restricted range of vision and where other ships are in danger of accidents, and the cases where the ship arrives in a port and departures from a port.~~

N16.5 Gas Fuel Plants and Related Storage Tanks

N16.5.3 Heating and Cooling Mediums

The wording "flame screen of an approved type" specified in **16.5.3, Part N of the Rules** refers to ones approved in accordance with the provisions of **Chapter 7, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

N17 has been amended as follows.

N17 SPECIAL REQUIREMENTS

N17.~~20~~18 Propylene Oxide and Mixtures of Ethylene Oxide-Propylene Oxide with Ethylene Oxide Content of not more than 30% by Weight

N17.~~20.15~~18.14 Padding of Nitrogen Gas

For the purpose of the requirements in **17.~~20.15~~18.14, Part N of the Rules**, the nitrogen gas generator of membrane type capable of ensuring a purity not less than 99% in volume may be used.

N18 has been amended as follows.

N18 OPERATING REQUIREMENTS

~~**N18.1 Operation Manual**~~

~~**N18.1.1 General**~~

~~In the Operation Manual specified in the requirements in **18.1.1, Part N of the Rules**, at least, the following items **(1)** through **(11)** are to be included, and the detailed contents are to be guided by the requirements in **Chapter 18** of the *IGC Codes* with the contents as specified in **18.2, Part N of the Rules**. These detailed contents may be covered under separate booklets, but in such a case, it is to be expressly shown in the specific operation manual that reference is to be made to separate booklet.~~

~~(1) Cargo information~~
- ~~(a) a full description of the physical and chemical properties necessary for the safe containment of the cargo;~~
- ~~(b) action to be taken in the event of spills or leaks;~~
- ~~(c) counter-measures against accidental personal contact;~~
- ~~(d) fire-fighting procedures and fire-fighting media;~~
- ~~(e) procedures for cargo transfer, gas-freeing, gas sampling, ballasting, tank cleaning and changing cargoes;~~
- ~~(f) special equipment needed for the safe handling of the particular cargo;~~
- ~~(g) minimum allowable inner hull steel temperatures; and~~
- ~~(h) emergency procedures.~~
- ~~(i) action to be taken for inhibition~~

~~(2) Cargo stowage information~~
- ~~(a) Hull strength and strength of cargo containment system~~
- ~~(b) Stability (intact and damage)~~

~~(3) Personal training~~
- ~~(a) Emergency measures~~
- ~~(b) Assignment of work duty (cargo handling, fire-fighting, etc.)~~
- ~~(c) Use of protective clothing and first-aiding~~

~~(4) Access to gas-dangerous spaces~~
- ~~(a) Entering after gas-free or entering wearing protective clothing under the supervision of the duty officer~~
- ~~(b) Exclusion of source of ignition~~
- ~~(c) Special measures in the case of internally insulated tanks~~

~~(5) Carriage of low temperature cargoes~~
- ~~(a) use of heating arrangement~~
- ~~(b) Procedures of cooling down~~

~~(6) Handling of protective equipment and their storage areas~~

~~(7) Cargo transfer system and control~~
- ~~(a) Tests and inspection of control~~
- ~~(b) Tests and inspection of alarms and emergency shutdown system~~

~~(8) Cargo transfer operation~~
- ~~(a) Discussion between ship personnel and the persons responsible at the shore facility at time of cargo discharge~~

~~(b) Emergency procedures~~
~~(c) Cargo stowage plan~~
~~(9) Cargo handling operation (including an instruction manual for emergency shutdown valves)~~
~~(10) Information on national rules and regulations~~
~~(11) The provisions in each Chapter of the *IGC Code* prescribing the working restrictions which are also specified in the following requirements of **Part N of the Rules**:~~
~~**1.1.4(27)**, **1.2**, **3.8.3(3)**, **3.9**, **4.10.14**, **7.3.2**, **8.6**, **9.1**, **9.2**, **9.4.2**, **9.4.5**, **12.1.1**, **12.1.10**, **12.2**, **13.7**, **14.2.4**, **14.2.5**, **14.5**, **15.1**, **15.2**, **16.2.2**, **16.3.2**, **17.4.2**, **17.6**, **17.7**, **17.8**, **17.10**, **17.12**, **17.14**, **17.15**, **17.16**, **17.17**, **17.18**, **17.19**, **17.20**, **17.21** and **17.22**.~~

N18.3 Cargo Emergency Shutdown (ESD) System

N18.3.1 Cargo Emergency Shutdown (ESD) System

1 "Recognized standards" referred to in **18.3.1-1.(4), Part N of the Rules**, means ***ISO*** 28460:2010.

2 For the purpose of **18.3.1-2, Part N of the Rules**, stop valves are not to be provided oil hydraulics and air piping for ESD valves.

3 "Fail-closed type" referred to in **18.3.1-2.(1)(b), Part N of the Rules**, is to be in accordance with the following requirements **(1)** and **(2)**.

(1) Oil hydraulics and air pressure are used only for the opening of the valves and the closing of the valves, including the fail-closed operation, is carried out by springs or weights.

(2) In cases where both the opening and closing of the valves are carried out by oil hydraulics or air pressure due to the impracticability of the **(1)** above derived from the large diameter of the valves, oil hydraulics or air pressure for the fail-closed operation is to be supplied from a specially provided pressure accumulation tank. The composition of the system is to be in accordance with the following requirements **(a)** through **(c)**.

(a) Cylinders for valve operation may be used both for the normal operation and the fail-closed operation. However, oil hydraulics and air pressure piping from the specially provided pressure accumulation tank for fail-closed operation to the cylinders for valve operation is not usable as that for the normal operation. Further, stop valves are in principle not to be provided for the oil hydraulics or air pressure piping for the fail-closed operation.

(b) The pressure accumulation tank for the fail-closed operation is to have the capacity sufficient to activate all the connected ESD valves at least twice. In cases where one accumulation pressure tank is connected to the identical ESD valves fitted to the both sides, the tank may have the capacity sufficient to activate the ESD valve on only one side at least twice.

(c) Alarms are to be activated at the loss of oil hydraulics or air pressure for the normal operation and at the fail-closed operation.

4 "Capable of local manual closure" referred to in **18.3.1-2.(1)(b), Part N of the Rules**, means the valves capable of closure by manual release of oil hydraulics or air pressure utilizing the fail-closed system, or by a manual pump, in addition to those capable of direct manual closure by a handle device.

5 "Close fully and smoothly within 30 *seconds* of actuation" referred to in **18.3.1-2.(1)(c), Part N of the Rules**, may not be applied to the manual closure as given in the **-4** above.

6 The confirmation of the actual valve position by the position of the handle device for ESD valves is not accepted as "positive indication of the actual valve position" referred to in **18.3.1-2(1)(b), Part N of the Rules**.

N18.4 Operating Requirements

N18.4.7 Entry into Enclosed Spaces

For the purpose of the requirements in **18.4.7, Part N of the Rules**, entry into enclosed spaces is to be in accordance with *IMO Resolution A*.1050(27).

N19 has been amended as follows.

N19 MINIMUM REQUIREMENTS

N19.1 General

N19.1.1 Application

The requirements for the construction and equipment of the ship when "Other liquefied gases having same hazard of the products listed above ~~the cargo recognized to have equivalent danger of the liquefied gas or other cargo indicated in the above column~~" referred to in column a of **Table N19.1** in **Chapter 19, Part N of the Rules** is carried are to be determined according to the physical properties (vapour pressure, liquid density, latent heat of evaporation, etc.) of the cargo as far as the basic design of the construction and equipment are concerned unless otherwise required by the Administration. Further, each item of the minimum requirements and special requirements specified in **Table N19.1** in **Chapter 19, Part N of the Rules** are to be determined individually.

Annex 1 GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK

Chapter 1 General

Section 1.2 has been amended as follows.

1.2 Submission of Plans and Documents

According to the requirements in **2.1.2-1(~~4~~6)** and **2.1.3-2, Part B of the Rules**, the following plans and documents relating to the equipment, etc. and those specified in **Chapter 2** and thereafter where appropriate are to be submitted to the Society:
((1) and (2) are omitted.)

Chapter 2 CARGO COMPRESSORS

2.1 General

2.1.1 Application

Sub-paragraph -1 has been amended as follows.

1 The requirements in this Chapter apply to the displacement type or centrifugal type gas compressors used for compression of boil-off gas from the cargo or pressure transfer in accordance with the requirements in **N5.~~8~~6.2-2** and **N7.~~1.2~~3.1-1(1)(b)vii)** of the Guidance.

2.3 Materials, Construction and Strength

2.3.3 Strength

Sub-paragraph -3 has been amended as follows.

3 As the allowable stress used in the calculation in the preceding **-2**, the value required for type *C* independent tanks in **4.~~5.1~~23.3-1(1), Part N of the Rules** is, as a rule, to be employed.

2.6 Tests and Inspection

2.6.1 Tests and Inspection during Manufacture

Sub-paragraph -3 has been amended as follows.

3 The compressors are to be subjected to service tests specified in **5.~~5.4~~13.2-5, Part N of the Rules**.

Chapter 3 CARGO PUMPS

3.1 General

Paragraph 3.1.1 has been amended as follows.

3.1.1 Application

1 The requirements in this Chapter apply to the centrifugal pumps of submerged type, deepwell type and deck-mounted type used for cargo discharging or transfer according to the requirements in **N5.~~8~~6.1-3** of the Guidance.

2 The driving motors of the cargo pumps are to conform to the requirements in this Chapter, and in addition the relevant requirements in **Part H** and **Part N of the Rules** are to be complied with.

3.3 Materials, Construction and Strength

Paragraph 3.3.3 has been amended as follows.

3.3.3 Strength

1 The pumps are to be designed by taking into account the combination of the following pressure and load **(1)** through **(8)**:

(1) Maximum cargo vapour pressure at service condition

(2) Cargo discharge pressure

(3) Local loading due to the piping connected and supports

(4) Shaft thrust

(5) Thermal stress

(6) Own weight

(7) Load due to rotation

(8) Other pressure and load as deemed necessary by the Society

2 The thickness of the pressure-bearing part of the pump is, as a rule, to be not less than the value determined by the requirements in **10.5** to **10.7, Part D of the Rules** by using the maximum internal pressure obtained from the ~~preceding~~ **-1** above. When deemed necessary, the Society may request submission of the direct calculations sheets.

3 The allowable stress used in the calculation in the ~~preceding~~ **-2** above is to be of the value required for type *C* independent tanks in **~~4.5.1~~4.23.3-1(1), Part N of the Rules**.

4 The efficiency of welded joints and corrosion allowance used in the calculation in the ~~preceding~~ **-2** above are to be of the values specified in **10.4.2** and **10.4.3, Part D of the Rules** respectively.

5 The strength of the structural members such as the shaft, shaft coupling and impeller excluding the pressure-bearing parts is left to the discretion of the Society.

3.6 Tests and Inspection

Paragraph 3.6.2 has been amended as follows.

3.6.2 Product Inspections

1 At time of manufacture, pumps are to be subjected to the tests and inspections specified in the following **(1)** through **(3)**:

(1) Material tests:
As per the requirements given in the relevant Chapters of **Part K of the Rules** and **Table N6.4, Part N of the Rules**.

(2) Hydraulic tests or hydrostatic tests:
The pressure bearing parts of pumps are to be subjected to a hydrostatic test or a pressure test by air or other suitable fluid. The test pressure is to be 1.5 times design pressure.

(3) Operating tests:
Pumps are to be subjected to design temperature operational tests. For submerged electric motor driven pumps, the capacity test is to be carried out with the design medium or with a medium below the minimum working temperature. For shaft driven deep well pumps, the capacity test may be carried out with water.

2 After being installed onboard ships, pumps are to be subjected to the service tests specified in **5.13.2.5~~5.4~~, Part N of the Rules**.

Chapter 4 HEAT EXCHANGERS

4.1 General

Paragraph 4.1.1 has been amended as follows.

4.1.1 Application

The requirements in this Chapter apply to heat exchangers used for the heating, evaporation or cooling of cargo liquid or vapour in accordance with the requirements in **N7.~~1.2~~3.1-1(1)(b)vii)** of the Guidance.

4.3 Tests and Inspection

4.3.2 Product Inspection

Sub-paragraph -3 has been amended as follows.

3 Heat exchangers, after being installed in ships, are to be subjected to service tests in accordance with the requirements in **N4.~~10.14~~20.3-4 to -7** of the Guidance.

Chapter 5 VALVES

Section 5.2 has been amended as follows.

5.2 Materials, Construction and Strength

1 The materials of principal pressure bearing parts of valves are to conform to the requirements in **N~~5.2.6~~5.12.1 of the Guidance**.

2 Valves with the design temperature below -55°C are to be subject to type testing specified in **5.13.1-1, Part N of the Rules** and approved for use as specified in the **Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

3 The construction and strength of valves are to be in accordance with the requirements in recognized standards.

4 For valves not conforming to the requirements in the preceding **-3**, detailed data on the construction and strength are to be submitted to the Society for type approval specified in **Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

Section 5.3 has been amended as follows.

5.3 Tests and Inspection

5.3.1 Type Test

In the tests specified in the preceding **5.2-2**, the test and inspection specified in the following **(1)** ~~through~~to **(~~7~~9)** are to be conducted in addition to the requirements of **5.3.1(1), Part N of the Rules**:

(1) Material test:
As per the requirements in the relevant Chapters of **Part K of the Rules** and **Table N6.4, Part N of the Rules**

(2) ~~Hydraulic~~ Pressure test:
Tests ~~is~~are to be conducted at a pressure 1.5 times the design pressure at room temperature.

(3) Airtightness test:
Tests ~~is~~are to be conducted after assembly at 1.1 times the design pressure at room temperature.

(4) Leakage verification test:
Tests ~~is~~are to be conducted at ~~room temperature and the temperature not higher than the design temperature at~~ over entire range of working temperature and working pressure, raised in increments, as given in **Table 5.1** up to 1.1 times the design pressure. For valves which are capable of sealing in both directions, tests are to be conducted for both directions. For valves having a tendency of greater leakage at low pressure, additional leakage tests ~~is~~are to be conducted at a temperature not higher than the design pressure which is designated by the Society. At the test at room temperature, there is, as a rule, to be no leakage. At the test at low temperature, there is to be no leakage exceeding the rate of leakage as deemed appropriate by the Society.

(5) Operating test at low temperature:
Operating tests of valves at a temperature not more than the lowest design temperature ~~with the design pressure imposed is~~are to be conducted for ~~5×10^2~~20 times. After completion of the tests~~In this case~~, tests for rate of leakage ~~is~~are to be conducted ~~at the intermediate point and~~

~~final point of repetitions whereby~~ and it is to be verified that there is no significant difference between the result of this verification test and that of the test given in the preceding **(4)**. After completion of ~~this~~the tests, the leakage test at room temperature in **(4)** is to be conducted once again to verify that there is no leakage.

(6) Open up inspection:
After completion of the test specified in the preceding **(5)**, valves are to be opened up and inspected for abnormality.

(7) Flow or capacity test:
Flow or capacity is to be verified according to a recognized standard.

(8) Fire test:
For emergency shutdown valves, with materials having melting temperatures lower than 925°C, fire tests are to be conducted to a standard acceptable to the Society.

(~~7~~9) Other tests and inspection as deemed necessary by the Society depending on the type of valve.

Table 5.1

Design pressure (*MPa*)	Increment[1] (*MPa*)
2.0 and below	0.35
5.0 and below	0.75
6.4 and below	1.0
10.0 and below	2.0

Note:

(1) For valves with design pressure exceeding 10.0*MPa*, increments are to the satisfaction of the Society

5.3.2 Product Inspection

1 At time of manufacture, valves are to be subjected to the tests and inspection specified in the following **(1)** ~~through~~to **(4)**:

(1) Material test:
As per the requirements in the relevant Chapters of **Part K of the Rules** and **Table N6.4, Part N of the Rules**.

(2) Hydraulic test:
Test is to be conducted at room temperature at a test pressure of 1.5 times the design pressure. However, for those to be fitted directly on type *C* independent tanks, the test is to be conducted at a pressure of ~~2 times~~twice the design pressure. Where test is conducted by a medium other than water, the requirements in **~~5.5.2~~5.13.2-2, Part N of the Rules** are to be complied with.

(3) Airtightness test:
Test is to be conducted at 1.1 times the design pressure at room temperature.

(4) Leakage verification test for valve seat:
Leakage verification test for valve seat is to be conducted at room temperature at 1.1 times the design pressure for all the number of valves. Further, in case where the design temperature is below -55°C at least 10% of the total number of valves are to be tested at the temperature not more than the minimum design temperature and the pressure not less than 1.1 times the design pressure for each size and type of valves. When part of this sampling test failed, test for part or the whole of the valves not sampled at the temperature not more than the minimum design temperature will be requested.

2 After assembled in the ship, valves are to be subjected to service test specified in **~~5.5.3~~5.13.2-3** and **~~5.5.4~~5.13.2-5, Part N of the Rules**.

3 With respect to the tests and surveys specified in **-1**~~.~~, except in the case of leakage verification tests for valve seats, are to be conducted at a temperature not more than the minimum design temperature specified in **-1~~.~~(4)**, in cases where manufactures have been assessed in accordance with the "**Rules for Approval of Manufacturers and Service Suppliers**", the items requiring testing in the presence of Surveyors attendance may be reduced by the submission of test results.

Chapter 6 RELIEF VALVES

6.1 General

Paragraph 6.1.1 has been amended as follows.

6.1.1 Application

1 The requirements in this Chapter apply to the relief valves (including vacuum relief valves and rupture discs) provided in the cargo containment system, process pressure vessels, cargo piping and process piping in accordance with the requirements in **N~~5.2.1-8~~5.5.6-2**, ~~**N5.2.3-2**,~~ **N8.2.5** and **N8.4.2** of the Guidance.

2 Unless otherwise specified, ~~F~~for relief valves fitted to process pressure vessels and cargo piping and process piping, application of part of the requirements in this Chapter may be dispensed with when deemed appropriate by the Society.

6.4 Tests and Inspection

Paragraph 6.4.1 has been amended as follows.

6.4.1 Prototype Test

1 Relief valves other than those fitted to cargo piping and process piping with a design temperature of -55°*C* or above are to be subjected to prototype tests to verify that they are possess the necessary performance. ~~However, part or the whole of this test for valves having sufficient service records and approved by the Society may be omitted.~~

2 The prototype test is to be conducted in accordance with the test plan approved by the Society. In the test plan, details of procedures to verify the following items **(1)** ~~through~~to **(9)** are to be specified depending on the type of relief valves~~:~~. However, part of this test (except for **(1)**, **(3)**, **(4)** and **(5)**) for valves having sufficient service records and approved by the Society may be omitted.

(1) Strength of relief valve casing (including the verification of strength at the design temperature. A hydraulic test is to be conducted at a test pressure of 2 times design pressure. However, relief valves other than those fitted directly on type *C* independent tanks and process pressure vessels may be tested at a test pressure of 1.5 times design pressure.)
(2) Strength of valve discs and valve seats (including verification of strength at the design temperature)
(3) Rate of leakage of vapour through the valve seat (including verification at the design temperature)
(4) Relieving capacity and coefficient of discharge (value of K) (as per the requirements in **6.4.2**)
(5) Operation at the design temperature and at the set pressure, if design temperature is below -55℃ (to be operated at least 20 times)
(6) Static strength and fatigue strength of membrane and bellows (including verification of strength at the design temperature)
(7) Compatibility of structural materials with the cargo vapour and characteristics of aging deterioration under the intended atmosphere (particularly, those non-metallic materials exposed to cargo vapour)
(8) Operating test under fire (however, this is applicable only to cases where non-metal bellows or membranes are used)
(9) Others as deemed necessary by the Society depending on the type of relief valves

3 For the relief valves with non-metallic membranes, the renewal intervals of non-metallic membranes may be prolonged exceeding 3 years to those approved by the Society considering results of the tests specified in **-2(6)**, **(7)** and **(9)** above.

Paragraph 6.4.3 has been amended as follows.

6.4.3 Tests at Manufacturing Plants

1 Individual relief valves are to be subjected to the following tests **(1)** to **(3)** after manufacture:

(1) Pressure test of pressure bearing parts:
A hydraulic test is to be conducted at a pressure 2 or more times design pressure. However, relief valves other than those fitted directly onto type *C* independent tanks and process pressure vessels may be tested at 1.5 times design pressure.

(2) Airtightness test of valve seats:
Airtightness test is to be conducted at a pressure in the proximity of the set pressure of the relief valve (at least 90% of the set pressure).

(3) Performance test:
The relieving pressure, blowdown pressure, valve lift and other operating conditions are to be verified.

2 The relieving pressure in the performance test is to be checked to verify if it is within the allowable range specified in **8.2.5-2(1), Part N of the Rules**, and the relief valve is to be sealed after the test in the presence of the Surveyor.

Chapter 7 EXPANSION JOINTS (for Cargo Piping and Process Piping Systems)

7.1 General

Paragraph 7.1.1 has been amended as follows.

7.1.1 Application

1 The requirements in this Chapter apply to bellows type expansion joints provided in the cargo piping and process piping systems in accordance with the requirements in **N~~5.3.1-2~~5.13.1-2** of the Guidance.

2 The requirements in this Chapter also apply to expansion joints of other types than bellows type of which use is approved only in cargo tanks.

7.2 Materials, Construction and Strength

Paragraph 7.2.1 has been amended as follows.

7.2.1 Materials

1 The materials of principal structural members of expansion joints with the design temperature below 0℃ are to be in accordance with the requirements in the relevant Chapters of **Part K of the Rules** and **Table N6.4 of the Rules** irrespective of the design pressure and nominal diameter.

2 The materials of principal structural members of expansion joints with the design temperature of not less than 0℃ may be in accordance with the requirements in **N~~5.2.6-1~~5.12.1-1(2)** and **(3)** of the Guidance.

3 In the preceding **-1** and **-2**, the term "principal structural members" means flanges and bellows where control rings and guide bars are not included.

4 In case where austenitic stainless steel is used as the material of bellows, the use of low carbon steel is recommended. When austenitic stainless steel is used, the solid solution heat treatment and passivation treatment are, as a rule, to be carried out after the completion of welding and plastic processing.

Paragraph 7.2.2 has been amended as follows.

7.2.2 Construction and Strength

1 The design pressure of expansion joints provided in the cargo liquid piping system is not to be made smaller than 1.0*MPa*. However, when they are provided on the cargo liquid piping system with open pipe ends within the cargo tank or pressure relief valve discharge lines, this requirement may be dispensed with, but even in this case the design pressure is not to be made smaller than 0.5*MPa* or 10 times the relief valve set pressure.

2 The design pressure of expansion joints provided on the cargo vapour piping system is not to be made smaller than 0.5*MPa* or 10 times the relief valve set pressure. However, when they are provided on the cargo vapour piping system with open pipe ends or pressure relief valve discharge lines, this requirement may be dispensed with, but not to be made smaller than 0.2*MPa*.

(-3 to -10 are omitted.)

7.3 Tests and Inspection

Paragraph 7.3.1 has been amended as follows.

7.3.1 Type Test

Expansion joints, except for those provided in the piping with open pipe ends and installed in the cargo tanks, are to be subjected to the type test specified in ~~**5.3.1(2)**~~**5.13.1-2, Part N of the Rules** for each type. ~~In the case as specified in **5.3.1(2)(e), Part N of the Rules**, the requirements may be dispensed with.~~

Paragraph 7.3.2 has been amended as follows.

7.3.2 Product Test

1 All expansion joints are, at time of manufacture, to be subjected to the following tests and inspection:

(1) Material test:

To be in accordance with the requirements given in **Table N6.4, Part N of the Rules** and those specified in the relevant Chapters of **Part K of the Rules**.

However, in case where the provisions in **7.2.1-1** are relevant, submission of mill sheets may only be required.

(2) Non-destructive tests for butt welded joints of bellows:

100% of the welded joints of the bellows with the ~~service~~design temperature not more than -10℃ ~~and~~, or with ~~the~~ inside diameters exceeding 75*mm* are to be subjected to non-destructive tests, and for cases other than above, it is left to the discretion of the Society, but sampling tests are to be conducted for, at least, 10% of the bellows.

(3) Hydraulic test:

Hydraulic test is to be conducted at a test pressure of 1.5 times the design pressure at room temperature.

(4) Airtightness test:

After completion of the test specified in the preceding **(2)**, airtightness test is to be conducted by applying the design pressure.

2 All expansion joints are, after installed on board the ship, to be subjected to the tests specified in ~~**5.5.3** and **5.5.4**~~**5.13.2-3** and **-5, Part N of the Rules**.

Chapter 8 INERT GAS GENERATOR/STORAGE SYSTEM AND LIQUID NITROGEN TANK

8.2 Inert Gas Generators (*IGG*)

8.2.1 General

Sub-paragraph -1 has been amended as follows.

1 The inert gas generator (hereinafter as *IGG*) is to conform to the requirements in **9.~~4~~5, Part N of the Rules**, and in addition, to the requirements in **8.2** of this Chapter.

8.4 Liquid Nitrogen Tanks

8.4.3 Insulation

Sub-paragraph -1 has been amended as follows.

1 The insulation materials are to conform to the requirements in **4.~~9~~19.3, Part N of the Rules**.

Paragraph 8.4.4 has been amended as follows.

8.4.4 Filling Limits for Liquid Nitrogen

The filling volume of tank for liquid nitrogen is not to exceed the filling limits determined according to the requirements in **15.~~1~~3 and 15.4, Part N of the Rules**, correspondingly.

Chapter 10 PRESSURE GAUGES

10.1 General

Paragraph 10.1.1 has been amended as follows.

10.1.1 Application

~~**1**~~ The requirements in this Chapter apply to the systems to measure the cargo liquid or vapour pressure or atmospheric pressure in the cargo containment systems, process pressure vessels in accordance with the requirements in **N13.1.~~4~~3(1)(c)** and **N13.4.~~1~~2(3)** of the Guidance.

Chapter 11 TEMPERATURE INDICATING DEVICES

11.1 General

Paragraph 11.1.1 has been amended as follows.

11.1.1 Application

The requirements in this Chapter apply to the measuring and indicating devices for the temperatures of cargo liquid or vapour in the cargo containment systems and process pressure vessels in accordance with the requirements in **N13.1.~~4~~3(1)(c)** and **N13.5.1~~-2~~** of the Guidance. However, glass bar thermometers may be excluded.

Chapter 12 INSULATION MATERIALS

12.1 General

12.1.1 Application

Sub-paragraph -1 has been amended as follows.

1 The requirements in this Chapter apply to the insulation materials used in the cargo containment systems in accordance with the requirements in **~~N4.9.8(1)~~N4.19.3-3(1)** of the Guidance.

12.3 Tests and Inspection

12.3.1 Tests and Inspection

By using the test specimens taken with due regard paid to the actual application procedures, tests to verify the test items given in **Table 12.1** are to be conducted by the test procedure as specified in the same Table or suitable other procedure as approved by the Society, and it is to be verified that the specifications and physical properties established by the manufacturer are complied with.

Table 12.1 has been amended as follows.

Table 12.1 Test Items for Insulation Materials

No.	Test item	Procedure of test
1	Compatibility with the cargo	Tensile, compression, shearing, bending test after dipping in the cargo
2	Solubility in the cargo	Changes in the size and weight of test specimen before and after dipping in the cargo
3	Absorption of the cargo	Comparison of weight of test specimen or test of water absorbing properties before and after dipping in the cargo
4	Shinkage	*ASTM D 2126*
5	Aging	*ASTM D 576* (Comparison of thermal conductivity before and after aging)
6	Closed cell content	*ASTM D 2856*
7	Density	*ASTM D 1622*
8	Mechanical properties ・Bending strength ・Compression strength ・Tensile strength ・Shearing strength	 *ASTM C 203, D790* *ASTM D 1621* *ASTM D 1623* *ASTM C 273*
9	Thermal expansion	*ASTM D 696*
10	Abrasion	—
11	Cohesion	—
12	Thermal conductivity	*JIS A 1412, ASTM C 518*
13	Resistance to vibration	—
14	Resistance to fire and flame spread	*JIS A 9514, JIS A 9511, DIN 4102*
15	Resistance to fatigue failure and crack propagation	—

Note:

Of those test items given above, necessary items are to be selected and tested depending on the insulation system. However, at least, the test items 4, 6 (for independent foam material only), 7, 8, 12 and 14 are to be dealt with for all the insulation systems. See ~~**N4.9.7**~~**N4.19.3-4** to **-7**.

Chapter 14 OXYGEN CONTENT MEASURING EQUIPMENT

14.1 General

Paragraph 14.1.1 has been amended as follows.

14.1.1 Application

The requirements in this Chapter apply to the fixed type and portable type oxygen content measuring equipment used to verify that the oxygen content is less than the controlled value in accordance with the requirements in **N13.6.~~14~~20**.

Chapter 15 HUMIDITY MEASURING EQUIPMENT

15.1 General

Paragraph 15.1.1 has been amended as follows.

15.1.1 Application

The requirements in this Chapter apply to the fixed type and portable type humidity measuring equipment used for the purpose of verifying that the humidity is less than the controlled value in accordance with the requirements in **N9.2.2~~-3~~(3)(b)**.

Chapter 16 has been deleted.

Chapter 16 ~~FIXED DRY CHEMICAL FIRE-EXTINGUISHING EQUIPMENT~~ (Deleted)

~~16.1 General~~

~~16.1.1 Application~~

~~The requirements in this Chapter apply to the fixed dry chemical fire-extinguishing equipment in accordance with the requirements in **N11.4.2**.~~

~~16.2 Submission of Plans and Documents~~

~~16.2.1 Plans and Documents for Reference~~

~~In addition to those specified in the preceding **1.2(2)**, the following **(1)** through **(4)** are to be submitted:~~

~~(1) Discharging test report or piping calculation sheet~~
~~(2) Standard arrangement plan and piping diagram~~
~~(3) General instruction manual including descriptions on periodical inspection and maintenance inspection~~
~~(4) Data on dry chemical fire-extinguishing medium (certification of another organization)~~

~~16.3 Materials, Construction and Performance~~

~~16.3.1 Materials~~

~~The materials are to be corrosion resistant, and particularly the piping, containers, nozzles and monitors placed on exposed parts of the ship are to be sufficiently resistant to sea water and fire. The materials of the storage container of dry chemical fire-extinguishing medium (hereinafter referred to as "storage container") are to conform to the requirements in **Part K of the Rules** or recognized standards.~~

~~16.3.2 Construction~~

~~**1** The equipment is to be composed of two or more units. Each unit is to be composed of a storage container, a gas container for pressurizing chemical powder (hereinafter referred to as "pressurizing container"), starting gas container, monitor or hand hose, piping and fittings.~~

~~**2** The equipment is to be so arranged that two lines of discharge can be made to any place of the cargo area.~~

~~**3** The equipment is to be capable of being started from the installed positions of the monitors and hand hoses. When these locations are different from the installed place of the storage container, the equipment is to be started by other starting gas container separate from the pressurizing container installed in the adjacent place of the storage container. The gas used for these purposes is to be nitrogen gas, etc. and starting by electrical signals or any other power is not acceptable.~~

~~**4** The monitor provided for the purpose of protecting the manifold is to be capable of being started by remote control in addition to complying with the requirements in the preceding **-3**. This~~

~~starting position is to be in the safe areas such as the wheelhouse or cargo control room outside the cargo area.~~

~~**5** The storage containers, relief valves, piping, etc. are to conform to the requirements in **Part D of the Rules**. However, the pressurizing containers and starting gas containers are to conform to the requirements in the High Pressure Gas Control Law or equivalent standards.~~

~~**6** For the pressurizing containers and starting gas containers, means are to be provided so that the pressure and charged quantity can be verified.~~

~~**7** The monitors, hand hoses and piping are to be capable of being cleaned after the dry chemical fire-extinguishing medium is discharged.~~

~~**8** In case where one storage container is connected with two or more monitors or hand hoses, they are, as a rule, to be of the independent piping from the branch piping of the storage container.~~

~~**9** Hand hoses are to be fitted with a nozzle capable of locally controlling discharging and stopping after starting. Hand hoses are to be housed in a weathertight case.~~

~~**10** The monitors for protecting the manifolds which are unable to control discharging direction remotely are to be designed and arranged by taking sufficient consideration into account their discharging range.~~

~~16.3.3 Performance~~

~~**1** The capacities of the monitor and hand hose are to conform to the requirements in **11.4.5** and **11.4.6, Part N of the Rules**. When the capacity of a monitor assumes an intermediate value of the requirements, the range and reach are to be determined by linear interpolation.~~

~~**2** The performance data on the relationship among pressure, rate of discharge and effective reach and range are to be verified by experiment for each type of monitor and hand hose.~~

~~**3** The equipment is to have a mean rate of discharge in 45 seconds from the initiation of discharging not less than that specified in the preceding **-1**, and is to be capable of discharging more than 50% of the specified quantity of discharge in 45 seconds after the initiation of discharging.~~

~~**4** In case where one unit of the equipment comprises two or more monitors and/or hand hoses, this unit is to be capable of discharging the necessary quantity of the fire-extinguishing medium from each monitor or hose simultaneously or sequentially. In this case, necessary total quantity of the medium is to be determined on the basis of the actual discharge condition of taking account of capacity of monitors and hand hoses, pressure and piping arrangement of the system, etc. If necessary, the discharge condition is to be verified by experiments.~~

~~**5** The dry chemical fire-extinguishing medium used in the equipment is to have been approved by the organizations as deemed appropriate by the Society.~~

~~16.4 Marking and Maintenance/Inspection~~

~~16.4.1 General~~

~~**1** The storage containers are to be provided with marking on the following items:~~

~~(1) Name of manufacturer, date of manufacture and type number~~

~~(2) Design pressure and capacity~~

~~(3) Service life of dry chemical fire-extinguishing medium~~

~~**2** At the installed locations of the storage containers and remote control station of monitors, clear indication are to be provided whereby necessary precautions are to be displayed.~~

~~**3** An instruction manual describing all necessary items including how to use, post-service procedure, maintenance and inspection procedures is to be furnished on board the ship.~~

~~16.5 Tests and Inspection~~

~~16.5.1 Approval Tests for Use~~

~~**1** By conducting discharge test of the monitors and hand hoses for each type it is to be verified that their performances satisfy the specifications.~~

~~**2** In case where fixed dry chemical fire-extinguishing equipment is first manufactured or equipment largely modified from the conventional design is manufactured, the Society may request to conduct a discharge test in a condition close to the actual installation. In this case, calculation is to be carried out for the piping whereby its reliability is to be verified.~~

~~16.5.2 Product Tests~~

~~**1** The castings of monitors and hand hoses are to be subjected to hydraulic test at a pressure of 1.5 times the maximum working pressure.~~

~~**2** The storage containers, valves and piping systems are to be subjected to tests in accordance with the requirements in **Part D of the Rules**.~~

~~16.5.3 Shipboard Inspection~~

~~**1** The piping system is to be subjected to airtightness test at a pressure greater than the maximum working pressure.~~

~~**2** The piping system is to be subjected to blowing test.~~

~~**3** Starting from the installed position of the monitor or hand hose is to be verified at a rate of, at least, one for each unit. Remote starting of the monitor to protect the manifold is to be verified.~~

Chapter 17 WATER SPRAY SYSTEM

17.1 General

Paragraph 17.1.1 has been amended as follows.

17.1.1 Application

The requirements in this Chapter apply to the water spray system in accordance with the requirements in **N11.3.2(~~3~~2)**.

Chapter 18 FIXED NITROGEN GAS FIRE-EXTINGUISHING SYSTEM

18.1 General

Paragraph 18.1.1 has been amended as follows.

18.1.1 Application

The requirements in this Chapter apply to the fixed nitrogen gas fire-extinguishing systems ~~installed in cargo compressor rooms and cargo pump rooms~~ in accordance with the requirements in **N11.5.2**.

18.3 Materials, Construction and Performance

18.3.2 Construction

Sub-paragraph -4 has been amended as follows.

4 The storage and generating of nitrogen gas are to be arranged in safe areas other than the ~~cargo compressor rooms and cargo pump rooms~~ cargo machinery spaces.

18.4 Marking and Maintenance/Inspection

18.4.1 General

Sub-paragraph -2 has been amended as follows.

2 Necessary warning signs are to be posted in the ~~cargo compressor rooms or cargo pump rooms~~ cargo machinery spaces, nitrogen gas storage areas and equipment operating areas.

Chapter 19 MECHANICAL VENTILATION SYSTEM

19.1 General

Paragraph 19.1.1 has been amended as follows.

19.1.1 Application

The requirements in this Chapter apply to the fixed or portable mechanical ventilation systems provided in the gas-dangerous areas and cargo motor rooms in accordance with the requirements in **N12.1.~~9~~7(1)** and **N12.2.1**.

19.2 Materials, Construction and Strength

19.2.2 Construction and Strength

Sub-paragraph -1 has been amended as follows.

1 The system is to be of nonsparking construction. (*See* **12.1.~~9~~7, Part N of the Rules**)

Chapter 20 CARGO HOSES

20.1 General

Paragraph 20.1.1 has been amended as follows.

20.1.1 Application

The requirements in this Chapter apply to cargo hoses for cargo transfer in accordance with the requirements in **N5.11.7~~.1~~**.

Section 20.5 has been amended as follows.

20.5 Tests and Inspection

20.5.1 Approval Test for Use

1 Cargo hoses for which approval for use is intended are, as a rule, to be subjected to prototype test given in the preceding **-2** for each type and hose bore.

2 The prototype test is to conform to the following requirements **(1)** ~~through~~to **(6)**:

(1) With hose end fittings complete, the hose is to be subjected to 200 cyclic pressure from zero to at least twice the specified maximum working pressure at a normal ambient temperature.

(2) With hose end fittings complete, the hose in a state being bent to an allowable bend radius is to be subjected to a pressure corresponding to 1.5 *times* or more of the specified maximum working pressure at a normal ambient temperature.

(3) With hose end fittings complete, the hose in a straight condition is to be subjected to a pressure corresponding to 5 *times* or more of the specified maximum working pressure at the upper and lower extreme service temperature.

~~(4) In substitution for tests given in the preceding **(2)** and **(3)**, the hose in a state as in **(2)** is to be subjected to a pressure corresponding to 5 *times* or more of the specified maximum working pressure.~~

(~~5~~4) In applying the requirements **(1)** to **(4)**, ~~T~~the pressure is to be retained for a period of 5 *minutes* or more.

(~~6~~5) The length of the hose excluding the hose end fittings for prototype test is to be approximately 1.5 *times* of the allowable bend radius or more.

(~~7~~6) ~~The temperature of the hose during the test is, excluding for those to be used in ambient temperature, to be the minimum service temperature or below. When necessary, test is to be conducted at a temperature higher than the maximum service temperature. However, when the ambient temperature is severer than the maximum or minimum service temperature, test may be conducted at the ambient temperature.~~ In case where the test procedures given above are hardly followed, they may be substituted by other test procedures complying with **5.11.7, Part N of the Rules** and as deemed appropriate by the Society.

3 The hoses subjected to the prototype test are not to be used in actual cargo operation.

20.5.2 Product Inspection

When the hoses approved for use are shipped, each hose is to be subjected to the following tests and inspection **(1)** to **(3)** in the attendance of the Surveyor:

(1) Dimensional inspection:
It is to be checked that the dimensions of each part of the hose are as given on the drawing.

(2) Visual inspection:
It is to be checked that the hose is free from any defects or deformation.

(3) Pressure test:
Hydraulic ~~test or pneumatic~~ tests ~~is~~are to be conducted at a pressure corresponding to 1.5 *times* or more of the specified maximum working pressure at a normal ambient temperature and 2/5 or less of the bursting pressure.

Chapter 21 REMOVABLE CARGO HANDLING EQUIPMENT

21.3 Construction and Installations

Paragraph 21.3.2 has been amended as follows.

21.3.2 Cargo Piping System

(-1 and -2 are omitted.)

3 In case where the shore-connection referred to in the preceding **-2** is not used, the removable equipment is to be provided with a shore-connection assembly of exclusive use including the emergency shutoff valve specified in **~~5.6.3~~5.5.3, Part N of the Rules**. This shore-connection assembly is to be given sufficient consideration so as not to impose risk of damage on the cargo pump and emergency shutoff valves in the course of cargo hose connecting and disconnecting operation.

(-4 and -5 are omitted.)

Annex 2 GUIDANCE FOR DUAL FUEL BOILERS

Chapter 1 GENERAL

Section 1.1 has been amended as follows.

1.1 Scope

1 This guidance applies to main boilers using methane (boil-off gases and cargo vapour) (hereinafter referred to as "DF boiler") and gas fuel supply systems in accordance with the requirements in **16.1.1, Part N of the Rules**.
2 DF boilers and gas fuel supply systems are to comply with the relevant requirements of **Part D** and **Part N of the Rules**, in addition to the requirements of this Guidance and **Chapter 16, Part N of the Rules**.
3 The guidance also applies correspondingly to auxiliary boilers for which the use of methane has been approved.

Chapter 2 CONSTRUCTION AND EQUIPMENTS OF DF BOILER

2.3 Burners

Sub-paragraph -2 has been amended as follows.

2 Gas fuel supply pipes to each burner are to be purged automatically with appropriate inert gas ~~or steam~~ after the extinguishing of same burners.

Chapter 3 GAS FUEL SUPPLY SYSTEMS

3.2 Gas Fuel Supply Piping Systems

Paragraph 3.2.1 has been amended as follows.

3.2.1 General

1 Gas fuel supply piping systems are to comply with the relevant requirements of **~~16.3.9~~16.4.1-2, Part N of the Rules**.
2 Protection against gas fuel leaks from gas fuel supply piping systems located in other than cargo spaces is to comply with the relevant requirements of **16.4~~3~~, Part N of the Rules**.

Chapter 4 CONTROL SYSTEMS AND SAFETY SYSTEMS

Section 4.2 has been amended as follows.

4.2 Safety Systems

4.2.1 Safety Systems and Alarm Systems of DF Boilers

1 The safety system and alarm system of DF boilers are to comply with the following requirements **(1)** to **(3)**, in addition to the requirements of **9.9.10,** and **18.4.4** and **18.4.5, Part D of the Rules**.

(1) Safety systems are to be provided so that the gas fuel supplies to all burners are cut off to stop the operation of DF boilers when the following abnormalities **(a)** through **(g)** occur during gas burning or burning. The automatic valves specified in **~~16.3.6~~16.4.5, Part N of the Rules** may be used as the automatic cut off valve used for this purpose.
  (a) When all flame detectors specified in **2.3-4** issue flame-fail signals (in this case, it is to be able to stop the supply within 4 *seconds* after flame-fail).
  (b) When water level falls
  (c) When combustion air supply stops
  (d) When gas fuel supply pressure falls
  (e) When the automatic valve specified in **~~16.3.6~~16.4.5, Part N of the Rules** fails
  (f) When the master gas fuel valve specified in **~~16.3.7~~16.4.6, Part N of the Rules** closes
  (g) When considered necessary by the Society

(2) In the event of abnormalities given in **(1)(d)** through **(f)** above, automatic transfer to oil burning may be substituted for stopping the DF boiler.

(3) Means are to be provided to issue alarms in the following events **(a)** and **(b)**.
  (a) When gas fuel supply pressure falls
  (b) When one of two units of flame detectors specified in **2.3-4** issued a flame-fail signal.

(4) The following interlocking mechanism **(a)** and **(b)** are to be arranged concerning starting and stopping of gas burning or oil/gas burning.
  (a) When gas burning or oil/gas burning is started, the gas fuel supply valve is to be opened after detecting that the flame of oil fuel has been established.
  (b) Regulation or closing of the oil fuel supply valve is to be not effected before closing the gas fuel supply valve when oil/gas burning is stopped or extinguished.

2 DF boilers of ships to which the requirements in **1.1.1 of the Rules for Automatic and Remote Control Systems** apply are to comply with the requirements of **3.2** and **3.6** of the said Rules and **-1** above and to be provided with alarm devices activated on the event of any abnormalities specified in **(1)** through **(10)** given below.

(1) Abnormal gas fuel temperatures
(2) Abnormal gas fuel supply pressures
(3) Abnormalities in gas fuel supply compressors
(4) Stopping of ventilation fans for the protection ducts for gas fuel supply piping specified in **~~16.3.1~~16.4.3, Part N of the Rules** or low inert gas pressures in the space between concentric pipes
(5) Low inert gas supply pressures for purging gas fuel piping systems and burners
(6) Low pressures of hydraulic or pneumatic power sources for burning control, or loss of electric power supply
(7) Activation of automatic valves specified in **~~16.3.6~~16.4.5, Part N of the Rules**
(8) Closing of the master gas fuel valve specified in **~~16.3.7~~16.4.6, Part N of the Rules**

(9) Occurrence of factors causing to activate detecting systems specified in **Chapter 16, Part N of the Rules**
(10) Others considered necessary by the Society

4.2.2 Safety System for Gas Fuel Make-up Plants

1 Gas compressors for gas fuel make-up plants are to be equipped with the following safety systems :

(1) Remote stopping devices from readily accessible places and the position from which the main engine is normally controlled.
(2) An automatic stopping device actuating when the suction pressure of boil-off gas drops to below the predetermined value according to the cargo tank construction system, before the pressure reaches the set pressure of negative pressure relief valves for cargo tanks.
(3) ~~An automatic stopping system~~Emergency shut-down specified in **~~5.6.1(3)~~Table N18.1, Part N of the Rules**.
(4) Volumetric compressors are to be fitted with pressure relief valves discharging into the suction line of the compressor. The size of the pressure relief valves is to be determined in such away that, with the delivery valve kept close, the maximum pressure will not exceed the maximum working pressure by more than 10%.

2 Gas fuel supply compressors of ships to which the requirements in **1.1.1 of the Rules for Automatic and Remote Control Systems** apply are to be provided with safety systems and alarm systems such as the following **(1)** through **(8)**.

(1) Monitoring devices and protective devices specified in **2.4.2 of the Annex1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**"
(2) Emergency stop devices specified in **2.4.3 of the Annex1**, "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**"
(3) Automatic stop at over speed
(4) Automatic stop at low lubricating oil pressures
(5) Automatic stop at abnormal rise of discharge pressures
(6) Automatic stop at abnormally low temperature at boil-off gas heater outlet
(7) Device to avoid continuous operations in the barred speed range
(8) Safety systems and alarm systems specified in **3.9 of the Rules for Automatic and Remote Control Systems**, when the gas compressors are driven by steam turbines

3 The exit temperature and pressure (or flow-rates) of gas fuel at the gas fuel make-up plants are to be automatically controlled. Furthermore, visual and audible alarm devices are to be provided such as to be activated when the temperature and pressure exceed the preset range.

Annex 3 GUIDANCE FOR HIGH PRESSURE DUAL FUEL DIESEL ENGINES

Chapter 1 GENERAL

Section 1.1 has been amended as follows.

1.1 Scope

1 The Guidance applies to diesel engines so designed that directly inject methane gas fuel (boil-off gases and cargo vapour), which is precompressed to a high pressure, into cylinders at a high pressure, at the termination of the compression stroke and ignite with an appropriate source of ignition for due combustion (hereinafter referred to as “high pressure DFD engine”) and to gas fuel supply systems in accordance with the requirements in **16.1.1, Part N of the Rules**.
2 High pressure DFD engines and gas fuel supply system are to comply with the relevant requirements of **Part D** and **Part N of the Rules**, in addition to the requirements of this Guidance <u>and **Chapter 16, Part N of the Rules**</u>.

Chapter 2 CONSTRUCTION AND EQUIPMENT OF HIGH PRESSURE DFD ENGINES

2.1 General

Sub-paragraph -4 has been amended as follows.

4 Only oil fuel is, in principle, to be used when the operation of a high pressure DFD engine is unstable~~, and/or during manuvering and port operations~~.

2.3 Safety Systems

Paragraph 2.3.2 has been amended as follows.

2.3.2 Protection against Explosions

1 Relief valves of an approved type are to be provided for the crankcase at least at every crankthrow, and for every separate spaces on the crankcase such as gear case for camshaft or similar drives for protection against explosions.

2 The construction and operating pressure of the relief valves specified in **-1** above are to be determined considering explosions due to gas fuel leaks also.

3 ~~Exhaust gas manifolds and exhaust gas pipes located before and after the turbocharger~~ Unless designed with the strength to withstand the worst case overpressure due to ignited gas leaks, scavenge spaces and exhaust system are to be fitted with suitable pressure relief systems~~provided with an appropriate protection system against explosions due to gas fuel leaks~~.

4 The relief valves for cylinders installed in accordance with the requirements of **2.4.2, Part D of the Rules**, are to be provided with a system to monitor certain closing of the valves as far as practicable.

5 Effective gas detecting systems to detect gas fuel leaks are to be fitted at the following locations **(1)** through **(~~5~~4)**. If the sensors of these gas detecting systems are fitted to the high pressure DFD engine body, they are to be double as far as practicable.

(1) The lower space of each piston or the scavenging air manifolds of the crosshead-type high pressure DFD engines

(2) The crankcase of the trunk piston-type high pressure DFD engines. In this case, the sensors may be required at more than one location depending on the shape of crankcase.

(3) The void space between gas fuel injection lines and shielding systems specified in **2.4.3**, except the case of the same void space common to the void space of protective pipes for the gas fuel supply piping system or ducts specified in **3.2.3-2(1)** to **(3)**.

~~(4) The locations specified in **16.3.4, Part N of the Rules**.~~

(~~5~~4) Other locations considered necessary by the Society.

Chapter 3 GAS FUEL SUPPLY SYSTEMS

3.1 Gas Fuel Make-up Plants

3.1.1 General

Sub-paragraph -2 has been amended as follows.

2 High pressure gas compressors, pumps and heat exchangers forming a gas fuel make-up plant are to comply with the requirements of **Chapters 2** ~~and~~to **4 of Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

3.2 Gas Fuel Supply Piping Systems

3.2.2 Construction and Strength

Sub-paragraph -6 has been amended as follows.

6 For ~~all~~ butt-welded joints specified in **-4** above, post-weld heat treatment is to be performed in accordance with **5.9.2, Part N of the Rules**. ~~However, those located in cargo spaces may be subject to the requirements in **11.6.4, Part D of the Rules**.~~

Paragraph 3.2.3 has been amended as follows.

3.2.3 Protection against Gas Fuel Leaks

1 Gas fuel supply piping systems are not to be led through the accommodation spaces, service spaces, and control stations.

2 If either of the following items **(1)** to **(3)** are relevant, the piping system may be led through or led into the spaces other than that specified in **-1** above.

(1) The system complying with ~~**16.3.1(1)**~~**16.4.3(1), Part N of the Rules**, and in addition, with **(a)** to **(c)** given below:

  (a) The pressure in the space between concentric pipes is monitored continuously, an alarm is to be issued and automatic double block and bleed valves specified in ~~**16.3.6**~~**16.4.5, Part N of the Rules** ~~(hereinafter referred to as "interlocked gas valves")~~ and the master gas ~~fuel~~ valve specified in ~~**16.3.7**~~**16.4.6** ~~(hereinafter referred to as "master gas valve")~~ are to be closed before the pressure drops to below the inner pipe pressure (however, ~~an interlocked gas valve~~the automatic double block and bleed valve connected to vent outlet is to be opened).

  (b) Construction and strength of the outer pipes are to comply with the requirements in ~~**5.2**~~**5.4.4** and **5.11.4, Part N of the Rules**.

  (c) It is to be so arranged that the inside of the gas fuel supply piping system between the master gas valve and the high pressure DFD engine is to be automatically purged with inert gas, when the master gas valve is closed.

(2) The system complying with ~~**16.3.1(2)**~~**16.4.3(2), Part N of the Rules**, and in addition with **(a)** through **(e)** given below:

(a) Materials, construction and strength of ~~protection pipes~~outer pipes of double wall pipes or ducts and mechanical ventilating systems are to be sufficiently durable against bursting and rapid expansion of high pressure gases following the inner pipe failure.

(b) The capacity of mechanical ventilating systems is to be determined considering the flow rate of gas fuel and construction and arrangement of protective pipes or ducts, as deemed appropriate by the Society.

(c) The air intakes of mechanical ventilating systems are to be provided with non-return devices effective for gas fuel leaks. However, if the air intakes are opened directly to exposed spaces and located at places free from risk of ignition of leaked gas fuel, these requirements may be dispensed with.

(d) The number of flange joints of ~~protective pipes~~outer pipes of double wall pipes or ducts is to be minimized.

(e) Measure specified in **(1)(c)** above.

(3) The double wall piping system with gas fuel contained in the inner pipe, complying with the following requirements **(a)** ~~through~~to **(f)**:

(a) The space between the concentric pipes is to be pressurized constantly with inert gases at a pressure greater than 0.025*MPa* by means of an automatic inert gas filling system. However, if a monitoring system for the oxygen content in the space between the concentric pipe with an alarm device which is actionated when the oxygen content exceeds 5% is provided, inert gases may be filled manually.

(b) Pressure in the space between the concentric pipes is to be monitored continuously, and an alarm is to be issued before the pressure drops to below the atmospheric pressure and successively the ~~interlocked gas valves~~automatic double block and bleed valves and the master gas valve are to be closed (however, an ~~interlocked gas valve~~automatic double block and bleed valve connected to vent outlet is to open).

(c) Gas fuel leaks in the space between the concentric pipes are to be detected, an alarm is issued when the gas content reaches 30% of the lower flammable limit, and the ~~interlocked gas valves~~automatic double block and bleed valves and the master gas valve are closed before the content reaches 60% of the lower flammable limit (however, an ~~interlocked gas valve~~automatic double block and bleed valve connected to vent outlet are to be opened).

(d) The spaces between the concentric pipes are to be provided with two sets of appropriate pressure relief valves (or rupture discs) capable of preventing sharp pressure peak caused by gas fuel leaks.

(e) Material, construction and strength of the outer pipes are to be sufficiently durable against bursting and rapid expansion of high pressure gas fuel due to a failure of the inner pipes considering **(d)** above.

(f) Measures specified in **(1)(c)** above.

Chapter 4 CONTROL SYSTEMS AND SAFETY SYSTEMS

Section 4.1 has been amended as follows.

4.1 General

1 Control systems for operating high pressure DFD engines using gas fuel are to comply with the requirements in **18.1** to **18.3** and **18.7, Part D of the Rules**.

2 High pressure gas compressors and pumps for supplying gas fuel in the gas fuel make-up plant are to be provided with the following safety systems:

(1) Remote stopping devices from readily accessible places and the position from which the main engine is normally controlled.

(2) Automatic stopping device actuated when the suction pressure of boil-off gas or cargo liquids drops to below the predetermined value according to the cargo tank construction system, before the tank pressure reaches the set pressure of negative pressure relief valves for cargo tanks.

(3) ~~An automatic stopping device~~Emergency shut-down specified in **~~5.6.1(3)~~Table N18.1, Part N of the Rules**.

(4) Volumetric compressors are to be fitted with pressure relief valves discharging into the suction line of the compressor. The size of the pressure relief valves is to be determined in such away that, with the delivery valve kept close, the maximum pressure will not exceed the maximum working pressure by more than 10%.

3 The exit temperature and pressure of gas fuel at the gas fuel make-up plant are to be automatically controlled. Visual and audible alarm device are also to be provided such as to be activated when the temperature and pressure exceed the preset ranges.

Section 4.2 has been amended as follows.

4.2 High Pressure DFD Engines of Ships to Which the Rules for Automatic and Remote Control Systems Apply

High pressure DFD engines of ships to which the requirements in **1.1.1 of the Rules for Automatic and Remote Control Systems** apply are to comply with the requirements in **3.2**, **3.5**, **4.1** and **4.2** of the same Rules, in addition to the following requirements **(1)** and **(2)**:

(1) High pressure DFD engines are to be provided with safety system which automatically cut off gas fuel supply, and in addition, automatically transfer the mode of operation to oil fuel alone or stops the engines when abnormalities **(a)** ~~through~~to **(~~e~~d)** given below occur. However, automatic cut off of gas fuel supply with the automatic double block and bleed valves specified in **~~16.3.6~~16.4.5, Part N of the Rules** may be accepted.

(a) When abnormalities specified in **2.3.1-1** or **-2** are detected.

~~(b) When gas fuel leaks are detected by gas detecting devices specified in **2.3.2-5**.~~

(~~c~~b) When gas fuel leaks are detected by gas detecting devices specified in **3.2.3-2(2)** or **(3)(c)**.

(~~d~~c) When high pressure gas compressors or pumps for supplying gas fuel stopped for reasons specified in **4.3** (excluding however, the case in which arrangement is made for automatic starting of a stand-by compressor when the working compressor fails).

(~~e~~d) Other cases as deemed necessary by the Society.

(2) High pressure DFD engines are to be provided with a system which automatically reduces speed or transfers the mode of operation to oil fuel alone and issues an alarm in the event of the following **(a)** through **(g)**:
   (a) Abnormal gas fuel temperature
   (b) Abnormal gas fuel supply pressure
   (c) Abnormalities in high pressure gas compressors for gas fuel supply specified in **4.3(2)**.
   (d) Activation of alarms specified in **3.2.3-2(1)(a)**, **(2)** or **(3)(b)**.
   (e) Low inert gas supply pressures for purging gas fuel pipe lines
   (f) Low pressures of hydraulic pneumatic sources loss of electric power supply for gas fuel combustion control
   (g) Others as deemed necessary by the Society.

Annex 4 GUIDANCE FOR LOW PRESSURE DUAL FUEL DIESEL ENGINES

Chapter 1 GENERAL

Section 1.1 has been amended as follows.

1.1 Scope

1 The Guidance applies to trunk-piston type diesel engines so designed that methane (boil-off gases and cargo vapour), which is not compressed to high pressure, is directly injected into cylinders or the suction piping before the suction valve in the suction stroke of each cylinder and ignite for due combustion at the end compression stroke (hereinafter referred to as "low pressure DFD engine") and gas fuel supply systems in accordance with the requirements of **16.1.1, Part N of the Rules**.

2 Low pressure DFD engines and gas fuel supply systems are to comply with relevant requirements of **Part D** and **Part N of the Rules**, in addition to the requirements of this Guidance <u>and **Chapter 16, Part N of the Rules**</u>.

Chapter 2 CONSTRUCTION AND EQUIPMENT OF LOW PRESSURE DFD ENGINES

2.1 General

Sub-paragraph -5 has been amended as follows.

5 Only oil fuel is, in principle, to be used when the operation of a low pressure DFD engine is unstable~~, and/or during manuvering and port operations~~.

2.3 Safety Systems

Paragraph 2.3.2 has been amended as follows.

2.3.2 Protection against Explosions

1 Relief valves of an approved type are to be provided for the crankcase at least at every crankthrow, and for separate spaces on the crankcase such as gear case for camshaft or similar drives for protection against explosions.

2 Unless designed with the strength to withstand the worst case overpressure due to ignited gas leaks, ~~S~~suction manifolds and exhaust gas pipes ~~located after the turbocharger~~ are to be fitted with suitable pressure relief systems~~provided with an appropriate protection system against explosions due to gas fuel leaks~~. ~~However, if the Society considers it to be necessary for structural design of the engine, similar protections are to be provided for the exhaust gas pipe before the turbocharger.~~

3 The relief valves for cylinders installed in accordance with the requirements of **2.4.2, Part D of the Rules**, are to be provided with a system to monitor certain closing of the valves as far as practicable.

4 Each gas fuel injection line is to be provided with a non-return valve, and if necessary, rupture disks are to be provided between the gas fuel injection line and the non-return valve to prevent the failure of the gas fuel injection lines due to abnormal pressure peak.

5 ~~Engines of the type in which the gas fuel is directly injected into the suction line before the suction valve are to be provided with measures to prevent back-fire in each suction line~~When gas is supplied in a mixture with air through a common manifold, flame arrestors are to be installed before each cylinder head.

6 Effective gas detecting systems to detect gas fuel leaks are to be fitted at the following locations **(1)** ~~through~~and **(~~4~~2)**. ~~The crankcase is to be provided with an automatic inert gas spraying system to prevent a risk of explosions of the air mixtures containing leaked gas fuel/oil mist.~~

~~(1) Exhaust gas pipes~~

(~~2~~1) Crankcases. In this case, the sensors may be required at more than one location depending on the shape of the crankcase~~.~~; and

~~(3) The locations specified in **16.3.4, Part N of the Rules**.~~

(~~4~~2) Other locations considered necessary by the Society.

Chapter 3 GAS FUEL SUPPLY SYSTEMS

Section 3.2 has been amended as follows.

3.2 Gas Fuel Supply Piping Systems

3.2.1 General

Gas fuel supply piping systems are to comply with the relevant requirements of ~~**16.3.9**~~**16.4.1-2, Part N of the Rules**.

3.2.2 Protection against Gas Fuel Leaks

1 Gas fuel supply piping systems are not to be led through the accommodation spaces, service spaces and control stations.

2 The arrangements are to comply with the requirements in ~~**16.3.1**~~16.4.3**(1)** or **(2), Part N of the Rules**, or to be double wall piping system with gas fuel contained in the innerpipe and, in addition, the following requirements **(1)** through **(4)** when gas fuel supply piping systems are led through or led into the spaces other than those specified in **-1** above:

(1) The space between concentric pipes is to be pressurized constantly with inert gases at a pressure greater than 0.025*MPa* against the atmospheric pressure. However, if a monitoring system for the oxygen content in the space between the concentric pipes with an alarm device which is activated when the oxygen content exceeds 5% is provided, inert gases may be filled manually.

(2) The pressure in the space between the concentric pipes is to be monitored continuously, and an alarm is to be issued before the pressure drops to below the atmospheric pressure and automatic double block and bleed valves specified in ~~**16.3.6**~~**16.4.5, Part N of the Rules** ~~(hereinafter referred to as "interlocked gas valve")~~ and the master gas valve specified in ~~**16.3.7**~~**16.4.6** ~~(hereinafter referred to as "master gas valve")~~ are to be closed ~~(however, an interlocked gas valve connected to vent outlet is to be opened)~~.

(3) Gas fuel leaks in the space between the concentric pipes are to be detected, an alarm is issued when the gas content reaches 30% of the lower flammable limit, and the ~~interlocked gas valves~~automatic double block and bleed valves and the master gas valve are closed before the content reaches 60% of the lower flammable limit (however, an ~~interlocked gas valve~~automatic double block and bleed valve connected to vent outlets is to be opened).

(4) Means are to be provided so that internal space of the gas fuel supply piping systems between the master gas valve and the low pressure DFD engine is to be automatically purged to the atmosphere by inert gases.

Chapter 4 CONTROL SYSTEMS AND SAFETY SYSTEMS

Section 4.1 has been amended as follows.

4.1 General

1 Control systems for operating low pressure DFD engines using gas fuel are to comply with the requirements in **18.1** to **18.3** and **18.7, Part D of the Rules**.
2 Gas fuel supply compressors in the gas fuel make-up plant are to be provided with the following safety systems:
(1) Remote stopping devices from readily accessible places and the position from which station of the main engine is normally controlled.
(2) Automatic stopping devices actuated when the suction pressure of boil-off gases drops to below the predetermined value according to the cargo tank construction system, before the tank pressure reaches the set pressure of negative pressure relief valves for cargo tanks.
(3) ~~An automatic stopping system~~Emergency shut-down specified in **~~5.6.1(3)~~Table N18.1, Part N of the Rules**.
(4) Volumetric compressors are to be fitted with pressure relief valves discharging into the suction line of the compressor. The size of the pressure relief valves is to be determined in such away that, with the delivery valve kept close, the maximum pressure will not exceed the maximum working pressure by more than 10%.
3 The exit temperature and pressure or flow rate of the gas fuel at the gas fuel make-up plant are to be automatically controlled. Visual and audible alarm device are also to be provided such as to be activated when the temperature and pressure exceed the preset ranges.

Section 4.2 has been amended as follows.

4.2 Low Pressure DFD Engines of Ships to Which the Rules for Automatic Remote Control Systems Apply

Low pressure DFD engines of ships to which the requirement **1.1.1, of Rules for Automatic and Remote Control Systems** apply are to comply with the requirements of **3.2**, **3.5**, **4.1** and **4.2** of the same Rules, in addition to the following requirements **(1)** and **(2)**.
(1) Low pressure DFD engines are to be provided with safety systems which automatically cut off the gas fuel supply, and in addition, automatically transfer the mode of operation to oil fuel alone or stop the engines when abnormalities **(a)** ~~through~~to **(~~d~~c)** given below occur. However, automatic cut off of the gas fuel supply with the automatic double block and bleed valves specified in **~~16.3.6~~16.4.5, Part N of the Rules** may be accepted.
 (a) When abnormalities specified in **2.3.1-1** or **-2** are detected.
 ~~(b) When gas fuel leaks are detected with the gas detecting device specified in **2.3.2-6**.~~
 (~~c~~b) When gas leaks to double wall pipes or void spaces of ducts specified in **3.2.2-2** are detected.
 (~~d~~c) Others as deemed necessary by the Society.
(2) Low pressure DFD engines are to be provided with a system which automatically reduces speed or transfers the mode of operation to oil fuel alone and issues an alarm in the event of the following **(a)** through **(f)**:
 (a) Abnormal gas fuel temperature.
 (b) Abnormal gas fuel supply pressure.

(c) Activation of an alarm issued before the pressure of the space between concentric pipes specified in **3.2.2-2** drops to below the atmospheric pressure.
(d) Low inert gas supply pressure for purging gas fuel pipe lines.
(e) Low pressures of hydraulic and pneumatic sources or loss of electric power supply for gas fuel combustion control.
(f) Others as deemed necessary by the Society.

Annex 5 GUIDANCE FOR THE EVALUATION OF THE ADEQUACY OF TYPE *C* TANK SYSTEMS

Chapter 1 GENERAL

Section 1.1 has been amended as follows.

1.1 Scope

This guidance applies to the evaluation of the adequacy of type *C* tank systems in accordance with the relevant requirements in **8.2.18 of the Rules** and **N8.2.18 of the Guidance**, in relation to calculating the filling limits for cargo tanks specified in **~~15.1.2~~<u>15.5.2, Part N</u> of the Rules**, where the reference temperature is the maximum temperature of the cargo upon termination of loading, during transport, or unloading ~~specified in **15.1.4(1)**~~.

Chapter 2 CRITERION OF EVALUATION

Section 2.2 has been amended as follows.

2.2 Procedures

The following procedures will demonstrate the adequacy of a tank vent system to limit the pressure rise in a cargo tank to not greater than 120% of *MARVS* during all conditions, including fire conditions implicit in **~~8.5.1~~<u>8.4.1, Part N</u> of the Rules**.
(-1 is omitted.)
2 Calculate the *PRV* capacity (Q_{GCC}) of each tank *PRV*, in m^3/s of air at standard conditions in accordance with **~~8.5.1~~<u>8.4.1, Part N</u> of the Rules** and note the installed rated capacity (Q_{IR}) of each *PRV* in m^3/s air at standard conditions at 120% of *MARVS*. The calculation should be done for the highest gas factor of the products included in the cargo list.

Determine the mass flows for cargo conditions at 120% of *MARVS* through each *PRV* for the *PRV* capacity and for the installed rated capacity for both all vapour flow and for two-phase cargo flow. Also calculate the mass flow at *MARVS* for the installed rated capacity on all vapour flow. Equation (1) may be used for all vapour mass flow and equations (2), (3) and (4) may be used for two-phase mass flow.
(-3 to -9 are omitted.)

Section 2.3 has been amended as follows.

2.3 Equations

1 Equation (1) for all vapour mass flow rate from tank through *PRV*s:

$$W_g = \frac{71 \cdot 10^3 \cdot F \cdot A^{0.82}}{h_{fg}} \quad (kg/s) \qquad (1)$$

where

F : fire exposure factor according to ~~8.5.1~~**<u>8.4.1, Part N</u> of the Rules**

A : external surface area of cargo tank according to ~~8.5.1~~**<u>8.4.1, Part N</u> of the Rules** (m^2)

h_{fg} : latent heat of vaporization of cargo at 120% of *MARVS* (*J/kg*)

(-2 and -3 are omitted.)

4 Equation (4) for *PRV* capacity for two-phase mass flow:

$$W' = G_v \cdot K_w \cdot A_v \frac{Q_{GCC}}{Q_{IR}} \quad (kg/s) \qquad (4)$$

where

Q_{GCC} : *PRV* capacity of air at standard conditions in accordance with ~~8.5.1~~**<u>8.4.1, Part N</u> of the Rules** (m^3/s)

Q_{IR} : installed rated *PRV* capacity of air at T=273° K and p=1.013bar (m^3/s)

(-5 to -8 are omitted.)

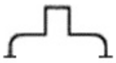
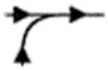
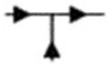
Table 1 has been amended as follows.

Table 1 Worked Example of the Procedure

Applicable provisions	Worked example of the procedure
2.2-2.	The minimum tank relief capacity of the Rules, Q_{GCC} , is calculated for the ship tank which has an external surface area of 747m^2 and *MARVS* of 11.0*bar g*. By ~~8.5.1~~**<u>8.4.1, Part N</u> of the Rules** for propane: for 1.2・*MARVS* = 11.0・1.2＋1.0 = 14.2*bar a* L = 308.6*kj/kg* T = 273 + 41 = 313° K D = 0.635, for k = 1.13 Z = 1.0 M = 44 $A^{0.82}$ = 227.05 F = 0.2 $Q_{GCC} = 0.2 \cdot \frac{12.4}{308.6 \cdot 0.635} \cdot \sqrt{\left(\frac{1.0 \cdot 314}{44}\right)} \cdot 227.05 = 7.68\ m^3/s$ of air at STP (Omitted)

Table 3 has been amended as follows.

Table 3 Typical Values for Dynamic Loss Coefficient (*N*) for Vent System Fittings “ *N* ” may vary with pipe diameter

Fitting		Dynamic loss coefficient *N*
Inlet pipe from tank to RPV :		
Square-edged inlet		0.5
Protruding conical inlet		0.15
Conical reduction		0.1
Discharge piping from RPV to mast vent exit :		
45° bend		0.2
45° single-mitre elbow		0.45
90° long radius bend		0.3
90° short radius bend		0.5
90° double-mitre elbow		0.6
Soft-tee		0.3
Hard-tee		1.1
Cowl mast vent exit		2.25
Top-hat mast vent exit		[4.5]
Flame screen for ~~17.10~~**<u>17.9, Part N</u> of the Rules**		1.4

Annex 6 has been added as follows.

Annex 6 NON-METALLIC MATERIALS

1 General

1 The guidance given in this appendix is in addition to the requirements of **4.19**, **Part N of the Rules**, where applicable to non-metallic materials.
2 The manufacture, testing, inspection and documentation of non-metallic materials should in general comply with recognized standards, and with the specific requirements of **Part N of the Rules**, as applicable.
3 When selecting a non-metallic material, the designer should ensure that it has properties appropriate to the analysis and specification of the system requirements. A material can be selected to fulfil one or more requirements.
4 A wide range of non-metallic materials may be considered. Therefore, the section below on material selection criteria cannot cover every eventuality and should be considered as guidance.

2 Material Selection Criteria

1 Non-metallic materials may be selected for use in various parts of liquefied gas carrier cargo systems based on consideration of the following basic properties:
(1) insulation – the ability to limit heat flow;
(2) load bearing – the ability to contribute to the strength of the containment system;
(3) tightness – the ability to provide liquid and vapour tight barriers;
(4) joining – the ability to be joined (for example by bonding, welding or fastening).
2 Additional considerations may apply depending on the specific system design.

3 Properties of Materials

1 Flexibility of insulating material is the ability of an insulating material to be bent or shaped easily without damage or breakage.
2 Loose fill material is a homogeneous solid generally in the form of fine particles, such as a powder or beads, normally used to fill the voids in an inaccessible space to provide an effective insulation.
3 Nanomaterial is a material with properties derived from its specific microscopic structure.
4 Cellular material is a material type containing cells that are either open, closed or both and which are dispersed throughout its mass.
5 Adhesive material is a product that joins or bonds two adjacent surfaces together by an adhesive process.
6 Other materials are materials that are not characterized in this section and should be identified and listed. The relevant tests used to evaluate the suitability of material for use in the cargo system should be identified and documented.

4 Material Selection and Testing Requirements

4.1 Material Specification

1 When the initial selection of a material has been made, tests should be conducted to validate the suitability of this material for the use intended.

2 The material used should clearly be identified and the relevant tests should be fully documented.

3 Materials should be selected according to their intended use. They should:

(1) be compatible with all the products that may be carried;

(2) not be contaminated by any cargo nor react with it;

(3) not have any characteristics or properties affected by the cargo; and

(4) be capable to withstand thermal shocks within the operating temperature range.

4.2 Material Testing

The tests required for a particular material depend on the design analysis, specification and intended duty. The list of tests below is for illustration. Any additional tests required, for example in respect of sliding, damping and galvanic insulation, should be identified clearly and documented. Materials selected according to **4.1** should be tested further according to the following table:

Function	Insulation	Load bearing structural	Tightness	Joining
Mechanical tests		X		X
Tightness tests			X	
Thermal tests	X			

Thermal shock testing should submit the material and/or assembly to the most extreme thermal gradient it will experience when in service.

4.2.1 Inherent Properties of Materials

1 Tests should be carried out to ensure that the inherent properties of the material selected will not have any negative impact in respect of the use intended.

2 For all selected materials, the following properties should be evaluated:

(1) density; example standard ISO 845; and

(2) linear coefficient of thermal expansion (LCTE); example standard ISO 11359 across the widest specified operating temperature range. However, for loose fill material the volumetric coefficient of thermal expansion (VCTE) should be evaluated, as this is more relevant.

3 Irrespective of its inherent properties and intended duty, all materials selected should be tested for the design service temperature range down to 5°C below the minimum design temperature, but not lower than -196°C.

4 Each property evaluation test should be performed in accordance with recognized standards. Where there are no such standards, the test procedure proposed should be fully detailed and submitted to the Society for acceptance. Sampling should be sufficient to ensure a true representation of the properties of the material selected.

4.2.2 Mechanical Tests

1 The mechanical tests should be performed in accordance with the following table.

Mechanical tests	Load bearing structural
Tensile	ISO 527 ISO 1421 ISO 3346 ISO 1926
Shearing	ISO 4587 ISO 3347 ISO 1922 ISO 6237
Compressive	ISO 604 ISO 844 ISO 3132
Bending	ISO 3133 ISO 14679
Creep	ISO 7850

2 If the chosen function for a material relies on particular properties such as tensile, compressive and shear strength, yield stress, modulus or elongation, these properties should be tested to a recognized standard. If the properties required are assessed by numerical simulation according to a high order behaviour law, the testing should be performed to the satisfaction of the Society.
3 Creep may be caused by sustained loads, for example cargo pressure or structural loads. Creep testing should be conducted based on the loads expected to be encountered during the design life of the containment system.

4.2.3 Tightness Tests

1 The tightness requirement for the material should relate to its operational functionality.
2 Tightness tests should be conducted to give a measurement of the material's permeability in the configuration corresponding to the application envisaged (e.g. thickness and stress conditions) using the fluid to be retained (e.g. cargo, water vapour or trace gas).
3 The tightness tests should be based on the tests indicated as examples in the following table.

Tightness tests	Tightness
Porosity/Permeability	ISO 15106 ISO 2528 ISO 2782

4.2.4 Thermal Conductivity Tests

1 Thermal conductivity tests should be representative of the lifecycle of the insulation material so its properties over the design life of the cargo system can be assessed. If these properties are likely to deteriorate over time, the material should be aged as best possible in an environment corresponding to its lifecycle, for example operating temperature, light, vapour and installation (e.g. packaging, bags, boxes, etc.).
2 Requirements for the absolute value and acceptable range of thermal conductivity and heat capacity should be chosen taking into account the effect on the operational efficiency of the cargo containment system. Particular attention should also be paid to the sizing of the associated cargo

handling system and components such as safety relief valves plus vapour return and handling equipment.

3 Thermal tests should be based on the tests indicated as examples in the following table or their equivalents:

Ternal tests	Insulating
Thermal conductivity	ISO 8301 ISO 8302
Heat capacity	X

4.2.5 Physical Tests

1 In addition to the requirements of **4.19.2-3** and **4.19.3-2**, **Part N of the Rules**, the following table provides guidance and information on some of the additional physical tests that may be considered.

Physical tests	Flexible insulating	Loose fill	Nano- material	Cellular	Adhesive
Particle size		X			
Closed cells content				ISO 4590	
Absorption/Desorption	ISO 12571	X	X	ISO 2896	
Viscosity					ISO 2555 ISO 2431
Open time					ISO 10364
Thixotropic properties					X
Hardness					ISO 868

2 Requirements for loose fill material segregation should be chosen considering its potential adverse effect on the material properties (density, thermal conductivity) when subjected to environmental variations such as thermal cycling and vibration.

3 Requirements for a material with closed cell structures should be based on its eventual impact on gas flow and buffering capacity during transient thermal phases.

4 Similarly, adsorption and absorption requirements should take into account the potential adverse effect an uncontrolled buffering of liquid or gas may have on the system.

5 Quality Assurance and Quality Control (QA/QC)

5.1 General

1 Once a material has been selected, after testing as outlined in **Section 4**, a detailed quality assurance/quality control (QA/QC) programme should be applied to ensure the continued conformity of the material during installation and service. This programme should consider the material starting from the manufacturer's quality manual (QM) and then follow it throughout the construction of the cargo system.

2 The QA/QC programme should include the procedure for fabrication, storage, handling and preventive actions to guard against exposure of a material to harmful effects. These may include, for example, the effect of sunlight on some insulation materials or the contamination of material surfaces by contact with personal products such as hand creams. The sampling methods and the frequency of testing in the QA/QC programme should be specified to ensure the continued conformity of the material selected throughout its production and installation.

3 Where powder or granulated insulation is produced, arrangements should be made to prevent compacting of the material due to vibrations.

5.2 QA/QC during Component Manufacture

The QA/QC programme in respect of component manufacture should include, as a minimum but not limited to, the following items.

5.2.1 Component Identification

1 For each material, the manufacturer should implement a marking system to clearly identify the production batch. The marking system should not interfere, in any way, with the properties of the product.

2 The marking system should ensure complete traceability of the component and should include:

(1) date of production and potential expiry date;
(2) manufacturer's references;
(3) reference specification;
(4) reference order; and
(5) when necessary, any potential environmental parameters to be maintained during transportation and storage.

5.2.2 Production Sampling and Audit Method

1 Regular sampling is required during production to ensure the quality level and continued conformity of a selected material.

2 The frequency, the method and the tests to be performed should be defined in QA/QC programme; for example, these tests will usually cover, inter alia, raw materials, process parameters and component checks.

3 Process parameters and results of the production QC tests should be in strict accordance with those detailed in the QM for the material selected.

4 The objective of the audit method as described in the QM is to control the repeatability of the process and the efficacy of the QA/QC programme.

5 During auditing, auditors should be provided with free access to all production and QC areas. Audit results should be in accordance with the values and tolerances as stated in the relevant QM.

6 Bonding and Joining Process Requirement and Testing

6.1 Bonding Procedure Qualification

1 The bonding procedure specification and qualification test should be defined in accordance with recognized standards.

2 The bonding procedures should be fully documented before work commences to ensure the properties of the bond are acceptable.

3 The following parameters should be considered when developing a bonding procedure specification:

(1) surface preparation;
(2) materials storage and handling prior to installation;
(3) covering-time;
(4) open-time;
(5) mixing ratio, deposited quantity;
(6) environmental parameters (temperature, humidity); and

(7) curing pressure, temperature and time.

4 Additional requirements may be included as necessary to ensure acceptable results.

5 The bonding procedures specification should be validated by an appropriate procedure qualification testing programme.

6.2 Personnel Qualifications

1 Personnel involved in bonding processes should be trained and qualified to recognized standards.

2 Regular tests should be made to ensure the continued performance of people carrying out bonding operations to ensure a consistent quality of bonding.

7 Production Bonding Tests and Controls

7.1 Destructive Testing

During production, representative samples should be taken and tested to check that they correspond to the required level of strength as required for the design.

7.2 Non-Destructive Testing

1 During production, tests which are not detrimental to bond integrity should be performed using an appropriate technique such as:

(1) visual examination;

(2) internal defects detection (for example acoustic, ultrasonic or shear test); and

(3) local tightness testing.

2 If the bonds have to provide tightness as part of their design function, a global tightness test of the cargo containment system should be completed after the end of the erection in accordance with the designer's and QA/QC programme.

3 The QA/QC standards should include acceptance standards for the tightness of the bonded components when built and during the lifecycle of the containment system.

Annex 7 has been added as follows.

Annex 7 STANDARD FOR THE USE OF LIMIT STATE METHODOLOGIES IN THE DESIGN OF CARGO CONTAINMENT SYSTEMS OF NOVEL CONFIGURATION

1 General

1 The purpose of this standard is to provide procedures and relevant design parameters of limit state design of cargo containment systems of a novel configuration in accordance with **4.27**, **Part N of the Rules**.

2 Limit state design is a systematic approach where each structural element is evaluated with respect to possible failure modes related to the design conditions identified in **4.3.4**, **Part N of the Rules**. A limit state can be defined as a condition beyond which the structure, or part of a structure, no longer satisfies the requirements.

3 The limit states are divided into the three following categories:

(1) Ultimate Limit States (ULS), which correspond to the maximum load-carrying capacity or, in some cases, to the maximum applicable strain, deformation or instability in structure resulting from buckling and plastic collapse; under intact (undamaged) conditions;

(2) Fatigue Limit States (FLS), which correspond to degradation due to the effect of cyclic loading; and

(3) Accident Limit States (ALS), which concern the ability of the structure to resist accident situations.

4 **4.3** to **4.20**, **Part N of the Rules** are to be complied with as applicable depending on the cargo containment system concept.

2 Design format

1 The design format in this standard is based on a Load and Resistance Factor Design format. The fundamental principle of the Load and Resistance Factor Design format is to verify that design load effects, L_d, do not exceed design resistances, R_d, for any of the considered failure modes in any scenario:

$$L_d \leq R_d$$

A design load is obtained by multiplying the characteristic load by a load factor relevant for the given load category:

$$F_{dk} = \gamma_f \cdot F_k$$

where:

γ_f : load factor

F_k : the characteristic load as specified in **4.11** to **4.18**, **Part N of the Rule**

A design load effect (e.g. stresses, strains, displacements and vibrations) is the most unfavourable combined load effect derived from the design loads, and may be expressed by:

$$L_d = q(F_{d1}, F_{d2}, \ldots, F_{dN})$$

where q denotes the functional relationship between load and load effect determined by structural analyses.

The design resistance R_d is determined as follows:

$$R_d = \frac{R_k}{\gamma_R \cdot \gamma_C}$$

where:

R_k: the characteristic resistance. In case of materials covered by **Chapter 6**, **Part N of the Rules**, it may be, but not limited to, specified minimum yield stress, specified minimum tensile strength, plastic resistance of cross sections, and ultimate buckling strength;

γ_R : the resistance factor, defined as ;

$$\gamma_R = \gamma_m \cdot \gamma_s$$

γ_m : the partial resistance factor to take account of the probabilistic distribution of the material properties (material factor)

γ_s : the partial resistance factor to take account of the uncertainties on the capacity of the structure, such as the quality of the construction, method considered for determination of the capacity including accuracy of analysis

γ_C : the consequence class factor, which accounts for the potential results of failure with regard to release of cargo and possible human injury

2 Cargo containment design is to take into account potential failure consequences. Consequence classes are defined in **Table 1**, to specify the consequences of failure when the mode of failure is related to the Ultimate Limit State, the Fatigue Limit State, or the Accident Limit State.

Table 1 Consequence classes

Consequence class	Definition
Low	Failure implies minor release of the cargo.
Medium	Failure implies release of the cargo and potential for human injury.
High	Failure implies significant release of the cargo and high potential for human injury/fatality.

3 Required Analyses

1 Three dimensional finite element analyses are to be carried out as an integrated model of the tank and the ship hull, including supports and keying system as applicable. All the failure modes are to be identified to avoid unexpected failures. Hydrodynamic analyses are to be carried out to determine the particular ship accelerations and motions in irregular waves, and the response of the ship and its cargo containment systems to these forces and motions.
2 Buckling strength analyses of cargo tanks subject to external pressure and other loads causing compressive stresses are to be carried out in accordance with recognized standards. The method is to adequately account for the difference in theoretical and actual buckling stress as a result of plate out of flatness, plate edge misalignment, straightness, ovality and deviation from true circular form over a specified arc or chord length, as relevant.
3 Fatigue and crack propagation analysis are to be carried out in accordance with paragraph **5-1**.

4 Ultimate Limit States

1 Structural resistance may be established by testing or by complete analysis taking account of both elastic and plastic material properties. Safety margins for ultimate strength are to be introduced by partial factors of safety taking account of the contribution of stochastic nature of loads and resistance (dynamic loads, pressure loads, gravity loads, material strength, and buckling capacities).
2 Appropriate combinations of permanent loads, functional loads and environmental loads including sloshing loads are to be considered in the analysis. At least two load combinations with

partial load factors as given in **Table 2** are to be used for the assessment of the ultimate limit states.

Table 2 Partial load factors

Load combination	Permanent loads	Functional loads	Environmental loads
'*a*'	1.1	1.1	0.7
'*b*'	1.0	1.0	1.3

The load factors for permanent and functional loads in load combination '*a*' are relevant for the normally well-controlled and/or specified loads applicable to cargo containment systems such as vapour pressure, cargo weight, system self-weight, etc. Higher load factors may be relevant for permanent and functional loads where the inherent variability and/or uncertainties in the prediction models are higher.

3 For sloshing loads, depending on the reliability of the estimation method, a larger load factor may be required by the Society.

4 In cases where structural failure of the cargo containment system are considered to imply high potential for human injury and significant release of cargo, the consequence class factor is to be taken as $\gamma_C = 1.2$. This value may be reduced if it is justified through risk analysis and subject to the approval by the Society. The risk analysis is to take account of factors including, but not limited to, provision of full or partial secondary barrier to protect hull structure from the leakage and less hazards associated with intended cargo. Conversely, higher values may be fixed by the Society, for example, for ships carrying more hazardous or higher pressure cargo. The consequence class factor is to in any case not be less than 1.0.

5 The load factors and the resistance factors used are to be such that the level of safety is equivalent to that of the cargo containment systems as described in sections **4.21** to **4.26**, **Part N of the Rules**. This may be carried out by calibrating the factors against known successful designs.

6 The material factor γ_m is to in general reflect the statistical distribution of the mechanical properties of the material, and needs to be interpreted in combination with the specified characteristic mechanical properties. For the materials defined in **Chapter 6**, **Part N of Rules**, the material factor γ_m may be taken as:

1.1: when the characteristic mechanical properties specified by the recognized organization typically represents the lower 2.5% quantile in the statistical distribution of the mechanical properties; or

1.0: when the characteristic mechanical properties specified by the recognized organization represents a sufficiently small quantile such that the probability of lower mechanical properties than specified is extremely low and can be neglected.

7 The partial resistance factors γ_{si} is to in general be established based on the uncertainties in the capacity of the structure considering construction tolerances, quality of construction, the accuracy of the analysis method applied, etc.

(1) For design against excessive plastic deformation using the limit state criteria given in paragraph **-8**, the partial resistance factors γ_{si} is to be taken as follows:

$$\gamma_{s1} = 0.76 \cdot \frac{B}{\kappa_1}$$

$$\gamma_{s2} = 0.76 \cdot \frac{D}{\kappa_2}$$

$$\kappa_1 = Min\left(\frac{R_m}{R_e} \cdot \frac{B}{A}; 1.0\right)$$

$$\kappa_2 = Min\left(\frac{R_m}{R_e} \cdot \frac{D}{C};1.0\right)$$

Factors A, B, C and D are defined in section **4.22.3-1**, **Part N of the Rules**. R_m and R_e are defined in section **4.18.1(3)**, **Part N of the Rules**.

The partial resistance factors given above are the results of calibration to conventional type B independent tanks.

8 Design against excessive plastic deformation

(1) Stress acceptance criteria given below refer to elastic stress analyses.

(2) Parts of cargo containment systems where loads are primarily carried by membrane response in the structure is to satisfy the following limit state criteria:

$$\sigma_m \le f$$
$$\sigma_L \le 1.5f$$
$$\sigma_b \le 1.5F$$
$$\sigma_L + \sigma_b \le 1.5F$$
$$\sigma_m + \sigma_b \le 1.5F$$
$$\sigma_m + \sigma_b + \sigma_g \le 3.0F$$
$$\sigma_L + \sigma_b + \sigma_g \le 3.0F$$

where:

σ_m: equivalent primary general membrane stress

σ_L: equivalent primary local membrane stress

σ_b: equivalent primary bending stress

σ_g: equivalent secondary stress

With regard to the stresses σ_m , σ_L , σ_b and σ_g , see also the definition of stress categories in section **4.28.3**, **Part N of the Rules**.

Guidance Note:

The stress summation described above is to be carried out by summing up each stress component (σ_x, σ_y, σ_{xy}), and subsequently the equivalent stress is to be calculated based on the resulting stress components as shown in the example below.

$$\sigma_L + \sigma_b = \sqrt{(\sigma_{Lx} + \sigma_{bx})^2 - (\sigma_{Lx} + \sigma_{bx})(\sigma_{Ly} + \sigma_{by}) + (\sigma_{Ly} + \sigma_{by})^2 + 3(\sigma_{Lxy} + \sigma_{bxy})^2}$$

(3) Parts of cargo containment systems where loads are primarily carried by bending of girders, stiffeners and plates, are to satisfy the following limit state criteria:

$\sigma_{ms} + \sigma_{bp} \le 1.25F$ (See notes 1, 2)

$\sigma_{ms} + \sigma_{bp} + \sigma_{bs} \le 1.25F$ (See note 2)

$\sigma_{ms} + \sigma_{bp} + \sigma_{bs} + \sigma_{bt} + \sigma_g \le 3.0F$

Note 1: The sum of equivalent section membrane stress and equivalent membrane stress in primary structure ($\sigma_{ms} + \sigma_{bp}$) will normally be directly available from three-dimensional finite element analyses.

Note 2: The coefficient, 1.25, may be modified by the Society considering the design concept, configuration of the structure, and the methodology used for calculation of stresses.

where:

σ_{ms}: equivalent section membrane stress in primary structure

σ_{bp} : equivalent membrane stress in primary structure and stress in secondary and tertiary structure caused by bending of primary structure

σ_{bs} : section bending stress in secondary structure and stress in tertiary structure caused by bending of secondary structure

σ_{bt} : section bending stress in tertiary structure

σ_g : equivalent secondary stress

The stresses σ_{ms} , σ_{bp} , σ_{bs} , and σ_{bt} are defined in **(4)**. For a definition of σ_g , see section **4.28.3**, **Part N of the Rules**.

Guidance Note:

The stress summation described above is to be carried out by summing up each stress component ($\sigma_x, \sigma_y, \sigma_{xy}$), and subsequently the equivalent stress is to be calculated based on the resulting stress components.

Skin plates are to be designed in accordance with the requirements of the Society. When membrane stress is significant, the effect of the membrane stress on the plate bending capacity is to be appropriately considered in addition.

(4) Section stress categories

Normal stress is the component of stress normal to the plane of reference.

Equivalent section membrane stress is the component of the normal stress that is uniformly distributed and equal to the average value of the stress across the cross section of the structure under consideration. If this is a simple shell section, the section membrane stress is identical to the membrane stress defined in paragraph **(2)** of this standard.

Section bending stress is the component of the normal stress that is linearly distributed over a structural section exposed to bending action, as illustrated in **Fig.1**.

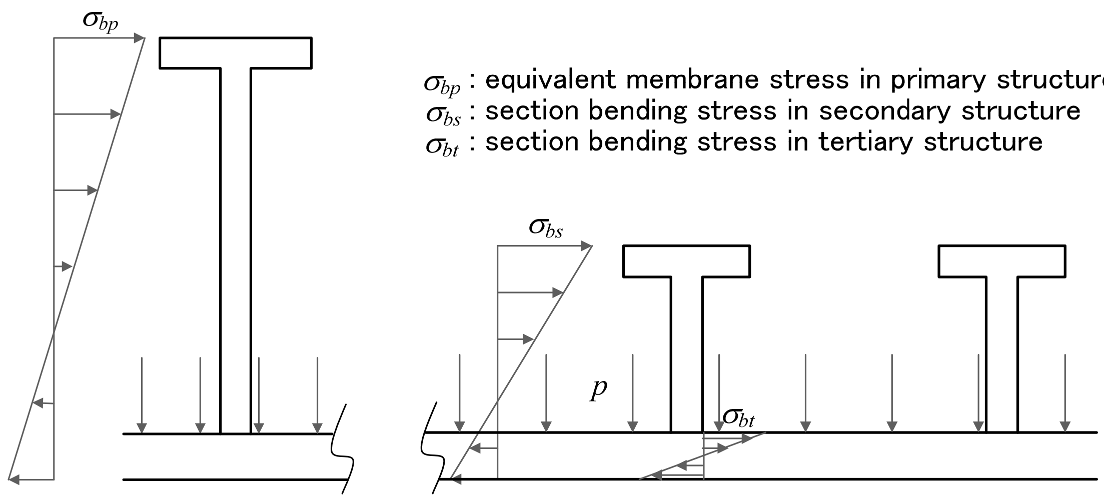


Fig.1 Definition of the three categories of section stress
(Stresses σ_{bp} and σ_{bs} are normal to the cross section shown.)

9 The same factors γ_C , γ_m , γ_{si} are to be used for design against buckling unless otherwise stated in the applied recognized buckling standard. In any case the overall level of safety is not to be less than given by these factors.

5 Fatigue Limit States

1 Fatigue design condition as described in section **4.18.2**, **Part N of the Rules** is to be complied with as applicable depending on the cargo containment system concept. Fatigue analysis is required for the cargo containment system designed under section **4.27**, **Part N of the Rules** and this standard.
2 The load factors for FLS are to be taken as 1.0 for all load categories.
3 Consequence class factor γ_C and resistance factor γ_R are to be taken as 1.0.
4 Fatigue damage is to be calculated as described in sections **4.18.2-2** to **4.18.2-5**, **Part N of the Rules**. The calculated cumulative fatigue damage ratio for the cargo containment systems is to be less than or equal to the values given in **Table 3**.

Table 3 Maximum allowable cumulative fatigue damage ratio

	Consequence class		
	Low	Medium	High
C_w	1.0	0.5	0.5*

Note*: Lower value is to be used in accordance with sections **4.18.2-7** to **4.18.2-9**, **Part N of the Rules**, depending on the detectability of defect or crack, etc.

5 Lower values may be fixed by the Society, for example for tank structures where effective detection of defect or crack cannot be assured, and for ships carrying more hazardous cargo.
6 Crack propagation analyses are required in accordance with sections **4.18.2-6** to **4.18.2-9**, **Part N of the Rules**. The analysis is to be carried out in accordance with methods laid down in a standard recognized by the Society.

6 Accident Limit States

1 Accident design condition as described in section **4.18.3**, **Part N of the Rules** is to be complied with as applicable, depending on the cargo containment system concept.
2 Load and resistance factors may be relaxed compared to the ultimate limit state considering that damages and deformations can be accepted as long as this does not escalate the accident scenario.
3 The load factors for ALS are to be taken as 1.0 for permanent loads, functional loads and environmental loads.
4 Loads mentioned in section **4.13.9** (Static heel loads) and section **4.15** (Collision and Loads due to flooding on ship), **Part N of the Rules** need not be combined with each other or with environmental loads, as defined in section **4.14**, **Part N of the Rules**.
5 Resistance factor γ_R is to in general be taken as 1.0.
6 Consequence class factors γ_C is to in general be taken as defined in paragraph **4-4**, but may be relaxed considering the nature of the accident scenario.
7 The characteristic resistance R_k is to in general be taken as for the ultimate limit state, but may be relaxed considering the nature of the accident scenario.
8 Additional relevant accident scenarios are to be determined based on a risk analysis.

7 Testing

Cargo containment systems designed according to this standard are to be tested to the same extent as described in section **4.20.3**, **Part N of the Rules**, as applicable depending on the cargo containment system concept."

EFFECTIVE DATE AND APPLICATION (Amendment 1-2)

1. The effective date of the amendments is 1 July 2016.

2. Notwithstanding the amendments to the Guidance, the current requirements may apply to ships the keels of which were laid or which were at *a similar stage of construction* before the effective date.

(Note) The term “*a similar stage of construction*” means the stage at which the construction identifiable with a specific ship begins and the assembly of that ship has commenced comprising at least 50 *tonnes* or 1% of the estimated mass of all structural material, whichever is the less.

Amendment 1-3

Annex 3 GUIDANCE FOR HIGH PRESSURE DUAL FUEL DIESEL ENGINES

Chapter 1 GENERAL

Section 1.3 has been amended as follows.

1.3 Drawings and Data

The drawings and data to be submitted are as follows.

(1) Drawings and data for approval

(a) Drawings and data specified in **2.1.~~2~~3-1(1), Part D of the Rules**.

((b) to (t) are omitted.)

(2) Drawings and data for reference

(a) Drawings and data specified in **2.1.~~2~~3-1(2), Part D of the Rules**.

((b) to (d) are omitted.)

Annex 4 GUIDANCE FOR LOW PRESSURE DUAL FUEL DIESEL ENGINES

Chapter 1 GENERAL

Section 1.3 has been amended as follows.

1.3 Drawings and Data

The drawings and data to be submitted are as follows.

(1) Drawings and data for approval
  (a) Drawings and data specified in **2.1.~~2~~3-1(1), Part D of the Rules**.
  ((b) to (q) are omitted.)

(2) Drawings and data for reference
  (a) Drawings and data specified in **2.1.~~2~~3-1(2), Part D of the Rules**.
  ((b) to (c) are omitted.)

EFFECTIVE DATE AND APPLICATION (Amendment 1-3)

1. The effective date of the amendments is 1 July 2016.

2. Notwithstanding the amendments to the Guidance, the current requirements may apply to diesel engines or exhaust driven turbochargers for which the date of application for approval is before the effective date.

Amendment 1-4

N5 PROCESS PRESSURE VESSELS AND LIQUID, VAPOUR, AND PRESSURE PIPING SYSTEMS

N5.12 Materials

N5.12.1 Materials

Sub-paragraph -1(5) has been added as follows.

1 For the purpose of **5.12.1, Part N of the Rules**, the materials used for piping, valves and fittings are to comply with the relevant requirements in **Chapter 6, Part N of the Rules**, and at the same time, to conform to the relevant requirements in **Part K of the Rules**. However, for materials used for the piping specified in the following **(1)** to **(45)**, those conforming to *JIS* or other standards deemed appropriate by the Society may be used where they comply with the requirements in **Chapter 6, Part N of the Rules**.

(1) Pipes, valves and pipe fittings used for cargo piping and process piping with design pressures not exceeding 1*MPa* and design temperatures of 0°C or more.

(2) Valves and pipe fittings used for cargo piping and process piping with design pressures not exceeding 3*MPa* and design temperatures of 0°C or more as well as nominal diameters less than 100*A*.

(3) Pipes, valves and pipe fittings used for accessory piping or instrumentation piping with diameters not exceeding 25*mm* irrespective of design pressure and design temperature.

(4) Open-ended pipes provided inside and outside cargo tanks, excluding membrane and semi-membrane tanks, with design temperatures of -55°C or higher.

(5) Pipe joints of a butt welded type and pipe joints of a slip-on sleeve welded type (such as elbows, reducers, tees, bends and sockets, etc.) for which hot forming or heat treatment is carried out during their manufacturing process in accordance with the requirements in **D12.6.1(1)(a)ii), Part D of the Rules** on the condition that they receive approval of use from Society in accordance with **Chapter 12, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

2 Notwithstanding the requirements in the **-1** above, piping having open ends not coming into contact with the liquid cargo led from the pressure relieving valves of cargo tanks and cargo piping or process piping with design temperatures of -55°C or higher may not be made of steel used for low temperature services specified in **Table N6.4**, **Chapter 6, Part N of the Rules**. Furthermore, piping material may be such as to comply with *JIS* or other standards deemed appropriate by the Society.

EFFECTIVE DATE AND APPLICATION (Amendment 1-4)

1. The effective date of the amendments is 30 December 2016.