財團法人驗船中心
CR CLASSIFICATION SOCIETY

RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022

AMENDMENT

July 2023

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The following Parts have been amended and the effective dates are:	
Part	**Effective date**
I	1 July, 2023
II	1 July, 2023
III	1 July, 2023
IV	1 July, 2023
V	1 July, 2023
VI	1 July, 2023
VII	1 July, 2023
IX	1 July, 2023
XI	1 July, 2023
XII	1 July, 2023
XIV	1 July, 2023
XV	1 July, 2023

The Rules for the Construction and Classification of Steel Ships 2022 and this Amendment are to be consolidated and published as *July 2023 Edition*.

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022 "

PART I CLASSIFICATION AND SURVEY

List of major changes in Part I from 2022 edition

1.4.6	New	A2.2.2(c)	Revised
1.6.2(f)(iii)	Revised		
1.15.1(j)	Revised		
Table I 1-3	Revised		
Table I 1-4	Revised		
Table I 1-6	Revised		
2.1.4(a)(i)	Revised		
2.2.1(i)(ii)	Deleted		
2.5	Revised		
2.6	Revised		
2.7	Revised		
2.7.1(l)	Revised		
2.10	Revised		
2.11.1	Revised		
2.13.1(g)&(h)	New		
2.14.1(g)&(h)	New		
2.17.2	Revised		
2.19.3	New		
Table I 2-3A	Revised		
Table I 2-7	Revised		
Table I 2-14	Revised		
3.3.1(i)	Revised		
3.5	New		
3.6	New		
3.7	New		
3.8	New		
3.9	New		

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 1 Classification of Steel Ship

Paragraph 1.4.6 has been added as follows:

1.4 Class Notations

1.4.6 Descriptive Notation

(a) A ship with purpose, function or feature not covered by existing notations, may be recognized by assignment of a descriptive notation.

(b) The descriptive notation may be assigned upon request to the Society.

(c) There are no class requirements associated with a descriptive notation.

(d) The descriptive notation will be identified by use of square brackets.

Paragraph 1.6.2(f)(iii) has been amended as follows:

1.6 Surveys of Steel Ships

1.6.2 Classification initial survey during construction

(f) Hull Survey for New Construction

(iii) Newbuilding survey planning

Prior to commencement of surveys for any newbuilding project, a kick off meeting shall be carried out.

A record of the meeting is to be made. The records are to take note of specific published Administration requirements and interpretations of statutory requirements. The shipyard shall be requested to advise of any changes to the activities agreed at the kick off meeting and these are to be documented. Shipbuilding quality standards for the hull structure during new construction are to be reviewed and agreed during the kick-off meeting. Structural fabrication is to be carried out in accordance with IACS Recommendation 47, "Shipbuilding and Repair Quality Standard", or a recognized fabrication standard which has been accepted by this Society prior to the commencement of fabrication/construction. The work is to be carried out in accordance with the Rules and under survey of this Society. In the event of series ship production* consideration may be given to waiving the requirement for a kick off meeting for the second and subsequent ships provided that no changes to the specific activities agreed in the kick off meeting for the first ship are introduced. If any changes are introduced, these are to be agreed in a new dedicated meeting and documented in a record of such meeting.

*Series Ship Production: ships in the series subsequent to the first one (prototype), i.e. sister ships built in the same shipyard.

Paragraph 1.15.1(j) has been amended as follows:

1.15 Sea Trials

1.15.1 In the classification survey of all ships, sea trials specified in following (a) to (j) are to be carried out in full load condition, in the calmest possible sea and weather condition and at the deep unrestricted water. However, where sea trials cannot be carried out in full load condition, sea trials may be carried out in an appropriate loaded condition. The noise measurements specified in (k) are to be carried out at either the full load condition or the ballast condition.

(j) Measurement of the sound pressure levels of ~~fixed fire detection and fire alarm systems~~ the general emergency alarm, fire alarm (if not incorporated in the general emergency alarm system) and the public address system (if used for sounding the general emergency alarm and/or the fire alarm).

Table I 1-3 has been amended as follows:

Table I 1-3
List of Additional Service Notation

Notation	Description	Reference
CSR	This notation will be assigned to bulk carriers or oil tankers which fully comply with the IACS's **C**ommon **S**tructural **R**ules.	IACS's **C**ommon **S**tructural **R**ules
BC-A	This notation will be assigned to bulk carriers designed to carry dry bulk cargoes of cargo density 1.0 t/m^3 and above with specified holds empty at maximum draught in addition to **BC-B** conditions.	Part III/1.2
BC-B	This notation will be assigned to bulk carriers designed to carry dry bulk cargoes of cargo density of 1.0 t/m^3 and above with all cargo holds loaded in addition to **BC-C** conditions.	Part III/1.2
BC-C	This notation will be assigned to bulk carriers designed to carry dry bulk cargoes of cargo density less than 1.0 t/m^3.	Part III/1.2
……	……	……
PSPC	This notation (**P**erformance **S**tandard for **P**rotective **C**oating) will be assigned to any ship where the applicable requirements in 23.1.4 of Part II are complied with.	Part II/23.1.4
HSC-PA or HSC-PB	This notation will be assigned to the craft meeting the Rules for High-Speed Craft and the requirements of category A (up to 450 passengers) or B (over 450 passengers) of International Code of Safety for High-Speed Craft (hereinafter referred to as HSC Code).	the Rules for High-Speed Craft and HSC Code
HSC-C	This notation will be assigned to the cargo craft meeting the Rules for High-Speed Craft and the requirements of cargo craft category of HSC Code.	the Rules for High-Speed Craft and HSC Code
LSC	This notation (**L**ight **S**tructure **C**raft) will be assigned to craft not engaged in international voyages which are capable of maximum speed 2.36 ≤ V/$\sqrt{L}$ and not to proceed in the course of their voyage more than the time as specified in 1.3.4 of the HSC Code. The craft with **LSC** notation are to comply with the requirements of the Rules for High-Speed Craft, and in addition the ~~requirements of Chapter 4, 7 and 8 of~~ HSC Code, as applicable.	the Rules for High-Speed Craft and ~~Chapter 4, 7 and 8 of~~ the HSC Code, as applicable.
BOR (x.x%)	This notation **BOR** (**B**oil-**O**ff **R**ate) will be assigned to ships when the calculation of design boil-off rate per day is submitted for approval.	Guidelines for Ships Carrying Liquefied Gases in Bulk
APBU	The notation **APBU** (**A**llowable **P**ressure **B**uild-**U**p) will be assigned when the notation (design) vapour pressure allows the cargo to warm up during the duration of the voyage with the purpose of containing the boil-off gas (BOG) within the cargo tanks during normal operations. The insulation and the allowable maximum vapour pressure will be considered when determining the maximum voyage length at the ambient design temperatures stated in 7.2 of CR LGC Guidelines. The given duration of voyage is to have a suitable margin, for the operating time and temperatures involved, which is to be acceptable to the Administration, see 7.5 of CR LGC Guidelines. The design vapour pressure will be no greater than permitted by the definitions of containment systems in 4.1.2 of CR LGC Guidelines. Compliance with relevant paragraphs of CR LGC Guidelines is required.	Guidelines for Ships Carrying Liquefied Gases in Bulk

Table I 1-4 has been amended as follows:

Table I 1-4
List of Service Restriction Notation

Notation	Description	Reference
Coastal Service	Service along a coast, the geographical limits of which will be indicated in the Register, and for a distance out to sea generally not exceeding 30 nautical miles, unless some other distance is specified for 'Coastal Service' by the Administration with which the ship is registered, or by the Administration of the coast off which it is operating, as applicable. The operation/service limitations, such as significant wave height, ~~or~~ maximum voyage, etc., may be indicated in the bracket affixed after this notation.	
Greater Coastal Service	Service ~~along a coast~~ in restricted area within 200 nautical miles from the safe harbor or place of refuge, the geographical limits of which will be indicated in the Register, and for a distance out to sea generally farther than the area of **Coastal Service** in domestic voyage or for the geographical limits of the intended service accepted to the Society. The operation/service limitations, such as significant wave height, ~~or~~ maximum voyage, etc., may be indicated in the bracket affixed after this notation.	
Protected Waters Service	Service in sheltered water adjacent to sand banks, reefs, breakwaters or other coastal features, and in sheltered waters between islands.	
Specified Operating Area Service	Service within one or more geographical area(s) which will be indicated in the Register.	
Specified Route Service	Service between two or more ports or other geographical features which will be indicated in the Register.	

Table I 1-6 has been amended as follows:

Table I 1-6
List of Special Equipment Notation

Notation	Description	Reference
CCB	This notation (**C**entralized System for **C**argo and **B**allast Water Handling) will be assigned to ships provided with centralized system for cargo and ballast water handling.	Part VIII/7.10
……		
Occasional Helicopter Landing Area	This notation (**Occasional Helicopter Landing Area**) will be assigned to ships provided with helicopter facilities in accordance with related requirements of the Rules.	Part II Chapter 12A
……	……	……
FC Installation(1)	This notation (**F**uel **C**ell **Installation**) will be assigned to ships complying with the safety and environmental requirements where the fuel cell energy source is not used for essential, important or emergency services.	Guidelines for Fuel Cell Installations
~~**Gas Fuel**~~ **GFS**(1)	This notation (~~**Gas Fuel**~~ **G**as **F**uelled **S**hip) will be assigned to ships ~~where~~ which ~~only the gas fuel is used for main propulsion engines~~ are arranged to burn natural gas as fuel for propulsion or auxiliary purposes. The **GFS** notation will be assigned in association with one or more of the following additional notations (e.g., **GFS (DFD, GCU)**).	Guidelines for ~~Natural Gas Fuelled Engine Installations~~ Ships Using Gases or Other Low-Flashpoint Fuels
LFFS(1)	This notation (**L**ow **F**lashpoint **F**ueled **S**hip) will be assigned to ships which are arranged to burn a low flashpoint fuel other than natural gas for propulsion or auxiliary purposes. The **LFFS** notation will be assigned in association with the specific low flashpoint fuel and one or more of the following additional notations (e.g., **LFFS (DFD - Methanol)**).	Guidelines for Ships Using Gases or Other Low-Flashpoint Fuels
RELIQ(1)	This notation (**RELIQ**uefaction system) will be assigned to ships which are arranged a Reliquefaction System. Where the system is used to comply with the Guidelines, the **RELIQ** notation is required.	Guidelines for Ships Using Gases or Other Low-Flashpoint Fuels/ CR LGC Guidelines
GCU(1)	This notation (**G**as **C**ombustion **U**nit) will be assigned to ships which are arranged a Gas Combustion Unit. Where the unit is used to comply with 6.9.1.1.2 of the Guidelines, the **GCU** notation is required.	Guidelines for Ships Using Gases or Other Low-Flashpoint Fuels
SGF(1)	This notation (**S**ingle **G**as **F**uel Engine Power Plant) will be assigned to ships where a single gas fuel engine power plant is fitted.	Guidelines for Ships Using Gases or Other Low-Flashpoint Fuels
DFGT(1)	This notation (**D**ual **F**uel **G**as **T**urbine Power Plant) will be assigned to ships where a dual fuel gas turbine power plant is fitted.	Guidelines for Ships Using Gases or Other Low-Flashpoint Fuels
~~**Dual Fuel**~~ **DFD**(1)	This notation (**D**ual **F**uel **D**iesel Engine Power Plant) will be assigned to ships where ~~the gas fuel and oil fuel are used for main propulsion engines~~ a dual fuel diesel engine power plant is fitted.	Guidelines for ~~Natural Gas Fuelled Engine Installations~~ Ships Using Gases or Other Low-Flashpoint Fuels
……		
ADW	This notation will be assigned to ships intended for regular anchoring at deep and unsheltered water.	Part II/25.11

Note:

(1) It means that the notation, when assigned, is to be added after the classification symbol **CMS**.

Chapter 2 Survey Requirements of Steel Ship

Paragraph 2.1.4(a)(i) has been amended as follows:

2.1 General

2.1.4 Procedures for class related services

(a) Thickness measurements and close-up surveys - hull structures

(i) Thickness measurements are to be carried out by a firm approved by the Society in accordance with the procedures for certification of firms engaged in thickness measurement of hull structures as specified in "Guidelines for Approval of Service Suppliers" of the Society~~, except that in respect of measurements of non-ESP ships less than 500 gross tonnage and all fishing vessels, the firm need not be so approved~~.

……

Paragraph 2.2.1(i)(ii) has been deleted as follows:

2.2 Bottom Surveys

2.2.1 Bottom Surveys in dry dock

At each Bottom Survey in dry dock the following requirements are to be complied with:

(i) For Mobile Offshore Unit, the parts are to be examined as follows:

~~(i) Parts to be examined~~

(~~1~~ i) Surface-type Units (ship or barge type units)

External surfaces of the hull, keel, stem, stern frame, rudder, nozzles, and sea strainers are to be selectively cleaned to the satisfaction of the attending Surveyor and examined together with appendages, the propeller, exposed parts of stern bearing assembly, rudder pintle and gudgeon securing arrangements, sea chest and strainers, and their fastenings.

Propeller shaft bearing, rudder bearing, and steering nozzle clearances are to be ascertained and recorded.

(~~2~~ ii) Self-Elevating Units

External surfaces of the upper hull or platform, spud cans, mat, underwater areas of legs, together with their connections as applicable, are to be selectively cleaned to the satisfaction of the attending Surveyor and examined.

At each Drydocking Survey or equivalent, after Special Survey No. 2, the Surveyor is to be satisfied with the condition of the internal structure of the mat or spud cans. Leg connections to mat and spud cans are to be examined at each Drydock Survey or equivalent. Non-destructive testing may be required of areas considered to be critical by the Society or found to be suspect by the Surveyor.

(~~3~~ iii) Column-Stabilized Units

External surfaces of the upper hull or platform, footings, pontoons or lower hulls, underwater areas of columns, bracing and their connections, sea chests, and propulsion units as applicable, are to be selectively cleaned and examined to the satisfaction of the attending Surveyor. Non-destructive testing may be required of areas considered to be critical by the Society or found to be suspect by the Surveyor.

~~(ii) Ballast Spaces~~

~~In conjunction with Drydocking Surveys (or equivalent) after Special Survey No. 1 and between subsequent Special Surveys, the following ballast spaces are to be internally examined, thickness gauged, placed in satisfactory condition as found necessary, and reported upon. If such examination reveals no visible structural defects, the examination may be limited to a verification that the corrosion prevention arrangements remain effective.~~

~~(1) All Units~~

~~Particular attention is to be given to corrosion prevention systems in ballast spaces, free-flooding areas and other locations subjected to sea water from both sides.~~

~~(2) Surface type units~~

~~One peak tank and at least two other representative ballast tanks between the peak bulkheads used primarily for water ballast.~~

~~(3) Self elevating units~~

~~Representative ballast tanks or free-flooding compartments in mat or spud cans, if accessible, and at least two representative hull pre-load tanks.~~

~~(4) Column stabilized units~~

~~Representative ballast tanks in footings, lower hulls, or free-flooding compartments as accessible, and at least two ballast tanks in columns or upper hull, if applicable.~~

Section 2.5 has been amended as follows:

2.5 Annual Surveys

These requirements apply to all ships.

Section 2.6 has been amended as follows:

2.6 Intermediate Surveys

These requirements apply to all ships.

Section 2.7 has been amended as follows:

2.7 Special Surveys

These requirements apply to all ships.

Paragraph 2.7.1(l) has been amended as follows:

2.7.1 Special Survey - hull

All Annual Survey requirements together with the following are to be complied with:

(l) For all ships ~~except for passenger ships~~, automatic air pipe heads are to be completely examined (both externally and internally) as indicated in Table I 2-23.
For designs where the inner parts cannot be properly inspected from outside, this is to include removal of the head from the air pipe. Particular attention is to be paid to the condition of the zinc coating in heads constructed from galvanized steel.

Section 2.10 has been amended as follows:

2.10 ~~Hull~~ Surveys of Liquefied Gas Carriers

2.10.1 Annual Surveys

(a) Hull Surveys

In addition to the surveys as per applicable requirements of 2.5 and the applicable requirements of 2.11.1, ~~the components, equipment and outfit as listed below are to be examined as to whether they are in unobjectionable maintenance condition~~ the Annual Survey is also to include the following:

(i) General

The log books are to be examined with regard to correct functioning of the cargo containment and cargo handling systems. The hours per day of the reliquefaction plants or the boil-off rate is to be considered.

(ii) Interbarrier Space Venting System

The venting system or other arrangements provided for the emergency removal of gas from the interbarrier spaces (i.e., between the primary and secondary barriers) is to be confirmed in satisfactory condition.

(iii) Cargo Tank Venting System

The venting system for the cargo tanks and hold spaces is to be confirmed in satisfactory operating condition. Vent line drainage arrangement is to be examined. It is to be verified that the cargo tank relief valves are sealed and that the certificate/record for the relief valves opening/closing pressures is on board.

(iv) Instrumentation and Safety Systems

Gas leakage detection equipment, including indicators and alarms, is to be confirmed in satisfactory operating conditions. Systems for temperature, pressure and liquid level indication of the cargo, cargo tank, insulation, the hull adjacent to the cargo containment system, and cargo refrigerating installations where fitted, including alarms, are to be confirmed in satisfactory operating condition. The piping of the gas detection system is to be visually examined for corrosion and damage and the integrity of the line between suction points and analyzing units is to be confirmed as far as possible.

(v) Environmental Control of Hold Spaces

Inert gas and dry air systems, including indicators and alarms, are to be confirmed in satisfactory operating condition. Means for prevention of backflow of cargo vapor into gas-safe spaces is to be confirmed in satisfactory operating condition. For membrane containment systems, normal operation of the nitrogen control system for insulation and interbarrier spaces shall be confirmed.

(vi) Cargo Handling Piping and Machinery

All piping, cargo hoses, emergency shutdown valves, remote operating valves, machinery and equipment for loading, unloading, venting, compressing, refrigerating, liquefying, heating or otherwise

handling the liquefied gas or vapor is to be examined, as far as possible. Stopping of the cargo pumps and compressors upon emergency shut-down of the system is to be confirmed.

Cargo hoses are to be verified, where appropriate, type-approved or marked with date of testing.

(vii) Cargo Tank Tightness

The tightness of cargo tanks is to be confirmed. For this purpose, the vessel gas leak detectors, micro-flow meters, etc. may be utilized providing that they are first proved to be in good order. The ship's log books are also to be reviewed to confirm the tightness of the cargo tanks.

(viii) Heating Coils

Heating coils and other heating systems which are fitted and essential for the heating of the hull structure to ensure that the temperature of the structure does not fall below the minimum allowable value for the material used are to be proven in satisfactory operating condition.

(ix) Ventilating System

Examination of the ventilation system is to be made for all gas dangerous spaces and zones, including air locks, cargo pump rooms, cargo compressor rooms, cargo control rooms and spaces used for cargo handling operations. All portable ventilating equipment required for use in the gas dangerous spaces is to be examined. Provision of spares for mechanical ventilation fans for gas dangerous spaces and zones, recommended by manufacturer is to be confirmed.

(x) Spaces in Cargo Areas

Air locks, cargo pump rooms, cargo compressor rooms, rooms containing electric motors for driving cargo pumps or compressors, cargo control rooms, other cargo machinery spaces, turret compartments, spaces used for cargo handling operations and escape routes are to be examined. All accessible gas-tight bulkhead penetrations including gas-tight shaft seals are to be examined. The means for accomplishing gas tightness of the wheelhouse doors and windows is to be examined.

The closing devices for all air intakes and openings into accommodation spaces, service spaces, machinery spaces, control stations and openings in superstructures and deckhouses facing the cargo area or bow and stern loading/unloading arrangements are to be examined.

All windows and sidescuttles within the area required to be of the fixed type (nonopening) are to be examined for gas tightness.

(xi) Drip Trays

Portable and fixed drip trays and insulation for the protection of the deck in the event of cargo leakage are to be examined.

(xii) Gas Burning Installations

Gas burning installations, including instrumentation and safety systems, are to be examined and confirmed in satisfactory operating condition. See also 2.10.1(a)(iv) of this Chapter.

(xiii) Sealing Arrangements

Sealing arrangements on the weather deck in way of openings for the cargo containment system are to be examined.

(xiv) Fire Protection and Fire Extinguishing Equipment

The fire water main equipment, water spray equipment, dry chemical powder fire extinguishing systems in the cargo area, and fixed inerting and fixed smothering installations in gas-dangerous spaces are to be examined and operationally tested, in so far as practicable.

(xv) Electrical Equipment

Electrical equipment in gas-dangerous spaces or zones is to be examined as far as practicable with particular respect to the following:

(1) Protective earthing

(2) Physical condition of electrical cables and supports

(3) Integrity of enclosures

(4) Intrinsically safe, explosion proof, or increased safety features of electrical equipment

(5) Functional testing of pressurized equipment and associated alarms

(6) Testing systems for de-energizing electrical equipment which is not certified safe for use in gas-hazardous areas but which is located in spaces protected by air-locks (e.g., electrical motor rooms or cargo control rooms)

(7) Insulation resistance readings of circuits. Where a proper record of testing is maintained, consideration may be given to accepting recent readings.

Note: See also IACS Recommendation No.35 - Inspection and maintenance of electrical equipment installed in hazardous areas.

(xvi) Personnel Protection

Firemen's outfits, protective clothing, and respiratory protection equipment are to be examined. Decontamination showers and eye wash are to be examined and operationally tested, in so far as practicable.

(xvii) Tightness of Hull

Means for detecting leakage into the hold space through the ship's structure forming the boundary of the hold space are to be examined.

(xviii) Operating Instructions

Instructions and information material, such as cargo handling plans, loading manual, filling limit information, cooling-down procedure are to be confirmed as being aboard the ship. Alternative design and arrangements for the segregation of the cargo area are to be examined, in accordance with the test, inspection and maintenance requirements, if any, specified in the approved documentation.

(xix) Relief Valves

All relief valves in the cargo containment and venting system are to be examined, including protective screens and flame screens, if provided, and seals confirmed intact. Records of opening and closing pressures of relief valves are to be confirmed onboard.

(xx) Ship Survival Capability and Location of Cargo Tanks

Confirm that any special arrangements to survive conditions of damage are in order.

(xxi) Access to Bow on Tankers

Arrangements for safe access to the bow are to be examined

(xxii) Emergency Towing Arrangements

For liquefied gas carriers of 20,000 tonnes deadweight and above, emergency towing arrangements are to be examined.

(b) Machinery Surveys

In addition to the surveys as per applicable requirements of 2.5.2 of this Chapter, the Annual Survey is also to include the following:

(i) General

The following is to be carried out during the survey of the boil-off gas(BOG) Utilization System:

(1) General

The log books are to be examined with regard to correct functioning of the BOG systems. The hours per day of the re-liquefaction plants or the boil-off rate are to be considered.

(2) Operating and maintenance instruction manual

The manufacturer/builder instructions and manuals covering the operations, safety and maintenance requirements and occupational health hazards relevant to the BOG utilization units and use of gas as fuel, are to be confirmed as being aboard the ship.

(3) Instrumentation and safety systems

Gas detection equipment in all compartments containing BOG utilization equipment or components, including indicators and alarms, is to be confirmed in satisfactory operating conditions. Verification of installed interlocks in the gas detection system is to be verified in working condition. Any piping of the gas detection system is to be visually examined for corrosion and damage and the integrity of the line between suction points and analyzing units is to be confirmed as far as possible. Recalibration of the gas detection systems should be verified in accordance with the manufacturers' recommendations.

(4) BOG handling piping and machinery

All piping, hoses, emergency shut-down valves, remote operating valves, machinery and equipment for BOG utilization such as venting, compressing, refrigerating, liquefying, heating, cooling or otherwise handling the liquefied gas or vapor is to be examined, as far as possible. Stopping of pumps and compressors upon emergency shut-down of the system is to be confirmed.

(5) Ventilating system

Examination of the ventilation system is to be made for all spaces containing boil off gas utilization units or components, including air locks, pump rooms, compressor rooms, gas valve rooms, control rooms and spaces containing gas burning equipment. All required portable ventilating equipment is to be examined. Where alarms, such as differential pressure and loss of pressure alarms, are fitted, these should be operationally tested as far as practicable.

(6) Drip trays

Portable and fixed drip trays and insulation for the protection of the deck in the event of gas leakage are to be examined.

(7) Sealing arrangements

Sealing arrangements in way of openings and bulkhead penetrations for the BOG system are to be examined.

(8) Fire protection and fire extinguishing equipment

The required fire protection and fire extinguishing system contained in areas and spaces where BOG utilization units are fitted are to be examined and operationally tested, in so far as practicable.

(9) Electrical equipment

Electrical equipment in gas-dangerous spaces or zones is to be examined for continued suitability for their intended service and installation area.

(10) Electrical bonding

Electrical bonding arrangements, including bonding straps where fitted, of the piping systems for BOG utilization systems located within cargo tanks, ballast tanks, pipe tunnels, cofferdams and void spaces bounding cargo tanks are to be examined.

(ii) Gas Combustion Unit

The following are to be examined, so far as applicable:

(1) The gas burning unit during working condition.

(2) External examination of all pressure vessels in the system.

(3) Testing of burner management control system, and flame scanner and installed interlocks.

(4) External examination of the combustion chamber and associated refractory.

(5) External examination of exhaust gas piping/ducts.

(6) Testing of the remote and local closing of the installed "master gas valve" and automatic gas shut-off valve for each Gas Combustion Unit compartment.

(iii) Re-Liquefaction Plant

The following are to be examined, so far as applicable. Insulation need not be removed, but any deterioration or evidence of dampness is to be investigated:

(1) The plant during working condition.

(2) External examination of all pressure vessels in the system.

(3) External examination of relief valves, if fitted.

(4) The re-liquefaction/refrigeration plant spare gears as recommended by the manufacturer.

(5) Testing of control, monitoring and shut-down systems as far as practicable, or verification of set-points in accordance with approved test program.

(6) Examination and testing of installed bilge alarms and means of drainage of the compartment.

(iv) Additional requirements

Confirm, when appropriate, that the requisite arrangements to regain steering capability in the event of the prescribed single failure are in satisfactory condition.

(a) Cargo handling systems are to be examined as follows:

(i) The cargo and process piping, expansion joints, cargo hoses and machinery, such as heat exchangers, vapourizers, pumps, compressors are to be externally examined.

(ii) The availability of the required spool pieces for piping separation is to be verified.

(iii) The log-books are to be examined with regard to correct functioning of the cargo containment and cargo handling systems. The running hours per day of the re-liquefaction plants or the boil-off rate and the inert gas consumption are to be considered.

(iv) It is to be ensured that the relevant instructions and information material such as cargo handling plants, cargo tank loading limit information, cooling down procedures etc. are on board.

(b) Cargo containment venting systems are to be examined as follows:

(i) Venting system for cargo tanks, inter barrier spaces (in case of Type A tanks, cargo holds) are to be visually examined. It is to be verified that the cargo tank relief valves are sealed and that the certificate containing details on opening/closing pressure of the relief valves is kept on board.

(ii) Protection screens and flame arresters, if fitted, are to be examined for corrosion and cleanliness.

(c) Instrumentation and safety systems are to be examined as follows:

(i) The monitoring and control equipment for pressure, temperature and liquid levels is to be verified as to its good working order, by one or several of the following methods:

(1) Visual external examination.

(2) Comparison of read-outs of different indicators.

(3) Comparison of read-outs with the data of the cargo actually handled.

(4) Examination of repair and maintenance records with reference to the cargo plant repair.

(ii) Emergency shut-down valves at shore connections and tanks are to be tested without flow in the pipe lines. It is to be verified that operation of the emergency shut-down system is to cause the cargo pumps and compressors to stop.

(iii) The fixed and portable gas detection equipment, including indicators and alarms, is to be tested for correct functioning.

(d) In gas-dangerous spaces and zones the electrical equipment including cables and their supports, is to be visually examined, particularly regarding explosion protection.

(e) Ventilation systems for all spaces in the cargo area, including cargo pump rooms, cargo compressor rooms, electrical motor rooms, cargo control rooms, and other spaces used for cargo handling operations are to be examined as to their satisfactory operating condition.

(f) Inert gas/dry air systems, including the means for prevention of backflow of cargo vapour to gas-safe spaces are to be checked as to their satisfactory operating condition. See also 3.3.1 of this Part.

(g) All fire fighting systems in the cargo area, including the compressor room, are to be checked visually. See also 2.5.1(j).

(h) The following items of equipment are to be inspected for their condition and correct functioning:

(i) Means for ensuring gas-tightness of wheelhouse windows and doors, windows in end bulkheads of superstructures and deck house facing the cargo area or stern loading/unloading arrangements, and closing devices of all air intakes and openings into accommodation, service and control stations.

(ii) Sealing arrangements for tanks or tank domes penetrating decks or tank covers.

(iii) Drip trays or insulation for deck protection against cargo leakage.

(iv) Arrangements for heating of hull structural elements, if any. Access to the heated cofferdams etc. is normally not required.

~~(v) Electric bonding of cargo piping systems.~~

~~(vi) Arrangements for the use of boil-off gas as fuel, including alarm and safety systems.~~

2.10.2 Intermediate Surveys

(a) Hull Surveys

In addition to the surveys as per Annual Survey in 2.10.1 and the applicable requirements of the Intermediate Surveys in 2.6, ~~the checks mentioned below are to be carried out.~~ the Intermediate Survey is also to include the following: ~~The Intermediate Survey supplements the preceding Annual Survey by testing of cargo handling installations, with pertinent automatic controls, alarm and safety systems, for their correct functioning.~~

(i) Instrumentation and safety systems

(1) The instrumentation of the cargo installation with regard to pressure, temperature and liquid level is to be visually examined and to be tested by changing the pressure, temperature and level, as applicable, and comparing with test instruments. Simulated testing may be accepted for sensors which are not accessible or for sensors located within cargo tanks or inerted hold spaces. The testing is to include testing of the alarm and safety functions.

(2) Gas detectors are to be calibrated or verified with sample gases.

(3) The emergency shutdown system is to be tested, without flow in the pipe lines, to verify that the system will cause the cargo pumps and compressors to stop.

(ii) Gas Burning Installations

The instrumentation and safety systems for gas burning installations are to be examined and tested in accordance with the requirements of 2.10.2(a)(i)(1) of this Chapter.

(iii) Close-up survey requirements

Close-up survey as required in Table I 2-24.

(1) For Ships 10 < Age ≤ 15 years:

a) All complete web frames including adjacent structural members and both transverse bulkheads complete, including girder system and adjacent members, and adjacent longitudinal bulkhead structure in the representative ballast tank.

b) The upper part of 1 web frame in another representative ballast tank.

c) 1 transverse bulkhead complete, including girder system and adjacent members, and adjacent longitudinal bulkhead structure.

(2) For Ships 15 years < Age:

All complete web frames including adjacent structural members and both transverse bulkheads complete, including girder system and adjacent members and adjacent longitudinal bulkhead structure in 2 representative ballast tanks.

(b) Machinery Surveys

At each Intermediate Survey, all the requirements of 2.6.5 and 2.10.1(b) of this Chapter are to be complied with.

~~(a) Cargo systems and tanks are to be examined as follows:~~

~~(i) The piping system in cargo tanks is to be examined. Bonding of tanks and pipes is to be controlled.~~

~~(ii) It is to be checked whether the ship's cargo hoses are approved and in satisfactory condition. At intervals of not more than 2.5 years, the cargo hoses are to be subjected to a pressure and conductivity test.~~

~~(iii) Weather deck: Piping systems essential for operation of the ship, e.g. cargo transfer, bunkering and ballast lines, are to be examined.~~

~~(iv) For ships between 5 and 10 years of age, an overall survey of representative ballast tanks is to be carried out.~~

~~(v) For ships over 10 years of age, an overall survey of all ballast tanks is to be carried out.~~

~~(vi) Close-up survey as required in Table I 2-24.~~

~~(b) Cargo containment venting systems are to be examined as follows:~~

~~(i) The drainage arrangements of venting systems are to be examined.~~

~~(ii) If cargo tanks are equipped with relief valves with non-metallic membranes in main or pilot valves, such membranes are to be replaced by new ones and the valves are to be adjusted, function tested and sealed. These measures need not be taken simultaneously with the Intermediate Survey, provided that the non-metallic membranes are renewed at intervals not exceeding 3 years.~~

~~(c) Instrumentation and safety systems are to be examined as follows:~~

~~(i) The alarm, control and safety systems of the cargo installation are to be visually examined and tested by varying pressures, temperatures and liquid levels, as far as practicable, and comparisons are to be drawn, using test instruments. Simulated testing may be accepted for sensors which are not accessible or for sensors located within cargo tanks or inertised cargo holds. This test is to include testing of alarm and safety functions.~~

~~(ii) The gas detection equipment, including indicators and alarms, is to be tested for correct functioning. The piping of the gas detection system is to be visually inspected for corrosion and damages. The tightness and integrity of suction lines between suction points and analyzing units are to be verified as far as possible.~~

~~(iii) On ships having arrangements for the use of boil-off gases as fuel, safety, control, alarm and shut-down systems are to be checked. The extent of the checks is to be determined from case to case.~~

~~(d) Electrical installations are to be examined as follows:~~

~~Electrical equipment in gas dangerous spaces and zones is to be examined in respect of the following:~~

~~(i) Protective earthing (spot check).~~

~~(ii) Integrity of certified safe type equipment.~~

~~(iii) Damage to outer sheath of cables.~~

~~(iv) Function testing of pressurized equipment, and of associated alarms.~~

~~(v) Testing of systems for de-energizing noncertified safe electrical equipment located in spaces protected by air locks, such as electric motor rooms, cargo control rooms, etc.~~

~~(vi) Checking of insulation resistance of circuits. Relevant measurements are only to be made when the ship is in gas free or inertised condition. If proper test reports are available on board, readings made by the crew may be accepted.~~

~~(vii) When the ship is in gas free condition, it is to be verified that the cargo tanks are electrically bonded to the hull.~~

2.10.3 Special Survey

(a) Hull Survey

Where applicable, in addition to the surveys as per requirements of the Intermediate Survey in 2.10.2 and applicable requirements of the Special Survey in 2.7, ~~the examinations and tests as mentioned below are to be carried out~~ the Special Survey is also to include the following:

(i) Special Surveys No. 1 and No. 2

(1) Cargo tanks (primary containers)

An internal examination is to be made of all cargo tanks, after being gas freed, including internal mountings and equipment.

(2) Cargo tank supports, insulation and hull structures

For independent tanks, foundations, chocks, sway braces, keys, anti-flotation arrangements, the secondary barriers or hull plating or both are to be examined, with special attention being given to the cargo tanks and insulation in way of the above. See 2.10.3(a)(i)(6) of this Chapter for insulation removal. Framing adjacent to the cargo containment system is also to be examined. Where the arrangement is such that the insulation cannot be examined, the surrounding structures in the wing tanks, double bottom tanks and cofferdams are to be examined for cold spots while

the cargo tank is in cold condition, unless sufficient evidence of the integrity of the insulation is available from the voyage records.

(3) Interbarrier space venting system

Venting systems, relief valves or other arrangements provided for emergency removal of gas from the interbarrier spaces and hold spaces are to be opened, inspected, tested and readjusted as necessary.

(4) Cargo tank venting system and liquid-level indicators

Relief valves, liquid level indicators, and venting systems for the primary cargo containment system are to be examined. All relief valves are to be opened, inspected, tested, and readjusted as necessary. If the cargo tanks are equipped with relief valves with non-metallic membranes in the main or pilot valves, such non-metallic membranes are to be replaced. Liquid-level indicators and alarms are to be proven satisfactory. Where a proper record of continuous overhaul and retesting of individually identifiable relief valves is maintained, consideration will be given to acceptance on the basis of opening, internal examination, and testing of a representative sampling of valves including each size of each type of liquefied gas or vapor relief valve in use, provided there is log book evidence that the remaining valves have been overhauled and tested since the crediting of the previous Special Survey. The testing and setting of relief valves may be carried out in place or after removal.

(5) Cargo handling and piping systems

All piping, machinery and equipment for loading, unloading, venting, compressing, refrigerating, liquefying, heating or otherwise handling the liquefied gas or vapor and liquid nitrogen, and gas burning installations is to be examined including removal of insulation and opening for examination, as deemed necessary. Where deemed suspect, a hydrostatic test to 1.25 times the maximum allowable relief valve setting (MARVS) for the pipeline is to be carried out. After reassembly, the complete piping is to be tested for leaks. Where water cannot be tolerated and the piping cannot be dried prior to putting the system into service, the Surveyor may accept alternative testing fluids or alternative means of testing. All emergency shut-down valves and remote operating valves in the cargo piping systems are to be inspected and proven operable. The pressure relief valves are to be function-tested. A random selection of valves is to be opened for examination and adjusted.

(6) Insulation removals

Insulation is to be removed in way of any distorted or otherwise suspect insulation or structural part of the cargo tanks or elsewhere to carry out any of the examinations as required by the Surveyor.

(7) Thickness measurements

Where there is evidence of corrosion, or where one side of the cargo tank is exposed to possible corrosive atmosphere, the plating of the cargo tanks is to be gauged by non-destructive means to determine the thickness.

(8) Cargo pump towers

All cargo pump tower structures are to be examined including stiffeners, bracings, fasteners and locking devices, spray nozzles, wiring with associated conduits and pipe connections. Where deemed necessary by the Surveyor, dimensional measurements and/or non-destructive testing may be required. See also 2.10.3(a)(i)(10).

(9) Secondary barriers

The secondary barrier is to be checked for its effectiveness by means of a pressure/vacuum test, a visual inspection, or other acceptable method.

For membrane containment systems, a tightness test of the primary and secondary barrier shall be carried out in accordance with the system designers' procedures and acceptance criteria as approved by the Society. Low differential pressure tests may be used for monitoring the cargo containment system performance, but are not considered an acceptable test for the tightness of the secondary barrier.

For membrane containment systems with glued secondary barriers if the designer's threshold values are exceeded, an investigation is to be carried out and additional testing such as thermographic or acoustic emissions testing should be carried out.

(10) Non-destructive testing

a) Non-destructive testing is to supplement cargo tank inspection with special attention to be given to the integrity of the main structural members, tank shell and highly stressed areas, including welded connections as deemed necessary by the Surveyor.

However, for type C tanks, this does not mean that non-destructive testing can be dispensed with totally. The following items are, inter alia, considered as highly stressed areas:

i) Cargo tank supports and anti-rolling/anti pitching devices.

ii) Web frames or stiffening rings.

iii) Y-connections between tank shell and a longitudinal bulkhead of bilobe tanks.

iv) Swash bulkhead boundaries.

v) Dome and sump connections to the tank shell.

vi) Foundations for pumps, towers, ladders etc.

vii) Pipe connections.

b) For independent tanks type C, in addition to the requirements of 3.10.3(a)(i)(10)a) above, at alternate Special Surveys, at least 10% of the length of the welded connections in each highly stressed area is to be tested. This testing is to be carried out internally and externally, as applicable. Insulation is to be removed, as necessary, for the required non-destructive testing.

c) Vacuum insulated independent storage tanks of type C without access openings need not be examined internally. Where fitted, the vacuum monitoring system is to be examined and records are to be reviewed. The tank insulation and tank support arrangements are to be visually examined. Non-destructive testing may be required if conditions raise doubt to the structural integrity.

d) For independent tanks type B, the extent of the non-destructive testing is to be in accordance with a planned program specially prepared and approved for the cargo tank design.

(11) Tank testing

Where non-destructive testing, or other evidence such as leakage or distortion, raises doubts as to the structural integrity of a cargo tank, a hydrostatic or hydropneumatic pressure test is to be carried out. For integral tanks and independent tanks type A and B, the test pressure is to be at least MARVS at the top of the tank. For independent tanks type C and pressurized tanks type B with MARVS 2.06 bar and over, the test pressure is to be 1.25 times MARVS.

(12) Electrical bonding

Electrical bonding arrangements, including bonding straps where fitted, of the piping systems located within cargo tanks, ballast tanks, pipe tunnels, cofferdams and void spaces bounding cargo tanks are to be examined.

(13) Drainage arrangements

Systems for removing water or cargo from interbarrier spaces and holds are to be examined and tested as deemed necessary.

(14) Membrane and semi-membrane tank

For membrane and semi-membrane tanks systems, inspection and testing are to be carried out in accordance with programs specially prepared in accordance with an approved method for the actual tank system.

(15) Gas-tight bulkhead

All gas-tight bulkheads are to be examined. The effectiveness of gas-tight shaft sealing is to be verified.

(16) Miscellaneous

The hoses and spool pieces used for segregation of piping systems for cargo, inert gas and bilge are to be examined.

(ii) Special Survey No. 3 and Subsequent Special Surveys

In addition to all the requirements of Special Survey No. 1 or No. 2, the following requirements are to be complied with for Special Survey No. 3 and all subsequent Special Surveys.

(1) Cargo tanks

The plating of at least one cargo tank of gas carriers with independent tanks (LPG and LNG) is to be gauged by non-destructive means to determine the thickness. Where only cargoes of a non-corrosive nature are carried, modifications to the extent of thickness measurements may be specially considered.

(iii) Close-up survey requirements, see Table I 2-25

(iv) Thickness measurement requirements, see Table I 2-26

(b) Machinery Surveys

In addition to the applicable requirements of 2.7.2 and 2.10.2(b) of this Chapter, the Special Survey is also to include the following:

(i) Boil-off gas (BOG) handling and piping material

All piping, machinery and equipment for BOG utilization, such as venting, compressing, refrigerating, liquefying, heating storing, burning or otherwise handling the liquefied gas or vapor and liquid nitrogen installations are to be examined including removal of insulation and opening for examination, as deemed necessary. Where deemed suspect, a hydrostatic test to 1.25 times the Maximum Allowable Relief Valve Setting (MARVS) for the pipeline is to be carried out. After reassembly, the complete piping is to be tested for leaks. Where water cannot be tolerated and the piping cannot be dried prior to putting the system into service, the Surveyor may accept alternative testing fluids or alternative means of testing.

(ii) BOG utilization valves

All emergency shut-down valves, check valves, block and bleed valves, master gas valves, remote operating valves in the BOG utilization piping systems are to be inspected and proven operable. The pressure relief valves are to be function tested. A random selection of valves is to be opened for examination and adjusted as necessary.

(iii) Pressure vessels

Internal examination and thickness measurement of the fitted pressure vessels in the BOG utilization units as deemed necessary by the Surveyor.

(iv) Electrical equipment

This examination is to include the physical condition of electrical cables and supports, intrinsically safe, explosion proof, or increased safety features of electrical equipment, functional testing of pressurized equipment and associated alarms, testing systems for de-energizing electrical equipment which is not certified for use in gas-hazardous areas, and insulation resistance readings of circuits. Where a proper record of testing is maintained, consideration may be given to accepting recent readings.

(v) Gas combustion unit

Internal examination of the gas combustion unit, combustion chamber and associated refractory.

~~2.10.3 Special Survey~~

~~(a) The cargo containment systems is to be examined as follows:~~

~~(i) All cargo tanks are to be examined internally.~~

~~(ii) As far as practicable, the outer surface of un-insulated cargo tanks or the outer surface of cargo tanks insulations, including vapour or protective cover if any, is to be examined, as are areas in way of supports, keys and anti-flotation chocks. Partial removal of insulation may be required in order to verify the condition of the tank or the insulation itself, if found necessary by the Surveyor. Where, e.g. in the case of membrane type cargo tanks, the insulation arrangement is such that it cannot be examined, the surrounding structures of wing tanks, double bottom tanks and cofferdams are to be examined for cold spots when cargo tanks are in cold condition. This examination may be dispensed with if the log book, together monitoring instruments gives sufficient evidence of the integrity of the insulation system.~~

~~(iii) Thickness measurements of cargo tanks may be required if deemed necessary by the Surveyor.~~

~~(iv) Non-destructive examination of main structural members, tank shells and highly stressed parts, including welded connections is to supplement cargo tank inspections as far as deemed necessary by the Surveyor. The following items are inter alia considered as highly stressed parts:~~

~~(1) Cargo tank supports and longitudinal and transverse securing devices.~~

~~(2) Y-connections between tank shells and longitudinal bulkheads of slop tanks.~~

~~(3) Web frames or stiffening rings.~~

~~(4) Swash bulkheads and their fixations.~~

~~(5) Dome and sump connection to tank shells.~~

~~(6) Foundations for pumps, towers, ladders, etc.~~

~~(7) Pipe connections.~~

~~(v) For independent Type B tanks, the extent of non-destructive examination is defined in a plan specially prepared for the particular cargo tank design.~~

~~(vi) The tightness of all cargo tanks is to be verified by an appropriate procedure – provided that the effectiveness of the ship gas detection equipment has been confirmed, it is to be acceptable to utilize this equipment for the tightness test of independent tanks below deck during the first process of filling of the cargo tanks subsequent to the Special Survey.~~

~~(vii) Where the findings of checks according to 2.10.3(a)(i) to (vi) above or an examination of the log book raise doubts as to the structural integrity of a cargo tank, a hydrostatic or hydro-pneumatic test is to be carried out. For integral tanks and for independent Type A and B tanks, the test pressure at the top of tank is to correspond to the MARVS (maximum allowable relief valve setting) of the tank. For independent Type C tanks, the test pressure at the top of the tank is not to less than 1.25 times the MARVS.~~

~~(viii) Extended tests~~

~~On the occasion of Special Surveys No. 3, 4, 5, etc., all independent type C tanks are to be either~~

~~(1) Hydrostatically or hydro-pneumatically tested to a pressure at the upper edge of the tanks of 1.25 times MARVS and thereafter, non-destructively, in accordance with (iv)/(v) of this subparagraph, or~~

~~(2) Subjected to a thorough, systematically planned nondestructive examination procedure. These tests are to be carried out in accordance with a plan specially prepared for the particular tank design. If a special plan dose not exist, the following applies with regard to nondestructive testing:~~

~~Testing is to be concentrated on the detection of surface cracks in welded connections in highly stressed areas, as listed in 2.10.3(a)(iv) above. At least 10% of the length of the welded connections in each of the above mentioned areas are to be tested. This testing is to be carried out internally and externally, as far as practicable. Insulation is to be removed as necessary for the required nondestructive examination.~~

~~(b) Tank supporting structures and insulation are to be examined as follows:~~

~~(i) As far as practicable, all hold spaces and hull insulation (if provided), secondary barriers and tank supporting structures are to be visually examined. The secondary barrier of all tanks is to be checked for its effectiveness by means of a pressure/vacuum test, a visual examination or some other acceptable methods.~~

~~(ii) For membrane and semi-membrane tank systems, the inspection and testing as per 2.10.3(b)(i) above are to be carried out in accordance with a plan and an approved method specially prepared for the actual tank system.~~

~~(c) Pressure and vacuum relief valves are to be examined as follows:~~

~~(i) The pressure relief valves for cargo tanks are to be opened up for examination, adjusted, function tested and sealed. The requirements of 2.10.2(b)(ii) regarding replacement of nonmetallic membrane apply. The following tolerances apply regarding the set pressures of cargo tank pressure relief valves:~~

~~Set pressure P~~			~~Tolerance~~
	~~P~~	~~≤ 0.15 MPa~~	~~± 10 %~~
~~0.15 MPa<~~	~~P~~	~~≤ 0.3 MPa~~	~~± 6 %~~
~~0.3 MPa<~~	~~P~~		~~± 3 %~~

(ii) Pressure/vacuum relief valves, rupture discs and other pressure relief devices for inter-barrier spaces and hold spaces are to be examined, opened and tested if necessary, depending on their design.

(d) It is to be verified that cargo tanks are to be electrically bonded to the hull.

(e) Piping systems are to be examined as follows:

(i) Cargo, liquid nitrogen and process piping systems, including their valves and actuators, compensators etc., are to be opened up for examination as deemed necessary by the Surveyor. Insulation is to be removed as deemed necessary to ascertain the external condition of pipes. At the Surveyor's discretion welded seams at branches and bends are to be subjected to non-destructive random crack tests. If the visual examination raises doubts as to the integrity of pipelines, they are to be pressure tested to 1.25 times MARVS. After reassembly the complete piping system is to be tested for leaks.

(ii) The pressure relief valves in piping systems are to be function tested. A random selection of valves is to be opened up for examination and adjusted.

(iii) Cargo pumps, booster pumps and gas compressors are to be inspected and tested.

(f) The re-liquefaction installation is to be examined as follows:

(i) The parts of compressors subject to wear, such as cylinders, pistons, connecting rods, glands, bearings, auxiliary components, such as shafts, rotors and diffusers of centrifugal pumps, etc., are to be examined.

(ii) The drives of compressors, including those components which are required for operation of the drives, are to be inspected.

(iii) All the covers of heat exchangers are to be dismounted for inspection of pipe plates, if necessary, pressure and tightness tests are to be connected. If only a few pipes have been exchanged, a tightness test may be sufficient.

(iv) The safety equipment (pressure relief valves, rupture discs) is to be checked.

(g) At Special Surveys No. 2 and subsequent, all other pressure vessels in the reliquefaction/refrigeration system, gas fuel burning system and other handling systems are to be pneumatically tested to a pressure equal to the designed working pressure.

(h) The equipment connected with fuel gas evaporated from the LNG cargo is to be examined as follows:

(i) The gas conditioning plant is to be inspected externally.

(ii) The pipe or duct enclosing the fuel gas line is to be inspected for leaks. The ventilation system of that pipe or duct as well as the inertising equipment of a double wall piping system is to be checked for their operability. Heat exchangers are to be visually examined internally.

(iii) Safety devices: See 2.10.2(c).

(i) In addition to the visual examinations and tests as per 2.10.2(d) the protection devices of electric motors are to be tested.

(j) Miscellaneous items are to be examined as follows:

(i) Drainage systems for removal of water or cargo inter-barrier spaces and hold spaces are to be examined and tested where necessary.

(ii) All gas tight bulkheads are to be inspected. The effectiveness of gas tight shaft sealings is to be verified.

(iii) It is to be checked whether the spare parts stipulated in the GC code or IGC code are kept on board.

(iv) Any installations for heating of hull structures are to be examined for correct functioning.

(k) Close-up survey as required in Table I 2-25.

~~(l) Ballast tanks, including double bottom tanks, pump rooms, compressor rooms, pipe tunnels, cofferdams and void spaces bounding cargo tanks, decks and outer hull are to be examined. All piping systems within the above spaces are to be examined and operationally tested to working pressure to attending Surveyor's satisfaction.~~

~~(m) Thickness measurement as required in Table I 2-26.~~

~~(n) Tank testing for ballast tanks and fuel oil tanks~~

~~(i) All boundaries of water ballast tanks and deep tanks used for water ballast within the cargo area are to be pressure tested. For fuel oil tanks, the representative tanks are to be pressure tested.~~

~~(ii) The Surveyor may extend the tank testing as deemed necessary.~~

~~(iii) Tank testing of fuel oil tanks is to be carried out with a head of liquid to the highest point that liquid will rise under service conditions. Tank testing of fuel oil tanks may be specially considered based on a satisfactory external examination of the tank boundaries, and a confirmation from the Master stating that the pressure testing has been carried out according to the requirements with satisfactory results.~~

~~(o) Cargo tank testing~~

~~Cargo tank testing carried out by the vessel's crew under the direction of the Master may be accepted by the Surveyor provided the following conditions are complied with:~~

~~(i) A tank testing procedure has been submitted by the owner and reviewed by this Society prior to the testing being carried out;~~

~~(ii) There is no record of leakage, distortion or substantial corrosion that would affect the structural integrity of the tank;~~

~~(iii) The tank testing has been satisfactorily carried out within Special Survey window not more than 3 months prior to the date of the survey on which the overall or close up survey is completed;~~

~~(iv) The satisfactory results of the testing is recorded in the vessel's logbook;~~

~~(v) The internal and external condition of the tanks and associated structure are found satisfactory by the surveyor at the time of the overall and close up survey.~~

Paragraph 2.11.1 has been amended as follows:

2.11 Hull Surveys of Oil Tankers

Procedures for class related services, see 2.1.4 of this Chapter. Provision for surveys, see 2.1.5 of this Chapter. Preparation for enhanced survey for ESP ships, see 2.1.6 of this Chapter.

2.11.1 Annual Surveys

In addition to the requiements of the Annual Survey in 2.5, those items herein are to be carried out.

The survey is to consist of an examination for the purpose of ensuring, as far as practicable, that the hull and piping are maintained in a satisfactory condition and should take into account the service history, condition and extent of the corrosion prevention system of ballast tanks and areas identified in the survey report file.

(a) Examination of the Hull

(i) Examination of the hull plating and its closing appliances as far as can be seen.

(ii) Examination of watertight penetrations as far as practicable

(b) Examination of weather decks

(i) Examination of cargo tank openings including gaskets, covers, coamings and flame screens.

(ii) Examination of cargo tanks pressure/vacuum valves and flame screens.

(iii) Examination of flame screens on vents to all bunker tanks.

(iv) Examination of cargo, crude oil washing, bunker and vent piping systems, including vent masts and headers.

(c) Examination of Cargo pump rooms and pipe tunnels if fitted.

(i) Examination of all pumproom bulkheads for signs of oil leakage or fractures and, in particular, the sealing arrangements of all penetrations of pumproom bulkheads.

~~(ii) Examination of the condition of all piping systems~~.

(ii) Confirmation that there are no potential sources of ignition in or near the cargo pump room and cargo area and that pump room access ladders are in good condition.

(iii) Operation of pump room bilge pumping system.

(iv) Pump room ventilation system including ducting, dampers and screens.

(v) Visual examination of the cargo piping system including valves and fittings.

(vi) Verification that bolts on the cargo pumps and associated fittings, such as pedestal fixing bolts, pump casing bolts and bolts securing shaft guards are secure.

(d) Examination of Ballast Tanks

Examination of Ballast Tanks where required as a consequence of the results of the Special Survey (see 2.11.3(c)) and Intermediate Survey (see 2.11.2(b)(i) and 2.11.2(b)(ii)) is to be carried out. When considered necessary by the Surveyor, or when extensive corrosion exists, thickness measurements are to be carried out and if the results of these thickness measurements indicate that Substantial Corrosion is found, the extent of thickness measurements is to be increased in accordance with Table I 2-4B. These extended thickness measurements are to be carried out before the survey is credited as completed. Suspect Areas identified at previous surveys are to be examined. Areas of substantial corrosion identified at previous surveys are to have thickness measurements taken.

(e) Examination of Cargo Tanks

Cargo tank openings including gaskets, covers and coamings.

Pressure/vacuum relief valves, flame arresters, and flame screens. Tank vent protective devices are to be examined externally for proper assembly and installation, damage, deterioration or traces of carryover at the outlet. Where deemed suspect, the tank protective device is to be opened for examination.

(f) Examination of Electrical Bonding and Equipment

Electrical bonding arrangements on the weather deck and in cargo pump rooms, including bonding straps where fitted, of cargo piping systems carrying flammable liquids and piping systems routed through hazardous areas. Bonding of cargo tanks to hull, where applicable, is to be examined.

Confirmation that electrical equipment in hazardous locations including the cargo pump room, has been properly maintained, including the following items.

(i) Intrinsically safe and explosion-proof features of electrical equipment installed in the hazardous areas, in particular any associated sealing arrangement.

(ii) The physical condition of cables (wiring) and fixtures and test of insulation resistance of the circuits. In cases where proper record of testing is maintained consideration may be given to accepting recent readings.

(iii) The cable supports and the means of cable protection from mechanical damage, as originally provided.

(iv) Gas detection system in the cargo pump room, if fitted.

(v) Temperature-sensing devices fitted on bulkhead shaft glands, pump bearings and casings.

(g) Access to Bow on Tankers

Arrangements for safe access to the bow are to be examined.

(h) Emergency Towing Arrangements

For oil tankers of 20,000 tonnes deadweight and above, emergency towing arrangements are to be examined.

Paragraph 2.13.1(g)&(h) have been added as follows:

2.13 Hull Surveys of Chemical Tankers

Procedures for class related services, see 2.1.4 of this Chapter. Provision for surveys, see 2.1.5 of this Chapter. Preparation for enhanced survey for ESP ships, see 2.1.6 of this Chapter.

2.13.1 Annual Surveys

In addition to the applicable requirements of Annual Survey in 2.5, those items herein are to be carried out.

The survey is to consist of an examination for the purpose of ensuring, as far as practicable, that the hull and piping are maintained in a satisfactory condition and should take into account the service history, condition and extent of the corrosion prevention system of ballast tanks and areas identified in the survey report file.

(a) Examination of the Hull

(i) Examination of the hull plating and its closing appliances which is accessible.

(ii) Examination of watertight penetrations as far as practicable

……

(e) Examination of installations, equipment and outfit

In addition to the surveys as per requirements in 2.13.1(a)~(d) above, the following installations, items of equipment and outfit listed are to be checked as to their perfect maintenance condition:

……

(f) Access to Bow on Tankers

Arrangements for safe access to the bow are to be examined.

(g) Emergency Towing Arrangements

For chemical tankers of 20,000 tonnes deadweight and above, emergency towing arrangements are to be examined.

Paragraph 2.14.1(g)&(h) have been added as follows:

2.14 Hull Surveys of Double Hull Oil Tankers

Procedures for class related services, see 2.1.4 of this Chapter. Provision for surveys, see 2.1.5 of this Chapter. Preparation for enhanced survey for ESP ships, see 2.1.6 of this Chapter.

These requirements apply to surveys of hull structure and piping systems in way of cargo tanks, pump rooms, cofferdams, pipe tunnels, void spaces within the cargo area and all ballast tanks for the double hull oil tankers with **ESP** notation.

2.14.1 Annual Survey

(a) General

(i) In addition to the applicable requirements of the Annual Survey in 2.5, those items herein are to be carried out.

(ii) The survey is to consist of an examination for the purpose of ensuring, as far as practicable, that the hull and piping are maintained in a satisfactory condition and should take into account the service history, condition and extent of the corrosion prevention system of ballast tanks and areas identified in the survey report file.

……

(e) Examination of ballast tanks

(i) Examination of ballast tanks where required as a consequence of the results of the Special Survey (see 2.14.3(b)) and Intermediate Survey (see 2.14.2(b)(i) and 2.14.2(b)(ii)) is to be carried out. When considered necessary by the Surveyor, or when extensive corrosion exists, thickness measurement are to be carried out and if the results of these thickness measurements indicate that Substantial Corrosion is found, the extent of thickness measurements is to be increased in accordance with Table I 2-15. These extended thickness measurements are to be carried out before the survey is credited as completed. Suspect Areas identified at previous surveys are to be examined. Areas of substantial corrosion identified at previous surveys are to have thickness measurements taken.

For ships built under IACS Common Structural Rules, the identified substantial corrosion areas are required to be examined and additional thickness measurements are to be carried out.

(f) Access to Bow on Tankers

Arrangements for safe access to the bow are to be examined.

(g) Emergency Towing Arrangements

For double hull oil tankers of 20,000 tonnes deadweight and above, emergency towing arrangements are to be examined.

Paragraph 2.17.2 has been amended as follows:

2.17 Surveys of Passenger Ships

2.17.2 Annual Survey:

In addition to the requirements of Annual Survey in 2.5, following items are also to be carried out:
According to ship's age, the applicable requirements of Intermediate Survey are also to be carried out.

Paragraph 2.19.3 has been added as follows:

2.19 Hull and Special Equipment Survey of Mobile Offshore Unit

2.19.3 Intermediate Survey

(a) For all units 5 < Age ≤ 10, representative salt-water ballast tanks and other spaces are to be examined as follows:

(i) All units

Particular attention is to be given to corrosion control systems in ballast tanks, free-flooding areas and other locations subjected to sea water from both sides where accessible.

(ii) Surface type units

1 peak tank and at least 2 other representative ballast tanks between the peak bulkheads used primarily for water ballast.

(iii) Self-elevating units

Representative ballast tanks and at least 2 representative pre-load tanks. Accessible free-flooding compartments in mat or footings.

(iv) Column-stabilised units

Representative ballast tanks in pontoons, lower hulls, and free-flooding compartments as accessible, and at least 2 ballast tanks in columns and upper hull, if applicable.

(b) For all units 10 < age, all salt-water ballast tanks and free-flooding areas are to be examined.

2.19.4~~3~~ Special Survey

(a) Special Survey No. 1 (SS No.1) - Hull, Structure and Equipment

(i) All Units

The following parts are to be examined:

(1) The hull or platform structure including tanks, watertight bulkheads and deck, cofferdams, void spaces, sponsons, chain lockers, duct keels, helicopter deck and its supporting structure, machinery spaces, peak spaces, steering gear spaces, and all other internal spaces are to be examined externally and internally for damage, fractures, or excessive diminution. Thickness gauging of plating and framing may be required where wastage is evident or suspected.

(2) All tanks, compartments and free-flooding spaces throughout the drilling unit are to be examined externally and internally for excess wastage or damage.

(3) Internal examinations of spud cans and mats may be specially considered.

(4) Watertight integrity of tanks, bulkheads, hull, decks and other compartments is to be verified by visual inspection.

(5) Suspect areas and critical structural areas should be examined and may be required to be tested for tightness, non-destructive tested or thickness gauged.

(6) All special and primary application structures and identified critical structural areas are to be subjected to Close up survey.

(7) Tanks and other normally closed compartments are to be ventilated, gas freed and cleaned as necessary to expose damages and allow meaningful examination and thickness gauged in case of excessive diminution.

(8) Internal examination and testing of void spaces, compartments filled with foam or corrosion inhibitors, and tanks used only for lube oil, light fuel oil, diesel oil, fresh water, drinking water or other non-corrosive products may be waived provided that upon a general examination the

Surveyor considers their condition to be satisfactory. External thickness gauging may be required to confirm corrosion control.

(9) Structures such as derrick substructure and supporting structure, jack-houses, deck houses, superstructures, helicopter landing areas, raw water (sea water intake) towers and their respective attachments to the deck or hull.

(10) Windlass and attachments of anchor racks and anchor cable fairleads.

(11) Foundations and supporting headers, brackets, and stiffeners for drilling related apparatus, where attached to hull, deck, superstructure or deck house.

(12) Thickness gaugings are to be carried out where wastage is evident or suspect.

(13) Where provided, the condition of corrosion prevention system of ballast tanks is to be examined. Where a hard protective coating is found in POOR condition and it is not renewed, where soft or semi-hard coating has been applied, or where a hard protective coating was not applied from time of construction, the tanks in question are to be examined at a frequency determined by the Society. Thickness measurements are to be carried out as deemed necessary by the Surveyor.

(14) Thickness measurements are to be carried out in accordance with Table I 2-27~ Table I 2-29 as applicable. The Surveyor may extend the thickness measurements as deemed necessary. When thickness measurements indicate substantial corrosion, the extent of thickness measurements is to be increased to determine areas of substantial corrosion. Table I 2-4A may be used as guidance for these additional thickness measurements. These extended thickness measurements are to be carried out before the survey is credited as completed.

(ii) Surface-type Units

In addition to the requirements of 2.19.4~~3~~(a)(i) the following items are to be examined:

Structural appendages and ducts for positioning units.

(iii) Self-Elevating Units

In addition to the requirements of 2.19.4~~3~~(a)(i) the following items are to be examined:

(1) All legs, including chords, diagonal and horizontal braces, gussets, racks, joints, together with leg guides. Tubular or similar type legs are to be examined externally and internally, together with internal stiffeners and pinholes as applicable.

(2) Structure in, around and under jack-house and leg wells. Non-destructive testing of these areas may be required.

(3) Leg jacking or other elevating systems externally.

(4) Leg connections to bottom mats or spud cans, including non-destructive testing of leg connections to mats or spud cans.

(5) Jetting piping systems or other external piping, particularly where penetrating mats or spud cans.

(6) Spud cans or mats. Where the spud cans or mat are partly or entirely obscured below the mud line where the Special Survey is otherwise being completed, consideration may be given to postponement of the examinations until the next Rig move.

(iv) Column-Stabilized Units

In addition to the requirements of 2.19.4~~3~~ (a)(i) the following items are to be examined:

……

Table I 2-3A has been amended as follows:

Table I 2-3A
Minimum Requirements for Thickness Measurements at Hull Special Surveys

SS No. 1 (Age ≤ 5)	SS No. 2 (5 < Age ≤ 10)	SS No. 3 (10 < Age ≤ 15)	SS No. 4 and Subsequent (15 < Age)
1. Suspect Areas throughout the ship	1. Suspect Areas throughout the ship 2. One transverse section of deck plating ~~in way of a cargo space~~ within the amidships 0.5L(5) (in way of cargo spaces, if applicable)	1. Suspect Areas throughout the ship 2. 2 transverse sections within the amidships 0.5L (in way of 2 ~~different~~ cargo spaces(5) , if applicable) 3. Internals in forepeak tank and after peak ballast tanks 4. All cargo hold hatch covers and coamings (plating and stiffeners)	1. Suspect Areas throughout the ship 2. A minimum of 3 transverse sections ~~in way of cargo spaces~~ within the amidships 0.5L(5) (in way of cargo spaces, if applicable) 3. Internals in forepeak and after peak ballast tanks 4. All cargo hold hatch covers and coamings (plating and stiffeners) 5. All exposed main deck plating full length 6. Representative exposed superstructure deck plating (poop, bridge, and forecastle deck) 7. Lowest strake and strakes in way of tween decks of all transverse bulkheads in cargo spaces together with internals in way(5) 8. All wind- and water strakes, port and starboard, full length 9. All keel plates full length. Also, additional bottom plates in way of cofferdams, machinery space, and aft end of tanks 10. Plating of sea chests. Shell plating in way of overboard discharges as considered necessary by the attending Surveyor

Notes:

(1) Thickness measurement locations are to be selected to provide the best representative sampling of areas likely to be most exposed to corrosion, considering cargo and ballast history and arrangement and condition of protective coatings.

(2) Thickness measurements of internals may be specially considered by the Surveyor if the protective coating is in Good condition.

(3) For ships less than 100 meters in length, the number of transverse sections required at Special Survey No. 3 may be reduced to 1, and the number of transverse sections required at Subsequent Special Surveys may be reduced to 2.

(4) For ships more than 100 meters in length, at Special Survey No. 3, thickness measurements of exposed deck plating within amidships 0.5 L may be required.

(5) For ships without defined cargo spaces, thickness measurements are to be taken at the appropriate, most onerous locations selected to provide the best representative sampling of areas likely to be exposed to corrosion the most.

(6) Subject to cargo hold hatch covers of approved design which structurally have no access to the internals, thickness measurement shall be done of accessible parts of hatch covers structures.

Table I 2-7 has been amended as follows:

Table I 2-7
Minimum Requirements for Thickness Measurements
at Hull Special Survey of Chemical Tankers

SS No. 1 (Age ≤ 5)	SS No. 2 (5 < Age ≤ 10)	SS No. 3 (10 < Age ≤ 15)	SS No. 4 and Subsequent (15 < Age)
1. Suspect Areas	1. Suspect Areas	1. Suspect Areas	1. Suspect Areas
~~2. 1 section of deck plating for the full beam of the ship within the cargo area (in way of a ballast tank, if any, or a cargo tank used primarily for water ballast)~~	2. Within the cargo area: a. Each deck plate b. 1 transverse section	2. Within the cargo area: a. Each deck plate b. 2 Transverse sections(1) c. All wind and water strakes	2. Within the cargo area: a. Each deck plate b. 3 transverse sections (1) c. Each bottom plate
	3. Selected wind and water strakes outside the cargo area	3. Selected wind and water strakes outside the cargo area	3. All wind and water strakes, full length
~~4. Measurements, for general assessment and recording of corrosion pattern, of those structural members subject to close-up survey according to Table I 2-6A or Table I 2-6B, as applicable.~~	4. Measurements, for general assessment and recording of corrosion pattern, of those structural members subject to close-up survey according to Table I 2-6A or Table I 2-6B, as applicable.	4. Measurements, for general assessment and recording of corrosion pattern, of those structural members subject to close-up survey according to Table I 2-6A or Table I 2-6B, as applicable.	4. Measurements, for general assessment and recording of corrosion pattern, of structural members subject to close-up survey according to Table I 2-6A or Table I 2-6B, as applicable.

Note:

(1) At least one section is to include a ballast tank within 0.5L amidships.

Table I 2-14 has been amended as follows:

Table I 2-14
Minimum Requirements for Thickness Measurements at Hull Special Survey of Double Hull Oil Tankers

SS No. 1 (Age ≤ 5)	SS No. 2 (5 < Age ≤ 10)	SS No. 3 (10 < Age ≤ 15)	SS No. 4 and Subsequent (15 < Age)
1. Suspect Areas	1. Suspect Areas	1. Suspect Areas	1. Suspect Areas
~~2. 1 section of deck plating for the full beam of the ship within the cargo area~~	2. Within the cargo area: a. each deck plate b. 1 transverse section	2. Within the cargo area: a. each deck plate b. 2 transverse sections(1) c. all wind and water strakes	2. Within the cargo area: a. each deck plate b. 3 transverse sections(1) c. each bottom plate
	3. Selected wind and water strakes outside the cargo area	3. Selected wind and water strakes outside the cargo area	3. All wind and water strakes, full length
~~4. Measurements, for general assessment and recording of corrosion pattern, of those structural members subject to close-up survey according to Table I 2-13~~	4. Measurements, for general assessment and recording of corrosion pattern, of those structural members subject to close-up survey according to Table I 2-13	4. Measurements, for general assessment and recording of corrosion pattern, of those structural members subject to close-up survey according to Table I 2-13	4. Measurements, for general assessment and recording of corrosion pattern, of those structural members subject to close-up survey according to Table I 2-13

Note:

(1) At least 1 section is to include a ballast tank within 0.5L amidships.

Chapter 3 Survey Requirements for Additional Systems and Services

Paragraph 3.3.1(i) has been amended as follows:

3.3 Surveys of Inert Gas Systems

3.3.1 Annual Surveys

At each Annual Survey the inert gas system is to be generally examined so far as can be seen and placed in satisfactory condition. The survey is to include the following items:

(i) Verification of the operation of the following alarms and safety devices using simulated conditions where necessary.

(i) Flue gas systems

(1) Low water pressure or low water flow rate to the flue gas scrubber, including automatic shut-down of the inert gas blowers and gas regulating valve.

(2) High water level in the flue gas scrubber, including automatic shut-down of the inert gas blowers and gas regulating valve.

(3) High gas temperature at inert gas blower discharge, including automatic shut-down of the inert gas blowers and gas regulating valve.

(4) Failure of inert gas blowers, including automatic shut-down of the gas regulating valve.

(5) Oxygen content in excess of 8% by volume.

(6) Failure of the power supply to the automatic control system for the gas regulating valve and to the oxygen content and gas pressure indicating devices.

(7) Low water level in the water seal.

(8) Gas pressure less than 100 mm water gauge(For combination carrier, the alarm arrangements are to ensure that the pressure in slop tanks can be monitored at all times.).

(9) Additional low gas pressure audible alarm system independent of alarm system for gas pressure less than 100mm water gauge, if fitted.

(10) Automatic shutdown of cargo pumps to operate on predetermined limits of low pressure in the inert gas mains, if fitted.

(~~9~~11) High gas pressure.

(~~10~~12)Accuracy of fixed and portable oxygen measuring equipment by means of a calibration gas.

(ii) Inert ~~G~~gas generating systems

(1) Low water pressure or low water flow rate to the inert ~~flue~~ gas scrubber, including automatic shut-down of the inert gas blowers, gas regulating valve and fuel oil supply to the gas generator.

(2) ~~High gas pressure~~ High water level in the inert gas scrubber, including automatic shut-down of the inert gas blowers and gas regulating valve.

(3) High gas temperature at inert gas blower discharge, including automatic shut-down of the inert gas blowers, gas regulating valve and fuel oil supply to the gas generator.

(4) Failure of the inert gas blowers, including automatic shut-down of the gas regulating valve.

(~~4~~5) Oxygen content in excess of 8% by volume.

(6) Failure of the power supply to the automatic control system for the gas regulating valve and to the oxygen content and gas pressure indicating devices.

(7) Low water level in the water seal.

(8) Gas pressure less than 100 mm water gauge. (For combination carrier, the alarm arrangements are to ensure that the pressure in slop tanks can be monitored at all times.)

(9) Additional low gas pressure audible alarm system independent of alarm system for gas pressure less than 100 mm water gauge, if fitted.

(10) Automatic shutdown of cargo pumps to operate on predetermined limits of low pressure in the inert gas mains, if fitted.

(11) High gas pressure.

(~~5~~12)Insufficient fuel oil supply.

(~~6~~13)Failure of the power supply to the generator, including automatic shut-down of the gas regulating valve.

(~~7~~14) Failure of the power supply to the automatic control system for the generator.

(~~8~~15) Accuracy of fixed and portable oxygen measuring equipment by means of a calibration gas.

(iii) Nitrogen generating systems

(1) Low air pressure, including automatic shut-down of the system.

(2) High air temperature, including automatic shut-down of the system.

(3) High condensate level at automatic drain of water separator, including automatic shut-down of the system.

(4) High gas temperature, including automatic shut-down of the gas regulating valve.

(5) Failure of electrical heater, if fitted, including automatic shut-down of the system.

(6) Failure of nitrogen gas pressure, including automatic shut-down of the gas regulating valve.

(7) Oxygen content in excess of 5% by volume, including automatic shut-down of the system.

(8) Failure of the power supply to the automatic control system for the gas regulating valve and to the oxygen content and gas pressure indicating devices.

(9) Gas pressure less than 100 mm water gauge. (For combination carrier, the alarm arrangements are to ensure that the pressure in slop tanks can be monitored at all times.)

(10) Additional low gas pressure audible alarm system independent of alarm system for gas pressure less than 100mm water gauge, if fitted.

(11) Automatic shutdown of cargo pumps to operate on predetermined limits of low pressure in the nitrogen gas mains, if fitted.

(12) High gas pressure.

(13) Accuracy of fixed and portable oxygen measuring equipment by means of a calibration gas.

Section 3.5 has been added as follows:

3.5 Survey for Towing Winch Emergency Release System

3.5.1 Annual Surveys

(a) Operation of the towing winch emergency release system is to be confirmed with the reference to the documented instructions for surveys provided by the manufacturer. Operation of the winch emergency release system under no load condition is to be verified. Where practical, activation of the emergency release system may be confirmed by observation of the winch brake.

(b) The function of the alarms associated with the emergency release system is to be verified, as far as practicable and reasonable.

(c) The condition of the emergency release system is to be visually examined to confirm it remains in satisfactory condition.

(d) The means of emergency release of the towline in the event of a blackout is to be examined, and where additional sources of energy are arranged for this purpose, the sources of energy are to be visually inspected and operationally tested.

(e) It is to be verified that the performance capabilities and operating instructions of the emergency release system are documented and made available on board the ship on which the winch has been installed.

3.5.2 Special Surveys

(a) The Annual Survey requirements are to be carried out, with the additional instructions for special survey provided by the manufacturer, as appropriate, being followed.

(b) The full functionality of the emergency release system is to be tested to the satisfaction of the surveyor. Testing may be conducted either during static bollard pull test or by applying the load against a strong point on the deck of the tug or the shore that is certified to the appropriate load.

(c) The emergency release system is to be tested at a towline load that is equal to the lesser of 30% of the maximum design load or 80% of ship bollard pull in both a normal power condition and power blackout condition to the satisfaction of the Surveyor.

Section 3.6 has been added as follows:

3.6 Survey for Ballast Water Management

3.6.1 Annual Surveys

(a) A general, external examination of the structure, any equipment, systems, fittings, arrangements and material or process associated with the ballast water management plan(BWMP), to confirm that they have been maintained.

(b) Operation and Maintenance Records

The Surveyor is to review the ballast water record book to confirm that the record book has been maintained and that the activities, including the maintenance of the ballast water management system(BWMS), have been properly recorded and that the ballast water management plan is current.

(c) Ballast Water Management

The Surveyor is to verify that an approved BWMP is onboard and the information including the operational and safety procedures, qualification of the BWM officer, and crew training, is current.

(d) Control and Monitoring Equipment

The Surveyor is to verify that control equipment that automatically monitors and adjusts the necessary treatment dosages or intensities or other aspects of the BWMS of the ship are operating properly. This includes examination of records of the proper functioning or failure of the BWMS.

(e) Operation of the Ballast Water Management System

On inspection of the records detailed in 3.6.1(b) and (d) of this Part, if it is found that:

(i) During Annual Survey, the BWMS has not been in operation since the last applicable survey and/or

(ii) During the examination of the BWMS maintenance records, the BWMS has not been subject to the manufacturer's recommended maintenance schedule, then a function test is to be performed to the satisfaction of the Surveyor.

Note: If the operational status of the ship does not permit the ship to perform any part of the function test during the Annual Survey, the remaining tests are to be performed at the ship's next convenient port to the satisfaction of the Surveyor.

3.6.2 Special Surveys

In addition to the requirements of the Annual Survey, the survey is to include the following:

(a) The mechanical and electrical components are to be examined, including but not limited to valves, seals, pumps, control panels, vents, air pipes and monitoring sensors.

(b) The operation of the BWMS in accordance with the manufacturer's technical installation specifications is to be demonstrated to the satisfaction of the Surveyor.

Section 3.7 has been added as follows:

3.7 Survey for Selective Catalytic Reduction (SCR) System, SOx Scrubber System and Exhaust Gas Recirculation (EGR) System

3.7.1 Annual Surveys

(a) Exhaust Emission Abatement Systems

The following is to be carried out during each Annual Survey of the exhaust emission abatement equipment, associated systems and monitoring equipment:

(i) Log books are to be examined to verify correct functioning of the exhaust emission abatement systems, emissions monitoring, and washwater monitoring systems, etc. The hours per day of the prime movers, SOx scrubbers system, selective catalytic reduction systems, exhaust gas recirculation systems and monitoring equipment, as applicable, are to be reviewed together with historical records.

(ii) Operating and maintenance instruction manual

The approved instructions and manuals covering the operations, safety, and maintenance requirements and occupational health hazards relevant to exhaust emission abatement units and associated systems are to be confirmed as being aboard the vessel.

(iii) Instrumentation, control, monitoring and safety systems

The instrumentation, control, monitoring and safety equipment applicable to each particular type of installed exhaust emission abatement unit and associated systems, including indicators and alarms, is to be confirmed in satisfactory operating conditions. The examination is to be made with one or more ship's service generator(s) in operation and the control system energized to permit random checking of function indicators, alarms, and such control actuators as may be operational. Installed interlocks, where applicable, are to be verified in working condition.

(iv) Exhaust gas handling piping and machinery

Piping, hoses, bellows, blowers/fans, heaters, dry scrubbing equipment, soot blowing equipment, emergency shutdown or bypass valves, remote operating valves, and machinery and equipment associated with processing or distribution of exhaust gases are to be examined to the satisfaction of the Surveyor. Stopping of pumps, fans, and blowers upon emergency shutdown of the system is to be confirmed.

(v) Where applicable, exhaust system bypass, isolation, or mixing valve sealing arrangements are to be examined.

(vi) The integrity and effectiveness of insulation arrangements is to be confirmed.

(vii) Water treatment, reductant, and residue systems

Tanks, piping, hoses, pumps, strainers, separators, filtration units, dosing systems, and equipment associated with processing of washwater, injection of reductant or collection of exhaust residues are to be examined and verified to be in operational condition.

(viii) Drip trays, overflow arrangements, shielding, or insulation installed for the protection of personnel or the ship from the effects of hazardous or corrosive chemicals used in exhaust emission abatement systems or system temperatures are to be examined for continued suitability for their intended service.

(ix) Electrical equipment associated with the operation or monitoring of exhaust emission abatement systems is to be examined for continued suitability for its intended service and installation area.

(x) Personal protective equipment (PPE)

The required personal protective equipment and facilities are to be confirmed as being onboard and in an operational condition.

(xi) Warning notices

The location of the applicable warning notices is to be confirmed.

(xii) Spare parts are to be verified as available onboard in consideration of the equipment redundancy arrangements.

(b) Selective Catalytic Reduction Systems

In addition to the requirements of 3.7.1(a) of this Part, the following are to be examined, as applicable. Insulation need not be removed, but any deterioration or evidence of leakage is to be investigated.

(i) External examination

External examination of all components, including selective catalytic reduction reaction chamber, injectors, dosing units, heating, soot blowing equipment, piping, tanks, insulation, valves, pumps, drip trays, etc., including foundations and attachments.

(ii) Equipment operation

Confirmation of correct operation of all rotating and reciprocating components, such as dosing pumps, ventilation fans, etc.

(iii) Control valves

Verify the correct operation of all remotely operated or automatically controlled valves in the exhaust, reductant dosing, or soot blowing systems.

(iv) System operation

Examination of the exhaust emission abatement system during working condition.

(c) SOx Scrubber system

In addition to the requirements of 3.7.1(a) of this Part, the following are to be examined, as applicable. Insulation need not be removed, but any deterioration or evidence of leakage is to be investigated.

(i) External examination

External examination of all components including scrubber units, piping, tanks, fans, insulation, valves, pumps, drip trays, etc., including foundations and attachments.

(ii) Equipment operation

Confirmation of correct operation of all rotating and reciprocating components, such as exhaust gas fans, water treatment pumps, dry handling conveyors, ventilation fans, etc.

(iii) Control valves

Verify the correct operation of all remotely operated or automatically controlled valves in the exhaust, water treatment, or dry handling systems.

(iv) System operation

Examination of the exhaust emission abatement system during working condition. Multi-mode SOx scrubbers are to be tested in all operational modes as far as practicable.

(d) Exhaust Gas Recirculation Systems

In addition to the requirements of 3.7.1(a) of this Part, the following are to be examined, as applicable. Insulation need not be removed, but any deterioration or evidence of leakage is to be investigated.

(i) External examination

External examination of all components including scrubbers, exhaust gas recirculation coolers, piping, tanks, blowers, insulation, valves, pumps, drip trays, etc., including foundations and attachments.

(ii) Equipment operation

Confirmation of correct operation of all rotating and reciprocating components such as exhaust gas blowers, water treatment pumps, ventilation fans, etc.

(iii) Control valves

Verify the correct operation of all remotely operated or automatically controlled valves in the exhaust or water treatment systems.

(iv) System operation

Examination of the exhaust emission abatement system during working condition at full exhaust gas recirculation rate. Multi-mode systems are to be tested in all operational modes as far as practicable.

(e) Exhaust Emissions Monitoring Systems

In addition to the requirements of 3.7.1(a) of this Part, the following are to be examined, as applicable. Insulation need not be removed, but any deterioration or evidence of leakage is to be investigated.

(i) External examination

External examination of all components including exhaust gas sample probes, pre-filters, heated lines, analyzer units, pneumatic systems, span and calibration gases, etc.

(ii) System operation

Examination of the exhaust emissions monitoring systems during calibration and exhaust gas sampling conditions; verification of the emissions monitoring and data logging functions is to be undertaken.

3.7.2 Special Survey

In addition to the items covered by the Annual Survey listed in 3.7.1 of this Part, the Special Survey of the exhaust emission abatement equipment, associated systems is also to include the following:

(a) Washwater, Water Treatment, and Dosing Pumps

All washwater, water treatment pumps, and reductant dosing pumps are to be examined including opening for examination, as deemed necessary.

(b) Exhaust Fans and Blowers

All exhaust fans, exhaust gas recirculation blowers and associated prime movers are to be examined including opening for examination, as deemed necessary.

(c) Control Valves

All bypass, mixing, isolating, shut-down, or control valves in the exhaust, water treatment, and dosing systems are to be inspected and proven operable. Pressure relief valves are to be function-tested. A random selection of valves is to be opened for examination and adjusted as necessary.

(d) Control Actuators

All mechanical, hydraulic, and pneumatic control actuators and their power systems are to be examined and tested as considered necessary.

(e) Electrical Equipment

The electrical equipment is to be examined to include the physical condition of electrical cables and supports, together with insulation resistance testing of the windings of electrical control motors and actuators. Where a proper record of testing is maintained, consideration may be given to accepting recent readings.

(f) Automatic Controls

Automatic controls for components associated with the exhaust emission abatement equipment and associated systems, including auto-changeover for system pumps/fans and electrical power supply, are to be examined for functionality and for continued system serviceability.

(g) Instrumentation, Control, Monitoring, and Safety Systems

Control systems are to be subjected to dock trials to verify correct operation of the following automatic functions, alarms, and safety systems:

(i) Function test of the monitoring and alarm systems

(ii) Function test of safety systems, including override of system functions, if provided

(iii) Manual control of the exhaust gas cleaning equipment and systems

(iv) Automatic changeover of designated machinery associated with the exhaust emission abatement equipment

Section 3.8 has been added as follows:

3.8 Survey for Single or Dual Fuel Engines

3.8.1 Annual Survey

(a) Single Gas Fuel Engine Power Plant

In addition to the Annual Survey requirements for liquid fuel diesel engines, the following are to be examined, so far as applicable. Insulation need not be removed, but any deterioration or evidence of dampness is to be investigated.

(i) External examination of any pressure vessels, heat exchangers, compressors, filters etc. for making-up the gas for its use as fuel.

(ii) Operational test, as far as practicable of the power management system for the emergency shutdown of the single fuel engine compartments and testing of the automatic shut-off of gas fuel supply.

(iii) Where double wall fuel gas piping is provided, means for detecting any leakage should be tested.

(iv) Verification of redundancy and testing of gas detection system in engine rooms together with any interlocks.

(v) Testing of alarm for the access doors to the engine rooms.

(vi) Testing of the remote and local closing of the installed main tank valve and master gas valve for each engine compartment.

(b) Dual Fuel Diesel Engine Power Plant

In addition to the Annual Survey requirements for liquid fuel diesel engines, the following are to be examined, so far as applicable. Insulation need not be removed, but any deterioration or evidence of dampness is to be investigated.

(i) External examination of any pressure vessels, heat exchangers, compressors, filters etc. for making-up the gas for its use as fuel.

(ii) Operational test, as far as practicable of the power management system for the emergency shutdown of the dual fuel engine compartments and testing of the automatic shut-off of gas fuel supply.

(iii) Where double wall fuel gas piping is provided, means for detecting any leakage should be tested.

(iv) Verification of redundancy and testing of gas detection system in engine rooms together with any interlocks.

(v) Testing of alarm for the access doors to the engine rooms.

(vi) Testing of the remote and local closing of the installed main tank valve and master gas valve for each engine compartment.

(c) Dual Fuel Gas Turbine Power Plant

The Surveyor is to examine, as far as applicable, the following:

(i) Verify compliance with the approved maintenance schedule and manufacturers' recommendations, taking into consideration the "in-service" records for the unit and applicable hours of running time for each type of fuel.

(ii) Structural examination of the gas turbine enclosure and foundation.

(iii) Verify satisfactory operation of any fitted interlocks on the gas enclosure.

(iv) Verify air-tightness of the gas turbine enclosure or its capability of maintaining a negative pressure inside the enclosure by means of testing of installed alarms if fitted.

(v) Examination and testing of installed gas turbine enclosure ventilation and associated alarms.

(vi) External examination of gas turbine enclosure air intakes, combustion air intake and exhaust system and fitted dampers.

(vii) Testing of the remote and local closing of the installed main tank valve and master gas valve for each dual fuel gas turbine.

(viii) Testing of the control system for the gas turbine and associated alarms, changeover and shutdown functions.

Section 3.9 has been added as follows:

3.9 Survey for Ships other than Liquefied Gas Carriers Utilizing Gas or other Low Flash Point Fuels

3.9.1 Annual Survey

(a) General

The following is to be carried out during the survey of the fuel storage, fuel bunkering system, and fuel supply system:

(i) General

The log books are to be examined with regard to correct functioning of the gas detection systems, fuel supply/gas systems, etc. The hours per day of the prime movers, re-liquefaction plant, gas combustion unit, as applicable, or the boil-off rate are to be considered together with gas detection records.

(ii) Operating and maintenance instruction manual

The manufacturer/builder instructions and manuals covering the operations, safety and maintenance requirements and occupational health hazards relevant to fuel storage, fuel bunkering, fuel supply, and associated systems for the use of fuel, are to be confirmed as being aboard the ship.

(iii) Control, monitoring and safety systems

(1) Gas detection and other leakage detection equipment in compartments containing fuel storage, fuel bunkering, and fuel supply equipment or components or associated systems, including indicators and alarms, is to be confirmed in satisfactory operating conditions. Recalibration of the gas detection systems should be verified in accordance with the manufacturers' recommendations.

(2) Verification of the satisfactory operation of the control, monitoring and automatic shut-down systems as far as practicable of the fuel supply and bunkering systems.

(3) Operational test, as far as practicable, of the shutdown of ESD-protected machinery spaces.

(iv) Fuel handling piping, machinery and equipment

Piping, hoses, emergency shut-down valves, remote operating valves, relief valves, machinery and equipment for fuel storage, fuel bunkering, and fuel supply such as venting, compressing, refrigerating, liquefying, heating, cooling or otherwise handling the fuel is to be examined, as far as possible. Means of inerting is to be examined. Stopping of pumps and compressors upon emergency shut-down of the system is to be confirmed as far as practicable.

(v) Ventilating system

Examination of the ventilation system including portable ventilating equipment where fitted, is to be made for all spaces containing fuel storage, fuel bunkering, and fuel supply or components or associated systems, including air locks, pump rooms, compressor rooms, fuel preparation rooms, fuel valve rooms, control rooms and spaces containing gas burning equipment. Where alarms, such as differential pressure and loss of pressure alarms, are fitted, these should be operationally tested as far as practicable.

(vi) Drip trays

Portable and fixed drip trays and insulation for the protection of the ship's structure in the event of leakage are to be examined.

(vii) Hazardous areas

Electrical equipment and bulkhead/deck penetrations including access openings in hazardous areas are to be examined for continued suitability for their intended service and installation area.

(viii) Fire protection and fire extinguishing equipment

The required fire protection and fire extinguishing system contained in areas and spaces where fuel storage, fuel bunkering, and fuel supply are fitted are to be examined and operationally tested, in so far as practicable.

(ix) Electrical bonding

Electrical bonding arrangements in hazardous areas, including bonding straps where fitted are to be examined.

(b) Fuel Storage, Bunkering and Supply Systems

The following are to be examined, so far as applicable. Insulation need not be removed, but any deterioration or evidence of dampness is to be investigated.

(i) Fuel storage

(1) External examination of storage tanks and secondary barrier if fitted and accessible.

(2) General examination of the fuel storage space.

(3) External examination of tank relief valves.

(4) Examination and testing of installed bilge alarms and means of drainage of the compartment in accordance with an approved inspection/survey plan for the liquefied gas fuel containment system.

(5) Testing of the remote and local closing of the installed main tank valve.

(6) Verification of satisfactory operation of tank monitoring system.

(ii) Fuel bunkering system

(1) Examination of bunker stations and the fuel bunkering system.

(2) Verification of satisfactory operation of the fuel bunkering control, monitoring and shutdown systems.

(iii) Fuel supply system

(1) Examination of the fuel supply system during working condition as far as practicable.

(2) Verification of satisfactory operation of the fuel supply system control, monitoring and shut-down systems.

(3) Testing of the remote and local closing of the master fuel valve for each engine compartment.

3.9.2 Special Survey

In addition to the applicable requirements of 3.9.1 of this Chapter, the Special Survey is also to include:

(a) Fuel Handling and Piping Material

All piping for fuel storage, fuel bunkering and fuel supply, such as venting, compressing, refrigerating, liquefying, heating storing, burning or otherwise handling the fuel and liquid nitrogen installations are to be examined including removal of insulation and opening for examination, as deemed necessary. Where deemed suspect, a hydrostatic test to 1.25 times the Maximum Allowable Relief Valve Setting (MARVS) for the pipeline is to be carried out. After reassembly, the complete piping is to be tested for leaks. Where water cannot be tolerated and the piping cannot be dried prior to putting the system into service, the Surveyor may accept alternative testing fluids or alternative means of testing.

(b) Fuel Valves

All emergency shut-down valves, check valves, block and bleed valves, master gas valves, remote operating valves and isolating valves for pressure relief valves in the fuel storage, fuel bunkering, and fuel supply are to be examined and proven operable. A random selection of valves is to be opened for examination and adjusted as necessary.

(c) Pressure Relief Valves

(i) Fuel storage tank pressure relief valves

The pressure relief valves for the fuel storage tanks are to be opened for examination, adjusted, and function tested. If the tanks are equipped with relief valves with non-metallic membranes in the main or pilot valves, such non-metallic membranes are to be renewed.

(ii) Fuel supply and bunkering piping pressure relief valves

Pressure relief valves for the fuel supply and bunkering piping are to be opened for examination, adjusted, and function tested. Where a proper record of continuous overhaul and retesting of individually identifiable relief valves is maintained, consideration will be given to acceptance on the basis of opening, internal examination, and testing of a representative sampling of valves, including each size and type of liquefied gas or vapor relief valve in use, provided there is log book evidence that the remaining valves have been overhauled and tested since crediting of the previous Special Survey.

(iii) Pressure/Vacuum relief valves

The pressure/vacuum relief valves, rupture disc and other pressure relief devices for interbarrier spaces and hold spaces are to be opened, examined, tested and readjusted as necessary, depending on their design.

(d) Electrical Equipment

(i) Examination of electrical equipment to include the physical condition of electrical cables and supports, intrinsically safe, explosion proof, or increased safety features of electrical equipment.

(ii) Functional testing of pressurized equipment and associated alarms.

(iii) Testing of systems for de-energizing electrical equipment which is not certified for use in hazardous areas.

(iv) An electrical insulation resistance test of the circuits terminating in, or passing through, the hazardous zones and spaces is to be carried out.

(e) Safety Systems

Gas detectors, temperature sensors, pressure sensors, level indicators, and other equipment providing input to the fuel safety system are to be tested to confirm satisfactory operating condition.

(i) Proper response of the fuel safety system upon fault conditions is to be verified.

(ii) Pressure, temperature and level indicating equipment are to be calibrated in accordance with the manufacturer's requirements

(f) Fuel Storage Tanks

(i) Liquefied gas fuel storage tanks are to be examined in accordance with an approved inspection/survey plan for liquefied gas fuel containment system taking into account the applicable parts of 2.10.3 of this Part.

(ii) Vacuum insulated independent fuel storage tanks of type C without access openings need not be examined internally. Where fitted, the vacuum monitoring system is to be examined, and records are to be reviewed. The tank insulation and tank support arrangements are to be visually examined. Non-destructive testing may be required if conditions raise doubt to the structural integrity.

(iii) Verification of satisfactory operation of tank high level alarms.

Appendix 2 Guidance for Inclining Test

Paragraph A2.2.2(c) has been amended as follows:

A2.2 Preparation for the Test

A2.2.2 Inclining test condition

(c) The total value of missing weights is not to exceed 2% and surplus weights, excluding liquid ballast~~, fuel oil, diesel oil and fresh water~~, not exceed 4% of the light ship displacement. For smaller ships, higher percentages may be allowed.

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022

PART II HULL CONSTRUCTION AND EQUIPMENT

List of major changes in Part II from 2022 edition

5.7.9	Deleted
5.7.10	Renumbered
11.3.1	Revised
12A.1.3	New
12A.1.4	New
12A.1.3~12A.1.10	Renumbered
12A.1.10(c)	Revised
Table II 12A-2	Revised
12A.4.7(a)	Revised
13.6	New
13.6	Renumbered
13.6.1~13.6.4	Renumbered
13.7.3(d)	New
Fig II 14-1	Revised
25.1.3	Revised
25.2.1	Revised
25.2.2	Revised
25.9.2(b)	Revised
Fig. II 25-1	Renumbered
25.9.3(b)	Revised

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 5 Double Bottoms

Paragraph 5.7.9 has been deleted as follows:

5.7 Inner Bottoms, Margin and Bottom Plates

~~5.7.9 Where the inner bottom or the double bottom structure forms part of a sea chest, the thickness of the plating is not to be less than that of the shell plating in the same location, but need not exceed 25 mm.~~

Chapter 11 Decks

Paragraph 11.3.1 has been amended as follows:

11.3 Plated Decks

11.3.1 ~~If the thickness of the strength deck plating is less than that of the side shell plating, a stringer plate having the width of the sheer strake and the thickness of the side shell plating is to be fitted to strength deck.~~ The thickness of sheer strakes connected with the strength deck for the midship part is not to be less than 0.75 times that of the stringer plate of the strength deck. However, the thickness is not to be less than that of the adjacent side shell plating.

Chapter 12A Helicopter Decks and Facilities

Section 12A.1 has been renumbered and amended as follows:

12A.1 General

12A.1.1 The structure of the helicopter deck is to be designed to suit landing of the largest type of helicopter intended to use.

12A.1.2 Ships with helicopter decks built in accordance with these rules are to be assigned a class notation "Helideck" affixed to classification symbols, which is classified into four classes: **Helideck-I**, **Helideck-II**, **Helideck-III** and **Helideck-IV**.

12A.1.3 Where the requirements of the Rules have been complied with for an area on a ship designated for occasional or emergency landing of helicopters, the ship is to be assigned a class notation **Occasional Helicopter Landing Area**.

12A.1.4 Class notation **Occasional Helicopter Landing Area** requires compliance with the requirements given in 12A.1, 12A.2, 12A.3 and SOLAS Reg. II-2/18.2.2, 18.2.3.

~~12A.1.3~~12A.1.5 Class notation **Helideck-I** requires compliance with the requirements given in 12A.1, 12A.2, 12A.3 and 12A.4.

~~12A.1.4~~12A.1.6 Class notation **Helideck-II** requires compliance with the requirements given in 12A.5, in addition to the requirements for **Helideck-I**.

~~12A.1.5~~12A.1.7 Class notation **Helideck-III** requires compliance with the requirements given in 12A.6, in addition to the requirements for **Helideck-II**.

~~12A.1.6~~12A.1.8 Class notation **Helideck-IV** requires compliance with the requirements given in 12A.7, in addition to the requirements for **Helideck-III**.

~~12A.1.7~~12A.1.9 Details of the helicopter types to be used are to be included in the Loading Manual (See 3.1.2), and be contained in a notice displayed on the helicopter landing deck.

~~12A.1.8~~12A.1.10 The attention of owners, builders and designers is drawn to various international and governmental regulations and guides regarding the operational and other design requirements for helicopters landing on ships.

~~12A.1.9~~12A.1.11 Construction of helicopter decks

……

~~12A.1.10~~12A.1.12 Definition

(a) Helicopter deck is a purpose built helicopter landing area located on a ship including all structure, fire-fighting appliances and other equipment necessary for the safe operation of helicopters.

(b) Helicopter facility is a helicopter deck including any refueling and hangar facilities.

(c) ~~Helicopter landing area means an area on a ship designed for emergency landing of helicopters.~~ Helicopter landing area is an area on a ship designated for occasional or emergency landing of helicopters but not designed for routine helicopter operations.

12A.3 Structural Strength

Table II 12A-2 has been amended as follows:

Table II 12A-2
Design Load Cases for Deck Stiffening and Supporting Structure

	Loads			
	Supporting structure		Landing area(1)	
Load case	Self weight	Horizontal load(2)	Uniformly distributed vertical load over entire landing area, kN/m^2	Helicopter(2)(4)
1. Overall distributed loading	–	–	2	–
2. Helicopter emergency landing	W	0.5 P	0.5	2.5 P_wf
3. Normal usage	W	0.5 P + 0.5 W	0.5	1.5 P_w

Notes:

(1) For the design of the supporting structure for helicopter platforms applicable self weight and horizontal loads are to be added to the landing area loads.

(2) The helicopter is to be so positioned as to produce the most severe loading condition for each structural member under consideration.

(3) ~~f = As defined in 12A.3.1.~~

W = The structural weight of helicopter platform, in ton.

P = The maximum all up weight of the helicopter, in ton.

P_w = As defined in 12A.3.1.

P_w = As defined in 12A.3.1.

(4) f = As defined below:

For the emergency landing and normal usage load cases, the helicopter patch load is to be increased by a suitable structural response factor depending upon the natural frequency of the helideck structure. This factor is to be taken as 1.3 unless calculations are submitted justifying a lower factor. In cases where the Occasional Helicopter Landing Area notation is to be assigned, this factor can be taken as 1.0.

For helidecks constructed of aluminium alloys, the value of the structural response factor is to be specially considered.

12A.4 Arrangements

Paragraph 12A.4.7(a) has been amended as follows:

12A.4.7 Fire-fighting appliances

(a) In close proximity to the helicopter deck, the following fire-fighting appliances are to be provided and stored near the means of access to that helicopter deck:

(i) at least two dry powder extinguishers having a total capacity of not less than 45 kg;

(ii) carbon dioxide extinguishers of a total capacity of not less than 18 kg or equivalent;

……

(vi) in lieu of the requirements of (iii) through (v), on ships having a helideck, foam firefighting appliances which comply with the provisions of the Fire Safety Systems Code.

~~(vi)~~(vii) in addition to the requirements of SOLAS Reg. II-2/10.10, two sets of fire-fighter's outfits; and

~~(vii)~~ (viii) at least the following equipment is to be stored in a manner that provides for immediate use and protection from the elements:

Chapter 13 Bulwarks, Freeing Ports, Side Scuttles, Shell Doors and Gangways

Paragraph 13.6 has been added as follows:

13.6 Gangways

Satisfactory means for safety passage required by Regulation 25-1 in the International Convention on Load Lines (ICLL) (in the form of guardrails, life lines, gangways or under deck passages, etc.) are to be provided for the protection of the crew in getting to and from their quarters, the machinery space and all other parts used in the necessary work of the ship.

Section 13.6 has been renumbered and amended as follows:

~~13.6~~13.7 Means of Embarkation and Disembarkation

~~13.6.1~~13.7.1Ships are to be provided with appropriate means of embarkation on and disembarkation from ships for use in port and in port related operations, such as gangways and accommodation ladders.

~~13.6.2~~13.7.2Where a ship is engaged in voyages between designated ports where appropriate shore accommodation / embarkation ladders (platforms) are provided, special approval may be made by the Society.

~~13.6.3~~13.7.3the means of embarkation and disembarkation are to be in accordance with the following.

(a) Accommodation ladders and gangways are to be constructed based on ISO 5488:1979 "Shipbuilding - accommodation ladders", ISO 7061:1993 "Shipbuilding - aluminium shore gangways for seagoing vessels" or standards where deemed appropriate by the Society. Accommodation ladder winches are to be constructed based on ISO 7364:1983 "Shipbuilding and marine structures – deck machinery – accommodation ladder winches" or standards where deemed appropriate by the Society or are to be the one pursuant to aforementioned standards.

(b) The structure of the accommodation ladders and gangways and their fittings and attachments are to be such as to allow regular inspection, maintenance of all parts and, if necessary, lubrication of their pivot pin. Special care is to be paid to welding connection.

(c) As far as practicable, the means of embarkation and disembarkation are to be sited clear of the working area and are not to be placed where cargo or other suspended loads may pass overhead. However, in cases where the Society recognizes unavoidable circumstances, the means of embarkation and disembarkation may be installed within the above mentioned areas or places, provided that safe passage is ensured through description in operation manuals, the installation of warning plates, and so on.

(d) The means of embarkation and disembarkation are to be constructed and installed based on the "guidelines for construction, installation, maintenance and inspection/survey of means of embarkation and disembarkation(MSC.1/Circ.1331)."

~~(d)~~(e) Each accommodation ladder is to be of such a length to ensure that, at a maximum design operating angle of inclination, the lowest platform will be not more than 600 mm above the waterline in the lightest seagoing condition (in this regard, trim is to be the condition resulting from the loading condition of the lightest seagoing condition), as defined in SOLAS Regulation III/3.13. However, in cases where the height of the embarkation / disembarkation deck exceeds 20 m above the waterline or is deemed appropriate by the Society, an alternative means of providing safe access to the ship or supplementary means of access to the bottom platform of the accommodation ladder may be accepted.

~~(e)~~ (f) The arrangement at the head of the accommodation ladder is to provide direct access between the ladder and the ship's deck by a platform securely guarded by handrails and handholds. The ladder is to be securely attached to the ship to prevent overturning.

~~(f)~~ (g) Each accommodation ladder or gangway is to be clearly marked at each end with a plate showing the restrictions on the safe operation and loading, including the maximum and minimum permitted design angles of inclination, design load, maximum load on bottom end plate, etc. Where the maximum operational load is less than the design load, it is also to be shown on the marking plate.

~~(g)~~ (h) Gangways are not to be used at an angle of inclination greater than 30 degrees from the horizontal and accommodation ladders are not to be used at an angle greater than 55 degrees from the horizontal, unless designed and constructed for use at angles greater than these and marked as such.

~~(h)~~ (i) Gangways are not to be secured to a ship's guardrails unless they have been designed for that purpose. If positioned through an open section of bulwark or railings, any remaining gaps are to be adequately fenced.

~~(i)~~ (j) Adequate lighting is to be provided to illuminate the means of embarkation and disembarkation, the position on deck where persons embark or disembark and the controls of the arrangement.

~~(j)~~ (k) A lifebuoy equipped with a self-igniting light and a buoyant lifeline is to be available for immediate use in the vicinity of the embarkation and disembarkation arrangement when in use.

~~(k)~~ (l) A safety net is to be mounted and arrangements that enable the installation of such net are to be provided to prevent falling accident in cases where it is possible that a person may fall from the means of embarkation and disembarkation or between the ship and quayside.

~~13.6.4~~13.7.4 Ships that have small freeboards and are provided with boarding ramps needs not to be in accordance with the requirements of 13.6.3.

Fig II 14-1 has been amended as follows:

Chapter 14 Watertight Bulkheads

14.4 Other Watertight Construction

14.4.1 For the application of this Chapter, trunks required to maintain watertightness are to be capable of withstanding internal or external pressure under the most severe conditions at the intermediate or final stages of flooding.

Table II 14-2
Value of C

Vertical Stiffener				
Lower end	Upper end			
	Lug-connection or supported by horizontal girders	Connection		End of stiffener unattached
		Type A	Type B	
Lug-connection or supported by horizontal girders	1.00	1.00	1.15	1.35
Connected by brackets	0.80	0.80	0.90	1.00
stiffener web attached at end only	1.15	1.15	1.35	1.60
End of stiffener unattached	1.35	1.35	1.60	2.00

Horizontal Stiffener		
The other end	One end	
	Lug-connection, connected by brackets or supported by vertical girders	End of stiffener unattached
Lug-connection, connected by brackets or supported by vertical girders	1.00	1.35
End of stiffener unattached	1.35	2.00

Notes:

(1) Lug-connection is a connection where both webs and face plates of stiffeners are effectively attached to the bulkhead plating, decks or inner bottoms and which are strengthened by effective supporting members on the opposite side of the plating.

(2) " Type A" of vertical stiffeners is a connection by bracket to the longitudinal members or to the adjacent members, in line with the stiffeners, of the same or larger sections. (See Fig. II 14-1 (a))

(3) " Type B" of vertical stiffeners is a connection by bracket to the transverse members such as beams, or other connections equivalent to the connection mentioned above. (See Fig. II 14-1 (b))

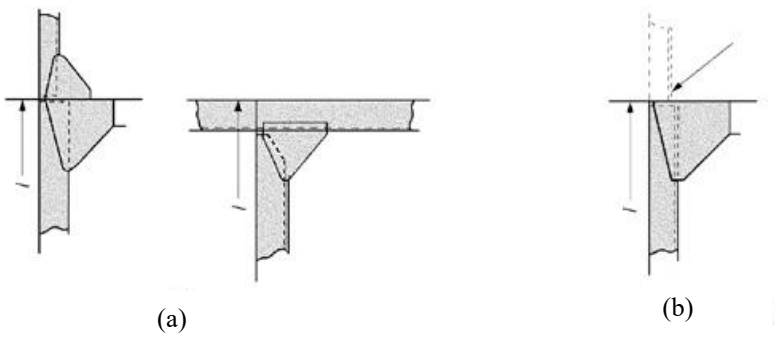


Fig. II 14-1
Types of End Connections

Chapter 25 Equipment

Paragraph 25.1.3 has been amended as follows:

25.1 General

25.1.1 All ships are to be provided with a complete equipment of the anchor, the chain, the towline and the mooring rope in accordance with the following requirements. The letter **E** will be placed after the symbol of classification of hull in the Register Book as **CR100 ✠ E**.

25.1.2 In the case of ships classed for a special or restricted service, if approved by the Society that requirements of the Rules are not necessary to apply, no equipment symbol is to be affixed.

25.1.3 The number and mass of anchors and the length and the size of the chain, the towline, and the mooring rope for a classed ship are to be determined from Table II 25-1. For ships having equipment numbers not more than 50 or more than 16,000, the number and mass of anchors, chain cables and mooring lines are to be determined by the Society. The total length of chain given in Table II 25-1 is to be divided in approximately equal parts between the two bower anchors.

……

25.1.6 The anchoring equipment required herewith is intended for temporary mooring of a ship within a harbour or sheltered area when the ship is awaiting berth, tide, etc. Additional class notation **ADW** may be assigned to ships intended for regular anchoring at deep and unsheltered water, in accordance with 25.11.

Paragraph 25.2.1 has been amended as follows:

25.2 Equipment Number

25.2.1 The equipment given in Table II 25-1 is based on the "Equipment Number", EN, which is to be calculated as follows:

$$EN = \Delta^{\frac{2}{3}} + 2(hB\cancel{H} + S_{fun}) + 0.1A$$

where:

Δ	=	Molded displacement to the summer load waterline, in ton.
B	=	Breadth of ship, in m, as specified in 1.2.2.
~~H~~h	=	Effective height , in m, from the summer load waterline to the top of the uppermost house, in m. $h = a + \Sigma h_i$
a	=	Vertical distance amidships from the summer load waterline to the top of uppermost continuous deck beam at side, in m.
~~Σ~~h_i	=	~~Sum of the~~ H~~h~~eight~~s~~, in m, at centerline of superstructure and each tier of deck-houses having a breadth greater than 0.25B. For the lowest tier h_1 is to be measured at centerline from the upper deck or from a notional deck line where there is local discontinuity in the upper deck, see Fig. II 25-1 below for an example.
S_{fun}	=	Effective front projected area of the funnel, in m^2, defined as: $S_{fun} = A_{FS} - S_{shield}$

A_{FS} = Front projected area of the funnel, in m^2, calculated between the upper deck at centerline, or notional deck line where there is local discontinuity in the upper deck, and the effective height h_F. A_{FS} is taken equal to 0 if the funnel breadth is less than or equal to 0.25B at all elevations along the funnel height.

h_F = Effective height of the funnel, in m, measured from the upper deck at centerline, or notional deck line where there is local discontinuity in the upper deck, and the top of the funnel. The top of the funnel may be taken at the level where the funnel breadth reaches 0.25B.

S_{shield} = The section of front projected area A_{FS}, in m^2, which is shielded by all deck houses having breadth greater than 0.25B. If there are more than one shielded section, the individual shielded sections i.e $S_{shield1}$, $S_{shield2}$ etc as shown in Fig. II 25-2 to be added together. To determine S_{shield}, the deckhouse breadth is assumed B for all deck houses having breadth greater than 0.25B as shown for $S_{shield1}$, $S_{shield2}$ in Fig. II 25-2.

A = ~~Sum of the profile area, in m^2, of the hull above summer load waterline, superstructures and deckhouses having a breadth greater than 0.25B, which are within the length of ship L.~~

Side projected area, in m^2, of the hull, superstructures, houses and funnels above the summer load waterline which are within the equipment length of the ship and also have a breadth greater than 0.25B. The side projected area of the funnel is considered in A when A_{FS} is greater than 0. In this case, the side projected area of the funnel should be calculated between the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the effective height h_F.

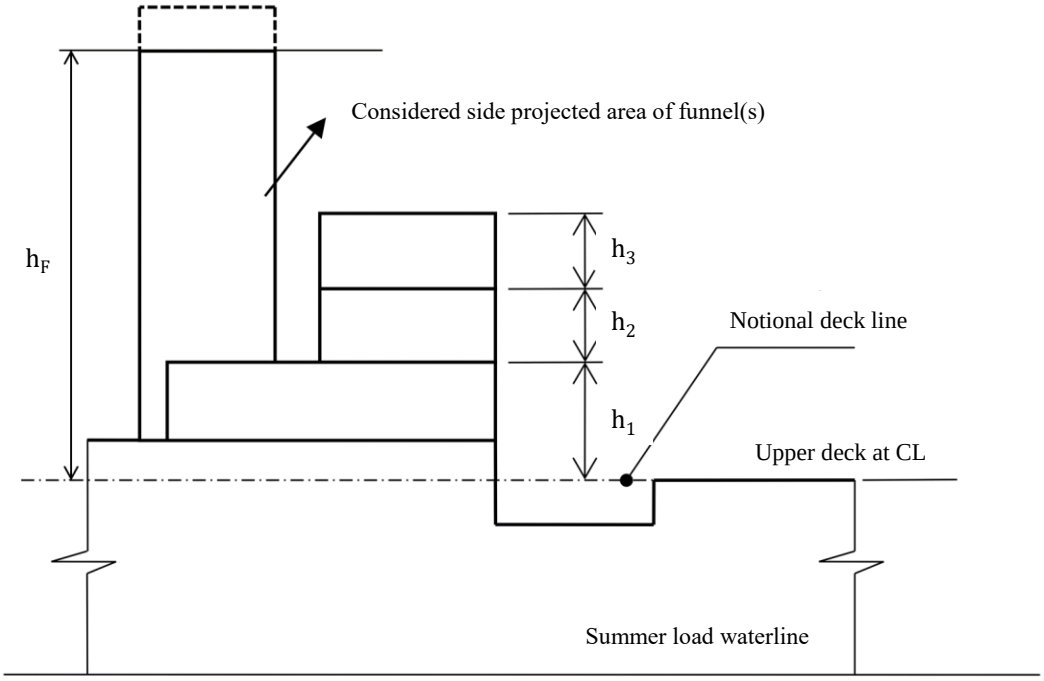


Fig. II 25-1
Effective Height

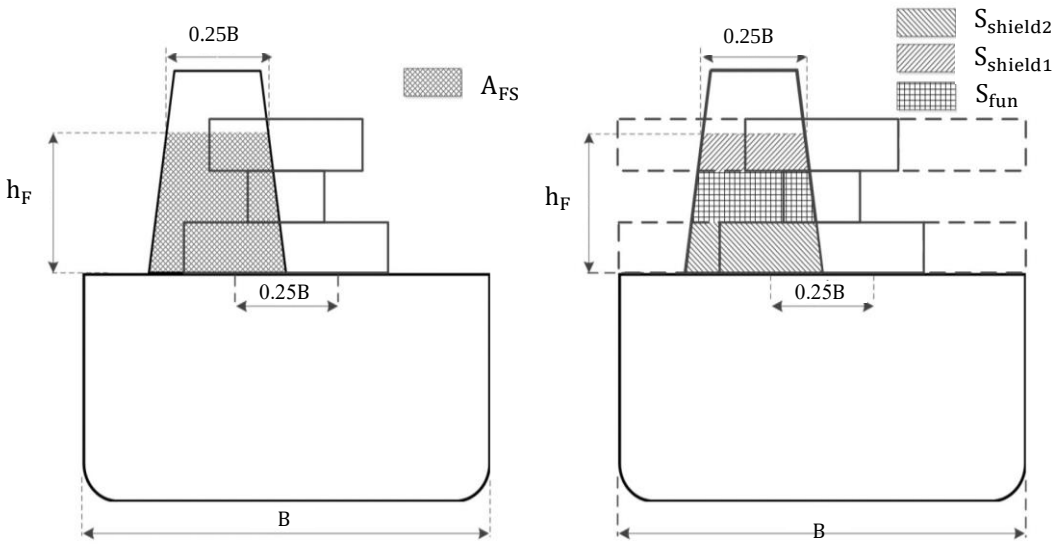


Fig. II 25-2
Front Projected Area of Funnel

Notes:

(~~a~~1) When calculating of ~~H~~ h, sheer, camber and trim are to be neglected. i.e. h is the sum of freeboard amidships plus the height (at centerline) of each tier of houses having a breadth greater than 0.25B.

(2) ~~Where~~ If a deckhouse having a breadth greater than 0.25B is located above a deckhouse with a breadth of 0.25B or less, then the wide deckhouse is to be included, but the narrow deckhouse ignored.

(~~b~~3) Screens or bulwarks 1.5 m or more in height are to be regarded as parts of superstructure or deckhouse when calculating ~~H~~ h and A. ~~Where a screen or bulwark is of varying height, the portion exceeding 1.5 m in height is to be included.~~ The height of the hatch coamings and that of any deck cargo, such as containers, may be disregarded when determining h and A. With regard to determining A, when a bulwark is more than 1.5 m high, the area shown in Fig. II 25-3 as A_2 is to be included in A.

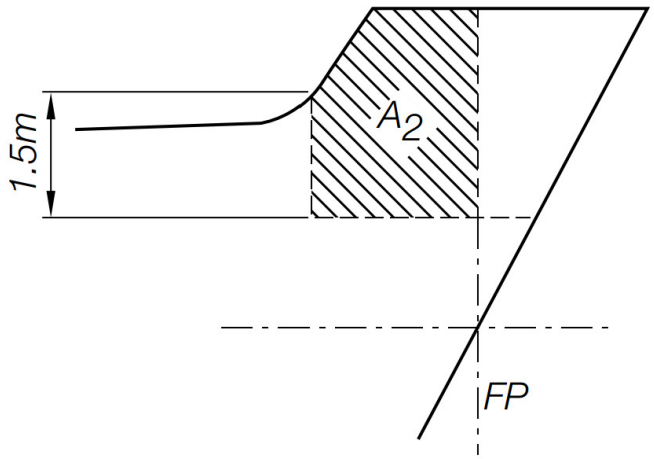


Fig. II 25-3
Effective Area for Screens, Bulwarks, etc.

(4) The equipment length of the ship is the length between perpendiculars but is not to be less than 96% nor greater than 97% of the extreme length on the summer load waterline (measured from the forward end of the waterline).

(5) When several funnels are fitted on the ship, the above parameters are taken as follows:

h_F = Effective height of the funnel, in m, measured from the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the top of the highest funnel. The top of the highest funnel may be taken at the level where the sum of each funnel breadth reaches 0.25B.

A_{FS} = Sum of the front projected area of each funnel, in m², calculated between the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the effective height h_F.
A_{FS} is to be taken equal to 0 if the sum of each funnel breadth is less than or equal to 0.25B at all elevations along the funnels height.

A = Side projected area, in m^2, of the hull, superstructures, houses and funnels above the summer load waterline which are within the equipment length of the ship. The total side projected area of the funnels is to be considered in the side projected area of the ship, A, when A_{FS} is greater than 0. The shielding effect of funnels in transverse direction may be considered in the total side projected area, i.e., when the side projected areas of two or more funnels fully or partially overlap, the overlapped area needs only to be counted once.

~~(c) The total length of chain given in Table II 25-1 is to be divided in approximately equal parts between the two bower anchors.~~

Paragraph 25.2.2 has been amended as follows:

25.2.2 Equipment for tugs

For tugs, the term 2hB~~H~~ specified in 25.2.1 for calculating "Equipment Number", EN, is to be substituted by the following formula:

$$2 (a B + \Sigma h_i b_i)$$

where:

a = As specified 25.2.1 of this Chapter.
B = As specified 25.2.1 of this Chapter.
h_i = As specified 25.2.1 of this Chapter.
b_i = The breadth, in m, of the widest superstructure or deckhouse of each tier having a breadth greater than 0.25B.

25.9 Towing and Mooring Fittings

Paragraph 25.9.2(b) has been amended as follows:

25.9.2 Towing Fittings

(b) Design Load

Design load, see Fig. II 25-~~1~~4, for towing fittings and their supporting structures are to be as specified in (i) to (vi) below:

(i) For normal towing operations (e.g. harbour/manoeuvring), the design load on the line (see Fig. II 25-~~1~~4) is to be 1.25 times the intended maximum towing load.

Fig. II 25-1 has been renumbered as follows:

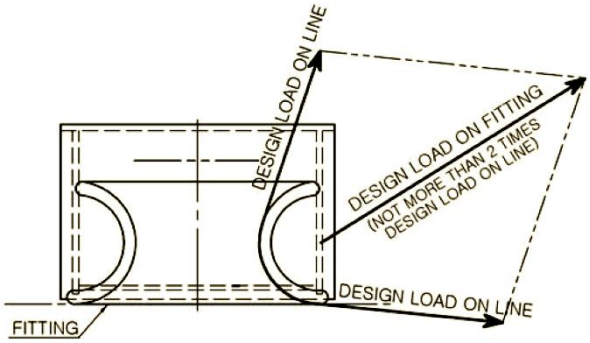


Fig. II 25-~~1~~4
Design load

Paragraph 25.9.3(b) has been amended as follows:

25.9.3 Mooring Fittings

(b) Design Load

Design load, see Fig. II 25-~~1~~4, for mooring fittings and their supporting structures are to be as specified in (i) to (vii) below:

(i) The minimum design load on the line (see Fig. II 25-~~1~~4) is to be 1.15 times the breaking strength of the mooring line specified in Table II 25-1 according to the equipment number determined in 25.2.

(iv) The design load on fittings is to take into account the total design load on the line specified in (i) (see Fig. II 25-~~1~~4), but need not exceed twice the design load on the line.

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022"

PART III SPECIAL SERVICE AND TYPE OF SHIPS

List of major changes in Part III from 2022 edition

1.3.1(a)	Revised
1.11	Deleted
1A.2.2(c)	Revised
1A.8~1A.9	Deleted
2A.2.2(c)(iii)	Revised
4.1	Revised
4.2	Revised
4.3.4~4.3.18	New
11.7.5(f)	Revised
12.8	New
16.2.2(b)(i)	Revised
16.2.2(c)(iii)	Revised
16.2.3(a)(iii)	Revised
16.2.5(e)	Revised
16.4.2(a)(i)	Revised

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 1 Bulk or Ore Carriers

Paragraph 1.3.1(a) has been amended as follows:

1.3 Shell and Deck Plating

1.3.1 The thickness of the shell plating and the deck plating is not to be less than required by Chapters 3, 7 and 11 of Part II, with the exception of 7.2.1, 7.2.2 and 7.3.1(b) of Part II that are not applicable to Bulk Carriers. The thickness of shell plating is also to comply with the following requirements.

(a) Shell plating

The thickness of the shell plating including bottom and side shell is not to be less than the value obtained from the following formula.

$$t = 0.0176 \cdot \alpha_p \cdot 1000b\sqrt{\frac{|P|}{C_a \sigma_y}} \qquad \text{mm}$$

$$\alpha_p = 1.2 - \frac{b}{2.1a}$$

where:

a = The longest edge of the panel, in m.

b = The shortest edge of the panel, in m.

σ_y = The yield stress of the plating material, in N/mm^2.

P = $10.06(d + 0.038L')$

Where:

d is the scantling draft in m, measured vertically on the midship transverse section, from the moulded base line to the waterline at which the strength requirements for the scantlings of the ships are met. It is to be not less than that corresponding the assigned freeboard. In the case of a ship with a solid bar keel, the moulded base line is to be taken at the intersection between the upper face of the bottom plating with the solid bar keel at the middle of length L. ~~L' is the rule length in m not taken greater than 230 m~~.

L is length of ship, in m, as specified in 1.2.1 of Part II, not taken greater than 230 m.

C_a = Permissible bending stress coefficient for plate taken equal to:

= $\beta - \alpha\frac{\left|\frac{\sigma_{hg}}{0.9}\right|}{\sigma_y}$, not to be greater than C_{a-max}

Where:

Structural member	β	α	$C_{a\text{-}max}$
Longitudinally stiffened plating	1.05	0.5	0.95
Transversally stiffened plating	1.05	1.0	0.95

σ_{hg} the maximum hull girder stress in N/mm^2 over the hogging and sagging conditions calculated at the lower or upper end of the panel under consideration located above or below the horizontal neutral axis respectively, as defined in CR Pt.II 3.2 (Hull girder bending strength).

Section 1.11 has been deleted as follows:

~~1.11 Coating~~

~~Protective coatings of cargo holds are to comply with the requirements in 23.1.6 of Part II.~~

Chapter 1A Additional Requirement for Bulk Carriers

Paragraph 1A.2.2(c) has been amended as follows:

1A.2 Loading Manuals and Loading Instruments for Bulk Carriers

1A.2.2 Loading manual

Loading manual is a document which describes:

(c) for single skin bulk carriers, envelope results and permissible limits of still water bending moments and shear forces in the hold flooded condition according to 1A.4;
In addition to hull construction complies with the definition of double skin construction, the other construction arrangement is to be defined as single skin bulk carrier. Double skin construction in which any part of longitudinal bulkhead is located within B/5 or 11.5 m, whichever is less, inboard from the ship's side at right angle to the centreline at the assigned summer load line.

Paragraph 1A.8~1A.9 have been deleted as follows:

~~1A.8 Cargo Hatch Cover Securing Arrangements for Bulk Carriers not Built in Accordance with 1A.7~~

~~1A.8.1 Application and implementation~~

~~(a) These requirements apply to all bulk carriers, which were not built in accordance with 1A.7 and are for steel hatch cover securing devices and stoppers for cargo hold hatchways No.1 and No.2 which are wholly or partially within 0.25L of the fore perpendicular, except pontoon type hatch cover.~~

~~(b) All bulk carriers not built in accordance with 1A.7 are to comply with the requirements of 1A.8 in accordance with the following schedule:~~

~~(i) For ships which will be 15 years of age or more on 1 January 2004 by the due date of the first intermediate or special survey after that date;~~

~~(ii) For ships which will be 10 years of age or more on 1 January 2004 by the due date of the first special survey after that date;~~

~~(iii) For ships which will be less than 10 years of age on 1 January 2004 by the date on which the ship reaches 10 years of age.~~

~~(c) Completion prior to 1 January 2004 of an intermediate or special survey with a due date after 1 January 2004 cannot be used to postpone compliance. However, completion prior to 1 January 2004 of an intermediate survey the window for which straddles 1 January 2004 can be accepted.~~

~~1A.8.2 Securing devices~~

~~(a) The strength of securing devices is to comply with the following requirements:~~

~~(i) Panel hatch covers are to be secured by appropriate devices (bolts, wedges or similar) suitably spaced alongside the coamings and between cover elements.~~

~~Arrangement and spacing are to be determined with due attention to the effectiveness for weather-tightness, depending upon the type and the size of the hatch cover, as well as on the stiffness of the cover edges between the securing devices.~~

~~(ii) The net sectional area of each securing device is not to be less than:~~

~~$A = 1.4\ a/f$ ——————— cm^2~~

~~where:~~

~~a = Spacing between securing devices not to be taken less than 2 meters.~~

~~f = $(\sigma_Y/235)^e$~~

~~σ_Y = Specified minimum upper yield stress in N/mm^2 of the steel used for fabrication, not to be taken greater than 70% of the ultimate tensile strength.~~

~~e = 0.75 for $\sigma_Y > 235$~~

~~= 1.0 for $\sigma_Y \leq 235$~~

~~Rods or bolts are to have a net diameter not less than 19 mm for hatchways exceeding 5 m^2 in area.~~

~~(iii) Between cover and coaming and at cross-joints, a packing line pressure sufficient to obtain weathertightness is to be maintained by the securing devices.~~

~~For packing line pressures exceeding 5 N/mm, the cross-section area is to be increased in direct proportion. The packing line pressure is to be specified.~~

~~(iv) The cover edge stiffness is to be sufficient to maintain adequate sealing pressure between securing devices. The moment of inertia, I, of edge elements is not to be less than:~~

~~$I = 6\ p\ a^4$ ——————— cm^4~~

~~where:~~

~~p = Packing line pressure in N/mm, minimum 5 N/mm.~~

~~a = Spacing in m of securing devices.~~

~~(v) Securing devices are to be of reliable construction and securely attached to the hatchway coamings, decks or covers. Individual securing devices on each cover are to have approximately the same stiffness characteristics.~~

~~(vi) Where rod cleats are fitted, resilient washers or cushions are to be incorporated.~~

~~(vii) Where hydraulic cleating is adopted, a positive means is to be provided to ensure that it remains mechanically locked in the closed position in the event of failure of the hydraulic system.~~

~~1A.8.3 Stoppers~~

~~(a) No. 1 and 2 hatch covers are to be effectively secured, by means of stoppers, against the transverse forces arising from a pressure of 175 kN/m^2.~~

~~(b) No. 2 hatch covers are to be effectively secured, by means of stoppers, against the longitudinal forces acting on the forward end arising from a pressure of 175 kN/m^2.~~

~~(c) No. 1 hatch cover is to be effectively secured, by means of stoppers, against the longitudinal forces acting on the forward end arising from a pressure of 230 kN/m^2. This pressure may be reduced to 175 kN/m^2 if a forecastle is fitted.~~

~~(d) The equivalent stress~~

~~(i) in stoppers and their supporting structures, and~~

~~(ii) calculated in the throat of the stopper welds is not to exceed the allowable value of $0.8\ \sigma_Y$.~~

1A.8.4 Materials and welding

Where stoppers or securing devices are fitted to comply with 1A.8, they are to be manufactured of materials, including welding electrodes, meeting the relevant requirements of the Rules.

1A.9 Renewal Criteria for Side Shell Frames and Brackets in Single Side Skin Bulk Carriers not Built in Accordance with 1A.3

1A.9.1 Application and definitions

These requirements apply to the side shell frames and brackets of cargo holds bounded by the single side shell of bulk carriers constructed with single deck, topside tanks and hopper tanks in cargo spaces intended primarily to carry dry cargo in bulk, which were not built in accordance with 1A.3.

Ships subject to these requirements are to be assessed for compliance with the requirements of 1A.9 and steel renewal, reinforcement or coating, where required in accordance with 1A.9, is to be carried out in accordance with the schedule as specified in 1A.8.1(b) to (c) and at subsequent intermediate and special surveys.

These requirements define steel renewal criteria or other measures to be taken for the webs and flanges of side shell frames and brackets as per 1A.9.2. Reinforcing measures of side frames are also defined as per 1A.9.2(e).

(a) Ice strengthened ships

(i) Where bulk carriers are reinforced to comply with an ice class notation, the intermediate frames are not to be included when considering compliance with 1A.9.

(ii) The renewal thicknesses for the additional structure required to meet the ice strengthening notation are to be based on the Society's requirements.

(iii) If the ice class notation is requested to be withdrawn, the additional ice strengthening structure, with the exception of tripping brackets (see 1A.9.2(b)(i)(2) and 1A.9.2(e), is not to be considered to contribute to compliance with 1A.9.

1A.9.2 Criteria for renewal or other measures

(a) Symbols used in 1A.9.2

t_M = Thickness as measured, in mm.

t_{REN} = Thickness at which renewal is required. See 1A.9.2(b).

$t_{REN,d/t}$ = Thickness criteria based on d/t ratio. See 1A.9.2(b)(i).

$t_{REN,S}$ = Thickness criteria based on strength. See 1A.9.2(b)(ii).

t_{COAT} = $0.75\ t_{S12}$

t_{S12} = Thickness in mm as required by 1A.3.3 for frame webs and 1A.3.4 for upper and lower brackets.

t_{AB} = Thickness as built, in mm

t_C = See Table III 1A.1 below

Table III 1A.1
t_C Values, in mm

Ship's length L, in m	Holds other than No. 1		Hold No. 1	
	Span and upper brackets	Lower brackets	Span and upper brackets	Lower brackets
≤ 100	2.0	2.5	2.0	3.0
150	2.0	3.0	3.0	3.5
≥ 200	2.0	3.0	3.0	4.0

Note: For intermediate ship lengths, t_c is obtained by linear interpolation between the above values.

(b) Criteria for webs (Shear and other checks)

~~The webs of side shell frames and brackets are to be renewed when the measured thickness (t_M) is equal to or less than the thickness (t_{REN}) as defined below:~~

~~t_{REN} is the greatest of (t_{COAT} — t_C), (0.75 t_{AB}), ($t_{REN,d/t}$) and ($t_{REN,S}$) (where required by 1A.9.2(b)(ii)).~~

~~(i) Thickness criteria based on d/t ratio~~

~~Subject to (2) and (3) below, $t_{REN,d/t}$ is given by the following equation:~~

~~$t_{REN,d/t}$ = (web depth in mm)/R~~

~~where:~~

~~For frames~~

~~R = $65K^{0.5}$ for symmetrically flanged frames.~~

~~= $55K^{0.5}$ for asymmetrically flanged frames.~~

~~For lower brackets (see (1) below)~~

~~R = $87K^{0.5}$ for symmetrically flanged frames.~~

~~= $73K^{0.5}$ for asymmetrically flanged frames.~~

~~K = 1.0 for ordinary hull structural steel and according to 1.5.2(a) of Part II of the Rules for higher tensile steel.~~

~~In no instance is $t_{REN,d/t}$ for lower integral brackets to be taken as less than $t_{REN,d/t}$ for the frames they support.~~

~~(1) Lower brackets~~

~~In calculating the web depth of the lower brackets, the following will apply:~~

~~a) The web depth of lower bracket may be measured from the intersection of the sloped bulkhead of the hopper tank and the side shell plate, perpendicularly to the face plate of the lower bracket (see Fig.III 1A 20).~~

~~b) Where stiffeners are fitted on the lower bracket plate, the web depth may be taken as the distance between the side shell and the stiffener, between the stiffeners or between the outermost stiffener and the face plate of the brackets, whichever is the greatest.~~

~~(2) Tripping bracket alternative~~

~~When t_M is less than $t_{REN,d/t}$ at section b) of the side frames as shown in Fig. III 1A 19, tripping brackets in accordance with 1A.9.2(c) may be fitted as an alternative to the requirements for the web depth to thickness ratio of side frames, in which case $t_{REN,d/t}$ may be disregarded in the determination of t_{REN} in accordance with 1A.9.2(b).~~

~~(3) Immediately abaft collision bulkhead~~

~~For the side frames located immediately abaft the collision bulkheads, whose scantlings are increased in order that their moment of inertia is such to avoid undesirable flexibility of the side shell, when their web as built thickness t_{AB} is greater than 1.65 $t_{REN,S}$, the thickness $t_{REN,d/t}$ may be taken as the value $t'_{REN,d/t}$ obtained from the following equation:~~

~~$$t'_{REN,d/t} = \sqrt[3]{t^2_{REN,\frac{d}{t}} \times t_{REN,S}}$$~~

~~where $t_{REN,S}$ is obtained from 1A.9.3(c).~~

~~(ii) Thickness criteria based on shear strength check~~

~~Where t_M in the lower part of side frames, as defined in Fig. III 1A 18, is equal to or less than t_{COAT}, $t_{REN,S}$ is to be determined in accordance with 1A.9.3(c).~~

~~(iii) Thickness of renewed webs of frames and lower brackets~~

~~Where steel renewal is required, the renewed webs are to be of a thickness not less than t_{AB}, 1.2 t_{COAT} or 1.2 t_{REN}, whichever is the greatest.~~

~~(iv) Criteria for other measures~~

~~When $t_{REN} < t_M < t_{COAT}$, measures are to be taken, consisting of all the following:~~

~~(1) sand blasting, or equivalent, and coating (see 1A.9.2(d));~~

(2) fitting tripping brackets (see 1A.9.2(e)), when the above condition occurs for any of the side frame zones A, B, C and D, shown in Fig. III 1A-18, and

(3) maintaining the coating in "as-new" condition (i.e. without breakdown or rusting) at Special and Intermediate Surveys.

The above measures may be waived if the structural members show no thickness diminution with respect to the as built thicknesses and coating is in "as-new" condition (i.e. without breakdown or rusting).

(c) Criteria for frames and brackets (Bending check)

Where the length or depth of the lower bracket does not meet the requirements in 1A.3, a bending strength check in accordance with 1A.9.3(d) is to be carried out and renewals or reinforcements of frames and/or brackets effected as required therein.

(d) Thickness measurements, steel renewal, sand blasting and coating

For the purpose of steel renewal, sand blasting and coating, four zones A, B, C and D are defined, as shown in Fig. III 1A-18.

Representative thickness measurements are to be taken for each zone and are to be assessed against the criteria in 1A.9.2.

In case of integral brackets, when the criteria in 1A.9.2 are not satisfied for zone A or B, steel renewal, sand blasting and coating, as applicable, are to be done for both zones A and B.

In case of separate brackets, when the criteria in 1A.9.2 are not satisfied for zone A or B, steel renewal, sand blasting and coating is to be done for each one of these zones, as applicable.

When steel renewal is required for zone C according to 1A.9.2, it is to be done for both zones B and C. When sand blasting and coating is required for zone C according to 1A.9.2, it is to be done for zones B, C and D.

When steel renewal is required for zone D according to 1A.9.2, it needs only to be done for this zone. When sand blasting and coating is required for zone D according to 1A.9.2, it is to be done for both zones C and D.

Special consideration may be given by the Society to zones previously renewed or recoated, if found in "as-new" condition (i.e., without breakdown or rusting).

When adopted, on the basis of the renewal thickness criteria in 1A.9.2, in general coating is to be applied in compliance with the requirements of 23.1.6, Part II of the Rules as applicable.

Where, according to the requirements in 1A.9.2, a limited number of side frames and brackets are shown to require coating over part of their length, the following criteria apply.

(i) The part to be coated includes:

(1) the web and the face plate of the side frames and brackets,

(2) the hold surface of side shell, hopper tank and topside tank plating, as applicable, over a width not less than 100 mm from the web of the side frame.

(ii) Epoxy coating or equivalent is to be applied.

In all cases, all the surfaces to be coated are to be sand blasted prior to coating application.

(e) Reinforcing measures

Reinforcing measures are constituted by tripping brackets, located at the lower part and at midspan of side frames (see Fig. III 1A-4). Tripping brackets may be located at every two frames, but lower and midspan brackets are to be fitted in line between alternate pairs of frames.

The thickness of the tripping brackets is to be not less than the as-built thickness of the side frame webs to which they are connected.

Double continuous welding is to be adopted for the connections of tripping brackets to the side shell frames and shell plating.

(f) Weld throat thickness

In case of steel renewal the welded connections are to comply with 1A.3.7.

~~(g) Pitting and grooving~~

~~If pitting intensity is higher than 15% in area (see Fig. III 1A-21), thickness measurement is to be taken to check pitting corrosion.~~

~~The minimum acceptable remaining thickness in pits or grooves is equal to:~~

~~(i) 75% of the as-built thickness, for pitting or grooving in the frame and brackets webs and flanges.~~

~~(ii) 70% of the as-built thickness, for pitting or grooving in the side shell, hopper tank and topside tank plating attached to the side frame, over a width up to 30 mm from each side of it.~~

~~1A.9.3 Strength check criteria~~

~~In general, loads are to be calculated and strength checks are to be carried out for the aft, middle and forward frames of each hold. The scantlings required for frames in intermediate positions are to be obtained by linear interpolation between the results obtained for the above frames.~~

~~When scantlings of side frames vary within a hold, the required scantlings are also to be calculated for the mid frame of each group of frames having the same scantlings. The scantlings required for frames in intermediate positions are to be obtained by linear interpolation between the results obtained for the calculated frames.~~

~~(a) Load model~~

~~(i) Forces~~

~~The forces $P_{fr,a}$ and $P_{fr,b}$, in kN, to be considered for the strength checks at sections a) and b) of side frames (specified in Fig. III 1A-19; in the case of separate lower brackets, section b) is at the top of the lower bracket), are given by:~~

~~$P_{fr,a} = P_S + \max(P_1, P_2)$~~

~~$P_{fr,b} = P_{fr,a} \frac{h - 2h_B}{h}$~~

~~where:~~

~~P_S = Still water force, in kN.~~

~~= $sh \frac{(p_{s,U} + p_{s,L})}{2}$ when the upper end of the side frame span h (see Fig. III 1A-18) is below the load water line.~~

~~= $sh' \left(\frac{p_{s,L}}{2} \right)$ when the upper end of the side frame span h (see Fig. III 1A-18) is at or above the load water line.~~

~~P_1 = $sh \frac{(p_{1,U} + p_{1,L})}{2}$,wave force, in kN, in head sea.~~

~~P_2 = $sh \frac{(p_{2,U} + p_{2,L})}{2}$,wave force, in kN, in beam sea.~~

~~h, h_B = Side frame span and lower bracket length, in m, defined in Fig. III 1A-18 and 19, respectively.~~

~~h' = Distance, in m, between the lower end of side frame span h (see Fig. III 1A-18) and the load water line.~~

~~s = Frame spacing, in m.~~

~~$p_{S,U}$, $p_{S,L}$ = Still water pressure, in kN/m^2, at the upper and lower end of the side frame span h (see Fig. III 1A-18), respectively.~~

~~$p_{1,U}$, $p_{1,L}$ = Wave pressure, in kN/m^2, at defined in 1A.9.3(a)(ii)(1). below for the upper and lower end of the side frame span h, respectively.~~

~~$p_{2,U}$, $p_{2,L}$ = Wave pressure, in kN/m^2, as defined in 1A.9.3(a)(ii)(2). below for the upper and lower end of the side frame span h, respectively.~~

~~(ii) Wave Pressure~~

~~(1) Wave pressure p_1~~

~~a) The wave pressure p_1, in kN/m^2, at and below the waterline is given by:~~

~~$$p_1 = 1.50\left[p_{11} + 135\frac{B}{2(B+75)} - 1.2(d-z)\right]$$~~

~~$$p_{11} = 3k_s C + k_f$$~~

~~b) The wave pressure p_1, in kN/m^2, above the water line is given by:~~

~~$$p_1 = p_{1WL} - 7.50(z-d)$$~~

~~(2) Wave pressure p_2~~

~~a) The wave pressure p_2, in kN/m^2, at d and below the waterline is given by:~~

~~$$p_2 = 13.0\left[0.5B\frac{50C_f}{2(B+75)} + C_b\frac{0.5B+k_f}{14}\left(0.7+2\frac{z}{d}\right)\right]$$~~

~~b) The wave pressure p_2, in kN/m^2, above the water line is given by:~~

~~$$p_2 = p_{2WL} - 5.0(z-d)$$~~

~~where:~~

~~p_{1WL} = p_1 wave sea pressure at the waterline.~~

~~p_{2WL} = p_2 wave sea pressure at the waterline.~~

~~L = Length of ship, in m, as defined in 1.2, Part II of the Rules.~~

~~B = Greatest moulded breadth, in m.~~

~~C_b = Block coefficient, as defined in 1.2, Part II of the Rules but not to be taken less than 0.6.~~

~~d = Maximum design draught, in m.~~

~~C = Coefficient,~~

~~$= 10.75 - \left(\frac{300-L}{100}\right)^{1.5}$ for $90 \text{ m} \le L \le 300\text{m}$,~~

~~$= 10.75$ for $300 \text{ m} < L$.~~

~~$C_f = \left(1.25 - 0.025\frac{2k_f}{\sqrt{GM}}\right)k$~~

~~k = 1.2 for ships without bilge keel.~~

~~= 1.0 for ships with bilge keel.~~

~~k_f = Roll radius of gyration. If the actual value of k_f is not available,~~

~~= 0.39 B for ships with even distribution of mass in transverse section (e.g. alternate heavy cargo loading or homogeneous light cargo loading).~~

~~= 0.25 B for ships with uneven distribution of mass in transverse section (e.g. homogeneous heavy cargo distribution).~~

~~GM = 0.12 B if the actual value of GM is not available.~~

~~z = Vertical distance, in m, from the baseline to the load point.~~

~~$k_s = C_b + \frac{0.83}{\sqrt{C_b}}$ at aft end of L,~~

~~= C_b between 0.2 L and 0.6 L from aft end of L,~~

~~$= C_b + \frac{1.33}{C_b}$ at forward end of L.~~

~~Between the above specified points, k_s is to be interpolated linearly.~~

~~k_f = 0.8 C~~

~~(b) Allowable stresses~~

~~The allowable normal and shear stresses σ_a and τ_a, in N/mm^2, in the side shell frames and brackets are given by:~~

~~$$\sigma_a = 0.90\sigma_F$$~~

~~$$\tau_a = 0.40\sigma_F$$~~

~~where σ_F is the minimum upper yield stress, in N/mm^2, of the material.~~

~~(c) Shear strength check~~

~~Where t_M in the lower part of side frames, as defined in Fig. III 1A-18, is equal to or less than t_{COAT}, shear strength check is to be carried out in accordance with the following.~~

~~The thickness $t_{REN,S}$, in mm, is the greater of the thicknesses $t_{REN,Sa}$ and $t_{REN,Sb}$ obtained from the shear strength check at sections a) and b) (see Fig. III 1A-19 and 1A.9.3(a)) given by the following, but need not be taken in excess of $0.75t_{S12}$:~~

~~(i) At sections a): $t_{REN,Sa}=\frac{1000k_s p_{fi,a}}{d_a \sin\phi \tau_a}$~~

~~(ii) At sections b): $t_{REN,Sb}=\frac{1000k_s p_{fi,b}}{d_b \sin\phi \tau_a}$~~

~~where:~~

~~k_s = Shear force distribution factor, to be taken equal to 0.6~~

~~$P_{i,a}$, $P_{i,b}$ = Pressures forces defined in 1A.9.3(a)(i).~~

~~d_a, d_b = Bracket and frame web depth, in mm, at sections a) and b), respectively (see Fig. III 1A-19); in case of separate (non integral) brackets, d_b is to be taken as the minimum web depth deducing possible scallops.~~

~~ϕ = Angle between frame web and shell plate.~~

~~τ_a = Allowable shear stress, in N/mm^2, defined in 1A.9.3(b).~~

~~(d) Bending strength check~~

~~Where the lower bracket length or depth does not meet the requirements in 1A.3.4, the actual section modulus, in cm^3, of the brackets and side frames at sections a) and b) is to be not less than:~~

~~(i) At section a): $Z_a=\frac{1000p_{fi,a}h}{m_a\sigma_a}$~~

~~(ii) At section b): $Z_b=\frac{1000p_{fi,b}h}{m_b\sigma_a}$~~

~~where:~~

~~$p_{fi,a}$ = Pressures force defined in 1A.9.3(a)(i).~~

~~h = Side frame span, in m, defined in Fig. III 1A-18.~~

~~σ_a = Allowable normal stress, in N/mm^2, defined in 1A.9.3(b).~~

~~m_a, m_b = Bending moment coefficients defined in Table III 1A-2.~~

~~The actual section modulus of the brackets and side frames is to be calculated about an axis parallel to the attached plate, based on the measured thicknesses. For pre-calculations, alternative thickness values may be used, provided they are not less than:~~

~~- t_{REN}, for the web thickness.~~
~~- the minimum thicknesses allowed by the Society renewal criteria for flange and attached plating.~~

~~The attached plate breadth is equal to the frame spacing, measured along the shell at midspan of h.~~

~~If the actual section moduli at sections a) and b) are less than the values Z_a and Z_b, the frames and brackets are to be renewed or reinforced in order to obtain actual section moduli not less than $1.2\,Z_a$ and $1.2\,Z_b$, respectively.~~

~~In such a case, renewal or reinforcements of the flange are to be extended over the lower part of side frames, as defined in Fig. III 1A-18.~~

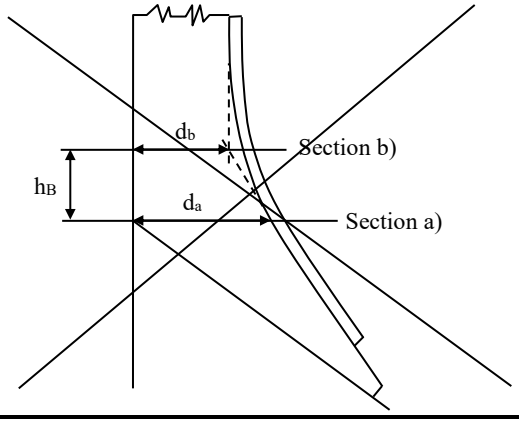
~~**Table III 1A-2**~~
~~**Bending Moment Coefficients m_a and m_b**~~

	m_a	m_b		
		$h_B = 0.08h$	$h_B = 0.1h$	$h_B = 0.125h$
Empty holds of ships approved to operate in non-homogeneous loading conditions	10	17	19	22
Other cases	12	20	22	26

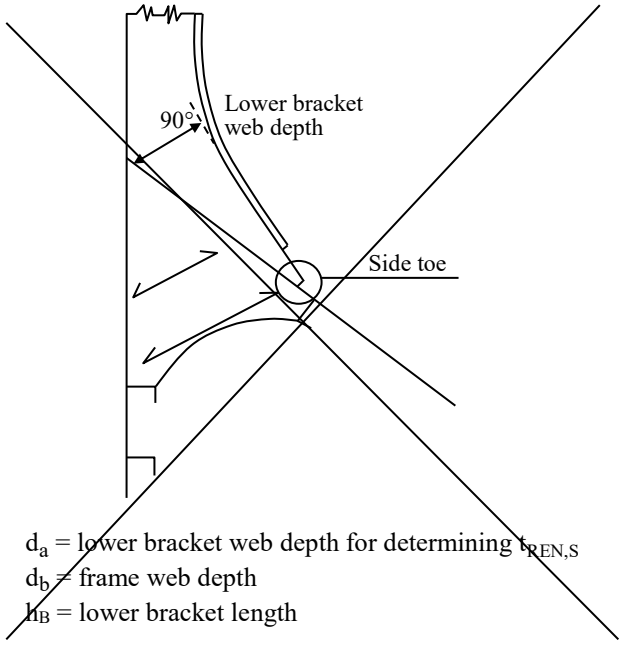
~~Notes:~~

~~(1) Non homogeneous loading condition means a loading condition in which the ratio between the highest and the lowest filling ratio, evaluated for each hold, exceeds 1.20 corrected for different cargo densities.~~

~~(2) For intermediate values of the bracket length hB, the coefficient mb is obtained by linear interpolation between the table values.~~

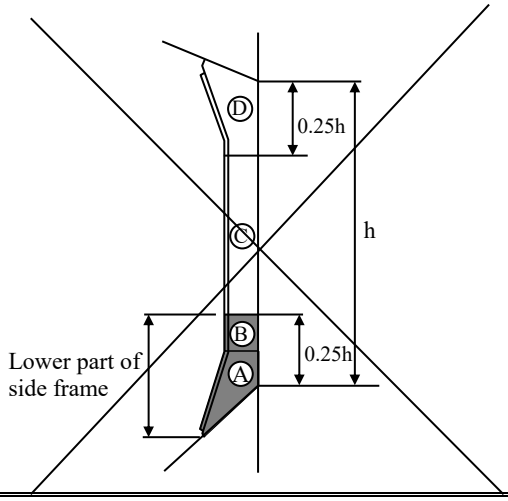


~~**Fig. III 1A-18**~~
~~**Lower Part and Zones of Side Frames**~~

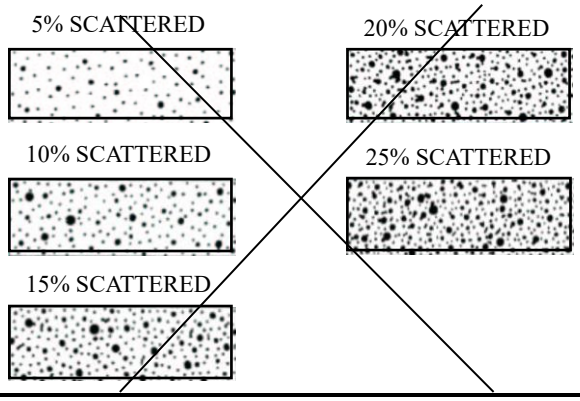


d_a = lower bracket web depth for determining $t_{REN,S}$
d_b = frame web depth
h_B = lower bracket length

~~**Fig. III 1A-19**~~
~~**Sections a) and b)**~~



~~Fig. III 1A-20~~
~~Definition of the Lower Bracket Web Depth for Determining $t_{REN,d/t}$~~



~~Fig. III 1A-21~~
~~Pitting Intensity Diagrams (from 5% to 25% Intensity)~~

Chapter 2A Double Hull Tankers

Paragraph 2A.2.2(c)(iii) has been amended as follows:

2A.2 Tank Arrangement

2A.2.2 Subdivisions and stability

(c) Oil tankers are to be regarded as complying with the damage stability criteria of the following requirements as shown (i) to (v) are met:

(iii) It may be regarded as sufficient if the righting lever curve has at least a range of 20 degrees beyond the position of equilibrium in association with a maximum residual righting lever of at least 0.1 m within the 20 degrees range. The area within this range below the curve is to be 0.0175 ~~m-radian~~ meter-radians or more. Except for the case in which the relevant compartments are assumed flooded, unprotected openings are to be assumed not to immerse. Within this range, all openings listed in (i) and other openings which can be closed with a weathertight cover may be accepted by the Society.

Chapter 4 Liquefied Gas Carriers

Section 4.1 has been amended as follows:

4.1 General

4.1.1 This Chapter applies to ships classed for the carriage in bulk of liquefied gases having an absolute vapor pressure exceeding 0.28 MPa (2.8 kgf/mm^2) at a temperature of 37.8°C. Where permitted by the class notations assigned to the ship, certain other substances may also be carried.

4.1.2 Except otherwise provided by this Chapter, the ship's hull, machinery and equipment are generally to comply with the requirements in relevant Parts of the Rules.

4.1.3 In addition to the applicable requirements of the Rules, the ship is to comply with the requirements of the CR Guidelines for Ships Carrying Liquefied Gases in Bulk (hereinafter referred to as 'CR LGC Guidelines') which incorporate the full text of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) and amendments in force. ~~International Maritime Organization (IMO) Resolution MSC.5(48) "International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk" (hereinafter referred to as IGC Code), adopted on 17 June 1983 and amendments in force, except that the requirements for personnel, operating and as prescribed in 4.1.4 are not within the scope of classification.~~

~~4.1.4 The following requirements of IGC Code are not classification requirements, however, when the Society is authorized to issue an "International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk" under provisions of IGC Code 1.5, and carries out surveys on behalf of an Administration, all requirements are to be applied:~~

~~- 2.2 Freeboard and stability~~
~~- 2.3 Damage and flooding assumptions~~
~~- 2.4 Survival requirements~~
~~- 2.5 Standard of damage~~
~~- 2.6 Location of cargo tanks~~
~~- 2.7 Special consideration for small ships~~

4.1.4 The IGC Code contains requirements for surveys and certification, ship survival capability, location of cargo tanks and fire protection and fire extinction, personnel protection and operational matters which are not within the scope of classification as defined in the 4.1.5 of this Chapter. However, these matters are the responsibility of the Administration responsible for issuing the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk.

4.1.5 When authorised to issue an International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk, the Society will also be required to verify that the Ship Survival Capability and Location of Cargo Tanks requirements contained in Chapter 2 and the fire protection and fire-extinction requirements contained in Chapter 11 and personnel protection requirements contained in Chapter 14 of CR LGC Guidelines have been complied with in addition to classification requirements. On request, such investigations can also be carried out for or on behalf of an Administration which has not authorised the Society to issue an International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk. When requested, the Society will also issue a Statement of Compliance with respect to all or part of the IGC Code for the purpose of confirming to the Administation that the ship complies fully with the applicable requirements, as interpreted by the Society.

4.1.6 Where, for the purpose of issuing an International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk, the Administration has specifically accepted an equivalent under the terms of 1.3 Equivalents of CR LGC Guidelines, or has adopted an interpretation different from that quoted by the Socity in the Rules, individual

consideration will be given to acceptance of the equivalent or interpretation concerned for the purposes of classification, where applicable.

~~4.1.5~~4.1.7 Gas carriers also intended for carriage of oil are to comply with the rules for oil tankers, Chapter 2 of this Part.

~~4.1.6~~4.1.8 Gas carriers also intended for carriage of dangerous liquid chemical cargoes in bulk are to comply with the rules for chemical carriers, Chapter 5 of this Part.

Section 4.2 has been amended as follows:

4.2 Class Notations

4.2.1 For ships for which an International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk has been issued by the Society in accordance with 4.1.5 of this Chapter, the ship type for survival capability and cargo tank arrangement (Type 1G, 2G, 2PG, and/or 3G) are to be included in the class notations.

4.2.2 ~~For ships for which the survival capability as prescribed in Chapter 2 of IGC Code has been approved by the Society in accordance with 4.1.4, the ship type for survival capability and cargo tank arrangement (Type 1G, 2G, 2PG, and/or 3G) are to be included in the class notations.~~The assignment of a Ship Type notation does not imply that the ship is suitable for all cargoes listed in Chapter 19 as requiring that Ship Type of the IGC Code. A list of products intended to be carried by the ship and noting the corresponding minimum special requirements is to be submitted to the Society for information.

~~4.2.1~~4.2.3 For ships to which the requirements in this Chapter applies, a ship type notation of **"Liquefied Gas Carrier"** is to be assigned in accordance with 1.4~~.5~~ of Part I. The following suffixes to the **"Liquefied Gas Carrier"** notation, which indicating the survival capability and cargo tank arrangement, cargo tank type and loading characteristics, etc. are to be curly-bracketed and each separated by a semicolon ";" and appended as applicable, e.g. : **Liquefied Gas Carrier{Type 2G; Independent tanks Type C; MARVS 4.9 bar gauge; Min. cargo temperature -104°C; RELIQ; APBU }**

(a) Survival capability and cargo tank arrangement

In accordance with the degree of protection against cargo leakage and the requirement for the distance between cargo tanks and shell plating, the following type will be appended respectively:

(i) Type 1G
(ii) Type 2G
(iii) Type 2PG
(iv) Type 3G

(b) Cargo tank type

In accordance with the type of cargo containment system, the following cargo tank type will be appended respectively:

(i) Independent tanks Type A
(ii) Independent tanks Type B
(iii) Independent tanks Type C
(iv) Integral tanks
(v) Membrane tanks
(vi) Semi-membrane tanks

(c) Cargo and loading characteristics

(i) Maximum allowable relief valve setting (MARVS), e.g.: **MARVS 4.9 bar gauge**.

(ii) Minimum and (where necessary) maximum cargo temperature, e.g.: **Min. cargo temperature -104°C**.

(d) Reliquefaction and/or refrigeration equipment

The suffix **RELIQ** is mandatory when reliquefaction and/or refrigeration equipment is fitted. The equipment is to be constructed, installed and tested in accordance with the requirements of Chapter 7 of CR LGC Guidelines and elsewhere in the Rules. The minimum temperature for which the installation is suitable will be that given in above (c)(ii) unless otherwise specified.

(e) Allowable Pressure Build-up (**APBU**)

The suffix **APBU** (maximum duration in days) will be assigned when the (design) vapour pressure allows the cargo to warm up during the duration of the voyage with the purpose of containing the boil-off gas (BOG) within the cargo tanks during normal operations. The insulation and the allowable maximum vapour pressure will be considered when determining the maximum voyage length at the ambient design temperatures stated in Chapter 7, 7.2 of CR LGC Guidelines. The given duration of voyage is to have a suitable margin, for the operating time and temperatures involved, which is to be acceptable to the Administration, see Chapter 7, 7.5 of CR LGC Guidelines. The design vapour pressure will be no greater than permitted by the definitions of containment systems in Chapter 4, 4.1.2 of CR LGC Guidelines. Compliance with relevant paragraphs of CR LGC Guidelines is required.

(f) Boil-Off Rate (**BOR**)

The suffix **BOR (x.x%)** may be assigned when the calculation of design boil-off rate per day is submitted for approval, if requested by the Owner.

4.2.4 In addition to the specific suffixes to the **"Liquefied Gas Carrier"** notation listed in 4.2.3 of this Chapter, at the request of the owner, other appropriate special suffix to the class notation will be assigned, provided that relevant rules, guidelines of the Society and other acceptable standards and the requirements equivalent thereto are complied with.

4.3 Submission of Plans and Data

Paragraph 4.3.4~4.3.18 have been added as follows:

4.3.4 In addition to the plans required by above 4.3.2 and 4.3.3 of this Chapter, the following plans and data are to be submitted, where applicable.

(a) Full particulars of the intended cargo or cargoes and its properties, including flashpoint, maximum vapor pressure, minimum and, if necessary, maximum temperature, loading and carriage procedures and other relevant design conditions.

(b) General arrangement showing location of cargo tanks and the relative location of fuel oil, water ballast and other tanks.

(c) Openings in main deck.

(d) Location of void spaces and dangerous zones – openings and access arrangements.

(e) Details of hull structure in way of cargo tanks, including support arrangements for tanks and associated pipes and fittings, deck sealing arrangements, etc.

(f) Distribution of quality and grade of steel, supported by calculations of the determined hull steel temperature. The steel grade and temperature in regions where cold spots are likely to occur (e.g. pump supports and where pipes pass through the deck) are also to be indicated.

(g) Scantlings, materials, and arrangements of the cargo containment system, including primary and (where fitted) secondary barriers, keying and support arrangements, and attachments of fittings, piping, etc.

(h) Ladders, suction supports and towers inside cargo tanks (arrangements, materials and loadings).

(i) Tank dome plans.

(j) End coamings around dome.

(k) Particulars of filling, discharging, venting, relieving and inerting arrangements.

(l) Details of test procedures.

(m) Temperature control arrangements.

(n) Such information and data as may be required to enable analysis of the hull and containment system structure to be carried out by direct calculation methods.

(o) Details of personnel protection equipment to be included on the safety plan as applicable to the ship.

(p) Assumptions and details of direct calculations procedures used in the structural analysis of the hull.

(q) Where horizontal and vertical girders are used to support the bulkhead, the bulkhead scantlings may be determined using direct calculation procedures. The assumptions made and the calculations are to be submitted.

4.3.5 The following plans and particulars for Type C independent tanks are to be submitted for approval before construction is commenced:

(a) Nature of cargoes, together with maximum vapour pressures and minimum liquid temperature for which the pressure vessels are to be approved, and proposed hydraulic test pressure.

(b) Particulars of materials proposed for the construction of the vessels.

(c) Particulars of refrigeration equipment.

(d) General arrangement plan showing location of pressure vessels in the ship.

(e) Plans of pressure vessels showing attachments, openings, dimensions, details of welded joints and particulars of proposed stress relief heat treatment.

(f) Plans of seating, securing arrangements and deck sealing arrangements.

(g) Plans showing arrangement of mountings, level gauges and number, type and size of safety valves.

4.3.6 Details of the arrangements proposed to ensure that the tank or cargo temperature cannot be lowered below the minimum design temperature required by 4.1.3 of CR LGC Guidelines.

4.3.7 Plans showing filling, discharging, venting and inerting pipe arrangements, together with particulars of the intended cargo, maximum vapour pressure and minimum liquid temperature.

4.3.8 When partial filling of tanks is contemplated for seagoing conditions an assessment of the tank boundaries is to be made. Details of calculations and/or model tests are required.

4.3.9 Allowable stresses of any materials not covered by Chapter 6 required by 4.18.1.5 of CR LGC Guidelines.

4.3.10 Details verifying compliance with the periodical examination of the secondary barrier required by 4.5 of CR LGC Guidelines, if applicable.

4.3.11 Details of the heating system of the hull structure required by 4.19.1.5 and 4.19.1.6 of CR LGC Guidelines, if fitted.

4.3.12 For the acceptance of increased filling limit as per 15.4 of CR LGC Guidelines, submission of detailed documentation to demonstrate compliance with requirements as indicated in 15.4.1 of CR LGC Guidelines or suitable equivalent arrangements.

4.3.13 A document specifying the maximum allowable loading limits for each cargo tank and product, at each applicable loading temperature and maximum reference temperature, is to be submitted for approval in accordance with 15.6.1 of CR LGC Guidelines where CR is acting on behalf of the Administration. The pressures at which the pressure relief valves (PRVs) have been set, shall also be stated in the document in accordance with 15.6.2 of CR LGC Guidelines.

4.3.14 The cargo system operation manuals are to be submitted for approval in accordance with 18.2.1 of CR LGC Guidelines where CR is acting on behalf of the Administration.

4.3.15 Specification and plans of the containment system are to be submitted for approval. Plans are to include:

(a) Details of insulation material and if used any adhesive, sealers, coatings or similar products.

(b) Details of non-metallic materials.

(c) Details of insulation arrangement.

(d) Internal bearers or steelwork.

(e) Tank supports, chocks, etc.

(f) Hatch trunks.

(g) Attachment and support of insulation and linings.

(h) Data and information to enable a heat leakage calculation to be carried out to assess the capacity of the arrangements provided to deal with boil-off including:

(i) Thermal conductivity of insulation between upper ambient and design temperatures.

(ii) Details of reliquefaction/refrigeration plant duty or maximum allowable boil-off rate for each cargo.

(i) The proposed procedure for fabrication, storage, handling, erection, quality control and control against harmful exposure to sunlight of insulation materials.

(j) Calculations and/or analysis of strength of insulation where it is subjected to high mechanical or thermal loads.

(k) Fatigue and crack propagation properties for insulation in membrane systems is also to be submitted.

4.3.16 Specifications of the containment system items are to include both those applicable to initial approval of the material, and those applicable to subsequent delivery of batches of material.

4.3.17 Plans illustrating the means of protection for the ship steelwork, e.g. drip trays, cladding, etc. at loading manifolds; deck tanks, cargo handling system, etc.

4.3.18 Additional Requirements

Additional requirements for information and plans for details of proposed system of cargo pressure/temperature control may be found in the appropriate Chapters of the Rules (see 1.4 of Part X).

Chapter 11 Tugs

Paragraph 11.7.5(f) has been amended as follows:

11.7 Towing Arrangement

11.7.5 Towing winch

(f) ~~Emergency release~~Towing winch emergency release systems

~~The winch is to be designed to allow drum release in an emergency, and in all operational modes.~~

~~The release capabilities are to be as specified on towing arrangement drawing.~~

~~The action to release the drum is to be possible locally at the winch and from a position at the bridge with full view and control of the operation. Identical means of equipment for the release operation to be used on all release stations.~~

~~After an emergency release the winch brakes are to be in normal function without delay. It shall always be possible to carry out the emergency release sequence (emergency release and/or application of brake), even during a black-out.~~

~~Control handles, buttons etc. for emergency release are to be protected against unintentional operation.~~

The requirements of towing winch emergency release systems are to be complied with IACS UR M79.

Chapter 12 Fire-fighting Ships

Section 12.8 has been added as follows:

12.8 Stability

12.8.1 General

The intact stability of each ship fitted with water monitors for fire fighting operation is to be evaluated for the loading conditions indicated in 12.8.2 of this Chapter for compliance with the intact stability criteria in 12.8.3 of this Chapter, and the results are to be submitted for review and approval.

12.8.2 The following conditions of loading are to be examined in the Trim and Stability Booklet:

(a) Ship at the maximum Load Line draft, with full stores and fuel and fully loaded with all liquid and dry cargo distributed below deck and with remaining deadweight distributed as above deck cargo (specified by weight, LCG, VCG and total height above deck) corresponding to the worst service departure condition in which all the relevant stability criteria are met.

(b) Ship with 10% stores and fuel and fully loaded cargoes of (a) above, arrival condition.

(c) Ship with full stores and fuel and loaded with the maximum design deck cargo (specified by weight, LCG, VCG and total height above deck) and with remaining deadweight distributed below deck in liquid and dry cargo spaces corresponding to the worst service departure condition in which all the relevant stability criteria are met.

(d) Ship with 10% stores and fuel and fully loaded cargoes of (c) above, arrival condition

(e) Ship with full stores and fuel in ballast departure condition.

(f) Ship with 10% stores and fuel in ballast arrival condition.

(g) Ship in the worst anticipated operating condition (i.e., arrival condition with deck cargo only – 100% deck cargo with 10% stores and fuel).

On a case-by-case basis, specific loading conditions may be excluded if it can be shown that the conditions are not applicable to a specific ship type and/or operation.

12.8.3 Intact Stability Criteria

(a) Fire Fighting Operations

Each ship is to have adequate stability for all loading conditions, with all fire fighting monitors operating at maximum output multiplied by a factor of 1.1 of this Chapter in the direction most unfavorable to the stability of the ship. The thruster(s) are to be considered operating at the power needed to counter-act that force. For the calculation purposes, the total thruster force should be vertically located at the location of the lowest available thruster (see Fig. III 12-1).

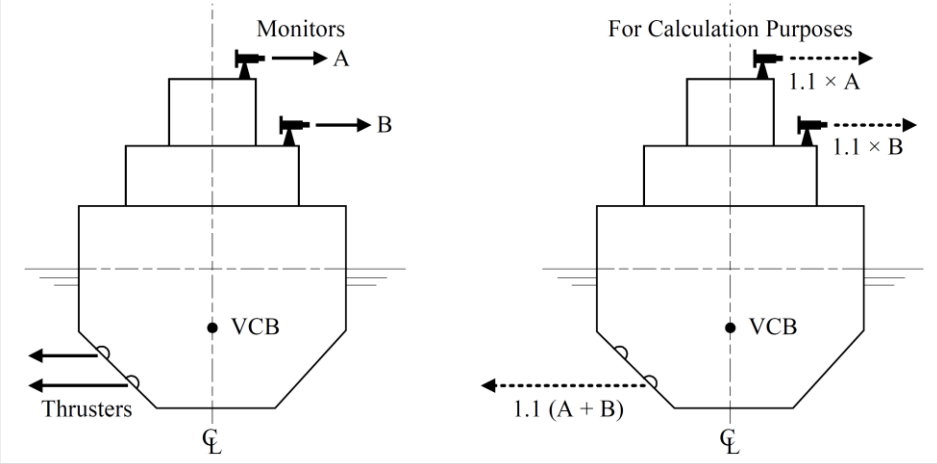


Fig. III 12-1
Heeling Moments – Fire Fighting Operations

The heeling moment due to the operation of all fire fighting monitors and thrusters is to be converted to a heeling arm, and superimposed on the righting arm curve of each loading condition. The first intercept must occur before half of the freeboard at amidships is submerged. The area of the residual stability (area between the righting arm and heeling arm curves beyond the angle of the first intercept) up to an angle of heel 40° beyond the angle of the first intercept; or the angle of downflooding if this angle is less than 40° beyond the angle of the first intercept, should not be less than 0.09 meter-radians (see Fig. III 12-2).

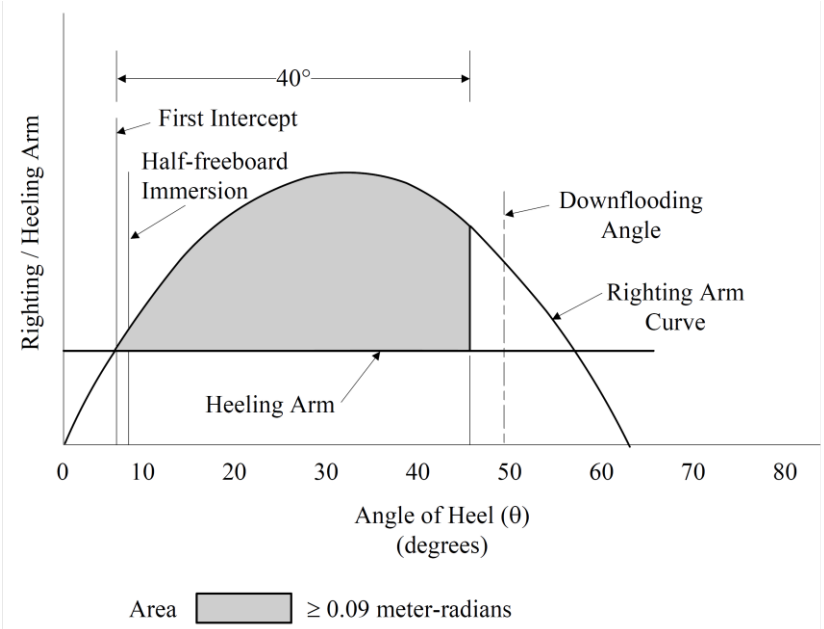


Fig. III 12-2
Righting Arm and Heeling Arm Curves

12.8.4 Stability Guidance for the Master

(a) The Master of the ship should receive information in the Trim and Stability Booklet regarding cargo limitations, list of protected flooding openings that need to be kept closed, wind and/or wave restrictions, etc., necessary to ensure that the stability is in compliance with the criteria given in 12.8.3 of this Chapter.

(b) If any loading condition requires water ballast for compliance with the criteria in 12.8.3 of this Chapter, the quantity and disposition should be stated in the guidance to the Master.

Chapter 16 Offshore Service Vessels

16.2 Offshore Service Vessels

Paragraph 16.2.2(b)~(c) has been amended as follows:

16.2.2 Hull

(b) Hull local scantling

(i) Yield check of plating and stiffeners

General reference is given to Chapters 6A and 7 of Part II (L≧90 m) or Chapters 6 and 8 of Part XV (L <90m) for prescriptive requirements to stiffeners and plating respectively. For wheel loading from cargo handling/transporting vehicles, reference is given to Chapter 6 of this Part.

Additional hull local scantling requirements for offshore service vessels are given in 16.2.2(c) to 16.2.2(f) as below.

(c) Ship's sides and stern

(i) Longitudinal steel fenders are to be fitted on the ship's sides at freeboard cargo deck and the second deck above. The fenders are not to extend less than 0.02L forward of the section where the deck has its full breadth.

……

(iii) The net section modulus, in cm^3, of transverse stiffeners or side longitudinals is not in any region to be less than:

$$Z_1 = 1.15Z$$

where Z is the required net section modulus, in cm^3, as given in Chapters 6A and 12 of Part II (L≧90m) and Chapters 6 and 13 of Part XV (L <90m).

All stiffeners up to the second deck above the freeboard deck, and forward of 0.2L from the forward perpendicular up to the forecastle deck, are to have end connections with brackets.

(iv) Non-continuous welds are not to be used in connections between stiffeners and shell plating.

Paragraph 16.2.3(a)(iii) has been amended as follows:

16.2.3 Hull local scantling for ships assigned class notation **OSV–Harsh Weather**.

(a) Ship's sides and stern

(iii) The net section modulus, in cm^3, of transverse stiffeners or side longitudinals up to the second deck above the freeboard deck is not to be less than:

$$Z_1 = 0.0014\, L_{90}\, l_e\, s\, K$$

or, if steel fenders are omitted:

$Z_1 = 0.0023\ L_{90}\ l_e\ s\ K$

The net section modulus, in cm^3, of transverse stiffeners or side longitudinals is to, however, not in any region be taken less than:

$Z_{min} = 1.25Z$

where:

Z = Required net section modulus, in cm^3, as given in Chapters 6A and 12 of Part II (L ≧ 90m) and Chapters 6 and 13 of Part XV (L < 90m).

L_{90} = Length of ship as specified in 1.2.1 of Part II, but need not be taken greater than 90 m.

l_e = Effective bending span of stiffener, in m, as defined in CSR-H Pt.1 Ch.3 Sec.7 [1.1.2], where the notation l_{bdg} is employed

s = Stiffener spacing in mm, as defined in CSR-H Pt.1 Ch.3 Sec.7 [1.2.1]

K = Material factor as specified in 1.5.2(a) of Part II

The requirement for Z_1 given above refers to the ship's sides, which have an inclination to the vertical (along the ship's depth) less than 15°. For greater inclinations, the requirement given for Z_{min} is to be applied.

All stiffeners up to the second deck above the freeboard deck, and stiffeners forward of 0.2L from F.E. up to forecastle deck, are to have end connections with brackets.

Paragraph 16.2.5(e) has been amended as follows:

16.2.5 Stability

(e) Damage stability for ships assigned class notation **Damage Stability** ~~**OSV-DS**~~

Paragraph 16.4.2(a)(i) has been amended as follows:

16.4 Standby Vessels

16.4.2 Hull

(a) Ship's sides

(i) The net section modulus of transverse stiffeners or side longitudinals, in cm^3, is not, in any region, to be less than:

$Z_1 = 1.25Z$

where Z is the net section modulus, as given in Chapters 6A and 12 of Part II (L≧90m) and Chapters 6 and 13 of Part XV (L <90m).

All stiffeners up to the second deck above the freeboard deck, and forward of 0.2L from F.E. up to forecastle deck, are to have end connections with brackets.

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022"

PART IV MACHINERY INSTALLATIONS－CONSTRUCTION AND SHAFTING

List of major changes in Part IV from 2022 edition

1.3.2	Revised
1.6.3	Revised
4.1.5(a)(iii)	Revised
4.2.17	Revised
4.3.10(e)(ii)	Revised
4.5.5	Revised
4.6.3(g)(iii)	Revised
Table IV 4-2	Revised
4.7.2(a)(iii)&(v)	Revised
4.7.3	Revised
4.7.4	New
4.7.4	Renumbered and Revised

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 1 General

Paragraph 1.3.2 has been amended as follows:

1.3 Essential Service Auxiliaries

1.3.2 Auxiliaries include their prime movers and controllers which are necessary for the propulsion of the ship:

Cooling pumps.

General service pumps.

Auxiliary machinery for fuel oil systems: F.O. supply (service) pumps, F.O. transfer pumps, boiler burning pumps, F.O. purifiers.

Auxiliary machinery for lubricating oil systems: camshaft L.O. pumps, turbocharger L.O. pumps, crosshead L.O. pumps, reduction gear L.O. pumps, stern tube L.O. pumps, (not applicable for gravitational circulation systems), L.O. purifiers.

Fuel gas supply pumps, low duty gas compressor and other boil-off gas treatment facilities supporting boil-off gas usage as fuel to main propulsion or electric power generation machinery.

~~Fuel pumps.~~

~~Lubricating oil pumps.~~

~~Purifiers.~~

Hydraulic pumps (for control use).

Air compressors (for starting and control use).

Scavenging pumps, blowers and exhaust gas turbochargers.

Condensate pumps.

Drain pumps.

Circulating cooling water pumps.

Condenser ejector pumps.

Gland exhaust fans.

Boiler feed water pumps.

Boiler water circulating pumps.

Boiler fans.

Electric generators.

Evaporators (for main propelling machinery and boiler use).

Paragraph 1.6.3 has been amended as follows:

1.6 General Construction

1.6.3 Astern powers for main propulsion

~~The machinery built for propulsion purposes are to be of sufficient power for going astern in order to secure proper control of the ship in all normal circumstances. The astern power is to be of sufficient for maintaining in free route astern 70% of the ahead rated shaft revolutions for a period of at least 30 minutes. The output astern which may be developed in transient conditions is to be such as to enable the braking of the ship within a reasonable time. For main propulsion systems with reversing gear, controllable pitch propellers or electric propulsion equipment, the running astern is not to lead to the overload of the propulsion machinery.~~

(a) In order to maintain sufficient maneuverability and secure control of the ship in all normal circumstances, the main propulsion machinery is to be capable of reversing the direction of thrust so as to bring the ship to rest from the maximum service speed. The main propulsion machinery is to be capable of maintaining in free route astern at least 70% of the ahead revolutions.

Note:

The ahead revolutions as mentioned above are understood as those corresponding to the maximum continuous ahead power for which the ship is classed.

(b) Where steam turbines are used for main propulsion, they are to be capable of maintaining in free route astern at least 70% of the ahead revolutions for a period of at least 15 minutes. The astern trial is to be limited to 30 minutes or in accordance with manufacturer's recommendation to avoid overheating of the turbine due to the effects of "windage" and friction.

(c) For the main propulsion systems with reversing gears, controllable pitch propellers or electric propeller drive, running astern should not lead to the overload of propulsion machinery.

(d) Main propulsion systems are to undergo tests to demonstrate the astern response characteristics. The tests are to be carried out at least over the maneuvering range of the propulsion system and from all control positions. A test plan is to be provided by the yard and accepted by the Surveyor. If specific operational characteristics have been defined by the manufacturer these shall be included in the test plan.

(e) The reversing characteristics of the propulsion plant, including the blade pitch control system of controllable pitch propellers, are to be demonstrated and recorded during trials.

Chapter 4 Deck Machinery and Essential Auxiliaries

4.1 General

Paragraph 4.1.5(a)(iii) has been amended as follows:

4.1.5 Materials

(a) For steering gear

(iii) Ram cylinders, pressure housings of rotary vane type actuators, hydraulic power piping, valves, flanges and fittings; and all steering gear components transmitting mechanical forces to the rudder stock (such as tillers, quadrants, or similar components) are to be of steel or other approved ductile material, duly tested in accordance with the requirements of Part XI. In general, such material is to have an elongation of not less than 12 per cent nor a tensile strength in excess of 650 N/mm^2. ~~Special consideration will be given to the acceptance of grey cast iron for valve bodies and redundant parts with low stress levels.~~

Paragraph 4.2.17 has been amended as follows:

4.2.17 Design

(a) The construction should be such as to minimize local concentrations of stress.

(b) Welds

(i) The welding details and welding procedures should be approved.

(ii) All welded joints within the pressure boundary of a rudder actuator or connecting parts transmitting mechanical loads should be full penetration type or of equivalent strength.

(c) Oil seals

(i) Oil seals between non-moving parts, forming part of the external pressure boundary, should be of the metal upon metal type or of an equivalent type.

(ii) Oil seals between moving parts, forming part of the external pressure boundary, should be duplicated, so that the failure of one seal does not render the actuator inoperative. Alternative arrangements providing equivalent protection against leakage may be accepted at the discretion of the Society.

(d) All steering gear components transmitting mechanical forces to the rudder stock, which are not protected against overload by structural rudder stops or mechanical buffers, are to have a strength at least equivalent to that of the rudder stock in way of the tiller.

(e) Friction connections between steering gear and rudder stock, with or without key, shall comply with the following:

(i) Tapered contact area shall be evenly distributed and shall not be less than 70% of total contact area.

(ii) If oil (or similar) is used for fitting, the design shall enable escape of oil from between the mating surfaces. Where necessary tapered connections shall be provided with suitable means to facilitate dismantling of the hub (e.g. oil grooves and bores to connect hydraulic injection pump).

(iii) Tapered connections shall be secured against axial displacement between rudder stock and steering gear by means of a nut properly tightened and secured to the shaft.

(fe) Rudder actuators other than those covered by 4.2.15 and relating IMO Guidelines are to be designed in accordance with Group I pressure vessels (notwithstanding any exemptions for hydraulic cylinders).

(gf) In application of such rules the permissible primary general membrance stress is not to exceed the lower of the following values:

$\frac{\sigma_B}{A}$ or

$\frac{\sigma_Y}{B}$

where:

σB = Specified minimum tensile strength of material at ambient temperature

σY = Specified minimum yield stress or 0.2% proof stress of the material, at ambient temperature

A, B = A and B are as follows:

	Steel	Cast steel	Nodular cast iron
A	3.5	4	5
B	1.7	2	3

(hg) The design pressure is to be at least equal to the greater of the following:

(i) 1.25 times the maximum working pressure,

(ii) the relief valve setting.

(ih) Accumulators, if any, are to comply with requirements for pressure vessels in Part V of the Rules.

Paragraph 4.3.10 has been amended as follows:

4.3.10 Shop Tests and Inspection

The windlass and cable lifter unit are to be inspected during fabrication at the manufacturers' facilities by a Surveyor for conformance with the approved plans. Acceptance tests, as specified in the specified standard of compliance, are to be witnessed by the Surveyor and include the following tests, as a minimum. The test results are to be recorded.

(a) "No-load Test": The windlass is to be run without load once in normal and once in reverse directions, for a sum of 30 minutes, under the rated voltage at the speed of rotation equivalent to the rated speed. When the windlass is provided with a gear change, an additional 5 min similar test is to be carried out for each additional gear change.

During the test, the following items are to be checked or measured:

(i) tightness against oil leakage;

(ii) temperature of bearings;

(iii) pressure of abnormal noise.

(b) "Load Test": The windlass is to be tested to verify that the continuous duty pull, overload capacity and hoisting speed as specified in 4.3.3 can be attained. Where the manufacturing works does not have adequate facilities, these tests, including the adjustment of the overload protection, can be carried out on board ship. In these cases, functional testing in the manufacturer's works is to be performed under no-load conditions.

(c) Brake capacity test. The holding power of the brake is to be verified either through testing or by calculation.

(d) "Cable Lifter Brake Test": The holding power of the cable lifter brake is to be verified. The cable lifter brake is also to be tested with the anchor dropping, operated onboard with the holding load controlled and sustained by applying the brake at each half length of the chain.

(e) Performance Tests

(i) When provided with the remote control or other special device, their performances are to be verified.

(ii) The function of the automatic control brake system for electric windlass is to be tested at the manufacturer’s shop of the electric motor, see 9.3 of Part VII.

(iii) The clutch and slipping clutch (for electric windlass) are to be tested to verify their performance.

4.5 Pumps

Paragraph 4.5.5 has been amended as follows:

4.5.5 Hydrostatic tests

Pump casing ~~housings~~, except those for cargo oil pumps, shall be hydrostatically tested at a pressure of 1.5 times the design pressure.

Cargo oil pumps shall be tested to 1.3 times the design pressure, with a minimum of 14 bar. For centrifugal pumps the design pressure shall be the design pressure head on the head-capacity curve. For displacement pumps the design pressure shall not be taken less than the relief valve opening pressure.

The steamside of steam-driven pumps shall be hydraulically tested to 1.5 times the steam pressure.

Hydrostatic testing of pump casing ~~housings~~ on submerged pumps may not be required.

Paragraph 4.6.3(g)(iii) has been amended as follows:

4.6.3 Design

(g) Arrangements

(iii) Independent source of power(applies to steering propulsion units having certain proven steering capability due to ship speed also in case propulsion power has failed)

Where the propulsion power exceeds 2,500 kW per thruster unit, an alternative power supply, sufficient at least to supply the steering arrangements which complies with the requirements of 4.6.3(g)(ii)(1)b) above and also its associated control system and the steering system response indicator, is to be provided automatically, within 45 seconds, either from the emergency source of electrical power or from an independent source of power located in the steering gear compartment. This independent source of power is to be used only for this purpose. In every ship of 10,000 gross tonnage and upwards, the alternative power supply is to have a capacity for at least 30 minutes of continuous operation and in any other ship for at least 10 minutes.

4.7 Tests and Inspections

4.7.1 Hydraulic pressure tests

Hydraulic pressure tests on deck machinery and pump parts after machining are to be carried out in the presence of the Surveyor under the conditions specified in Table IV 4-2.

Table IV 4-2 has been amended as follows:

Table IV 4-2
Hydraulic Test Pressure on Deck Machinery and Pump Parts

Parts to be Tested	Test Pressure, MPa
Steering gear:	
Steam reciprocating steering engine.	See 2.9.1 of this Part.
Hydraulic steering gear, pump case, cylinder etc.	1.5 W or W + 7, whichever is smaller.
Windlass:	
Steam reciprocating windlass engine.	See 2.9.1 of this Part.
Diesel windlass engine.	See 3.10.1 of this Part.
Hydraulic pump and motor.	1.5 W or W + 7, whichever is smaller.
Reciprocating compressors:	
Air Compressor:	
Cylinder, liner, cover, inter- and after-coolers.	
Compressed air side.	1.5 W
Cooling water space.	0.4 but not less than 1.5 W
Refrigerant compressor.	See Part X
Pump:	
Pump prime mover, steam or diesel engine.	See 2.9.1 and 3.10.1 of this Part.
Pump casing.	~~0.4 but not less than 1.5 W.~~ See 4.5.5 of this Part.
Piping:	
Group-I and -II pipes and fittings.	See Part VI.
Where: W = Design pressure and/or maximum working pressure for the respective parts, in MPa.	

Paragraph 4.7.2 has been amended as follows:

4.7 Tests and Inspections

4.7.2 Shop trials

(a) The following operational tests are to be carried out at the manufacturer's workshop in the presence of the Surveyor:

(i) For the steering gear: Characteristic tests of hydraulic pump units, if used. Running tests of steering gear. Adjustments and tests of safety devices and brake arrangements. Each new design power unit pump for steering gear is to be type tested before come into the market. The type test is to be for a duration of not less than

100 hours, the test arrangements are to be such that the pump may run in idling conditions, and at maximum delivery capacity at maximum working pressure. During the test, idling periods are to be alternated with periods at maximum delivery capacity at maximum working pressure. The passage from one condition to another is to occur at least as quickly as on board. During the whole test no abnormal heating, excessive vibration or other irregularities are permitted. After the test, the pump is to be disassembled and inspected. Type tests may be waived for a power unit which has been proven to be reliable in marine service.

(ii) For the athwartship thruster: Running tests of thruster. Adjustment and tests of the control and monitoring systems.

(iii) For the windlass, see 4.3.~~6~~10 of this Part.

(iv) For the reciprocating compressor:

Running test for 2 hours and safety device test. Charging test for air compressor. Performance test for refrigerant compressor if deemed necessary by the Surveyor.

(v) For the pump : Characteristic tests with the pump running at designed condition. See 4.5.6 of this Part.

(b) The overhaul inspection after shop trial is to be carried out in the presence of the Surveyor. The range and extent of inspection are subject to the discretion of the Surveyor.

Paragraph 4.7.3 has been amended as follows:

4.7.3 On-board trials

(a) For the steering gear: After installation on board the ship, and prior to seatrial the steering gear shall be subjected to the required hydrostatic and running tests. The steering gear is to be tried out ~~on the trial trip~~ in order to demonstrate to the Surveyor's satisfaction that the requirements of the Rules have been met.
The test shall as a minimum comprise of:

(i) hydrostatic testing:

(1) parts of steering gear that has not been pressure tested at workshop shall be tested at 1.5 times design pressure

(2) assembly shall be tested at minimum 1.5 times maximum working pressure

(ii) function testing of the steering gear

(iii) testing alarms and indicators

(iv) autostart test of power units

(v) testing all start and stop functions

(vi) test control transfer between bridge and local control

(vii) test safety valve setting (if not performed during workshop test)

(viii) testing function and setting of overcurrent protection

(ix) test and check functions and settings in frequency converter (if applicable)

(x) checking mechanical rudder indicator.

On double rudder installations where the two units are synchronised by mechanical means, mutual adjustment shall be tested.

~~The trial is to include the operation of the following:~~

~~(i) The steering gear, including demonstration of the performances required by 4.2.2(b) and 4.2.3 (b). For the main steering gear trial, the propeller pitch of controllable pitch propellers is to be at the maximum continuous ahead RPM. If the vessel cannot be tested at the deepest draught, alternative trial conditions may be specially considered. In this case, for the main steering gear trial, the speed of the ship corresponding to the maximum continuous revolutions of the main engine is to apply;~~

~~(ii) The steering gear power units, including transfer between steering gear power units;~~

~~(iii) The isolation of one power actuating system, checking the time for regaining steering capability;~~

~~(iv) The hydraulic fluid recharging system;~~

~~(v) The emergency power supply required by 2.3.10 of Part VII;~~

~~(vi) The steering gear controls, including transfer of control and local control;~~

~~(vii) The means of communication between the steering gear compartment and the wheelhouse, also the engine room, if applicable;~~

~~(viii) The alarms and indicators;~~

~~(ix) Where the steering gear is designed to avoid hydraulic locking this feature is to be demonstrated.~~

~~Test items (iv), (vii), (viii) & (ix) may be effected at the dockside.~~

(b) For the windlass, an anchoring test is to be carried out in the presence of the Surveyor to demonstrate that the windlass with brakes, etc., functions satisfactorily and that the lifting power specified by the Rules can be developed. See 4.3.~~6~~11 of this Part.

(c) For the athwartship thruster, mooring winch and capstan, an on-board running under working condition, if available, is to be carried out in the presence of the Surveyor.

(d) For reciprocating compressor, the following on-board trials are normally to be carried out in the presence of the Surveyor:

(i) Running and charging.

(ii) Safety device adjusting and setting.

(e) For pumps, an on-board running under working condition is to be carried out in the presence of the Surveyor.

Paragraph 4.7.4 has been added as follows:

4.7.4 Sea trials

For the steering gear:

(a) The steering gear shall be tested on sea trial in order to demonstrate the function of the steering gear and that the rule requirements have been met.

The test and inspection items shall include as follows:

(i) Testing of steering gear function and capacity.

(ii) The steering gear power units, including transfer between steering gear power units.

(iii) The isolation of one power actuating system, checking the time for regaining steering capability.

(iv) The hydraulic fluid recharging system, if applicable.

(v) The emergency power supply required by 2.3.10 of Part VII;.

(vi) The steering gear controls, including transfer of control and local control.

(vii) The means of communication between the steering gear compartment and the wheelhouse. Also the engine room if applicable.

(viii) Where steering gear is designed to avoid hydraulic locking this feature shall be demonstrated.

(ix) Steering gear for over-balanced rudders or rudders of unconventional design (such as flap rudders, if applicable) shall additionally be tested turning the rudder over from maximum rudder angle on one side to maximum rudder angle on the other side and vice versa.

Test items (iv) and (viii) may be carried out and completed at the dockside.

(b) The trial shall be performed under the following operational conditions:

For ships complying with the Rules for Steel Ship:

(i) loaded on summer load waterline. If this can not be done alternative trial conditions may be specially considered. See (d) and (e) of this section.

(ii) For the main steering gear trial, the propeller pitch of controllable pitch propellers is to be at the maximum continuous ahead RPM. If the ship cannot be tested at the deepest draught, alternative trial conditions may be specially considered. In this case, for the main steering gear trial, the speed of the ship corresponding to the maximum continuous revolutions of the main engine is to apply;

For ships complying with the Rules for High-Speed Craft:

(i) full load condition

(ii) running ahead at maximum service speed.

(iii) both in calm water and, as far as practically possible, in a sea state corresponding to upper part of operational condition.

(c) A record of the steering gear parameters during test shall be presented to the attending surveyor. As minimum the following parameters shall be logged: ship speed and propulsion engine speed, steering angle, hydraulic pressure and time used for moving of rudder as defined.

(d) When performance test is carried out at reduced draught with partly submerged rudder, calculations showing corresponding rudder force and torque for the trials shall be submitted on request. Acceptable methods for the extrapolation to deepest seagoing draught are described in IACS UI SC246, Rev.1.

(e) Ships fitted with semi-spade rudders shall be tested with the rudders completely submerged. However, when satisfactory results are proved by sister ships, tests according to (d) above with partly submerged rudder may be accepted.

Calculations of the expected rudder force and torque for the trials shall be submitted.

If test results for sister ships are not available, steering gear test with rudder partly submerged may be accepted upon special consideration in each case.

Paragraph 4.7.4 has been renumbered and amended as follows:

4.7.5~~4~~ Alternative proposals will be specially considered where any of the tests required by 4.7.2 and 4.7.4~~3~~ above are considered impracticable.

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022"

PART V BOILERS, PRESSURE VESSELS, THERMAL OIL HEATERS AND INCINERATORS

List of major changes in Part V from 2022 edition

1.1.4	Revised
7.1.4	New

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 1 General Requirements

1.1 General

Paragraph 1.1.4 has been amended as follows:

1.1.4 Design pressure

(a) Design pressures are those pressure used in the calculations made to determine the scantlings of each component and are the maximum allowable working pressure of a component. Design pressures of boiler drums are not to be less than the approved working pressure of their respective boilers.

~~The design pressure of a boiler or a pressure vessel is the maximum allowable working pressure and is to be not less than the highest set pressure of any safety valve.~~

(b) The Maximum Allowable Working Pressure (MAWP) of a boiler or pressure vessel is the maximum pressure permissible at the top of the boiler or pressure vessel in its normal operating condition and at the designated coincidental temperature specified for that pressure. It is the least of the values found for MAWP for any pressure-bearing parts, adjusted for the difference in static head that may exist between the part considered and the top of the boiler or pressure vessel. MAWP is not to exceed the design pressure.

(~~b~~c) The calculations made to determine the scantlings of the pressure parts are to be based on the design pressure, adjust where necessary to take account of pressure variations corresponding to the most severe operational conditions.

(~~c~~d) It is desirable that there is to be a suitable margin between the normal pressure at which the boiler or pressure vessel operates and the lowest pressure at which any safety valve is set to lift, to prevent unnecessary lifting of the safety valve.

(~~d~~e) The design pressure of economizer is not to be less than the maximum working pressure of the economizer determined basing upon the maximum working pressure of the feed pump.

(~~e~~f) The design pressure of exhaust gas economizer is not to be less than the maximum working pressure of the exhaust gas economizer determined basing upon the maximum working pressure of the boiler water circulating pump.

(~~f~~g) In the design of a boiler or pressure vessel it may be necessary to take into account the effect of the following loading in addition to the design pressure:

Chapter 7 Incinerators

Paragraph 7.1.4 has been added as follows:

7.1 General

7.1.4 Incinerators shall be complied with the regulations of MEPC.244(66).

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022"

PART VI PIPING AND PUMPING SYSTEMS

List of major changes in Part VI from 2022 edition

3.7.4	Revised
4.1.2(a) & (h)	Revised
4.4.1(i)	New
4.5.1(i)	New
4.6.2	Revised
4.9	New
5.8.6(c)	Revised

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 3 Hull Piping Systems

Paragraph 3.7.4 has been amended as follows:

3.7.4 For propulsion machinery spaces, in addition to the 2 suctions as required under preceding 3.7.1 the following arrangement of the emergency bilge suction is to be fitted for the ship:

(a) A suction pipe fitted with a screw-down non-return valve having a hand wheel and spindle extending above the floor plate is to be provided.

(b) In steam ships, this suction is to be fitted to the suction end of the main circulating pump. The diameter of this pipe and the bore of the valve are not to be less than 2/3 that of the main cooling water pump suction.

(c) In motor ships, the emergency bilge suction is to be led to the largest available pump in engine room and the area of the suction pipe is to be equal to the full suction inlet of the pump.

(d) Where the pump specified in above 3.7.4(c) to which the emergency bilge suction is connected is of the self-priming type, the direct bilge suction on the same side of the ship as the emergency suction may be omitted.

Chapter 4 Machinery Piping Systems

Paragraph 4.1.2(a) & (h) has been amended as follows:

4.1.2 Feed pumps

(a) ~~Steam ships are to have at least 2 entirely separate means of feeding main and auxiliary boilers continuously and simultaneously which are required for essential service.~~

2 separate means of feed are to be provided for all main and auxiliary boilers which are required for essential services. In the case of steam/steam generators, one means of feed will be accepted provided steam for essential services is available simultaneously from another source.

The feed of each boiler is to be automatically controlled by the water level in the boiler. Local manual control of feed is also to be provided.

(b) Where boilers are used exclusively for nonessential service one of the feeding units may be an injector of the required capacity.

(c) A boiler heated exclusively by engine exhaust gas or steam may be fed by one means of feeding provided an alternative supply of steam is available on board.

(d) In order to satisfy the condition stated in 4.1.2(a) above, 2 or more feed pumps of sufficient capacity are to be provided to supply boilers under normal conditions with any one pump out of action.

(e) Feed pumps may be either independent or driven by main engines but one at least of those required in pursuance of 4.1.2(d) above is to be independent.

(f) Where main engine driven feed pumps are fitted and there is only one independent feed pump, a harbor feed pump or an injector is to be fitted to provide the second means of feeding to boilers which are in use when main engines are not working.

(g) Feed pumps are to be so arranged that while one pumping unit is in operations, the others can be opened up for examination.

(h) ~~Suitable means is to be provided to prevent the water from running back while the pump is not in use.~~

A feed stop valve is to be fitted to each feedwater line to the boiler and is to be attached directly to the boiler. In addition and adjacent to the stop valve, a stop check valve is to be fitted, or as close thereto as practicable.

(i) Independent feed pumps for feeding main boilers are to be fitted with automatic feed regulators for controlling their output.

(j) Feed pumps are to be fitted with a relief valve except for the feed system served by the pumps so designed that the pressure delivered cannot exceed that for which the piping is designed.

Paragraph 4.4.1(i) has been added as follows:

4.4 Fuel Oil System

4.4.1 Fuel oil-general requirements

(i) Shut-off arrangement for fuel oil tanks

(i) Oil fuel pipes, which, if damaged, would allow oil to escape from a storage, settling or daily service tank having a capacity of 500 *l* and above and situated above the double bottom, shall be fitted with a cock or valve directly on the tank capable of being closed from a safe position outside the space concerned.

(ii) In machinery spaces, fuel oil valves on tanks shall be arranged as quick-acting shut-off valves with remote operation. This remote operation shall be carried out from a central position outside the space itself, and at a safe distance from openings to the engine and boiler rooms.

(iii) Oil fuel pipes, which are led into the engine room from tanks situated above the double bottom outside this space, are also to be fitted with quick-acting shut-off valves in the engine room close to the bulkhead. This is not applicable where the valve on the tank is arranged for quick acting shut-off.

(iv) The requirement for remote quick acting shut-off is not applicable for valves closed during normal service, valves on double bottom tanks or valves on tanks less than 0.5 m^3. For valves on filling lines connected below the liquid level, remote shut-off may be omitted if non-return valves are used.

(v) The means used to operate the quick acting shut-off valves shall be independent of any power sources located in the same space as the valves. For a pneumatically operated system, the air supply may be from a source located within the same space as the valves provided that an air receiver complying with the following is located outside the space:

- sufficient capacity to close all connected valves twice
- fitted with low air pressure alarm
- fitted with a non-return valve adjacent to the air receiver in the air supply line.

Materials readily rendered ineffective by heat shall not be used in the construction of the valves or the closure mechanism.

(vi) The controls for remote shut-off for emergency generator and emergency fire pump shall be located separately from the controls of the other valves in order to avoid erroneous operation.

(vii) The arrangement shall be such that paint, corrosion, etc., shall not impair the efficiency of the remote operation of the valves.

(viii) The use of hydraulic or pneumatic systems for keeping quick-acting shut-off valves in open position shall not be accepted.

(ix) Pressurized mixing tanks shall be designed as pressure vessels and shall be fitted with the following equipment:

(1) a non-return valve in the recirculating lines from the engines

(2) an automatic degasser or a gas blanket monitor with manual degasser

(3) a drain/emptying device, which shall be locked in the closed position.

Paragraph 4.5.1(i) has been added as follows:

4.5 Lubricating Oil and Hydraulic System

4.5.1 General

(a) Where lubricating oil for the main engine(s) is circulated under pressure, a standby lubricating oil pump is to be provided where the following conditions apply:

(i) The lubricating oil pump is independently driven and the total output of the main engine(s) exceeds 375 kW.

(ii) One main engine with its own pump is fitted and the output of the engine exceeds 375 kW.

(iii) More than one main engine each with its own lubricating oil pump is fitted and the output of each engine exceeds 375 kW.

……

(h) The requirements specified in 4.4.1(h)(viii) are to be complied with insofar as they are applicable for the lubricating oil and hydraulic system.

(i) For separate L.O. tanks, if applicable, the tanks are to be tested by a head of water equal to the maximum to which the tanks may be subjected.

Paragraph 4.6.2 has been amended as follows:

4.6.2 Air vessels

(a) The starting air supply for main propelling engine is to be distributed between at least 2 air vessels to ensure the working of the installation. The capacity of the smaller air vessel, in the case of uneven distribution of the air supply, is not to be less than approximately 1/3 of the required total capacity.

(b) Where engines are installed in several engine compartments, air vessels are to be correspondingly distributed among engine compartments.

(c) The air supply in accordance with 4.6.2(d) and(e) of this Part is exclusively for operation of main propelling engines, and separate air vessels are to be provided for auxiliary machinery unless an adequate surplus of starting air or a correspondingly increased compressor capacity is available. The same is applied to pneumatic control and maneuvering equipment and to the air supply necessary for whistle and other air consuming devices.

(d) The total capacity of air vessels required to start main propelling engines is to be sufficient to provide, without replenishment, not less than the consecutive starts C as shown in Table VI 4-2.

(e) ~~The similar engine driving electric generators as main propelling engines, the total capacity of air vessels is to be at least that obtained by using the following consecutive starts C as given in Table VI 4-3.~~ At least 3 consecutive starts is to be possible for each engine driving electric generators and engines for other purposes. The capacity of a starting system serving two or more of the above specified purposes is to be the sum of the capacity requirements.

~~(f) Where there are several similar auxiliary engines, the total capacity of air vessels is to be at least that obtained by using the following consecutive starts C:~~

~~18 for 2 auxiliary engines,~~
~~24 for 3 auxiliary engines,~~
~~30 for 4 auxiliary engines and more.~~

(~~g~~f) For ~~engines having different number of cylinders and/or main dimensions in 4.6.2(e) and(f) above, and for~~ main propelling engine installations not specified in the preceding, the consecutive starts C required are to be approved in each case.

Table VI 4-2
Consecutive Starts C for Diesel Engine

Type \ Quantity	1 engine	2 engines	3 or more engines
Reversible Engines	12	12 (6 per engine)	3 per engine(1)
Non-reversible Engines	6	6 (3 per engine)	3 per engine(1)

Note:
(1) However, the total capacity is not to be less than 12 starts and need not exceed 18 starts.

~~**Table VI 4-3**~~
~~**Consecutive Starts C for Diesel-driven Electric Propulsion**~~

~~No. of Diesel-driven Electric Generators~~	~~1~~	~~2~~	~~3 and over~~
~~C~~	~~6~~	~~8~~	~~12~~

(g) For diesel-electric or turbine-electric propulsion, the minimum number of consecutive starts (total) required to be provided from the starting air reservoirs is to be determined from the following equation:

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

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

Section 4.9 has been added as follows:

4.9 Pneumatic Systems

4.9.1 Application

The requirements in this subsection apply to shipboard pneumatic systems for control and actuation services. Pneumatic systems fitted in self-contained equipment not associated with the propulsion and maneuvering of the ship and completely assembled by the equipment manufacturer need not comply with this subsection. Such pneumatic systems, however, are to comply with the accepted practice of the industry.

4.9.2 Pneumatic system components

(a) Air reservoir

Air reservoirs having a design pressure greater than 6.9 bar are to be certified by the Society. Air reservoirs are to be fitted with drain connections effective under extreme conditions of trim. Where they can be isolated from the system safety valve, they are to be provided with their own safety valves or equivalent devices.

(b) Pipe fittings and joints

Pipe fittings and joints are to meet the requirements for certification in 2.3 of this Part; design subject to limitations in Table VI 4-3.

Table VI 4-3
Pipe Joint Limitations for Pneumatic Systems

Pipe joints	Class I	Class II	Class III
Butt welded joint	No limitation	No limitation	No limitation
Socket welded joint(1)	Max. 80 mm	Max. 80 mm	No limitation
Slip-on welded sleeve joint(1)	Max. 80 mm	Max. 80 mm	No limitation
Flanged joint	See Table VI 2-14	See Table VI 2-14	See Table VI 2-14
Taper-thread joint	≤ 80 mm Permissible pressure/size	≤ 80 mm Permissible pressure/size	No limitation
Compression couplings	≤ 60 mm OD	≤ 60 mm OD	No limitation

Notes: (1). For further operational limitations

Pipe sizes indicated are nominal diameter, except where specified otherwise.

4.9.3 Pneumatic system requirements

(a) Pneumatic air source

Compressed air for general pneumatic control and actuation services may be drawn from engine starting air reservoirs. In which case, the aggregate capacity of the starting air reservoirs is to be sufficient for continued operation of these services after the air necessary for the required number of engine starts has been used.

For propulsion remote control purposes, pneumatic air is to be available from at least 2 air compressors. The starting air system, where consisting of 2 air compressors, may be used for this purpose. The required air pressure is to be automatically maintained. Pneumatic air supplies to safety and control systems may be derived from the same source but are to be by means of separate lines.

(b) Air quality

(i) General

Provisions are to be made to minimize the entry of oil or water into the compressed air system. Suitable separation and drainage arrangements are to be provided before the air enters the reservoirs.

(ii) Safety and control air systems

Compressed air for control and monitoring systems is to be supplied from at least 2 air compressors. The starting air system, where consisting of 2 air compressors, may be used for this purpose. The system is to be arranged such that a single failure will not result in the loss of air supply. The required air pressure is to be automatically maintained.

Means are to be provided to assure that the compressed air for control and monitoring systems is clean, dry and oil-free to a specification compatible with the control and monitoring equipment. In this regard, the compressors, cooling equipment, filters and dryers are to be selected and arranged as necessary to ensure the quality of the air supplied will comply with the standards or criteria identified by the manufacturers of the pneumatic equipment being installed in the system (e.g. max. solid particle size/density, max. dew point, max. oil content, etc.).

Air supplies to safety systems and control systems may be derived from the same source, but are to be by separate lines incorporating shutoff valves.

(c) Overpressure protection

Means are to be provided to prevent over-pressure in any part of the pneumatic system. This includes water jackets or casing of air compressors and coolers which may be subjected to dangerous over-pressure due to leakage into them from air pressure parts.

Chapter 5 Oil Tankers Piping Systems

Paragraph 5.8.6(c) has been amended as follows:

5.8 Inert Gas System

5.8.6 Gas distribution line

(a) A gas regulating valve is to be fitted in the inert gas supply main. This valve is to be automatically controlled to close as required. It is also to be capable of automatically regulating the flow of inert gas to the cargo tanks unless means are provided to automatically control the speed of the inert gas blowers required in 5.8.4 of this Part.

(b) The gas regulating valve referred to in (a) above is to be located at the forward bulkhead of the forward most gas safe space through which the inert gas supply main passes.

(c) At least 2 non-return devices, one of which is to be a water seal, are to be fitted in the inert gas supply main, in order to prevent the return of hydrocarbon vapour to the machinery space uptakes or to any gas safe space under all normal conditions of trim, list and motion of the ship. They are to be located between the automatic gas regulating valve and the after most connection to any cargo tank or cargo pipeline. The different types of the the non-return devices are to comply with 2.2.3.1 of Chapter 15 of the FSS Code.

(d) The non-return devices referred to in (c) above are to be located in the cargo tank area on deck.

(e) The water seal referred to in 5.8.6(c) above is to be capable of being supplied by 2 separate pumps, each of which is to be capable of maintaining an adequate supply at all times.

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AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022"

PART VII ELECTRICAL INSTALLATIONS

List of major changes in Part VII from 2022 edition

1.2.2(d)	Revised
Chapter 13	Revised

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 1 General

Paragraph 1.2.2(d) has been amended as follows:

1.2 Drawings and Data

1.2.2 The shipbuilder is to submit the following specification and data for approval before the work commences:

(a) Specifications and list of electrical equipment.

(b) Load analysis and protective device coordination study.

(i) This protective device coordination study is to be an organized time-current study of all protective devices, taken in series, from the utilization equipment to the source, under various conditions of short circuit. The time-current study is to indicate settings of long-time delay tripping, short-time delay tripping, and instantaneous tripping, as applicable. Where an overcurrent relay is provided in series and adjacent to the circuit protective devices, the operating and time-current characteristics of the relay are to be considered for coordination. Typical thermal withstanding capacity curves of the generators are to be included, as appropriate.

(ii) An electric-plant load analysis is to cover all operating conditions of the ship, such as conditions in normal sea going, cargo handling, harbor maneuver, emergency, and dynamic positioning operations.

(c) Calculations of short circuit currents at main, emergency and sub-switchboards including those fed from transformers.

(i) Maximum calculated short circuit current values, both symmetrical and asymmetrical values, available at the main and emergency switchboards and the downstream distribution boards.

(ii) Rated breaking and making capacities of the protective devices.

(d) Drawings and data~~Explanation~~ of electric propulsion system , including the following:

(i) One-line diagrams of propulsion control system for power supply, circuit protection, alarm, monitoring, safety and emergency shutdown systems including list of alarm and monitoring points.

(ii) Plans showing the location of propulsion controls and its monitoring stations.

(iii) Arrangements and details of the propulsion control console or panel including schematic diagram of the system therein.

(iv) Arrangements and details of the semiconductor converter enclosure for propulsion system, including data for semiconductor converter, cooling system with its interlocking arrangement.

(v) Harmonic distortion calculation

(e) For tankers, ships carrying liquefied gases in bulk and ships carrying dangerous chemicals in bulk, drawings indicating hazardous areas and the list of electrical equipment installed in the hazardous areas.

(f) Maintenance schedule of batteries

Chapter 13 has been amended as follows:

Chapter 13 Additional Requirements for Electric Propulsion ~~Equipment~~ System

13.1 General

13.1.1 Electrical installations for ships which rely solely on propulsion motors for their propulsion are to meet the relevant requirements specified in this Part, and in addition to those in this Chapter.

13.1.2 When the arrangement is such that a propulsion motor is connected to a generating plant with a continuous rated capacity larger than that of the motor, measures shall be provided to limit the continuous input to the motor to a value not exceeding the continuous full load torque value of the approved motor and shafts.

13.1.3 In general, for a ship to be assigned an unrestricted service notation, it is to have two independently driven propellers or other propulsion devices, each connected with at least one electric motor, where these form the sole means of propulsion.

13.2 Power Requirements

13.2.1 The propulsion system is to have sufficient power for maneuvering the ship and for going astern. With the ship travelling at its maximum speed the propulsion equipment is to be capable of stopping and reversing the ship in an agreed time.

13.2.2 The propulsion system is to have adequate torque and power margins for all operating conditions including manoeuvring and rough weather with due regard to propeller and ship characteristics.

13.2.3 The electric power for the propulsion system may be derived from generating sets dedicated to propulsion duty or from a central power generation plant which serves both propulsion and ship service loads.

13.2.4 In case an electric propulsion system is a system with a common generator set to supply power to the ship's service loads and propulsion loads. Its electric drivetrain is considered to consist of equipment connected to the electrical network, such as drives (frequency converters) and propulsion motors.

13.2.5 All electrical equipment that is part of the electric propulsion drive system should be redundant so that a single failure does not completely disable the propulsion of the ship. A single propulsion motor with double windings cannot meet this requirement when the electric motor provides the sole propulsion device for the ship.

13.2.6 When power is supplied from a central, common power generation system, the number and rating of generator sets shall be such that, under normal sailing conditions, when one generator is out of service, the remaining generator capacity shall be sufficient to carry the ship's service (basic service, normal service and minimum comfort Habitable Service) load and a propulsion load providing a speed not less than 7 knots or 1/2 of the design speed, whichever is the lesser.

13.3 Power Management System

13.3.1 For ships with an integrated electric propulsion system, a power management system is to be provided. The power management system is to be designed to control load sharing between generators, prevent blackouts, maintain power to the essential service loads and maintain power to the propulsion loads.

13.3.2 The power management system is to account for the following operating scenarios.

(a) All generators in operation, then the loss of one generator.

(b) When at least one generator is not in operation and there is an increase in the propulsion loads or a loss of one of the generators, that would result in the need to start a generator that was not in operation.

(c) Upon failure of the power management system, there is to be no change in the available electrical power. Failure of the power management system is to be alarmed at a manned control station.

(d) Further, the system is to prevent overloading the generators, by reducing the propulsion load or load shedding of non-essential loads. In general, the system is to limit power to the propulsion loads to maintain power to the ship's essential service loads. However, the system is to shed non-essential loads to maintain power to the propulsion loads.

(e) An audible and visible alarm is to be installed at each propulsion control location and is to be activated when the system is limiting the propulsion power in order to maintain power to the other essential service loads.

13.4 Regenerative Power

13.4.1 For systems where regenerative power may be developed, the regenerative power is not to cause a dangerous increase of speed in the prime mover or a dangerous overvoltage condition on the supply system. Where a central power generation system is used then the voltage and frequency fluctuations are not to exceed the limits given in 1.5.1.

13.4.2 Protection for regenerative power.

Braking resistors or ballast consumers are to be provided to absorb excess amounts of regenerative energy and to reduce the speed of rotation of the propulsion motor. These braking resistors or ballast consumers are to be located external to the mechanical and electric rotating machines. Alternatively, the amount of regenerated power may be limited by the action of the control system.

13.5 Electric Power Supply Systems

13.5.1 Propulsion Generators

(a) Power supply: The power for the propulsion equipment may be derived from a single generator. If a ship service generator is also used for propulsion purposes, other than for boosting the propulsion power, such generator and power supply circuits to propulsion systems are also to comply with the applicable requirements in this Chapter.

(b) Single system: If a propulsion system contains only one generator and one motor and cannot be connected to another propulsion system, more than one exciter set is to be provided for each machine. However, this is not necessary for self-excited generators or for multi-propeller propulsion ships where any additional exciter set may be common for the ship.

(c) Multiple systems: Systems having two or more propulsion generators, two or more semiconductor converters, or two or more motors on one propeller shaft are to be so arranged that any unit may be taken out of service and disconnected electrically without preventing the operation of the remaining units.

(d) Excitation systems: Arrangements for electric propulsion generators are to be such that propulsion can be maintained in case of failure of an excitation system or failure of a power supply for an excitation system. Propulsion may be at reduced power under such conditions where two or more propulsion generators are installed provided such reduced power is sufficient to provide for a speed of not less than 7 knots or 1/2 of the design speed, whichever is the lesser.

(e) Harmonics

(i) A harmonic distortion calculation is to be submitted for review for all ships with electric propulsion. The calculation is to indicate that the harmonic distortion levels at all locations throughout the power distribution system (main generation switchboard, downstream power distribution switchboards, etc.) are within the limits specified in 1.5.2 of this Part.

(ii) The harmonic distortion levels at dedicated propulsion buses are also to be within the limits specified in 1.5.2 of this Part, otherwise documentation from the manufacturer is to be submitted indicating that the equipment is designed for operation at a higher level of distortion. Where higher values of harmonic distortion are expected, any other possible effects, such as additional heat losses in machines, network resonances, errors in control and monitoring systems are to be considered.

(iii) Means of monitoring voltage harmonic distortion shall be provided, including alarms at the main generation switchboard and at continuously manned stations when to notify of an increase in total or individual harmonic distortion levels above the maximum allowable levels.

(iv) Where the electrical distribution system on board a ship includes harmonic filters, such ships are to be fitted with facilities to continuously monitor the levels of harmonic distortion experienced on the main bus bar as well as alert the crew should the level of harmonic distortion exceed the acceptable limits. However, harmonic filters installed for single application frequency drives such as pump motors may be excluded from this requirement.

(v) Notwithstanding the above (iv) requirements, the harmonic filter circuits shall be protected against overload and short circuit. In the event of overload or short-circuit protection activation, an alarm shall be initiated at a continuously manned location.

13.5.2 Propulsion Excitation

(a) Excitation circuits: Every exciter set is to be supplied by a separate feeder. Excitation circuits are not to be fitted with overload circuit-interrupting devices except those intended to function in connection with the protection for the propulsion generator. In such cases the field circuit breaker is to be provided with a discharge resistor unless a permanent discharge resistor is provided.

(b) Field circuits: Field circuits are to be provided with means for suppressing voltage rise when a field switch is opened. Where fuses are used for excitation circuit protection it is essential that they do not interrupt the field discharge resistor circuit upon rupturing.

(c) Ship service generator connection: Where the excitation supply is obtained from ship service generator, the connection should be made to the generator side of the generator circuit breaker with the excitation supply passing through the overload current device of the breaker.

13.6 Protection for Earth Leakage

13.6.1 Main Propulsion Circuits: Means for earth leakage detection are to be provided for the main propulsion circuit and be arranged to operate an alarm upon the occurrence of an earth fault. When the fault current flowing is liable to cause damage, arrangements for opening the main propulsion circuit are also to be provided.

13.6.2 Excitation Circuits: Means are to be provided for earth leakage detection in excitation circuits of propulsion machines but may be omitted in circuits of brushless excitation systems and of machines rated up to 500 kW.

13.6.3 Alternating-current (AC) Systems: Alternating-current propulsion circuits are to be provided with an earthing detector alarm or indicator. If the neutral is earthed for this purpose, it is to be through an arrangement which will limit the current at full-rated voltage so that it will not exceed approximately 20 A upon a fault to earth in the propulsion system. An unbalance relay is to be provided to open the generator and motor-field circuits upon the occurrence of an appreciable unbalanced fault.

13.6.4 Direct-current (DC) Systems: The earthing detector may consist of a voltmeter or lights. Provision is to be made for protection against severe overloads, excessive currents and electrical faults likely to result in damage to the plant. Protective equipment is to be capable of being so set as not to operate on the overloads or overcurrents experienced in a heavy seaway or when maneuvering.

13.7 Propulsion Control

13.7.1 Propulsion control systems are to be stable throughout their normal operating range and arranged to attenuate any effects of cyclic propeller load fluctuations caused by wave action.

13.7.2 Stepless control of propeller speed and/or pitch from zero to full power forward or reverse shall be provided.

13.7.3 Failure of a control signal is not to cause an excessive increase in propeller speed. The reference value transmitters in the control stations and the control equipment are to be so designed that any defect in the desired value transmitters or in the cables between the control station and the propulsion system will not cause a substantial increase in the propeller speed.

13.7.4 Propulsion machines may be controlled from the bridge or deck. Alternative control in the engine room is to be provided. Transfer of control to the engine room in an emergency is to be possible without excessive loss of time and simultaneous control from both bridge and the engine room is impossible.

13.7.5 Where two or more control stations are provided outside the engine room, or where the propulsion machinery space is intended for centralized control or unattended operation, the requirements of Part VIII of the Rules are to be complied with.

13.7.6 The control of the propulsion system can be activated only when the delegated control lever is in zero position and the system is ready for operation.

13.7.7 Each control station is to be provided with emergency stops for propulsion motors. The emergency stop is to be independent of the normal control system.

13.7.8 Provision should be made for propulsion systems to prevent equipment damage due to severe overloads and electrical failures.

13.7.9 All levers for operating contactors, line switches, field switches and similar devices are to be interlocked to prevent their improper operation. Interlocks are to be provided with the field lever to prevent the opening of any main circuits without first reducing the field excitation to zero, except that when the generators simultaneously supply power to an auxiliary load apart from the propulsion, the field excitation need only be reduced to a low value.

13.7.10 Machine side controls are to be provided, independent of any remote or automatic system, to permit effective control of the propulsion equipment.

13.8 Instrumentation at the Control Station

13.8.1 The main control station is to be provided with the following instruments:

(a) A.C. systems:

(i) an ammeter for each generator and propulsion motor; voltmeter, wattmeter and frequency meter for each generator and ammeter for each excitation circuit;

(ii) a temperature indicator for each propulsion generator and motor, rated above 500 kW, the indicator is to read stator winding and cooling system temperature;

(b) D.C. systems:

(i) a voltmeter and ammeter for each generator and propulsion motor; an ammeter for each excitation circuit;

(ii) a temperature indicator for each propulsion generator and motor, rated above 500 kW, the indicator is to read interpole winding and cooling system temperature.

13.8.2 Indication of Propulsion System Status

The control stations of the propulsion systems are to have at least the following indications for each propeller:

(a) propeller speed;

(b) The direction of rotation for fixed-pitch propellers or the pitch position for controllable-pitch propellers;

(c) Power limitation ; in case of disturbance, for example, in the ventilators for propulsion motors, in the converters, cooling water supply or load limitation of the generators;

13.9 Equipment Installation and Arrangements

13.9.1 General

The arrangement of bus bars and wiring on the back of propulsion-control assemblies is to be such that all parts, including the connections, are accessible. All nuts and connections are to be fitted with locking devices to prevent loosening due to vibration. Clearance and creepage distances are to be provided between parts of opposite polarity and between live parts and earth to prevent arcing; refer to the provisions of 5.3 and 14.2.3 of this Part.

13.9.2 Accessibility and Facilities for Repairs

(a) Accessibility: For inspection and maintenance purposes, provision should be made for accessing the stator and rotor coils and removing and replacing the field coils.

(b) Facility for supporting: Facilities are to be provided for supporting the shaft to permit inspection and withdrawal of bearings.

13.9.3 Propulsion Cables

Propulsion cables are not to have splices or joints except terminal joints and all cable terminals are to be sealed against the admission of moisture or air. Similar precautions are to be taken during installation by sealing all cable ends until the terminals are permanently attached. Cable supports are to be designed to withstand short- circuited conditions. For the design of the cable support, refer to 8.10 of this Part.

13.10 Equipment Requirements

13.10.1 The following materials intended for main propulsion installations are to be tested in the presence of a Surveyor: thrust shafts, line shafts, propeller shafts, shafting for propulsion generators and motors, coupling bolts, and in the case of direct-connected turbine-driven propulsion generators, fan shrouds, centering and retaining rings. Major castings or built-up parts such as frames, spiders and end shields are to be surface inspected and the welding is to be in accordance with the requirements of Part XII of the Rules for Construction and Classification of Steel Ships.

13.10.2 When generators, motors or slip-couplings for electric propulsion are fitted with an integral fan and will be operated at speeds below the rated speed with full-load torque, full-load current, or full-load excitation, temperature rise limits shall not exceed the provisions in Table VII 3-2 of this Part.

13.10.3 Means to prevent moisture condensation should be provided for rotating machines and converters when idle, regardless of machine weight.

13.10.4 Prime Movers

(a) The prime mover rated output is to have adequate overloading and build-up capacity for supplying the power which is necessary during transitional changes in operating conditions of the electrical equipment. When maneuvering from full propeller speed ahead to full propeller speed astern with the ship making full way ahead, the prime mover is to be capable of absorbing a proportion of the regenerated power without tripping due to overspeed.

(b) Prime movers of any type are to be provided with a governor capable of maintaining the pre-set steady speed within a range not exceeding 5% of the rated full-load speed for load changes from full-load to no-load.

(c) Where the speed control of the propeller requires speed variation of the prime mover, the governor is to be provided with means for local manual control as well as for remote control. For turbines driving AC propulsion generators, where required by the system of control, the governor is to be provided with means for local hand control as well as remote adjustment from the control station.

(d) In case of parallel operation of generators, the governing system is to permit stable operation to be maintained over the entire operational speed range of the prime movers

13.10.5 Rotating Machines for Propulsion

(a) Electric rotating machines for propulsion are to be enclosed ventilated or be provided with substantial wire or mesh screen to prevent personnel injury or entrance of foreign matter. Dampers are to be provided in ventilating air ducts except when recirculating systems are used.

(b) Electric rotating machines for propulsion which are enclosed or in which the air gap is not directly exposed are to be fitted with fire-extinguishing systems suitable for fires in electrical equipment. This will not be required where it can be established that the machinery insulation is self-extinguishing.

(c) The ventilation and cooling systems of electric propulsion equipment shall be provided with monitoring devices to activate an alarm when the temperature of the cooling medium exceeds a preset safe value. Water-to-air heat exchangers for rotary propulsion machines of single generator and single motor systems shall have double wall piping and be equipped with a leak detector function to monitor any water leaks. A visual and audible alarm is to be provided at a normally manned location to indicate detection of such water leakage.

(d) The stator windings of A.C. propulsion generators and motors and interpole windings of D.C. propulsion generators and motors, rated above 500 kW, are to be provided with temperature sensors.

(e) Excitation current for propulsion generators may be derived from attached rotating exciters, static exciters, excitation motor-generator sets or special purpose generating units. Power for these exciters may be derived from the machine being excited or from any ship service, emergency or special purpose generating units.

(f) Propulsion motors are to be designed to be capable of withstanding the mechanical and thermal effects of a short-circuit at its terminals.

13.10.6 Direct-current (DC) Propulsion Motors

(a) The rotors of DC propulsion motors are to be capable of withstanding overspeeding up to the limit reached in accordance with the characteristics of the overspeed protection device at its normal operational setting.

(b) An overspeed protection device is to be provided to prevent excessive overspeeding of the propulsion motors due to light loads, loss of propeller, etc.

13.10.7 Semiconductor Equipment for propulsion

Semiconductor equipment refers to semiconductor converters and related transformers, reactors, capacitors and filters, etc., which are to comply with the provisions of Chapter 15 of this Part.

13.10.8 Switches

(a) All switches are to be arranged for manual operation and so designed that they will not open under ordinary shock or vibration; contactors, however, may be operated pneumatically, by solenoids, or other means in addition to the manual method which is to be provided unless otherwise approved.

(b) Switches for generators and motors are preferably to be of the air-break type but for alternating-current systems, where they are to be designed to open full-load current at full voltage, oil-break switches using nonflammable liquid may be used if provided with leak-proof, nonspilling tanks.

(c) Where necessary, field switches are to be arranged for discharge resistors unless discharge resistors are permanently connected across the field. For alternating current systems, means are to be provided for de-energizing the excitation circuits by the unbalance relay and earth relay.

13.10.9 Propulsion Cables

(a) The conductors of cables external to the components of the propulsion plant, other than cables and interconnecting wiring for computers, data loggers or other automation equipment requiring currents of very small value, are to consist of not less than seven strands and have a cross-sectional area of not less than 1.5 mm^2.

(b) Ethylene-propylene rubber (EPR), cross-linked polyethylene (XLPE), or silicone rubber insulated cables are to be used for propulsion power cables. PVC insulated cables are not acceptable as per IEC 60092-360.

(c) Impervious metallic sheaths will be considered but are not to be used with single-conductor alternating-current cables.

(d) The insulation of internal wiring in main control gear, including switchboard wiring, shall be of flame-retardant quality.

(e) All propulsion cables, other than internal wiring in control gears and switchboards, are to be subjected to dielectric and insulation tests in the presence of the Surveyor.

13.10.10 Reduction Gear Safety – Lubrication

Where reduction gears are driven by electric motors, an automatic means is to be fitted to stop the motors in the event of failure of the lubricating oil supply to the reduction gear.

13.11 Trials

13.11.1 Complete tests of the entire electric propulsion system are to be carried out during sea-trials including the following:

(a) Duration runs with the ship at full propulsion load.

(b) Maneuvering tests which should include a reversal of the ship from full speed ahead to full speed astern during which important measurements such as system currents, voltages, speed, etc. shall be recorded.

(c) Tests to check for operation of all protective devices, safety functions, alarms, indicators, control modes and stability tests for control.

13.11.2 All tests necessary to demonstrate that major components of the electric propulsion plant and the system as a whole are satisfactory for duty are to be performed. Immediately prior to trials, the insulation resistance is to be measured and recorded.

~~13.1 General~~

~~13.1.1 Electrical installations for ships which rely solely on propulsion motors for their propulsion are to meet the relevant requirements specified in this part, and in addition to those in this Chapter.~~

~~13.1.2 Propulsion generators and motors are to be enclosed, ventilated or provided with substantial wire or mesh screens to prevent personnel injury or entrance of foreign matter.~~

~~13.1.3 Propulsion generators , motors , and converters are to be provided with means to prevent the accumulation of moisture and condensate when idle.~~

~~13.1.4 Where the arrangements permit a propulsion motor to be connected to a generating plant having a continuous rating greater than the motor rating, means are to be provided to limit the continuous input to the motor to a value not exceeding the continuous full load torque for which the motor and shafts are approved.~~

~~13.1.5 The ventilation and cooling systems for electrical propulsion equipment are to be provided with monitoring devices arranged to operate an alarm if the temperature of the heated cooling medium exceeds a predetermined safe value.~~

~~13.1.6 The stator windings of A.C. propulsion generators and motors and interpole windings of D.C. propulsion generators and motors, rated above 500 kW, are to be provided with temperature sensors.~~

~~13.1.7 The temperature sensors required by 13.1.6 are to be arranged to operate an alarm if the temperature exceeds a predetermined safe value.~~

~~13.1.8 In general, for a ship to be assigned an unrestricted service notation, it is to have two independently driven propellers or other propulsion devices, each connected with at least one electric motor, where these form the sole means of propulsion.~~

~~13.2 Power Requirements~~

~~13.2.1 The propulsion system is to have sufficient power for maneuvering the ship and for going astern. With the ship travelling at its maximum speed the propulsion equipment is to be capable of stopping and reversing the ship in an agreed time.~~

~~13.2.2 The propulsion system is to have adequate torque and power margins for all operating conditions including manoeuvring and rough weather with due regard to propeller and ship characteristics.~~

~~13.2.3 The electric power for the propulsion system may be derived from generating sets dedicated to propulsion duty or from a central power generation plant which serves both propulsion and ship service loads.~~

~~13.2.4 Where propulsion power is derived from a central, common, power plant the control system is to ensure a safe distribution of power between propulsion and ship services, with tripping of non-essential loads and/or reduction in propulsion power if necessary.~~

~~13.2.5 Where a central power generation system is employed, the number and rating of generator sets is to be such that with one set out of action the remaining sets are capable of providing all essential and normal ship service loads whilst maintaining an effective level of propulsion power.~~

~~13.2.6 Where, in a central power generation system, the electrical power requirements are normally supplied by two or more generating sets operating in parallel, on sudden loss of power from one set, the rating of the remaining set(s) in service is to be sufficient to ensure uninterrupted operation of essential services and an effective level of propulsion power.~~

~~13.3 Propulsion Control~~

~~13.3.1 Propulsion control systems are to be stable throughout their normal operating range and arranged to attenuate any effects of cyclic propeller load fluctuations caused by wave action.~~

~~13.3.2 Step less control of propeller speed, and/or pitch, from zero to full power ahead or astern is to be provided.~~

~~13.3.3 The control system is to ensure that there is no dangerous overspeeding of propulsion motors upon loss of load.~~

~~13.3.4 Interlocks are to be provided in the control system to ensure that ahead and astern circuits are not energized simultaneously.~~

~~13.3.5 Any single fault in either the propulsion excitation or power system is not to result in a total loss of propulsion power.~~

~~13.3.6 Propulsion machines may be controlled from the bridge or deck. Alternative control in the engine room is to be provided. Transfer of control to the engine room in an emergency is to be possible without excessive loss of time and simultaneous control from both bridge and the engine room is impossible.~~

~~13.3.7 Where two or more control stations are provided, indicating lights are to be located at each control station to indicate whether that station is in control. Means are to be provided to ensure that simultaneously control cannot be made from different stations.~~

~~13.3.8 Each control station is to be provided with emergency stops for propulsion motors. The emergency stop is to be independent of the normal control system.~~

~~13.3.9 The control system is to limit the propulsion power if the power available from the generator(s) is not sufficient to supply the demand level of propulsion power. In the event of a power limitation, there is to be a visual indication at the control stations.~~

~~13.3.10 Local controls are to be provided, independent of any remote or automatic system, to permit effective control of the propulsion equipment.~~

~~13.4 Protection of Propulsion System~~

~~13.4.1 Provision is to be made for protection against severe overloads, and electrical faults likely to result in damage to plant.~~

~~13.4.2 The main propulsion circuits are to be provided with means for detecting earth faults. Where the fault current flowing is liable to cause damage to the electrical equipment there are to be arrangements for interrupting the current.~~

~~13.4.3 For the protection of electrical equipment and cables against overvoltages means are to be provided for limiting the induced voltage when field windings, and other inductive circuits are opened. Protective resistors and devices are to be sized to cater for the likely extreme operating conditions.~~

~~13.4.4 Where, on stopping or reversing the propeller, regenerated energy is produced by the propulsion motor this is not to cause a dangerous increase of speed in the prime mover or a dangerous overvoltage condition on the supply system. Where a central power generation system is used then the voltage and frequency fluctuations are not to exceed the limits given in 1.5.1.~~

~~13.5 Instruments~~

~~13.5.1 The main control station is to be provided with the following instruments:~~

~~(a) A.C. systems:~~

~~(i) an ammeter for each generator and propulsion motor; voltmeter, wattmeter and frequency meter for each generator and ammeter for each excitation circuit;~~

~~(ii) a temperature indicator for each propulsion generator and motor, rated above 500 kW, the indicator is to read stator winding and cooling system temperature;~~

~~(b) D.C. systems:~~

~~(i) a voltmeter and ammeter for each generator and propulsion motor;~~
~~an ammeter for each excitation circuit;~~
~~(ii) a temperature indicator for each propulsion generator and motor, rated above 500 kW, the indicator is to read interpole winding and cooling system temperature.~~

~~13.5.2 Each control station is to be provided with instruments to indicate:~~

~~(a) propeller speed;~~

~~(b) direction of rotation for a fixed pitch propeller or pitch position for a controllable pitch propeller;~~

~~(c) visual indication of power limitation.~~

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022"

PART IX FIRE PROTECTION, DETECTION AND EXTINCTION

List of major changes in Part IX from 2022 edition

1.1.2(c)	Revised
14.1.1(d)	Deleted
14.1.2	Revised
Table IX 14-1-1	Revised
Table IX 14-1-2	Revised
Table IX 14-1-3	Revised

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 1 General Requirements

Paragraph 1.1.2(c) has been amended as follows:

1.1.2 General application

(a) Requirements for convention ships

The requirements in Chapter 2 to Chapter 13 of this Part apply to ships engaged on international voyages. Unless expressly provided otherwise, the requirements in Chapter 2 to Chapter 13 of this Part do not apply to the following ships:

(i) ships of war and troopships;

(ii) ships not propelled by mechanism means;

(iii) woodenships of primitive build;

(iv) pleasure yachts not engaged in trade; and

(v) fishing vessels.

(b) Cargo ships of less than 500 gross tonnage are to comply with the requirements in Chapter 2 to Chapter 13 of this Part. Where this is impractical, special consideration may be given by the Society.

(c) Ships not engaged on international voyages are to comply with the requirements of Chapter 14 of this Part. However, attention is also to be paid to any relevant statutory requirements of the National Authority of the country in which the ship is or to be registered. Compliance with these statutory requirements may be accepted as meeting the requirements of this Part.

(d) For vessels not propelled by mechanical means, e.g., barges, the requirements of 14-2.3 of this Part may be applicable. The extent and degree of application of the relevant requirements of Chapters 2 to 13 of this Part may be modified considering their construction, purpose, etc. These requirements may not apply to unmanned barges.

(e) Others

(i) Centralized bridge or automatic controls

When it is proposed to apply centralized bridge or automatic controls to the propulsion machinery and essential auxiliaries and it is intended that the engine and/or boiler room is not continuously manned at sea, the requirements stipulated in 5.12 of Part VIII of the Rules are to be complied with.

(ii) Offshore service units

The requirements of offshore service units are to be referred to the relevant requirements in Chapter 9 of Code for the Construction and Equipment of Mobile Offshore Drilling Units (herein after referred to as the MODU Code), as amended.

(f) Where the requirements of this Part are impractical, special consideration may be given by the Society.

Paragraph 14.1.1 & 14.1.2 have been amended as follows:

Chapter 14 Ships not Engaged on International Voyages

14.1 General

14.1.1 Application

Requirements of this Chapter ~~are to~~ apply to ships as described in (a), (b) and (c):

(a) Passenger ships not engaged on international voyages are to comply with the requirements of this Chapter in addition to Chapter 14-1.

(b) Cargo ships other than tankers not engaged on international voyages are to comply with the requirements of this Chapter and Chapter 14-2.

(c) Tankers not engaged on international voyages are to comply with the requirements of this Chapter and Chapter 14-3.

~~(d) Craft with **LSC** notation~~

~~Fire safety, means of escape and life-saving of craft with **LSC** notation are to be in accordance with Table I 1-3 in Part I of the Rules.~~

14.1.2 Statutory requirements

~~Notwithstanding the requirements of this Chapter, the ships are to comply with the relevant regulations of the Administration.~~When the Administration has issued specific rules covering fire protection, detection and extinction, the Society may accept such rules for classification purposes in lieu of those given in this Chapter.

Chapter 14-1 Ships not Engaged on International Voyages: Passenger Ships

14-1.7 Containment of Fire

Table IX 14-1-1 has been amended as follows:

Table IX 14-1-1
Fire Integrity of Bulkheads Separating Adjacent Spaces

Spaces		a)	b)	c)	d)	e)	f)	g)	h)	i)	j)	k)	l)	m)	n)
Control stations	a)	B-0	A-0	A-0	A-0	A-0 B-0	A-60	A-60	A-60	A-0	A-0	A-60	A-60	A-60	A-60
Stairways	b)		A-0	A-0	A-0	A-0	A-0	A-15 A-0	A-30 A-0	A-0	A-0	A-15	A-30	A-15 A-0	A-30
Corridors	c)			C	A-0	A-0 B-0	B-0	B-15 B-0	B-15 B-0	B-0	A-0	A-15	A-30	A-0	A-30 A-0
Evacuation stations ~~and external escape routes~~ , etc.	d)				-	-	A-0[(2)]	A-0[(2)]	A-0[(2)]	A-0[(2)]	A-0	A-0	A-15	A-0	A-15 A-0
Open deck spaces	e)					-	A-0 B-0	A-0 B-0	A-0 B-0	A-0 B-0	A-0	A-0	A-0	A-0 B-0	A-0
Accommodation spaces of minor fire risk	f)						B-0 C	B-15 C	B-15 C	B-0 C	A-0	A-15 A-0	A-30	A-0	A-30 A-0
Accommodation spaces of moderate fire risk	g)							B-15 C	B-15 C	B-0 C	A-0	A-15 A-0	A-60	A-15 A-0	A-60 A-15
Accommodation spaces of greater fire risk	h)								B-15 C	B-0 C	A-0	A-30 A-0	A-60	A-15 A-0	A-60 A-15
Sanitary spaces and similar spaces	i)									C	A-0	A-0	A-0	A-0	A-0
Auxiliary machinery spaces of little or no fire risk	j)										A-0[(1)]	A-0	A-0	A-0	A-0
Auxiliary machinery spaces of moderate fire risk	k)											A-0	A-0	A-0	A-30[(3)] A-15
Machinery spaces	l)												A-0[(1)]	A-0	A-60
Store rooms, workshops, pantries, etc.	m)													A-0[(1)]	A-0
Other spaces in which flammable liquids are stowed	n)														A-30[(3)] A-15

See notes below Table IX 14-1-3.

Table IX 14-1-2 has been amended as follows:

Table IX 14-1-2
Fire Integrity of Decks Separating Adjacent Spaces

Spaces above deck → / Spaces below deck↓		a)	b)	c)	d)	e)	f)	g)	h)	i)	j)	k)	l)	m)	n)
Control stations	a)	A-30 A-0	A-30 A-0	A-15 A-0	A-0	A-0 B-0	A-0	A-15 A-0	A-30 A-0	A-0	A-0	A-0	A-60	A-0	A-60 A-15
Stairways	b)	A-0	A-0	A-0	A-0	A-0 B-0	A-0	A-0	A-0	A-0	A-0	A-0	A-30	A-0	A-30 A-0
Corridors	c)	A-15 A-0	A-0	A-0 B-0	A-0	A-0 B-0	A-0 B-0	A-15 B-0	A-15 B-0	A-0 B-0	A-0	A-0	A-30	A-0	A-30 A-0
Evacuation stations ~~and external escape routes~~ , etc.	d)	A-0	A-0	A-0	A-0	-	A-0 B-0	A-0 B-0	A-0 B-0	A-0 B-0	A-0	A-0	A-0	A-0	A-0
Open deck spaces	e)	A-0	A-0	A-0 B-0	A-0	-	A-0 B-0	A-0 B-0	A-0 B-0	A-0 B-0	A-0	A-0	A-0	A-0 B-0	A-0
Accommodation spaces of minor fire risk	f)	A-60	A-15 A-0	A-0	A-0	A-0 B-0	A-0 B-0	A-0 B-0	A-0 B-0	A-0 B-0	A-0	A-0	A-15 A-0	A-0	A-15 A-0
Accommodation spaces of moderate fire risk	g)	A-60	A-30 A-0	A-15 A-0	A-15 A-0	A-0 B-0	A-0 B-0	A-15 B-0	A-30 B-0	A-0 B-0	A-0	A-15 A-0	A-30 A-0	A-0	A-30 A-0
Accommodation spaces of greater fire risk	h)	A-60	A-60 A-15	A-60 A-0	A-30 A-0	A-0 B-0	A-15 B-0	A-30 B-0	A-60 B-0	A-0 B-0	A-0	A-30 A-0	A-30 A-0	A-0	A-30 A-0
Sanitary spaces and similar spaces	i)	A-0	A-0	A-0 B-0	A-0	A-0 B-0	A-0 B-0	A-0 B-0	A-0 B-0	A-0 B-0	A-0	A-0	A-0	A-0	A-0
Auxiliary machinery spaces of little or no fire risk	j)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0[(1)]	A-0	A-0	A-0	A-0
Auxiliary machinery spaces of moderate fire risk	k)	A-60	A-60 A-15	A-60 A-15	A-30 A-0	A-0	A-0	A-15 A-0	A-30 A-0	A-0	A-0	A-0[(1)]	A-0	A-0	A-30[(3)] A-15
Machinery spaces	l)	A-60	A-60	A-60	A-60	A-0	A-60	A-60	A-60	A-0	A-0	A-30	A-30[(1)]	A-0	A-60
Store rooms, workshops, pantries, etc.	m)	A-60	A-30 A-0	A-15 A-0	A-15 A-0	A-0 B-0	A-15 A-0	A-30 A-0	A-30 A-0	A-0 B-0	A-0	A-0	A-0	A-0	A-15[(3)] A-0
Other spaces in which flammable liquids are stowed	n)	A-60	A-60 A-30	A-60 A-30	A-60	A-0	A-30 A-0	A-60 A-15	A-60 A-15	A-0	A-0	A-30[(3)] A-0	A-30[(3)] A-0	A-0	A-30[(3)] A-0

See notes below Table IX 14-1-3.

Table IX 14-1-3 has been amended as follows:

Table IX 14-1-3
Fire Integrity of Bulkheads and Decks Separating Adjacent Space from Special Category Spaces

Spaces ↓ \ Bulkheads and Decks →		Bulkheads	Decks above special category spaces	Decks below special category spaces
Control stations	a)	A-60	A-60	A-30
Stairways	b)	A-30	A-60	A-0
Corridors	c)	A-30	A-60	A-0
Evacuation stations ~~and external escape routes~~ , etc.	d)	A-0	A-60	A-0
Open deck spaces	e)	A-0	A-0	A-0
Accommodation spaces of minor fire risk	f)	A-15 A-0	A-30 A-0	A-15 A-0
Accommodation spaces of moderate fire risk	g)	A-30 A-0	A-60 A-15	A-30 A-0
Accommodation spaces of greater fire risk	h)	A-60 A-15	A-60 A-15	A-30 A-0
Sanitary spaces and similar spaces	i)	A-0	A-0	A-0
Auxiliary machinery spaces of little or no fire risk	j)	A-0	A-0	A-0
Auxiliary machinery spaces of moderate fire risk	k)	A-0	A-0	A-0
Machinery spaces	l)	A-60	A-30	A-60
Store rooms, workshops, pantries, etc.	m)	A-0	A-30(3) A-0	A-0
Other spaces in which flammable liquids are stowed	n)	A-60	A-30	A-60

Notes: To be applied to Table IX 14-1-1, Table IX 14-1-2 and Table IX 14-1-3

1. Refer to 7.1.2(c)(ii)(2) for the contents and use of the spaces, except the following spaces:

   (a) Corridors: corridors and lobbies.

   (b) Evacuation stations: open deck spaces and enclosed promenades forming lifeboat or liferaft embarkation and lowering stations.

   (c) Open deck spaces: open deck spaces and enclosed promenades clear of lifeboat and liferaft embarkation lowering stations and the spaces clear of spaces outside superstructures and lowering stations.

2. Where the contents and use of a space are such that there is a doubt as to its classification for the purpose of this Chapter, or where it is possible to assign two or more classifications to a space, it is to be treated as a space within the relevant category having the most stringent boundary requirements.

3. The superscript (1), (2) and (3) to the notations in the table means:

   (1): Where adjacent spaces are of the same alphabetic category, a bulkhead or deck of the rating shown in the table is only required when the adjacent spaces are for a different purpose.

   (2): Where all bulkheads are divisions at boundary adjacent to muster stations, the division may be "B-0".

   (3): See note 6(c) below.

4. "C" means "C" class division or non-combustible division constructed of combustible materials where the spaces in both sides of bulkheads are fitted with automatic sprinkler system.

5. "-" may be division other than "A", "B" and "C" class division.

6. Where two divisions in the table appear, the divisions are to comply with the following.

   (a) The division is to be one upper tier of two divisions in the table.

   (b) Notwithstanding (a) above, the division at boundary between two spaces which are protected by an automatic sprinkler system may be one in lower tier of two divisions in the table.

   (c) Notwithstanding (a) above, where superscript (3) appears, the division at boundary between space which is protected by an automatic sprinkler system and space which is not protected by an automatic sprinkler system may be one in lower tier of two divisions in the table.

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022"

PART XI MATERIALS

List of major changes in Part XI from 2022 edition

3.1.1(a) & (e)	Revised
3.6.7	Revised
Fig. XI 3-3	New
3.8.3~3.8.5	Revised
3.10.2(a)	Revised
3.10.4(b)	Revised
Fig. XI 3-3 ~ 3-6	Renumbered
Table XI 11-2	Revised
Table XI 11-3	Revised
18.2.3	Revised
Fig. XI 18-1	New
Table XI 18-1	Deleted

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 3 Rolled Steels for Hull Construction

Paragraph 3.1.1(a) & (e) have been amended as follows:

3.1 General

3.1.1 Application

(a) Scope

This Chapter gives the requirements for weldable normal, higher and extra high strength hot rolled steels, such as plates, wide flats, sections, structural pipes and bars, intended for use in hull construction.

(b) Thickness

(i) The requirements of this Chapter are primarily intended to apply to rolled steel products not exceeding the thickness limits given in Table XI 3-1 of this Chapter.

(ii) Steel plates supplied in EH47 strength grades (minimum yield stress 460 N/mm^2)

This chapter gives the requirements for steel plates in thickness greater than 50 mm and not greater than 100 mm intended for hatch coamings and upper decks of container ships. For YP47 steels outside scope of the said thickness range, special consideration is to be given by the Society.

(iii) Brittle crack arrest steels

The thickness range of brittle crack arrest steels is over 50 mm and not greater than 100 mm as specified in Table XI 3-5.

……

(d) Brittle crack arrest steels

(i) The brittle crack designation can be assigned to YP36, YP40 and YP47 steels specified in this chapter, which meet the additional brittle crack arrest requirements and properties defined in this chapter.

(ii) The application of brittle crack arrest steels is to comply with 3.10 of this chapter, which covers longitudinal structural members in the upper deck region of container carriers (such as hatch side coaming, upper deck, hatch coaming top and the attached longitudinals, etc.).

(e) Unless otherwise specified, pipes intended for structural use are to be tested to the applicable specification or physical requirements of Chapter 5 of this Part or a recognized standard.

Paragraph 3.6.7 has been amended as follows:

3.6 Quality Inspections

3.6.7 Dimensional tolerances

(a) The tolerances on thickness of a given product are defined as:

(i) Minus tolerance is the lower limit of the acceptable range below the nominal thickness.

(ii) Plus tolerance is the upper limit of the acceptable range above the nominal thickness.

Note: Nominal thickness is stated by the purchaser at the time of enquiry and order.

~~(a) The maximum permissible under thickness tolerance for hull construction rolled steel plates and wide flats is –0.3 mm irrespective of nominal thickness.~~

~~(c) Tolerances for length, width, flatness and over thickness of plates and wide flats and those for other products are to comply with the requirements of the recognized national or international standards.~~

(b) For materials of nominal thickness 5 mm and more intended for hull structural purposes specified in this Chapter, the minus tolerance on thickness of plates, strip and wide flats, where the width is greater than or equal to 600 mm, is 0.3 mm, irrespective of nominal thickness. The average thickness of a product or products is not to be less than the nominal thickness. Plus tolerance is to be in accordance with a National or International Standard unless agreed otherwise by the Society.

(c) Class C (for a fixed minus tolerance of 0 mm) of ISO 7452 or equivalent National or International Standards may be applied in lieu of 3.6.7(b) of this Part. Where this standard is applied, the steel mill is to ensure that the number of measurements and measurement distribution is appropriate to establish that the plates produced are greater than or equal to the specified nominal thickness.

(d) For materials of nominal thickness below 5 mm intended for hull structural purposes specified in this Chapter, the minus tolerances on thickness of plates, strip and wide flats, where the width is greater than or equal to 600 mm, is 0.3 mm. The plus tolerance is to be in accordance with Class B (for a fixed minus tolerance of 0.3mm) of ISO 7452 or an equivalent National or International Standard.

(e) The minus tolerance on bars and sections (except for wide flats with a width ≥ 600 mm) is to be in accordance with the requirements of a recognised National or International Standard.

(~~d~~f) The attention of Shipbuilders and Ship owners is to be drawn to the fact that when thickness gauging is carried out during the ship's life, estimation of the diminution of hull plating and structure is to be based on the nominal thickness, this being the original approved thickness for the item of structure under consideration.

(g) The dimensional tolerances for the products intended for the construction of lifting appliances are to be agreed with the Society.

(~~b~~h) For rolled steel plates and wide flats intended for machinery structures, the under thickness tolerance may relax to as follows:

Nominal thickness t (mm)	Minus tolerance on nominal thickness (mm)
$3 \leq t < 5$	–0.3
$5 \leq t < 8$	–0.4
$8 \leq t < 15$	–0.5
$15 \leq t < 25$	–0.6
$25 \leq t < 40$	–0.7
$40 \leq t < 80$	–0.9
$80 \leq t < 150$	–1.1
$150 \leq t < 250$	–1.2
$250 \leq t$	–1.3

(i) For materials intended for applications as detailed in Chapter 4 of this Part, no minus tolerance is permitted in the thickness of plates and strip. The minus tolerances on sections are to comply with the requirements of a recognised National or International Standard.

(j) For the materials detailed in Chapter 9 of this Part, the minus tolerance of material intended for use in the construction of cargo tanks is not to exceed 0.3 mm. For other applications, no minus tolerance is permitted in the thickness of plates and strip.

(k) The tolerances on diameter and ovality of the bar are to be in accordance with the following table.

Nominal diameter(d) mm	Tolerance on diameter mm	Tolerance on roundness (d max.– d min.) mm
$d \leq 20$	–0/+1.0	0.60
$20 < d \leq 25$	–0/+1.0	0.60
$26 < d \leq 35$	–0/+1.2	0.80
$36 < d \leq 50$	–0/+1.6	1.10
$51 < d \leq 80$	–0/+2.0	1.50
$81 < d \leq 100$	–0/+2.6	1.95
$101 < d \leq 120$	–0/+3.0	2.25
$121 < d \leq 160$	–0/+4.0	3.00
$161 < d \leq 210$	–0/+5.0	4.00

(l) The average thickness and thickness tolerance is to be measured at locations of a product or products as defined below:

(i) An automated method or manual method may be applied to the thickness measurements. The procedure and the records of measurements are to be made available to the Surveyor and copies provided on request.

(ii) At least 2 lines among Line 1, Line 2 or Line 3, as shown in Fig. XI 3-3, are to be selected for the thickness measurements and at least 3 points on each selected line as shown in Fig. XI 3-3 are to be selected for thickness measurement on each piece rolled from a single slab or single ingot. If more than 3 points are taken on each line, then the number of points shall be equal on each line.

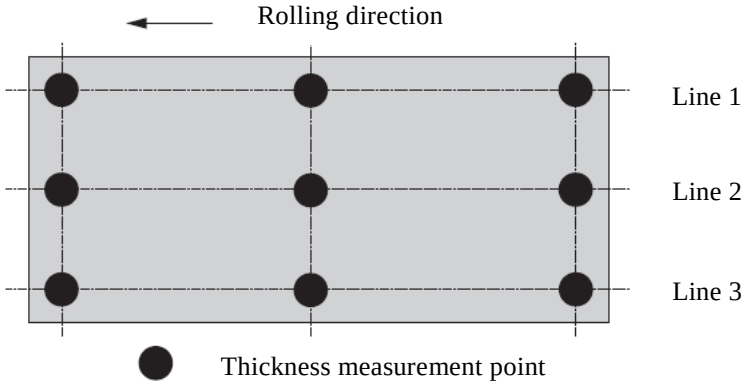


Fig. XI 3-3
Location of Thickness Measuring Points

(iii) For automated methods, the measuring points at sides are to be located not less than 10 mm but not greater than 300 mm from the transverse or longitudinal edges of the product.

(iv) For manual methods, the measuring points at sides are to be located not less than 10 mm but not greater than 100 mm from the transverse or longitudinal edges of the product.

(v) Additional measurements may be requested by the Surveyor.

~~(e) The thickness is to be measured at random locations whose distance from a longitudinal edge is to be at least 10 mm. Local surface depression resulting from imperfections and ground areas resulting from the elimination of defects may be disregarded provided the imperfections or grinding are in accordance with the requirements of the recognized national or international standards.~~

~~(f) The average thickness defined as the arithmetic mean of the measurements is not to be less than the nominal thickness.~~

(m) Local surface depressions resulting from imperfections and ground areas resulting from the elimination of defects may be disregarded provided that they are in accordance with the requirements of a recognised National or International Standard.

(n) Tolerances relating to length, width, flatness and plus thickness are to comply with a National or International Standard.

(o) The responsibility for maintaining the required tolerances and making the necessary measurements rests with the manufacturer. Occasional checking by the Surveyor does not absolve the manufacturer from this responsibility.

(p) The Shipbuilder is responsible for the storage and maintenance of product(s) delivered with acceptable surface conditions.

Paragraph 3.8.3~3.8.5 have been amended and renumbered as follows:

3.8 Additional Requirements for Through Thickness Properties ("Z" quality)

3.8.3 Test specimens for through thickness tensile test

(a) For plates, a test sample in a size sufficient for 6 test specimens is to be taken from the center of one end of each piece, or one representative piece of each batch, see Table XI 3-13 of this Chapter for selection of "piece or batch". Where plates having a weight exceeding 20 ton, another 6 specimens are to be prepared from the opposite end for the same testing. Where appropriate, the end selected is to be representative of the top end of an ingot or the start of a continuous cast strand. 3 tensile test specimens are to be prepared from each of these test samples in a line transverse to the final direction of rolling as shown in Fig. XI 3-~~3~~4 of this Chapter. Generally, the other 3 test specimens are prepared for possible retests.

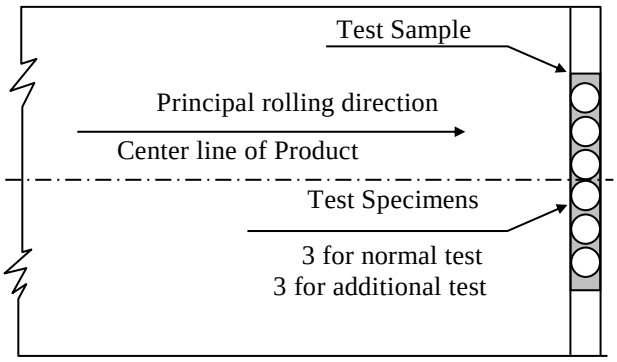


Fig. XI 3-~~3~~4
Test Sample for Through Thickness Tensile Test

3.8.4 Test results for through thickness tensile test

(c) The 3 through thickness tensile test specimens, for acceptance, are to give a minimum average reduction of area value of not less than that shown in Table XI 3-15 of this Chapter. Only one individual value may be below the minimum average but not less than minimum individual value shown for the appropriate grade. See Fig. XI 3-~~4~~5 of this Chapter.

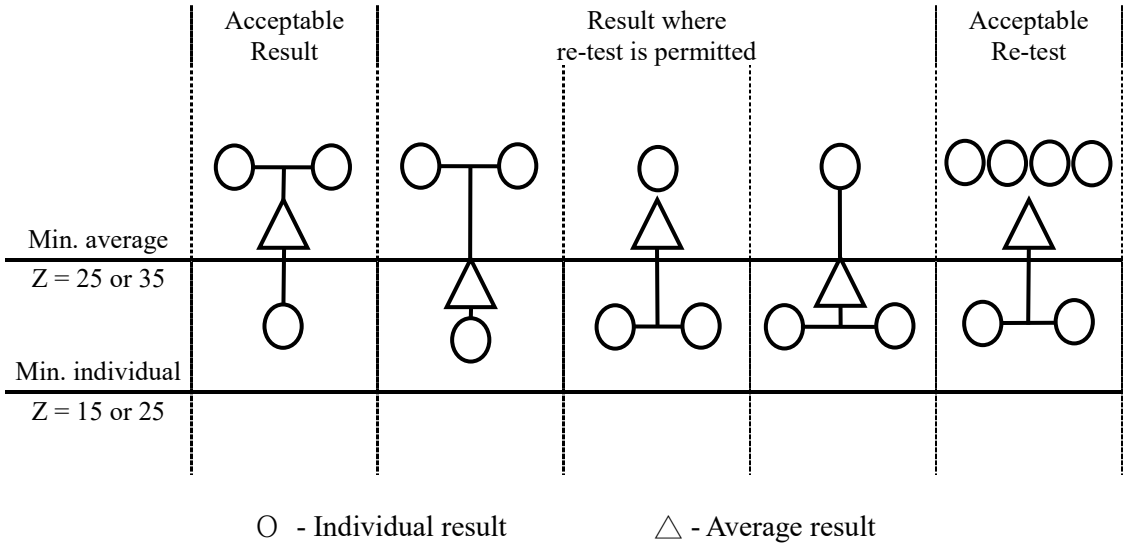


Fig. XI 3-~~4~~5
Diagram Showing Acceptance/Rejection and Retest Criteria

3.8.5 Retest for through thickness tensile test

(a) Fig. XI 3-~~4~~5 of this Chapter shows the 3 cases where a retest situation is permitted. In these instances 3 more tensile tests are to be taken from the remaining test sample. The average of all 6 tensile tests is to be greater than the required minimum average with no greater than 2 results below the minimum average.

Paragraph 3.10.2 has been amended as follows:

3.10.2 Non-destructive testing (NDT) during construction (Measure No.1 of 3.10.5 of this Chapter)

Where NDT during construction is required in 3.10.5 of this Chapter, the NDT is to be in accordance with 3.10.2(a) and 3.10.2(b) of this Chapter. Enhanced NDT as specified in 3.10.4(c)(v) of this Chapter is to be carried out in accordance with the appropriate standard.

(a) General

Ultrasonic testing (UT) in accordance with IACS UR W33 is to be carried out on all block-to-block butt joints of all upper flange longitudinal structural members in the cargo hold region. Upper flange longitudinal structural members include the topmost strakes of the inner hull/bulkhead, the sheer strake, main deck, coaming plate, coaming top plate, and all attached longitudinal stiffeners. These members are defined in Fig. XI 3-~~5~~6 of this Chapter.

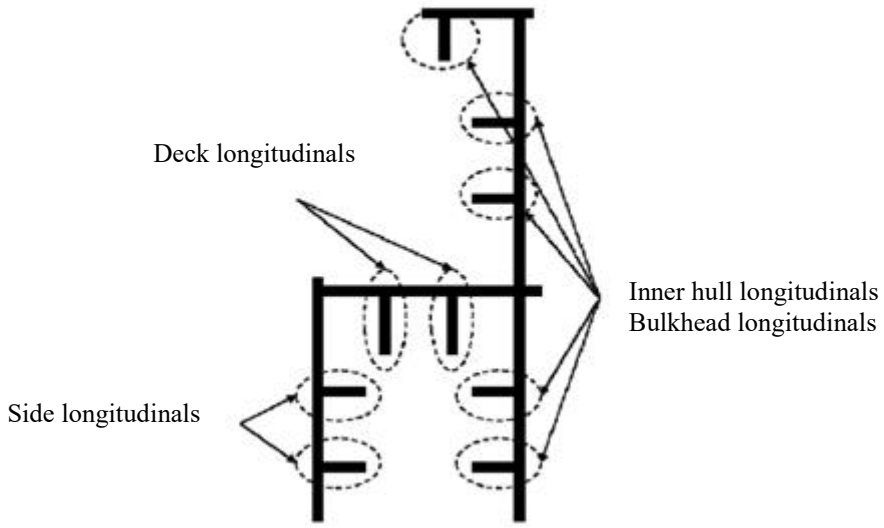


Fig. XI 3-~~5~~6
Upper Flange Longitudinal Structural Members

Paragraph 3.10.4 has been amended and renumbered as follows:

3.10.4 Brittle crack arrest design (Measure No.3, 4 and 5 of 3.10.5 of this Chapter)

(b) Functional requirements of brittle crack arrest design

The purpose of the brittle crack arrest design is to arrest propagation of a crack at a proper position and to prevent large scale fracture of the hull girder.

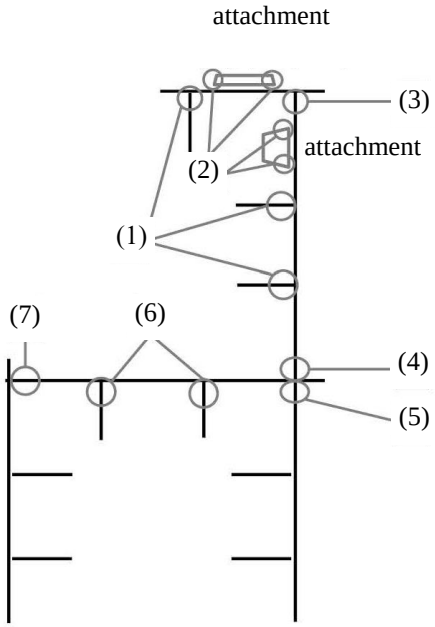
(i) The locations of most concern for brittle crack initiation and propagation are the block-to-block butt weld joints either on hatch side coaming or on upper deck plating. Other locations in block fabrication where joints are aligned may also present higher opportunity for crack initiation and propagation along butt weld joints.

(ii) Both of the following cases are to be considered:

(1) where the brittle crack runs straight along the butt joint, and

(2) where the brittle crack initiates in the butt joint but deviates away from the weld and into the plate, or where the brittle crack initiates from any other weld (see Fig. XI 3-~~5~~7) and propagates into the plate.

Fig. XI 3-6 has been amended and renumbered as follows:



Note:

(1) Fillet weld between hatch side coaming plating, including top plating, and longitudinals;
(2) Fillet weld between hatch side coaming plating, including top plating and longitudinals, and attachments. (e.g., Fillet weld between hatch side top plating and hatch cover pad plating.);
(3) Fillet weld between hatch side coaming top plating and hatch side coaming plating;
(4) Fillet weld between hatch side coaming plating and upper deck plating;
(5) Fillet weld between upper deck plating and inner hull/bulkheads;
(6) Fillet weld between upper deck plating and longitudinal; and
(7) Fillet weld between sheer strakes and upper deck plating.

Fig. XI 3-~~6~~7
Other Weld Areas

Chapter 11 Aluminium Alloys

11.2 Rolled and Extruded Aluminium Alloy Products

Table XI 11-2 has been amended as follows:

Table XI 11-2
Mechanical Properties for Rolled Aluminum Alloy Products, 3 mm ≤ t ≤ 50 mm

Material Grade	Temper Condition	Thickness, t mm	0.2% Proof Stress N/mm² (min.)	Tensile Strength N/mm² (min. or range)	Elongation, % (min.) (1)	
					Elongation on L=50 mm	Elongation on L=5d
5083	O	3 ≤ t ≤ 50	125	275 ~ 350	16	14
	H111	3 ≤ t ≤ 50	125	275 ~ 350	16	14
	H112	3 ≤ t ≤ 50	125	275	12	10
	H116	3 ≤ t ≤ 50	215	305	10	10
	H321	3 ≤ t ≤ 50	215 ~ 295	305 ~ 385	12	10
5383	O	3 ≤ t ≤ 50	145	290	-	17
	H111	3 ≤ t ≤ 50	145	290	-	17
	H116	3 ≤ t ≤ 50	220	305	10	10
	H321	3 ≤ t ≤ 50	220	305	10	10
5059	O	3 ≤ t ≤ 50	160	330	-	24
	H111	3 ≤ t ≤ 50	160	330	24	24
	H116	3 ≤ t ≤ 20	270	370	10	10
		20< t ≤ 50	260	360	10	10
	H321	3 ≤ t ≤ 20	270	370	10	10
		20< t ≤ 50	260	360	10	10
5086	O	3 ≤ t ≤ 50	95	240 ~ 305	16	14
	H111	3 ≤ t ≤ 50	95	240 ~ 305	16	14
	H112	3 ≤ t ≤ 12.5	125	250	8	-
		12.5< t ≤ 50	105	240	-	9
	H116	3 ≤ t ≤ 50	195	275	10 (2)	9
5754	O	3 ≤ t ≤ 50	80	190 ~ 240	18	17
	H111	3 ≤ t ≤ 50	80	190 ~ 240	18	17
5456	O	3 ≤t ≤ 6.3	130 ~ 205	290 ~ 365	16	-
		6.3< t ≤ 50	125 ~ 205	285 ~ 360	16	14
	H116	3 ≤ t ≤ 30	230	315	10	10
		30< t ≤ 40	215	305	-	10
		40< t ≤ 50	200	285	-	10
	H321	3 ≤ t ≤ 12.5	230 ~ 315	315 ~ 405	12	-
		12.5< t ≤ 40	215 ~ 305	305 ~ 385	-	10
		40< t ≤ 50	200 ~ 295	285~ 370	-	10

Notes:

(1) Elongation in 50 mm applies for thickness up to 12.5 mm tested by type T2 test specimen as given in Table XI 2-1 with gauge length of 50 mm and in 5d for thickness over 12.5 mm.

(2) 8 % for thicknesses up to and including 6.3 mm.

(3) The mechanical properties for the O and H111 tempers are the same. However, they are separated to discourage dual certification as these tempers represent different processing.

Table XI 11-3 has been amended as follows:

Table XI 11-3
Mechanical Properties for Extruded Aluminum Alloy Products, 3 mm ≤ t ≤ 50 mm

Material Grade	Temper Condition	Thickness, t mm	0.2% Proof Stress N/mm^2 (min.)	Tensile Strength N/mm^2 (min. or range)	Elongation, % (min.) (1), (2)	
					Elongation on L=50 mm	Elongation on L=5d
5083	O	3 ≤ t ≤ 50	110	270 ~ 350	14	12
	H111	3 ≤ t ≤ 50	165	2750	12	10
	H112	3 ≤ t ≤ 50	110	270	12	10
5383	O	3 ≤ t ≤ 50	145	290	17	17
	H111	3 ≤ t ≤ 50	145	290	17	17
	H112	3 ≤ t ≤ 50	190	310	-	13
5059	H112	3 ≤ t ≤ 50	200	330	-	10
5086	O	3 ≤ t ≤ 50	95	240 ~ 315	14	12
	H111	3 ≤ t ≤ 50	145	250	12	10
	H112	3 ≤ t ≤ 50	95	240	12	10
6005A	T5	3 ≤ t ≤ 50	215	260	9	8
	T6	3 ≤ t ≤ 10	215	260	8	6
		10< t ≤ 50	200	250	8	6
6061	T6	3 ≤ t ≤ 50	240	260	10	8
6082	T5	3 ≤ t ≤ 50	230	270	8	6
	T6	3 ≤ t ≤ 5	250	290	6	-
		5< t ≤ 50	260	310	10	8

Notes:

(1) The values are applicable for longitudinal and transverse tensile test specimen as well.

(2) Elongation in 50 mm applies for thickness up to 12.5 mm tested by type T2 test specimen as given in Table XI 2-1 with gauge length of 50 mm and in 5d for thickness over 12.5 mm.

Paragraph 18.2.3 has been amended as follows:

Chapter 18 Windows

18.2 Construction

18.2.3 Minimum glass thickness

The minimum glass thickness of windows is to be determined as follows:

$$t_w = \frac{b}{200}\sqrt{\beta P_w} \qquad \text{mm}$$

where:

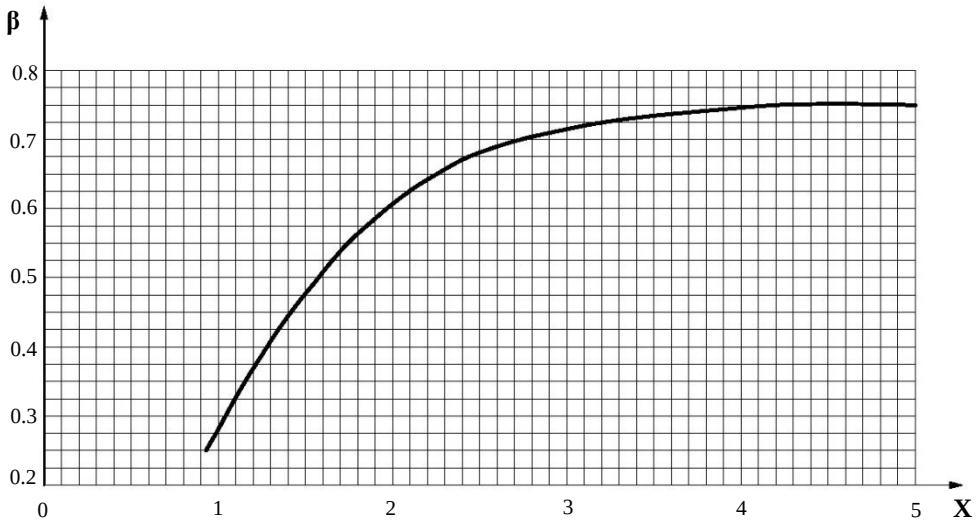
t_w = The minimum thickness of glass, in mm

P_w = Design load from 18.2.2, in kPa

β = A non-dimensional coefficient as specifed in ~~Table XI 18-1~~ Fig. XI 18-1

b = The length of the shorter dimension of the window, in mm

Fig. XI 18-1 has been added as follows:



Window size ratio (X) = Larger dimension (mm)/ Shorter dimension (mm)

Fig. XI 18-1
Values for Factor β Based on Window Size Ratio

Table XI 18-1 has been deleted as follows:

~~Table XI 18-1~~
~~Values for Factor β Based on Window Size Ratio K~~

~~Value of K(1)~~	~~1.0~~	~~0.9~~	~~0.8~~	~~0.7~~	~~0.6~~	~~0.5~~	~~0.4~~	~~0.3~~	~~0.2~~	~~0.1~~	~~0~~
~~X~~	~~1~~	~~1.11~~	~~1.25~~	~~1.43~~	~~1.67~~	~~2~~	~~2.5~~	~~3.33~~	~~5~~	~~10~~	~~0~~
~~β~~	~~0.287~~	~~0.330~~	~~0.393~~	~~0.478~~	~~0.545~~	~~0.612~~	~~0.668~~	~~0.704~~	~~0.730~~	~~0.745~~	~~0.750~~

~~Notes:~~

~~(1) K: window size ratio = $\frac{\text{Shorter dimension (mm)}}{\text{Larger dimension (mm)}}$~~

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022"

PART XII WELDING

List of major changes in Part XII from 2022 edition

1.3.3(a) & (b)	Revised
2.1.2	Revised
2.1.8 & 2.1.9	New
2.2	Revised
Table XII 2-1	New
Table XII 2-1	Renumbered
Table XII 2-2	Revised and Renumbered
Table XII 2-3	Renumbered
Table XII 2-4	Revised and Renumbered
2.7.2	Revised
Table XII 2-5~2-7	Renumbered
2.8	New
2.8	Renumbered
Fig. XII 2-5	Revised
3.2.5	Revised
3.2.7(b), (e) & (g)	Revised
Table XII 3-3	Revised
Table XII 3-4	Revised
Table XII 3-9	New
Table XII 3-10	New
4.1.3(a)(iv)&(v)	Revised
4.2.6(a)	Revised
Table XII 4-1~4-3	Revised
Table XII 4-5	Revised
Chapter 5	Revised

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 1 General

Paragraph 1.3.3(a)~(b) have been amended as follows:

1.3 Test Specimens and Mechanical Tests

1.3.3 Bending tests

(a) Face and root bending test specimens

(i) Test specimens, except for guided bend tests, are to be 30 mm in width and of the full plate thickness, where the thickness of the specimen exceeds 25 mm, the specimens may be machined on the compression side to reduce the thickness to 25 mm.

(ii) Test specimens for guided bend tests are to be 38 mm in width and of the full plate thickness in case the thickness of the specimen is ~~9~~ 10 mm or less. Where the thickness exceeds ~~9~~ 10 mm, the specimen is to be machined on the compression side to reduce the thickness to ~~9~~ 10 mm.

(b) Test specimens for side bending tests are to be ~~9~~ 10 mm in width and of the full plate thickness. For guided bend tests, where the thickness exceeds 38 mm, specimens are to be reduced to 38 mm thick by machining on one surface of the specimens.

(c) Bending test specimens are generally to be 250 mm in length. The weld deposited metal is to be located in way of mid-length of the specimen to subject to maximum tension and compression in test.

(d) Weld reinforcements and back straps are to be removed, filed, ground or machined flush with the surfaces of the plate. Edges of test specimens are to be rounded to a radius of 1 to 2 mm.

(e) Guided bend tests are to be carried out by jigs shown in Fig. XII 1-2.

(f) Bending tests which comply with national or international standards may be used when accepted by the Surveyors.

(g) The test is considered to be satisfactory if, after bending, the specimen is not to show any crack or other open defects exceeding 3 mm in length in any direction on the surface.

Chapter 2 Welding Procedures

2.1 General

Paragraph 2.1.2 has been amended as follows:

2.1.1 Where it is intended to use automatic, semi-automatic or manual welding in shipyard or works, to build welded constructions for special services, or to use new materials in which there is no previous experience, or to use new welding processes, or to alter the items described in the approved welding procedure specification, the procedure to be adopted is to be approved by the Society in advance.

2.1.2 Welding procedure specification (WPS) subjected to approval is to contain the following information:

……

2.1.7 If tack welds and/or start and stop points are a condition of the weld process they are to be fused into the joint and are to be included in the test assemblies.

Paragraph 2.1.8 & 2.1.9 have been added as follows:

2.1.8 Welding procedure tests made in accordance with EN, ISO, JIS, ASME or AWS may be considered for acceptance provided that, as a minimum, they are equivalent to and meet the technical intent of the Rules to the satisfaction of the Surveyor.

2.1.9 Approval of welding procedure for aluminium alloy is to be in accordance with Chapter 2 of Part II of the Rules for High Speed Craft.

Section 2.2 has been amended and renumbered as follows:

2.2 Approval Range of Welding Procedures

~~2.2.1~~ The welding procedure intended to be accepted by the Society is to be subjected to a satisfactory demonstration welding procedure qualification test in the presence of the Surveyors, unless otherwise specified. The scope of approval of the welding procedures is in accordance with the followings. However, the range of approval differing from the requirements specified in this Chapter may be accepted provided that it is deemed appropriate by the Society.

2.2.1 General

(a) All the conditions of validity stated below are to be met independently of each other.

(b) Changes outside of the ranges specified are to require a new welding procedure test.

(c) Shop primers may have an influence on the quality of fillet welds and is to be considered. Welding procedure qualification with shop primer will qualify those without shop primers but not vice versa.

2.2.2 ~~Range of approval welding procedures~~ Base metal

~~The scope of approval of the welding procedures is in accordance with the followings. However, the range of approval differing from the requirements specified in this Chapter may be accepted that it is deemed appropriate by the Society.~~

~~(a) Shop primers may have an influence on the quality of fillet welds and is to be considered. Welding procedure qualification with shop primer will qualify those without shop primers, but not vice versa.~~

(a) Normal and higher strength hull structural steels according to Chapter 3 of Part XI.

~~(b)~~ (i) For each strength level, welding procedures are considered applicable to the same and lower toughness grades as that tested.

~~(c)~~ (ii) For each toughness grade ~~of normal and higher strength rolled steels~~, welding procedures are considered applicable to the same and two lower strength levels as that tested. ~~For the high heat input processes over 50 kJ/cm, the welding procedures are considered applicable to that toughness grade tested and one strength below.~~

(iii) For applying the above (i) and (ii) to high heat input processes above 50 kJ/cm, e.g. the two-run technique with either submerged arc or gas shielded metal arc welding, electro slag and electro gas welding, welding procedure is applicable to that toughness grade tested and one strength level below.

Where steels used for construction are supplied from different delivery conditions from those tested the Society may require additional tests.

(b) High strength quenched and tempered steels according to Chapter 3 of Part XI.

(i) For each strength level, welding procedures are considered applicable to the same and lower toughness grades as that tested.

(ii) For each toughness grade, welding procedures are considered applicable to the same and one lower strength level as that tested.

(iii) The approval of quenched and tempered steels does not qualify thermo-mechanically rolled steels and vice versa.

~~(d) For each toughness grade of quenched and tempered rolled steels, welding procedures are considered applicable to the same and one lower strength level as that tested.~~

~~(e) The approval welding procedures of quenched and tempered rolled steels does not quality thermo-mechanically rolled steels (TMCP steels) and vice versa.~~

(c) Weldable C and C-Mn hull steel forgings according to Chapter 8 of Part XI.

~~(f)~~(i) ~~For weldable C and C-Mn hull steel forgings and steel castings,~~ Welding procedures are considered applicable to the same and lower strength level as that tested.

(ii) The approval of quenched and tempered hull steel forgings does not qualify other delivery conditions and vice versa.

(d) Weldable C and C-Mn hull steel castings according to Chapter 6 of Part XI.

(i) Welding procedures are considered applicable to the same and lower strength level as that tested.

(ii) The approval of quenched and tempered hull steel castings does not qualify other delivery conditions and vice versa.

~~(g) The approval welding procedures of quenched and tempered weldable C and C-Mn hull steel forgings and steel castings does not quality other delivery conditions and vice versa.~~

2.2.3 Thickness

(a) The qualification of a WPS carried out on a test assembly of thickness t is valid for the thickness range given in Table XII 2-1.

(b) In addition to the requirements of Table XII 2-1, the range of approval of throat thickness "a" for fillet welds is to be as follows:

- Single run ; "0.75 × a" to "1.5 × a"
- Multi-run ; as for butt welds with multi-run (i.e. a=t)

(c) For the vertical-down welding, the test piece thickness "t" is always taken as the upper limit of the range of application.

(d) For unequal plate thickness of butt welds the lesser thickness is ruling dimension.

(e) Notwithstanding the above, the approval of maximum thickness of base metal for any technique is to be restricted to the thickness of test assembly if three of the hardness values in the heat affected zone are found to be within 25 HV of the maximum permitted.

Table XII 2-1
Approval Range of Thickness for Butt and T-joint Welds and Fillet Welds

Thickness of test piece T(1) (mm)	Range of approval	
	Butt and T-joint welds with single run or single run from both sides	Butt and T-joint welds with multi-run and fillet welds(2)
3 < t ≦ 12	0.7t ~ 1.1t	3mm ~ 2t
12 < t ≦ 100	0.7t ~ 1.1t (3)	0.5t ~ 2t (Max. 150)

Note:

(1) For multi process procedures, the recorded thickness contribution of each process is to be used as a basis for the range of approval for the individual welding process.

(2) For fillet welds, the range of approval is to be applied to both base metals.

(3) For high heat input processes over 50kJ/cm, the upper limit of range of approval is to be 1.0 x t.

2.2.4 Welding position

~~(h)~~ Approval for a test made in any welding position is restricted to that position. To qualify a range of welding positions, test assemblies are to be welded for highest heat input welding position and lowest heat input welding position and all applicable tests are to be made on those assemblies.

2.2.5 Welding process

~~(i)~~(a) The approval of welding process is only valid for the welding process used in the welding procedure test. It is not permitted to change from a multi-run to a single run.

(b) For multi-process procedures the welding procedure approval may be carried out with separate welding procedure tests for each welding process. It is also possible to make the welding procedure test as a multi-process procedure test. The approval of such a test is only valid for the process sequence carried out during the multi-process procedure test.

2.2.6 Welding consumable

~~(j)~~ Except high heat input processes over 50 kJ/cm, welding materials used in the welding procedure test cover other approved welding materials having the same grade mark including all suffixes specified in Chapter 4 of this Part.

2.2.7 Heat input

(a) The upper limit of heat input approved is 25% greater than that used in welding the test piece or 55 kJ/cm whichever is smaller, except that the upper limit is 10% greater than that for high heat input processes over 50 kJ/cm.

(b) The lower limit of heat input approved is 25% lower than that used in welding the test piece.

2.2.8 Preheating and interpass temperature

(~~k~~a) The minimum preheating temperature is not to be less than that used in the welding procedure qualification test.

(~~l~~b) The maximum interpass temperature is not to be higher than that used in the welding procedure qualification test.

2.2.9 Post-weld heat treatment

The heat treatment used in the qualification test is to be maintained during manufacture. Holding time may be adjusted as a function of thickness.

2.2.10 Type of joint

~~(m) Range of approval for type of welded joints depending on type of welded joints for test assembly is to be specified in Table XII 2-1.~~

(a) Range of approval depending on type of welded joints for test assembly is to be specified in Table XII 2-2.

(~~n~~b) An approved welding procedure for butt welding is also qualify for fillet welding and T-joint with full penetration corresponding to the thickness range specified in 2.2.3 and welding position applied for that butt welding.

Table XII 2-2 ~~XII 2-1~~
Range of Approval for Type of Welded Joints

Type of welded joint for test assembly				Range of approval
Butt welding	One side	With backing	A	A & C
		Without backing	B	A, B, C & D
	Both side	With gouging	C	C
		Without gouging	D	C & D
Fillet welding			E	E

~~(o) Generally, the thickness of test assembly for test is to be equal to the maximum thickness of the materials capably applied by the welding procedure for single run welding, vertical-down welding and high heat input processes over 50 kJ/cm. The qualified thickness range for multi-run welding and fillet welding, except vertical-down welding, may be up to double thickness of the test assembly.~~

2.2.11 Other variables

~~(p)~~ The range of approval relating to other variables may be taken according to the requirements that it is deemed appropriate by the Society.

Paragraph 2.3.4(c)(i) has been amended as follows:

2.3 Butt Welding Tests

2.3.4 Test requirements

(a) The tensile strength of the transverse tensile test is not to be less than the specified requirements for the base material of the test assembly.

(b) Bending tests are to be in compliance with the requirements given in 1.3.3 of this Part. Generally, bending angle for test specimens is 180 degree.

(c) Test temperatures and absorbed energy requirements of impact tests are in accordance with the following requirements:

(i) For normal strength and higher strength rolled steels:

Test temperature and minimum average value of absorbed energy of impact tests are to be specified in Tables ~~XII 2-2, XII 2-3 & XII 2-4~~ XII 2-3 to Table XII 2-5.

Table XII 2-2 has been renumbered and amended as follows:

Table XII 2-3 ~~XII 2-2~~
Impact Test Temperature for Normal Strength and Higher Strength Rolled Steels

Impact test temperature	Grade of rolled steels
+20 ℃	A, AH32, AH36, AH40~~& AH47~~
0 ℃	B, D, DH32, DH36, DH40~~& DH47~~
-20 ℃	E, EH32, EH36, EH40& EH47
-40 ℃	FH32, FH36, FH40~~& FH47~~

Table XII 2-3 has been renumbered as follows:

Table XII 2-4 ~~XII 2-3~~
Minimum Average Value of Absorbed Energy for Normal Strength and Higher Strength Rolled Steels, where Thickness of Test Assembly is not Greater Than 50 mm(1),(2)

Grade of rolled steels	For manual and semi-automatic welding		For automatic welding
	Downhand, Horizontal, Overhead	Vertical	
A, B, D, E, AH32, DH32, EH32, FH32, AH36, DH36, EH36 & FH36	47 J	34 J	34 J
AH40, DH40, EH40 & FH40		39 J	39 J

Notes:
(1) These requirements are to apply to test piece of which butt weld is perpendicular to the rolling direction of the plates.
(2) For grade A and B rolled steels, the average absorbed energy on fusion line and in heat affected zone is to be minimum 27J.

Table XII 2-4 has been renumbered and amended as follows:

Table XII 2-5 ~~XII 2-4~~
Minimum Average Value of Absorbed Energy for Normal Strength and Higher Strength Rolled Steels, where Thickness of Test Assembly is Greater Than 50 mm (See Note)

Grade of rolled steels	For manual and semi-automatic welding		For automatic welding
	Downhand, Horizontal, Overhead	Vertical	
A & B	34 J		
D & E	47 J	38 J	38 J
AH32, DH32, EH32, FH32, AH36, DH36, EH36 ~~&~~, FH36 & EH36-BCA1	47 J	41 J	41 J
AH40, DH40, EH40 ~~&~~, FH40, EH40-BCA1 & EH40-BCA2	50 J	46 J	46 J
~~AH47, DH47,~~ EH47, ~~FH47~~ EH47-BCA1 & EH47-BCA2	~~53 J~~ 64 J		
Note：These requirements are to apply to test piece of which butt weld is perpendicular to the rolling direction of the plates.			

Paragraph 2.7.2 has been amended as follows:

2.7 Welding Procedure Qualification, Copper Alloy

2.7.2 Copper alloy castings for propellers

(b) Welding procedure

(i) Metal arc welding is recommended for all types of repair on bronze propellers. For CU1 and CU2 material thickness less than 30 mm, gas welding may give a satisfactory weldment. Arc welding with coated electrodes and gas-shielded metal arc process (GMAW) are generally to be applied. Argon-shielded tungsten welding (GTAW) should be used with care due to the higher specific heat input of this process. Recommended filler metals, pre-heating and stress relieving temperatures are listed in Table XII 2-6 ~~XII 2-5~~.

(ii) Adequate pre-heating is to be carried out with care to avoid local overheating, pre-heating temperatures are listed in Table XII 2-6 ~~XII 2-5~~.

(iii) All propeller alloys are generally to be welded in down-hand (flat) position. Where this cannot be done, gas-shielded metal arc welding should be carried out. The section to be welded is to be clean and dry. Flux-coated electrodes are to be dried before welding according to the maker's instructions. To minimize distortion and the risk of cracking, interpass temperatures are to be kept lower than the values specified in Table XII 2-6 ~~XII 2-5~~. This is especially the case with CU 3 alloys. Slag, undercuts and other defects are to be removed before depositing the next run.

(iv) All welding work is to be carried out preferably in the shop free from draughts and influence of the weather.

(v) With the exception of alloy CU3 (Ni-Al-bronze) all welds are to be stress relief heat treated, in order to avoid stress corrosion cracking. However, stress relief heat treatment of alloy CU3 propeller castings may be required after major repairs in zone B (and specially approved welding in Zone A) or if a welding consumable susceptible to stress corrosion cracking is used. In such cases the propeller is to be either stress relief heat treated in the temperature 450 to 500°C or annealed in the temperature range 650-800°C, depending on the extent of welding work, as given in Table XII 2-6 ~~XII 2-5~~.

(vi) The soaking times for stress relief heat treatment of copper alloy propellers should be in accordance with Table XII 2-7 ~~XII 2-6~~. The heating and cooling is to be carried out slowly under controlled conditions. The cooling rate after any stress relieving heat treatment shall not exceed 50°C/h until the temperature of 200°C is reached.

(c) Welding procedure qualification test

(iii) Qualification testing

(3) Mechanical testing

Two tensile tests should be prepared as specified in 1.3.2. The requirements to the tensile strength, as given in Table XII 2-8 ~~XII 2-7~~, should be met. Alternatively tensile test specimens according to recognized standards may be used as agreed by the Society.

Table XII 2-5~2-7 have been renumbered as follows:

Table XII 2-6 ~~XII 2-5~~
Recommended Filler Metal and Heat Treatment

Alloy type	Filler metal	Preheat temperature In degree [min]	Interpass temperature degree [max]	Stress relief temperature degree	Hot straightening Temperature degree
CU1	Al-bronze(1) Mn-bronze	150	300	350-500	500-800
CU2	Al-bronze Ni-Mn-bronze	150	300	350-550	500-800
CU3	Al-bronze Ni-Al-bronze(2) Mn-Al-bronze	50	250	450-500	700-900
CU4	Mn-Al-bronze	100	300	450-600	700-850

Notes:
(1) Ni-Al-bronze and Mn-Al-bronze are acceptable.
(2) Stress relieving not required, if filler metal Ni-Al-bronze is used.

Table XII 2-7 ~~XII 2-6~~
Soaking Times for Stress Relief Heat Treatment of Copper Alloy Propellers

Stress relief temperature in degrees	Alloy grade CU1 and CU2		Alloy grade CU3 and CU4	
	Hours per 25 mm thickness	Max. recommended total time hours	Hours per 25 mm thickness	Max. recommended total time hours
350	5	15	-	-
400	1	5	-	-
450	1/2	2	5	15
500	1/4	1	1	5
550	1/4	1/2	1/2 (see Note)	2 (see Note)
600	-	-	1/4 (see Note)	1 (see Note)

Note: 550 and 600 degrees only applicable for CU 4 alloys.

Table XII 2-8 ~~XII 2-7~~
Required Tensile Strength Values

Alloy type	Tensile strength N/mm^2, min
CU1	370
CU2	410
CU3	500
CU4	550

Section 2.8 has been added as follows:

2.8 Welding Procedure Qualification, EH47 Steels and Brittle Crack Arrest Steels

2.8.1 Welding procedures for EH47 and brittle crack arrest steels

(a) General

(i) Approval test items, test methods and acceptance criteria not specified in this section are to be in accordance with the requirements given in 2.1 to 2.6 of this Chapter.

(ii) Approval range for EH47 Steels is to be in accordance with 2.2 of this Chapter.

(iii) Where Welding Procedure Specification (WPS) for the non-BCA steels has been approved by the Society, the said WPS is applicable to the same welding procedure applied to the same grade with suffix "BCA1" or "BCA2" specified in Table XI 3-5 of Part XI except high heat input processes over 50 kJ/cm.
The requirements for welding procedure qualification test for brittle crack arrest steels is to be in accordance with the relevant requirements for each steel grade excluding suffix "BCA1" or "BCA2", except for 2.8.1(d) below.

(b) Parent metal

For EH47, the welding procedure is qualified for the parent metal tested.

(c) Impact test

2.3 of this Chapter is to be followed for impact test. 64J at -20°C is to be satisfied.

(d) Hardness

An additional row of indentations is to be carried out at mid-thickness. The results of hardness tests are not to exceed 350HV for EH47 and 380 HV for EH47BCA1 or EH47BCA2.

(e) Tensile test

Tensile strength in transverse tensile test is to be not less than 570 N/mm^2.

(f) Brittle fracture initiation test

Deep notch test or CTOD test may be required. Test method and acceptance criteria are to be in accordance with Part XI, 2.9 of the Rules for Steel Ships.

2.8.2 Production welding for EH47 Steels

(a) Welder

Welders engaged in EH47 welding work are to possess welder's qualifications issued or accepted by the Society.

(b) Welding Consumable

Approval procedure, approval test items, test methods and acceptance criteria not specified in this section are to be in accordance with Chapter 4 of this Part.

(i) Specifications of welding consumables for EH47 steel plates are to be in accordance with Table XII 4-2.

(ii) Consumable tests for butt weld assemblies for EH47 steels are to be in accordance with Table XII 4-3.

(c) Others

(i) Special care is to be paid to the final welding so that harmful defects do not remain.

2.8.3 Production welding for Brittle crack arrest steels

Welding work (such as relevant welder's qualification, short bead, preheating, selection of welding consumable, etc.) for brittle crack arrest steels is to be in accordance with the relevant requirements for each steel grade excluding suffix "BCA1" or "BCA2" specified in Table XI 3-5 of Part XI.

Section 2.8 has been renumbered as follows:

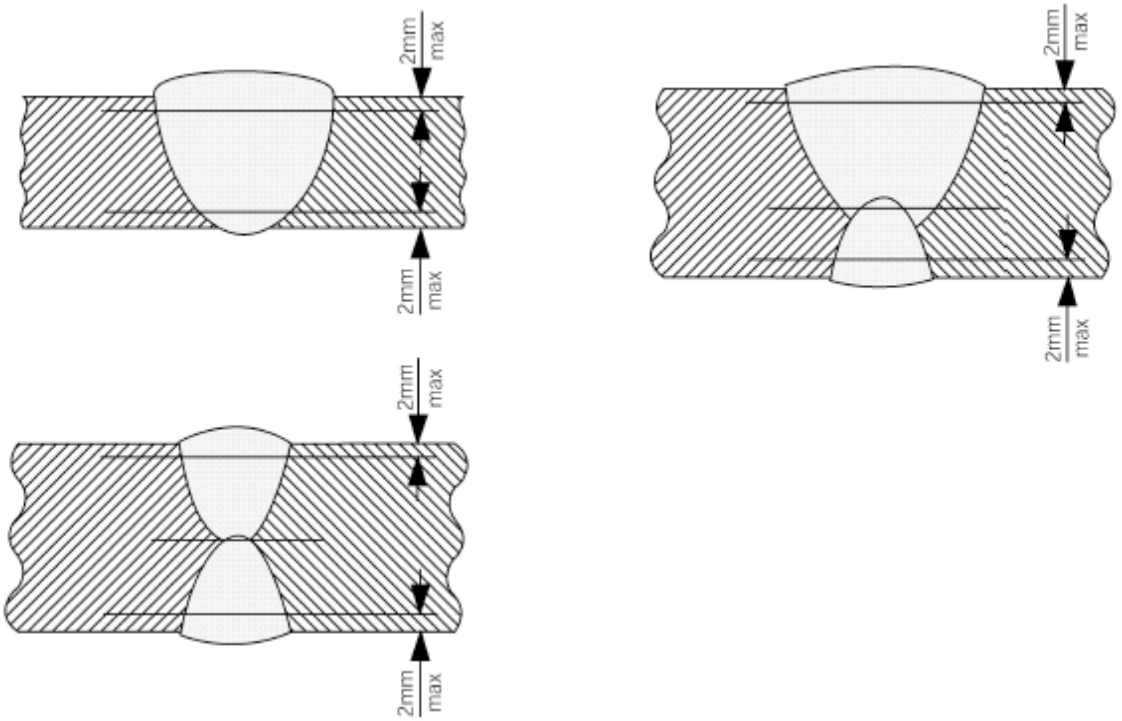
2.9 ~~2.8~~ Test Record

2.9.1 ~~2.8.1~~ Welding conditions for test assemblies and test results are to be recorded in welding procedure test record.

2.9.2 ~~2.8.2~~ The results of assessing each test piece (including repeat tests) is to be contained in the test report for each welding procedure test. The relevant items listed for the WPS of these requirements are to be included.

2.9.3 ~~2.8.3~~ The test report that the test piece was made according to the particular welding procedure is to be signed by the Surveyor witnessing the test and is to include the Society's identification.

Fig. XII 2-5 has been amended as follows:



Note: Measuring intervals are to be 1 mm in the heat affected zone.

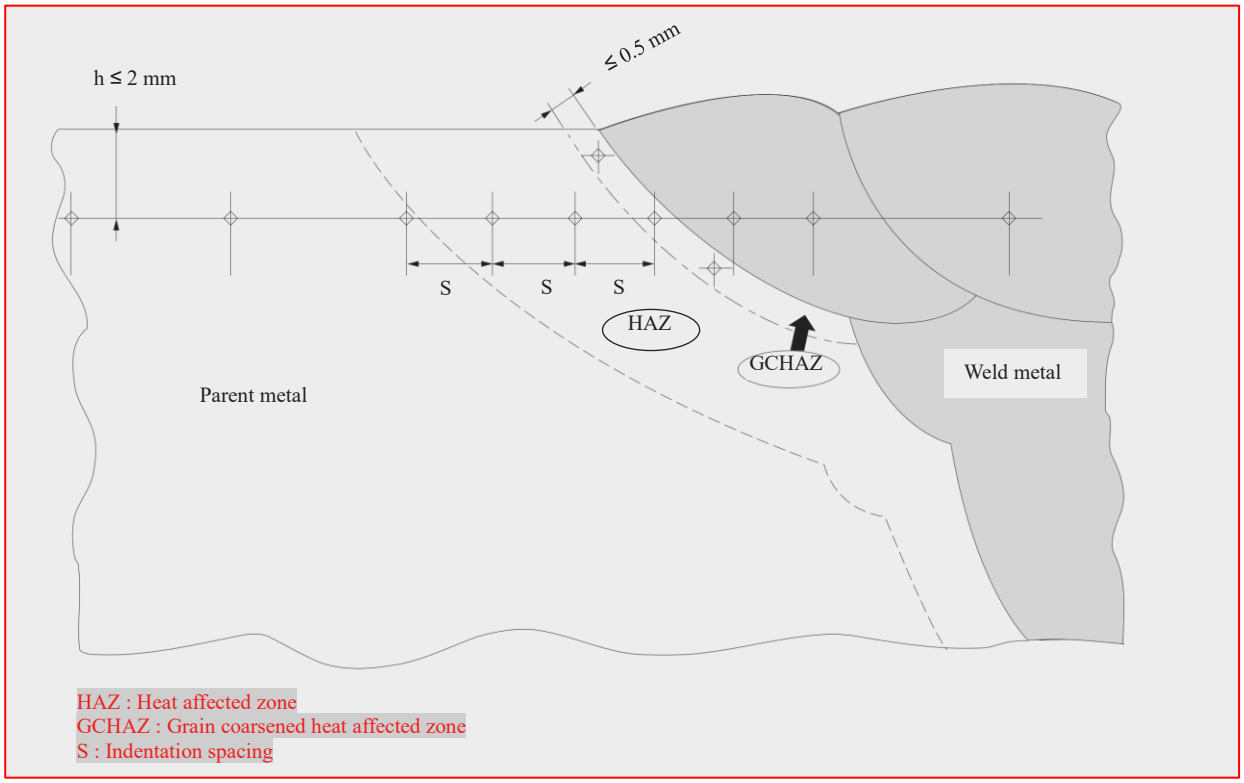


Fig. XII 2-5
Hardness Test for Butt Welding Procedure Approval

Chapter 3 Welder Qualifications and Control of Welding Operations

3.2 Welder and Welding Operator Qualifications

Paragraph 3.2.5 has been amended as follows:

3.2.5 Welders or welding operators qualified in accordance with national or international welder qualification standards may also be engaged in welding of hull structures at the discretion of the Society provided that the qualification testing, range of approval and revalidation requirements are considered equivalent to this Chapter.

Qualification scheme for welders of aluminium alloys made in accordance with IACS Rec. No. 105 may be considered for equivalent to the requirements of this Chapter. Welder qualification tests and related range of approval made in accordance with international standards ISO 9606 may be acceptable.

Paragraph 3.2.7(b), (e) & (g) has been amended as follows:

3.2.7 Range of qualification of welders

(a) A welder is to be qualified in relation to the following variables of welding:

(i) base metal
(ii) welding consumables type
(iii) welding process
(iv) type of welded joint
(v) plate thickness or outside diameter of pipe
(vi) welding position

(b) Base metals

Base metals for qualification of welders or welding operators are combined into one group with a specified minimum yield strength $R_{eH} \leq 460$ N/mm^2. The welding of any one metal in this group covers qualification of the welder or welding operator for the welding of all other metals within this group.

Material types are to be grouped as shown in Table XII 3-9. In addition, qualification on one group of materials may confer approval to weld other groups as shown in Table XII 3-10.

(c) Welding consumables type

For manual metal arc welding, qualification tests are required using basic, acid or rutile covered electrodes. The type of covered electrodes (basic, acid or rutile) included in the range of approval is left at the discretion of the Society.

Welding with filler material qualifies for welding without filler material, but not vice versa.

(d) Welding process

The welding processes for welder's qualification are to be classified in Table XII 3-1 as below.

Each testing normally qualifies only for one welding process. A change of welding process requires a new qualification test.

(e) Type of welded joint

The types of welded joint for welder's qualification are to be classified as shown in Table XII 3-2 in accordance with the qualification test.

A qualification test performed on a butt weld may be considered as giving approval for fillet welds. Where a welder is employed to perform fillet welding only, a fillet welding qualification test is required. For welding T joints with full or partial penetration a butt welding qualification is required.

(f) For fillet welding, welders who passed the qualification tests for multi-layer technique welding can be deemed as qualified for single layer technique, but not vice versa.

(g) Plate thickness or outside diameter of pipe

The qualified plate thickness range arising from the welder qualification test plate thickness is shown in Table XII 3-3 as below. The range of qualification for outside diameter of pipe is to be classified as given in Table XII 3-4 as below.

A qualification test performed on plate confers approval to weld on pipes having an outside diameter greater than 500 mm in a fixed position.

……

(i) A welder qualified for butt or fillet welding can be engaged in tack welding for the welding process and position corresponding to those permitted in his certificate.
Alternatively, welders engaged in tack welding only can be qualified on the test assemblies shown in Fig. XII 3-6 or Fig. XII 3-7 of this Chapter.

Table XII 3-3 has been amended as follows:

Table XII 3-3
Plate Thicknesses for Welder's Qualification

Material Type	Thickness of test assembly T (mm)	Qualified plate thickness range t (mm)
Steel and copper alloys	$T < 3$	$T \leq t \leq 2T$
	$3 \leq T < 12$	$3 \leq t \leq 2T$
	$12 \leq T$	$3 \leq t$
Aluminium alloys	$T \leq 6$	$0.5 \leq t \leq 2T$
	$T > 6$	$6 \leq t$

Table XII 3-4 has been amended as follows:

Table XII 3-4
Range of Qualification for Outside Diameter of Pipe

Material type	Outside diameter(1) of test assembly D (mm)	Range of outside diameter applicable to actual welding work d (mm)
Steel and copper alloys	D ≤ 25	D ≤ d ≤ 2D
	25 < D	0.5D(2) ≤ d
	Plate(3)	500 ≤ d
Aluminum alloys	D ≤ 125	0.25D ≤ d ≤ 2D
	125 < D	0.5D ≤ d
	Plate(3)	500 ≤ d

Notes:

(1) For non-circular sections, D is the dimension of the smaller side.

(2) Lower limit of 0.5D is not to be less than 25 mm.

(3) Plate qualification will approve welding on pipes greater than 150 mm diameter when the pipe is rotated.

Table XII 3-9 has been added as follows:

Table XII 3-9
Welder Qualification Materials Groupings

Material Group	Material Description	Typical CR Grades	References
WQ 01	Low carbon unalloyed,	A, B, D and E	Part XI, Ch.3
	C-Mn, or	AH32 to FH40 EH36-BCA, EH40-BCA,	Part XI, Ch.3
	Steel strength grade EH47, or	EH47, EH47-BCA	Part XI, Ch.3
	Low alloyed steels ($R_{eH} \leq 390$ N/mm^2)	Boiler and pressure vessels 1-410, 1-450, 1-480, 2-450, 2-480 0-235, 0-315, 0-355, 3-235, 3-325, 3-365	Part XI, Ch.4
		Steel Pipes T11, T12, T13, T21 P11, P12, P13 P21 P31L	Part XI, Ch.5
		Steel Castings Chain cable: E1 and E2	Part XI, Ch.6 Part XI, Ch.13
WQ 02	Cr-Mo, or	T22, T23, T24	Part XI, Ch.5
	Cr-Mo-V creep resisting steels	P22, P23, P24	
WQ 03	High strength steels ($R_{eH} > 390$ N/mm^2), or	A420 to E960	Part XI, Ch.3
	Ferritic low temperature nickel steels	4-295 Chain cable: E3, R3, R3S, R4	Part XI, Ch.4 Part XI, Ch.13
WQ 04	Ferritic, or martensitic stainless steels (12 to 20% Cr)	Stainless propeller castings: 12Cr 1Ni, 13Cr 4Ni 16Cr SNi, 19Cr 11Ni	Part XI, Ch.9, 9.2
WQ 05	Ferritic low temperature steels	4-315, 4-420, 4-520 P33L, P34L	Part XI, Ch.4, 4.4 Part XI, Ch.5
WQ 11	Ferritic-austenitic stainless steels Austenitic stainless steels, or Cr-Ni Steels	S304, S316, S317, S321, S329, S347	Part XI, Ch.9, 9.1
WQ 22	Aluminium alloy – Non-heat treatable Mg < 3.5% 3.5% < Mg < 5.6%	 5754 5083, 5383, 5059, 5086, 5456	Part XI, Ch.11
WQ 23	Aluminum alloy – Heat treatable	6005A, 6061, 6082	Part XI, Ch.11
WQ 30	Copper alloys for propellers – Manganese bronze	CU1	Part XI, Ch.10
WQ 31	Copper alloys for propellers – Nickel – manganese bronze	CU2	Part XI, Ch.10
WQ 32	Copper alloys for propellers – Nickel – aluminum bronze	CU3	Part XI, Ch.10
WQ 33	Copper alloys for propellers – Manganese - aluminum bronze	CU4	Part XI, Ch.10

Table XII 3-10 has been added as follows:

Table XII 3-10
Welder Qualification, Range of Approval for Material Groups

Material Group used for testing	Material Groups approved to weld			
WQ 01	WQ 01			
WQ 02	WQ 01	WQ 02		
WQ 03	WQ 01	WQ 02	WQ 03	
WQ 04	WQ 01	WQ 02	WQ 04	
WQ 05	WQ 05			
WQ 11	WQ 11	WQ 05(1)	WQ 04(1)	
WQ 22	WQ 22			
WQ 23	WQ 22	WQ 23		
WQ 30	WQ 30	WQ 31	WQ 32	WQ 33
WQ 31	WQ 30	WQ 31	WQ 32	WQ 33
WQ 32	WQ 30	WQ 31	WQ 32	WQ 33
WQ 33	WQ 30	WQ 31	WQ 32	WQ 33

Notes:

(1) Provided an austenitic welding consumable compatible with material group WQ 11 is used.

Chapter 4 Welding Materials

Paragraph 4.1.3(a)(iv)&(v) have been amended as follows:

4.1 General

4.1.3 Grading

(a) Welding materials for rolled steels are grading as follows based upon the kind of steels to be welded and upon the strength and toughness of the welding materials:

(i) Grades 1, 2 and 3, for welding normal strength steels.

(ii) Grades 1Y, 2Y, 3Y and 4Y, for welding higher strength steels with specified minimum yield stress up to 355 N/mm^2.

(iii) Grades 2Y40, 3Y40 and 4Y40, for welding higher strength steels with specified minimum yield stress up to 390 N/ mm^2.

(iv) Grades ~~2Y47,~~ 3Y47 ~~and 4Y47~~, for welding higher strength steels with specified minimum yield stress ~~390 N/mm^2 and~~ 460 N/mm^2.

(v) Grades 3Yxx, 4Yxx and 5Yxx, where xx is to be 42, 46, 50, 55, 62, 69, 89 or 96 for welding extra high strength steels with specified minimum yield stress 420, 460, 500, 550, 620 ~~and~~, 690, 890 and 960 N/mm^2 respectively. For nY89 and nY96 grade consumables, Grade 5 is not applicable.

(vi) Grades L1, L1Y, L2, L2Y and L3Y, for welding low temperature service steels.

Paragraph 4.2.6(a) has been amended as follows:

4.2 Approval Tests for Manual Arc Welding Electrodes

4.2.6 Hydrogen tests

(a) The hydrogen tests are to be carried out through the mercury method, thermal conductivity detector method or gas chromatography method according to Standard ISO 3690: 2018.

Four weld assemblies are to be prepared. The temperature of the specimens and minimum holding time are to be complied with following, according to the measuring method respectively:

Table XII 4-1~4-3 have been amended as follows:

Table XII 4-1
Grade of Plate Materials Used for Preparation of Test Assemblies

Grade of Welding materials	Grade of Plate Materials Used for Preparation of Test Assemblies (1)
1	A
2	A, B, D
3	A, B, D, E
1Y	AH32, AH36
2Y	AH32, AH36, DH32, DH36
3Y	AH32, AH36, DH32, DH36, EH32, EH36
4Y	AH32, AH36, DH32, DH36, EH32, EH36, FH32, FH36
2Y40	AH40, DH40
3Y40	AH40, DH40, EH40
4Y40, 5Y40	AH40, DH40, EH40, FH40
~~2Y47~~	~~AH47, DH47~~
3Y47 (2)	~~AH47, DH47,~~ EH47
~~4Y47 (2)~~	~~AH47, DH47, EH47, FH47~~
3Yxx (3)	Axx0, Dxx0 (3)
4Yxx (3)	Axx0, Dxx0, Exx0 (3)
5Yxx (3)	Axx0, Dxx0, Exx0, Fxx0 (3)
L1	3-235
L1Y	3-325 or 3-365
L2	4-295 or 4-315
L2Y	4-420
L3Y	4-520
For stainless steels	Corresponding grade of rolled stainless steels
For aluminum alloys	Corresponding grade of aluminum alloys

Notes:

(1) Where Grade H32, 3-325, 4-295 or 4-315 is used for preparation of butt weld test assemblies, the tensile strength of the steel is not to be less than the min. tensile strength required in Table XII 4-3 and Table XII 4-4 for each grade of welding materials respectively.

(2) For ~~n~~3Y47 grades, ~~where n is to be 3, 4 or 5,~~ as an alternative to Fig. XII 4-1, Fig. XII 4-2, Fig. XII 4-3, Fig. XII 4-5, Fig. 4-6, Table XII 4-6, Table XII 4-7, Table XII 4-8, Table XII 4-9 and Table XII 4-13, the thickness of the plate used for the test assembly may be taken as 50 mm.

(3) Where xx/xx0 denotes 42/420, 46/460, 50/500, 55/550, 62/620, 69/690, 89/890 and 96/960.

Table XII 4-2
Deposited Metal Test Requirements of Welding Materials for Hull Construction Steels

Grade of Welding Materials	Tensile Test (1)			Impact Test (2), (3)		
	Tensile Strength (N/mm^2)	Yield Stress min. (N/mm^2)	Elongation on L=5D min. (%)	Test Temperature (°C)	Absorbed energy min. (J)	
					I	II
1	400 - 560 (4)	305	22	20	47	34
2				0		
3				–20		
1Y (5)	490 - 660	375	22	20	47	34
2Y				0		
3Y				–20		
4Y				–40		
2Y40	510 - 690	400	22	0	47	39
3Y40				–20		
4Y40				–40		
5Y40				–60		
~~2Y47~~	570 - 720	460	19	~~0~~	~~53~~ 64	
3Y47				–20		
~~4Y47~~				~~–40~~		
nY42	530 - 680	420	20	–20 for n = 3 –40 for n = 4 –60 for n = 5	47	
nY46	570 - 720	460	20		47	
nY50	610 - 770	500	18		50	
nY55	670 - 830	550	18		55	
nY62	720 - 890	620	18		62	
nY69	770 - 940	690	17		69	
nY89	940-1100	890	14		69(6)	
nY96	980-1150	960	13		69(6)	

Notes:

(1) The tensile test requirements in this table are also applicable to the longitudinal tensile test in butt weld test.

(2) The impact test requirements I and II are applied to the following welding materials:

I : (a) Manual arc welding electrodes.
(b) Wires and wire-gas combinations for semi-automatic multi-run welding.

II: (a) Wire-flux combinations for submerged-arc automatic welding.
(b) Wires and wire-gas combinations for automatic welding.
(c) Electro-slag and electro-gas welding material.
(d) One side automatic welding material.

(3) The specified minimum value of absorbed energy is required to the average value of three impact test specimens.

(4) In case, the tested tensile strength exceeds the required upper limit, special consideration may be given to the approval, other mechanical test results and the chemical composition of the deposited metal being taken into consideration.

(5) For manual arc welding electrodes, Grade 1Y is not applicable.

(6) For nY89 and nY96 grade consumables, Grade 5 is not applicable.

Table XII 4-3
Butt Weld Test Requirements of Welding Materials for Hull Construction Steels

Grade of Welding Materials	Transverse Tensile Test (1)	Bending Test	Impact Test (2), (3)		
	Tensile Strength min. (N/mm^2)	Mandrel Dia. × Angle (t = thickness of test specimens)	Test Temperature (°C)	Absorbed energy min. (J)	
				I	II
1	400	3t × 120°	20	47	34
2			0		
3			–20		
1Y (4)	490		20	47	34
2Y			0		
3Y			–20		
4Y			–40		
2Y40	510		0	47	39
3Y40			–20		
4Y40			–40		
5Y40			–60		
~~2Y47~~	570 - 720	4t × 120°	~~0~~	~~53~~ 64	
3Y47			–20		
~~4Y47~~			~~–40~~		
nY42	530	4t × 120°	–20 for n = 3 –40 for n = 4 –60 for n = 5	47	
nY46	570			47	
nY50	610			50	
nY55	670	5t × 120°		55	
nY62	720			62	
nY69	770			69	
nY89	940	6t × 120°		69(5)	
nY96	980	7t × 120°		69(5)	

Notes:

(1) For the longitudinal tensile test, the tensile test requirements of deposited metal tests specified in Table XII 4-2 are applicable.

(2) The impact test requirements I and II are applicable to the following welding materials:

I : (a)Manual arc welding electrodes - Downhand and Horizontal.
(b)Wires and wire-gas combinations for semi-automatic multi-run welding - Downhand and Horizontal.

II: (a)Manual arc welding electrodes - Vertical.
(b)Wires and wire-gas combinations for semi-automatic multi-run welding - Vertical.
(c)Wires and wire-gas combinations for automatic welding.
(d)Wire-flux combinations for submerged-arc automatic welding.
(e)Electro-slag and electro-gas welding material.
(f)One side automatic welding material.

(3) The specified minimum value of absorbed energy is required to the average value of three impact test specimens.

(4) For manual arc welding electrodes, Grade 1Y is not applicable.

(5) For nY89 and nY96 grade consumables, Grade 5Y is not applicable.

Table XII 4-5 has been amended as follows:

Table XII 4-5
Test Requirements of Welding Material for Stainless Steels

Grade of Steels to be welded	Deposited Metal Test			Butt Weld Test(See Note)	
	Tensile Test			Transverse Tensile Test	Bending Test
	Tensile Strength min. (N/mm^2)	0.2% Proof Stress min. (N/mm^2)	Elongation on L=5D min. (%)	Tensile Strength min. (N/mm^2)	Mandrel Dia. × Angle
S304	550	225	35	520	3t × 120° (t = thickness of test specimens)
S304L	510	205	35	480	
S310S	550	225	30	520	
S316	550	225	30	520	
S316L	510	205	35	480	
S317	550	225	30	520	
S317L	510	205	30	520	
S321	550	225	30	520	
S347	550	225	30	520	
S329J1	590	390	15	590	
S329J4L	690	450	15	620	

Note:

In case longitudinal tensile tests in butt weld test are required, the deposited metal tensile test requirements are to be applied to the longitudinal tensile test.

Chapter 5 has been amended as follows:

~~Chapter 5 Welding Constructions~~

~~5.1 General~~

~~5.1.1 For the welding proposed to be used, details regarding the process, extend, joint design, welding material, base material, procedure, sequence and workmanship are to be shown clearly in the drawings or in the specifications and submitted to the Society for approval prior to welding works.~~

~~5.1.2 Before undertaking the welding, the shipyard or manufacturer is to prove to the Surveyor that the welding procedures and the welding materials have been approved and that welders are duly qualified for the work intended in accordance with Chapter 2, 3 and 4 of this Part. Welding work is to be carried out by certified welders, with approved welding procedures and welding materials.~~

~~5.1.3 The shipyard or manufacturer is to establish the methods to prevent the misuse of materials.~~

~~5.2 Workmanship~~

~~5.2.1 Structural arrangements are to be such as shall admit of easy access for welding and inspection and shall facilitate the use of downhand welding wherever possible.~~

~~5.2.2 Every precaution is to be taken to avoid structural discontinuity. Sudden changes of shapes or sections are, therefore, to be avoided, and all corners are to be well rounded. Brackets and stiffeners are not to terminate on an un-stiffened plate or flange. Local concentrations of welds are also to be avoided.~~

~~5.2.3 Where welds cross supporting members, special attention is to be paid to the joint design so that full penetration can be achieved in the butt weld.~~

~~5.2.4 The welding sequence is to be so carefully planned that the welding, in general, is to progress in a symmetrical manner, from the center towards the ends and the sides and that parts may contract freely and the shrinkage may be equally distributed.~~

~~5.2.5 All surfaces to be welded are to be cleaned, dried and kept free from rust, scale and grease. Paintings of welding portion are not to give harmful effect to the quality of welds. The surface and boundary of each run of deposit are to be thoroughly cleaned and kept free from slag before the next run is applied.~~

~~5.2.6 Edge preparations are to be accurate and uniform. Parts to be welded are to be fitted in accordance with approved joint details. Means are to be provided for holding parts to be welded in correct position and alignment during welding operation without undue restraint. Excessive force is not to be used in fairing and closing the work. Where excessive gaps exist between surfaces or edges to be joined corrective measures adopted are to be to the Surveyor's satisfaction. For butt welded joints of plates with thickness difference exceeding 4 mm, the thickener plate is to be suitably tapered.~~

~~5.2.7 Tack welding is to be kept to a minimum, and where used, is not to become a part of finished welds unless they are found to be of equal quality and free from cracks or other defects. Any defect on the surface of base material after the removal of temporary fittings is to be carefully repaired and dressed to the satisfaction of the Surveyor.~~

~~5.2.8 Proper precautions are to be taken to ensure that all welding be done under protection against the deleterious effects of moisture, wind and severe cold. Welding materials are to be kept clean and dry and subjected to proper drying before welding.~~

~~5.2.9 The deposit metal is to be fused smoothly and uniformly into the base material, and there is not to be any injurious defect, such as crack, porosity, undercut, overlap, etc. Arc strike on the surface of base material is to be avoided as far as possible. Arc is to be struck in the weld groove.~~

~~5.2.10 Preheating of welding joints is to be employed when necessitated by the strength, dimension, chemical composition and heat treatment of the base materials to be welded and the ambient condition.~~

~~5.2.11 Post weld heat treatment may be required for welded structures subjected to high restraint during production or intended to be used under high pressure, high temperature or excessive low temperature, etc.~~

~~5.3 Welding Practices~~

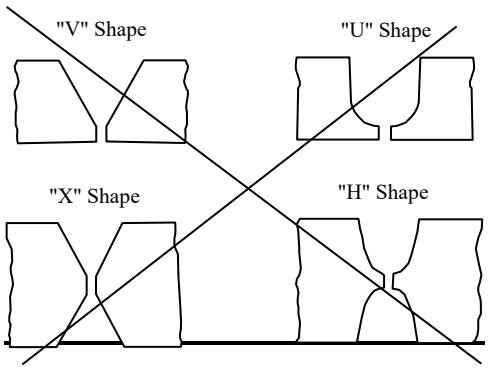
~~5.3.1 Joints welded by welding techniques are generally to be carried out in accordance with approved welding procedures.~~

~~5.3.2 Manual Butt welding~~

~~(a) The edge dimension and shape of plates to be joined are to be prepared to insure thorough fusion and complete penetration at the root of joints. In general, plates exceeding 6 mm in thickness to be joined are to be beveled on one or both edges of the plate, in the case of V type edge shape, an included angle of not less than 45° is to be provided.~~

~~(b) Double welded butt joints~~

~~Manual Welding butt joints are normally to be prepared by V, U, X or H shape of edge (see Fig. XII 5-1) and to be welded from both sides. The root face or shoulder is not to exceed 3 mm in depth and the root opening or gap between plates is not to be less than 2 mm nor more than 5 mm. Except in the case of V or U joints welded in downhand position where tight fit may be used. The reverse side is to be prepared by gouging, chipping, grinding, or otherwise cleaning out, so as to secure sound metal at the base of weld metal first deposited before applying weld metal from the reverse side unless approved otherwise.~~



~~Fig. XII 5-1~~
~~Shapes of Edge Preparation~~

~~(c) Single welded butt joints~~

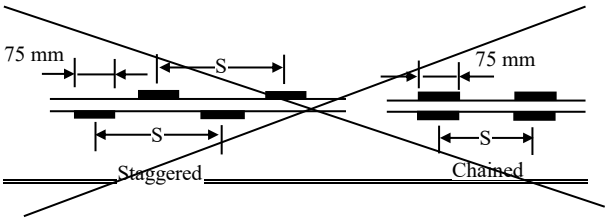
~~(i) V or U shape edge joints provided with backing strap, using ordinary welding techniques and welded from one side only may be accepted in lieu of double welded butt joints. The edges to be joined are to be spaced an adequate root gap.~~

~~(ii) Unless otherwise specified in the Rules, minor joints in a structure prepared in V or U shape edge, where the reverse side is impracticable for welding, may be welded by ordinary welding techniques from one side only without backing strap with the approval of the Surveyor. The edges of such joints are to be carefully aligned and so arranged as to insure complete penetration and fusion at the root of the joints.~~

~~5.3.3 Fillet welds~~

~~(a) The connection of T type abutting members is normally to be made by fillet welds. The sizes of fillet welds are to be indicated on detail drawings or on a separate welding schedule and are subject to approval in each case.~~

~~(b) Tee joints are generally to be made by fillet welds on both sides of the abutting plate. Where the connection is highly stressed, deep penetration or full penetration welding may be required. Where deep penetration or full penetration welding is required, the abutting plate may be required to be beveled. Where the connection is moderately stressed, intermittent welds in staggered or chained type as shown in Fig. XII 5-2 may be used.~~



~~Fig. XII 5-2~~
~~Types of Intermittent Weld~~

~~(c) Where the gap between faying surfaces of members exceeds 2.0 mm and is not greater than 5 mm, the weld leg size is to be increased by the amount of the opening. Where the gap between members is greater than 5 mm, fillet weld sizes and welding procedures are to be specially approved by the Surveyor. The weld throat thickness is not to be less than 70% of the weld leg length.~~

~~(d) Where structural members pass through the boundary of a tank, and leakage into the adjacent space could be hazardous or undesirable, full penetration welding is to be adopted for the members for at least 150 mm on each side of the boundary. Alternatively a small scallop of suitable shape may be cut in the member close to the boundary outside the compartment, and carefully welded all round.~~

~~(e) Where intermittent welding is used, the double continuous welding is to be made an ample length of and carried round at the ends of abutting members and at orthogonal connections with other members. The pitch of intermittent weld is to be measured over the correctly proportioned fillet, clear of end craters.~~

~~5.3.4 Lapped joints~~

~~(a) Unless otherwise prescribed in the Rules, lapped joints are generally to have overlaps of not less than twice the thinner plate thickness plus 25 mm. Both edges of an overlap joint are to be continuously fillet welded.~~

(b) Overlapped end joints used in way of important structures, such as longitudinal strength members of hull within 0.4 L amidships, machinery parts, boilers and pressure vessels subjected to high stress, are to have continuous fillet welds on both edges each equal in leg size to the thickness of the thinner of the two plates joined. Other overlapped end joints are to have continuous welds on each edge of leg size that the sum of the two is not less than 1.5 times the thickness of the thinner plate.

5.3.5 Plug or slot welds

(a) Plug welds or slot welds may be specially approved for particular applications. Where used in the body of doublers and similar locations, such welds may be spaced about 300 mm between centers in both directions.

(b) Where the plug weld is unavailable, it is to be of the oval hole of sufficient size to permit a thoroughly fused bead to be supplied all round the bottom edge of the opening.

5.3.6 Automatic and semi-automatic welding

Proper precautions are to be taken to the accuracy of edge preparation and fit-up of the parts to be joined by welding, the edges be kept particularly free from grease, moisture and any foreign matters. The welding voltage, current and speed are to be carefully adjusted and maintained by the operator.

5.4 Post Weld Heat Treatment for Machineries, Boilers, Pressure Vessels and Piping

5.4.1 Procedure of post weld heat treatment

(a) For welds using carbon steel, carbon manganese steel and low alloy steel, as the base metal, stress relieving procedures by the post weld heat treatment are generally to be of the furnace heating method and the local heating method as specified in Table XII 5.1.

Table XII 5-1
Post Weld Heat Treatment for Machinery Constructions

Kind of Steel	Furnace Temp. (°C)	Rate of Heating and Cooling (°C/h)	Min. Holding Temp. (2), (3) T (°C)	Min. Holding Time (h)	Heating Band in Local Heating Method
Carbon steel C-Mn steel 0.5 Mo steel 0.5 Cr-0.5 Mo steel 1 Cr-0.5 Mo steel 1 1/4 Cr—0.5Mo steel	≤ 400 When the object is placed in or out of furnace.	Above 400°C, 1. Heating: $\leq 220 \times \frac{25}{t}$, but in no case more than 220. 2. Cooling $\leq 275 \times \frac{25}{t}$, but in no case more than 275. (1)	600	$\frac{t}{25}$ (4)	1. Longitudinal joint: ≥ 6t each side measured from the center of weld. 2. Circumferential joint: ≥ 3t but 2t for piping on outer side of the welding bead of max. width.
2 1/4 Cr—1 Mo steel 5Cr—0.5Mo steel			680		
Where: t = Thickness of welded part, in mm.					

Notes:

(1) During the heating and cooling periods, there is not to be a greater variation in temperature throughout the portion being heated than 130°C within any 4,500 mm interval of length.

(2) During the temperature holding period, there is not to be a greater difference than 80°C between the highest and the lowest temperatures throughout the portion being heated.

(3) The maximum heating temperature at each portion of the object is not to exceed 20°C below the final temperature of heat treatment for the base metal.

(4) The Society is prepared to give special consideration to reduce the minimum holding temperature and its minimum holding time as follows:

Min. Holding Temp. (°C)	Min. Holding Time (h)	Notes
T—30	2	1. Applicable to carbon steel and C-Mn steel only. 2. Intermediate values are to be obtained by interpolation.
T—60	3	
T—90 (See Note 1)	5	
Where: T = Minimum holding temperature in main table of Table XII 5-1.		

(b) For post weld heat treatment procedures on materials other than those specified in 5.4.1(a) above, a special consideration is to be given by the Society according to the base metal, the welding material and the welding procedure.

(c) Attention is to be paid to the post weld heat treatment of low alloy steels, alloy steels and other special steels to avoid of undue degrading of the notch toughness the material and crack caused by heat treatment.

5.4.2 Temperature measurements and recording during post weld heat treatment

(a) In general, temperature measurements are to be carried out automatically by thermocouples. However, where the temperature of each part of the heated object can be readily assumed on the basis of the furnace temperature, such furnace temperature may be used in place of the temperature of the heated object.

(b) When post weld heat treatment is carried out, the following items are to be recorded:

(i) Type and kind of furnace or heating equipment.

(ii) Holding temperature and period.

(iii) Rate of heating and cooling.

~~(iv) Other items as deemed necessary.~~

~~5.5 Welding of Ship Constructions~~

~~5.5.1 When welding is used in the construction of hull and important equipment, following plans are to be submitted for approval prior to welding works.~~

~~(a) Plans indicating the arrangement of the plating, grade of materials and type of joints together with the proposed sequence of prefabrication, assembly and welding, and the kinds of welding procedures which are applied.~~

~~(b) Plans indicating details of welded connections of main structural members with types and size of welds.~~

~~5.5.2 Welding materials~~

~~(a) The application of welding materials for welded joints of various grades of steel is to be as specified in Table XII 5.2.~~

~~Table XII 5-2~~
~~Application of Welding Materials for Hull Constructions~~

~~Grade of Welding Materials to be Applied~~	~~Grade of Steel to be Welded~~
~~1~~	~~A~~
~~2~~	~~A, B or D~~
~~3~~	~~A, B, D or E~~
~~1Y~~	~~A, AH32 or AH36~~
~~2Y~~	~~A, B, D, AH32, AH36, DH32 or DH36~~
~~3Y~~	~~A, B, D, E, AH32, AH36, DH32, DH36, EH32 or EH36~~
~~4Y~~	~~A, B, D, E, AH32, AH36, DH32, DH36, EH32, EH36, FH32 or FH36~~
~~2Y40~~	~~A, B, D, AH32, AH36, AH40, DH32, DH36 or DH40~~
~~2Y47~~	~~AH40, DH40, AH47 or DH47~~
~~3Y40~~	~~A, B, D, E, AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36 or EH40~~
~~3Y47~~	~~AH40, DH40, EH40, AH47, DH47 or EH47~~
~~4Y40~~	~~A, B, D, E, AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36 or FH40~~
~~4Y47~~	~~AH40, DH40, EH40, FH40, AH47, DH47, EH47or FH47~~
~~3Y42~~	~~AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, A420 or D420~~
~~3Y46~~	~~AH40, DH40, EH40, A420, D420, A460 or D460~~
~~3Y50~~	~~A420, D420, A460, D460, A500 or D500~~
~~3Y55~~	~~A500, D500, A550 or D550~~
~~3Y62~~	~~A550, D550, A620 or D620~~
~~3Y69~~	~~A620, D620, A690 or D690~~
~~4Y42~~	~~AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36, FH40, A420, D420 or E420~~
~~4Y46~~	~~AH40, DH40, EH40, FH40, A420, D420, E420, A460, D460 or E460~~
~~4Y50~~	~~A420, D420, E420, A460, D460, E460, A500, D500 or E500~~
~~4Y55~~	~~A500, D500, E500, A550, D550 or E550~~
~~4Y62~~	~~A550, D550, E550, A620, D620 or E620~~
~~4Y69~~	~~A620, D620, E620, A690, D690 or E690~~
~~5Y42~~	~~AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36, FH40, A420, D420, E420 or F420~~
~~5Y46~~	~~AH40, DH40, EH40, FH40, A420, D420, E420, F420, A460, D460, E460 or F460~~
~~5Y50~~	~~A420, D420, E420, F420, A460, D460, E460, F460, A500, D500, E500 or F500~~
~~5Y55~~	~~A500, D500, E500, F500, A550, D550, E550 or F550~~
~~5Y62~~	~~A550, D550, E550, F550, A620, D620, E620 or F620~~
~~5Y69~~	~~A620, D620, E620, F620, A690, D690, E690 or F690~~

~~Notes:~~

~~(1) For the joining of different grade of same strength level steels, welding materials suitable for the lower grade of steels are generally acceptable except at discontinuities or other points of stress concentration.~~

~~(2) For the joining of steels of different strength level, welding materials suitable for the lower strength level of steels are generally acceptable provided that adequate means for preventing cracks are considered.~~

~~(b) In general, low hydrogen welding material is to be used for the welding of~~

~~(i) Important hull strength members, especially for ships in length over 90 m,~~

~~(ii) Very thick members,~~

~~(iii) Hull castings and forgings,~~

~~(iv) Members which are under restraint during welding operations, and~~

~~(v) Higher strength steels and extra high strength steels.~~

~~(c) The application of welding materials for welded joints of various grades of aluminum alloy is to be as specified in Table XII 4-14 of this Part.~~

~~5.5.3 Workmanship~~

(a) Welding is to be planned to progress symmetrically so that shrinkage on both sides of the structure will be equalized. The welding sequence is to be such that the parts may as far as possible contract freely in order to avoid cracks in already deposited runs of weld. Where a butt meets a seam, the welding of the seam is to be interrupted well clear of the junction and not be continued until the butt is completed. Welding of butts is to continue past the open seam and the weld be chipped out for the seam to be welded straight through.

(b) Adequate protection is to be provided where welding is required to be carried out in exposed positions in wet, windy or cold weather. In cold weather, precautions are to be taken to preheat the object and screen where necessary to prevent too rapid cooling of the weld; special care is to be taken when welding thick materials, higher strength steels and extra high strength steels.

5.5.4 Structural welding

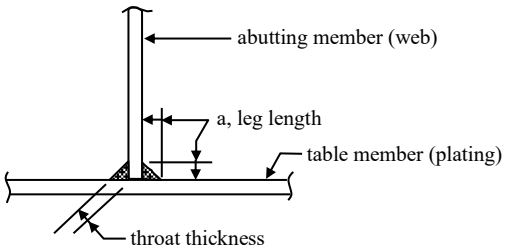
(a) Details of welding joints are to be in accordance with the requirements given in 5.3 of this Chapter.

(b) The size of fillet welds is to comply with the requirements given in Table XII 5-3. Tee-joint fillet welds are to have at least the size of double continuous or intermittent welding as given in Table XII 5-4.

(c) In case of oil tanker, special requirements of fillet weld for cargo space as given in Table XII 5-5 are also to be complied with.

~~Table XII 5-3~~
~~Size of Fillet Welds for Hull Constructions~~

~~Thickness of Plate to be Welded (t) (mm)~~	~~Min. Leg Length of Fillet Welds (a) (mm)~~				
	~~Type 1~~	~~Type 2~~	~~Type 3~~	~~Type 4~~	~~Type 5~~
~~Up to 5~~	~~4.0~~	~~4.0~~	~~3.5~~	~~3.5~~	~~3.0~~
~~6~~	~~4.5~~	~~4.0~~	~~4.0~~	~~3.5~~	~~3.0~~
~~7~~	~~5.5~~	~~5.0~~	~~4.5~~	~~4.0~~	~~3.5~~
~~8~~	~~6.0~~	~~5.5~~	~~5.0~~	~~4.0~~	~~4.0~~
~~9~~	~~6.5~~	~~6.0~~	~~5.0~~	~~4.5~~	~~4.0~~
~~10~~	~~7.5~~	~~6.5~~	~~5.5~~	~~4.5~~	~~4.5~~
~~11~~	~~"~~	~~7.0~~	~~6.0~~	~~5.0~~	~~4.5~~
~~12~~	~~"~~	~~"~~	~~6.0~~	~~5.5~~	~~5.0~~
~~13~~	~~"~~	~~"~~	~~"~~	~~5.5~~	~~5.0~~
~~14~~	~~"~~	~~"~~	~~"~~	~~6.0~~	~~5.0~~
~~15~~	~~"~~	~~"~~	~~"~~	~~6.0~~	~~5.5~~
~~16~~	~~"~~	~~"~~	~~"~~	~~"~~	~~5.5~~
~~17~~	~~0.72t~~	~~0.625t~~	~~"~~	~~"~~	~~5.5~~
~~18~~	~~"~~	~~"~~	~~"~~	~~"~~	~~6.0~~
~~19~~	~~"~~	~~"~~	~~0.5t~~	~~"~~	~~6.0~~
~~20~~	~~"~~	~~"~~	~~"~~	~~0.4t~~	~~6.0~~
~~21~~	~~"~~	~~"~~	~~"~~	~~"~~	~~"~~
~~22~~	~~"~~	~~"~~	~~"~~	~~"~~	~~"~~
~~23~~	~~"~~	~~"~~	~~"~~	~~"~~	~~0.3t~~
~~24~~	~~"~~	~~"~~	~~"~~	~~"~~	~~"~~
~~25~~	~~"~~	~~"~~	~~"~~	~~"~~	~~"~~



~~Notes:~~

~~1. Except otherwise specified, the leg length of the fillet weld is to be determined by the lesser thickness of the two members being joined.~~

~~2. The throat thickness of the weld is not to be less than 70% of the leg length.~~

~~3. For plates exceeding 25 mm in thickness, on which the fillet size is based, the leg length is to be specially considered.~~

~~4. Where the difference in thickness of the two members joined is considerable, the leg length of the fillet weld is to be specially considered.~~

~~Table XII 5-4~~
~~Fillet Welds for Hull Constructions~~

~~Connection of Structural Members~~			~~Fillet Welds~~	
			~~Double Continuous~~	~~Intermittent~~
			~~Type of fillet weld size~~	~~Pitch (S) (All with 75 mm long of Type 2 filled weld)~~
~~A. GENERAL APPLICATIONS~~				
~~1. Watertight or oiltight boundaries~~			~~3~~	
~~2. Stiffening members~~	~~(a) Top face plating~~	~~(i) In tanks~~	~~5~~ ~~(3)~~	~~250~~
		~~(ii) Clear of tanks~~		~~300~~
	~~(b) End attachments~~ ~~(4)~~	~~(i) Unbracketed~~	~~2~~	
		~~(ii) Bracketed~~	~~3~~	
~~3. Longitudinal strength members~~	~~(a) End connections~~ ~~(4)~~	~~(i) Clipped~~	~~1~~	
		~~(ii) Bracketed~~	~~2~~	
~~B. SINGLE BOTTOM~~				
~~1. Floor plates~~	~~(a) To shell~~	~~(i) In strengthened bottom forward, peaks and deep tanks~~		~~200~~
		~~(ii) Elsewhere~~		~~300~~
	~~(b) End connections~~	~~(i) To side shell or long'l bulkhead~~	~~3~~	
		~~(ii) To center or side keelsons~~	~~4~~	
	~~(c) To face plate~~	~~(i) In engine room~~		~~200~~
		~~(ii) Elsewhere~~		~~300~~
~~2. Center keelson~~	~~(a) To plate keel~~	~~(i) In strengthened bottom forward~~	~~4~~	
		~~(ii) Elsewhere~~		~~200~~
	~~(b) To face plate~~			
~~3. Side keelsons~~	~~(a) To shell~~	~~(i) In strengthened bottom forward~~		~~200~~
		~~(ii) Elsewhere~~		~~300~~
	~~(b) To face plate~~	~~(i) In engine room~~		~~200~~
		~~(ii) Elsewhere~~		~~300~~
~~4. Bottom frames~~	~~(a) To shell~~	~~(i) In strengthened bottom forward~~	~~5~~ ~~(3)~~	~~200~~
		~~(ii) Elsewhere~~		~~as A, 2 (a)~~
~~C. DOUBLE BOTTOM~~				
~~1. Solid floors~~	~~(a) To shell~~	~~(i) In strengthened bottom forward and peaks~~		~~200~~
		~~(ii) Elsewhere~~		~~300~~
	~~(b) To inner bottom~~	~~(i) In engine room~~	~~3~~	
		~~(ii) In strengthened bottom forward~~		~~200~~
		~~(iii) Elsewhere~~		~~300~~
	~~(c) To center or side girders~~		~~4~~	
	~~(d) Ends to margin plate or bilge shell~~		~~3~~	
	~~(e) Boundaries of floor under bulkhead~~		~~3~~	
	~~(f) Stiffeners~~	~~(i) On tank end floor or floor under bulkhead~~	~~4~~ ~~(3)~~	~~150~~
		~~(ii) Elsewhere~~	~~5~~ ~~(3)~~	~~as A, 2 (a)~~
~~2. Open floors~~	~~(a) Bottom frame or reverse frame to shell or inner bottom~~			~~as A, 2 (a)~~
	~~(b) Struts~~	~~(i) To girders~~	~~5~~	
		~~(ii) To bottom or reverse frames~~	~~3~~	

~~(To be continued)~~

~~Table XII 5-4~~
~~(Continued)~~

~~3. Longitudinal frames and intermediate frames~~	~~(a) To shell~~	~~(i) In strengthened bottom forward~~	~~5~~ [3]	~~200~~
		~~(ii) Elsewhere~~		~~as A, 2 (a)~~
	~~(b) To inner bottom~~	~~(i) In engine room~~	~~5~~ [3]	~~200~~
		~~(ii) Elsewhere~~		~~as A, 2 (a)~~
~~4. Center girder~~	~~(a) To shell~~	~~(i) In strengthened bottom forward~~	~~3~~	
		~~(ii) Elsewhere~~	~~5~~	
	~~(b) To inner bottom~~	~~(i) In engine room~~	~~3~~	
		~~(ii) Elsewhere~~	~~5~~	
~~5. Side girders~~	~~(a) To shell~~	~~(i) In strengthened bottom forward~~		~~200~~
		~~(ii) Elsewhere~~		~~300~~
	~~(b) To inner bottom~~	~~(i) In engine room~~		~~200~~
		~~(ii) Elsewhere~~		~~300~~
~~6. Brackets~~	~~(a) To girders~~		~~4~~	
	~~(b) To margin plate or bilge shell~~		~~3~~	
~~D. FRAMES~~				
~~1. Bottom frames~~	~~(a) To bottom shell~~	~~(i) In strengthened bottom forward~~	~~5~~ [3]	~~200~~
		~~(ii) Elsewhere~~		~~as A, 2 (a)~~
~~2. Side frames~~	~~(b) To side shell~~	~~(i) In peaks~~	~~5~~	
		~~(ii) Elsewhere~~	~~as A, 2 (a)~~	
~~E. PRIMARY SUPPORTING MEMBERS (GIRDERS, STRINGERS, TRANSVERSE WEBS)~~				
~~1. Web plates~~	~~(a) To plating~~	~~(i) Stringers in peaks~~	~~3~~	
		~~(ii) Elsewhere~~	~~5~~ [3]	~~200~~
	~~(b) To face plate~~	~~(i) When face plate sectional area $\leq$ 65 cm^2~~		~~250~~
		~~(ii) When face plate sectional area $\geq$ 65 cm^2~~		~~200~~
~~2. End attachments~~ [4]	~~(a) Clipped~~		~~2~~	
	~~(b) Bracketed~~		~~3~~	
~~F. BULKHEADS (including boundary bulkheads of superstructures and deck houses)~~				
~~1. Plating~~	~~(a) Tight boundaries~~		~~3~~	
	~~(b) Elsewhere~~		~~5~~	
~~G. DECK~~				
~~1. Boundary of plating~~	~~(a) Tight boundaries, strength deck, exposed deck~~		~~3~~	
	~~(b) Elsewhere~~		~~5~~	
~~H. HATCHWAYS~~				
~~1. Hatch coaming, hatch side girder and hatch end beams~~	~~(a) To deck~~		~~3~~	
	~~(b) To face plate~~		~~3~~	
	~~(c) Stays~~		~~4~~	
~~2. Hatch covers~~	~~(a) Plating~~	~~(i) Tight boundaries~~	~~3~~	
		~~(ii) Elsewhere~~		~~250~~
	~~(b) Stiffners, webs~~	~~(i) To plating~~		
		~~(ii) To face plate~~		
~~I. ENGINE SEATINGS~~ [5]				
~~1. For main engine, thrust bearing and major auxiliaries~~			~~2~~	
~~2. For boiler and other auxiliaries~~			~~3~~	

~~(to be continued)~~

~~Table XII 5-4~~
~~(Continued)~~

~~J. RUDDER~~			
~~1. Horizontal webs~~	~~(a) To side plating~~		~~150~~
	~~(b) To vertical webs~~	~~5~~	
	~~(c) To main piece~~	~~3~~	
~~2. Vertical webs~~	~~(a) To side plating~~		~~150~~
	~~(b) To top and bottom plates~~	~~3~~	
~~3. Main piece~~	~~(a) To side plating~~	~~2~~	
	~~(b) To top and bottom casting~~	~~Full penetration welds~~	
~~4. Side plating slot welding~~ ~~(6)~~		~~2~~	

~~Notes:~~

~~(1) The structure connection in way of stress concentrated portions are to be double continuously welded in an ample length with the fillet size at least of Type 3.~~

~~(2) Where double continuous welding is intended to be substituted for intermittent welding, 150 mm in pitch of intermittent weld may be substituted by Type 4 double continuous weld, and 200 mm and more in pitch may be by Type 5.~~

~~(3) For stiffening members and primary supporting members, where the thickness of the web exceeds the thickness of the plating, the welding is to be double continuous with the fillet size based on the thickness of the plating or based on the half thickness of the web, whichever is the greater.~~

~~(4) For longitudinal strength members, stiffening members and primary supporting members, the welding of end connections is to be such that the area of welding is not less than the cross-sectional area of the members.~~

~~(5) Where hull structural members form or adjoint to engine seatings, the welding requirements of item I are to be applied.~~

~~(6) The fillet size of slot welding is to be based on the thickness of the rudder side plating.~~

~~(7) The welding requirements for structure connections other than those specified in this table are to be specially considered.~~

~~(8) For special requirements of oil tankers, see Table XII 5-5.~~

~~Table XII 5-5~~
~~Special Requirements of Fillet Weld for Cargo Spaces of Oil Tankers~~

~~Connection of Structural Members~~			~~Fillet Welds~~	
			~~Double Continuous~~	~~Intermittent~~
			~~Type of fillet weld - size~~	~~Pitch (S) (All - with 75 mm long of Type 2 filled weld)~~
~~A. PRIMARY SUPPORTING MEMBERS~~				
~~1. Web plates~~	~~(a) To plating (See Note 2)~~	~~(i) Bottom~~	~~2~~	
		~~(ii) Else wheres~~	~~3~~	
	~~(b) To face plate~~			~~150~~
~~2. End connections (See Note 4 in Table XII 5-3)~~			~~2~~	
~~B. BULKHEADS~~				
~~1. Boundaries of oiltight bulkheads~~	~~(a) Longitudinal bulkheads~~		~~2~~	
	~~(b) Transverse bulkheads~~	~~(i) Bottom~~	~~2~~	
		~~(ii) Elsewhere~~	~~3~~	
~~2. Boundaries of non-tight bulkheads~~	~~(a) As a primary supporting member~~		~~as A, 1 (a)~~	
	~~(b) Elsewhere~~		~~5~~	
~~C. SECONDARY SUPPORTING MEMBERS (Stiffening members)~~				
~~1. To bottom shell~~			~~5~~	
~~2. To elsewhere~~			~~as A, 2 in Table XII 5-4~~	
~~3. End attachments~~				

~~Notes:~~

~~(1) The requirements in this table are to be also applied to the ballast spaces in cargo spaces region.~~

~~(2) In case the shearing force over the mid-half span of the primary supporting member is comparatively small, the fillet size within the mid-half span may be reduced provided with the web is of the same depth clear of end brackets and of same thickness throughout the length of the members.~~

~~5.5.5 Non-destructive examinations~~

~~(a) Important welds are to be examined by radiographic examinations or other approved means in positions indicated by the Surveyor. Particular attention is to be paid to butts and cross welds of the strength deck, sheer strake, side and bilge strakes, bottom and keel plates within the 0.4 L amidships.~~

~~(b) In ships over 150 m in length, all cross welds of erection butts and seams within 0.4 L amidships are to be radiographically examined.~~

~~(c) Random checks are to be made to butts of longitudinal bulkhead, butts of longitudinal stiffeners and girders which contribute to the longitudinal strength, butts of inner bottom, and joints of insert plates in way of openings.~~

~~(d) Welds for thick members, especially those made under restraint such as stern frames, masts and posts, shaft brackets, etc. are to be examined by radiographic examinations or other non-destructive examinations accepted by the Surveyors.~~

(e) The soundness of the welds of hull construction are to be complied, unless otherwise specified, with ISO 5817 level C for ferrous materials or ISO 10042 level C for aluminium alloy, or equivalent specifications. For critical areas of hull construction, which in way of critical load transfer points and large stress concentrations where a failure will endanger the safety of the ship, more stringent requirements such as ISO 5817 level B for ferrous materials or ISO 10042 level B for aluminium alloy, or equivalent specifications, may be applied.

(f) All injurious defects are to be carefully removed, re-welded and rechecked.

(g) Special considerations of welding examination are to be given to ships of novel design or for special purposes.

5.6 Welding of Machinery Constructions

5.6.1 Welded constructions of machinery parts are to be so designed that numbers of weld joints are reduced to a minimum and intersections of weld joints are to be avoided as far as possible. Weld joints are to be so arranged as to ensure full penetration and to weld and inspect effectively. In particular, fillet welds are to be avoided on forgings or castings. Butt-weld joints are to include a back welding as far as possible and thicker plates are to be gradually tapered down to that of thinner plates where plates of unequal thickness are joined.

5.6.2 When it is intended to build welded constructions for special services, or to use new materials in which there have been no previous experiences, or to use new welding processes, the procedures to be adopted are to be approved by the Society in advance.

5.6.3 Rolled steel plates and sections used for welded frames and bedplates of machinery as well as forged steels, hot rolled steel bars and cast steels used for welded construction parts of machinery are to be of welding quality with a carbon content generally not exceeding 0.23% for forged and cast steels, 0.35% for others, and of not a rimming steel unless specially approved otherwise.

5.6.4 Preparations and executions of welding, and preheating, stress relieving and inspections of welded construction part of machinery are to be done in accordance with the requirements stated in 5.1 to 5.5 of this Chapter, if applicable.

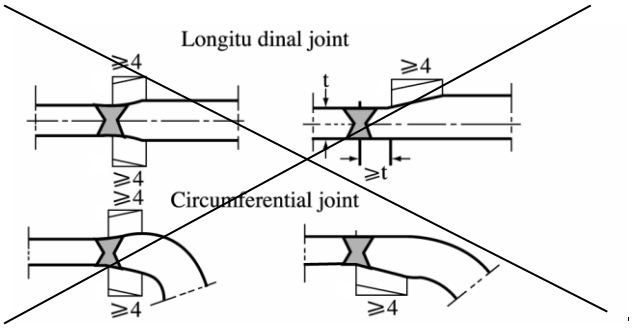
5.7 Welding of Boilers and Pressure Vessels

5.7.1 Application

Pressure parts of boilers and pressure vessels together with their accessories may be fabricated by means of an approved process of welding in accordance with the following requirements and to comply with all other respects with the applicable requirements of Chapter 2 in Part V.

5.7.2 Workmanship

(a) Where plates of unequal thicknesses are to be joined in a butt weld; the thicker plate is to be reduced to approximately the thickness of the thinner plate with an inclination of not more than 1/4. In this case, the reduction in thickness may be made on only one side for circumferential joints; however, for longitudinal joints, in general, the reduction is to be made on both sides so as to coincide the center lines of both plates. Where the reduction in thickness is made on one side, the distance between center lines of the weld and commencement of the inclination is to be at least equal to the thickness of the thinner plate (See Fig. XII 5-3).



~~Fig. XII 5-3~~
~~Butt-welded Joints for Plates of Unequal Thickness~~

~~(b) The welded part is to be so designed as not to be subjected to the direct bending stress. Where the construction is such that bending stress is concentrated at the bottom of the weld due to deformation caused by bending, single welded butt joints or fillet welding are to be avoided.~~

~~(c) Misalignment of joints~~

~~Butting edges of plates are to be in line within a limited allowance of misalignment as shown in Table XII 5-6.~~

~~Table XII 5-6~~
~~Allowable Misalignment for Butt Joints of Boilers and Pressure Vessels~~

~~Butt Weld Joints~~	~~Plate Thickness t(mm)~~ ~~(See Note)~~	~~Max. Allowable Misaligment~~	
		~~Group I~~	~~Groups II and III~~
~~Longitudinal Joint~~	~~t ≤ 20~~	~~1.0 mm~~	~~2.0 mm~~
	~~t > 20~~	~~0.05t (max. 3 mm)~~	~~0.10t (max. 6 mm)~~
~~Circumferential Joint~~	~~t ≤ 15~~	~~1.5 mm~~	~~2.5 mm~~
	~~t > 15~~	~~0.10t (max. 6 mm)~~	~~0.10t + 1 mm (max. 12 mm)~~

~~Note: Where t is thickness of the thinner plate at the butt joint.~~

~~(d) Measurement of deformation~~

~~Deformation of pressure vessels of cylindrical type is to be measured upon completion of the welding or after heat treating where heat treatment is required. The shell of a drum is to be cylindrical within a limit of 1% based on the difference between the maximum and minimum diameters of any section and there is to be no flat part on welded line.~~

~~5.7.3 Post weld heat treatment for boilers~~

~~(a) Each boiler is to be subjected to post weld heat treatment for stress relieving after completion of welding work of all fittings such as nozzles, compensating plates, etc.~~

~~(b) However, the following parts may be exempted from post weld heat treatment where the thickness of welded part does not exceed 19 mm for carbon steel or 13 mm for alloy steel:~~

~~(i) Welded joints between tubes, tubes and tube flanges and tubes and headers.~~

~~(ii) Circumferential joints of headers.~~

~~(iii) Welded parts specially approved by the Society.~~

~~(c) The following fillet welded connections may be added to a boiler which has been post weld heat treated without further stress relieving:~~

(i) Seal welding applied to boilers provided that it does not fear to induce a remarkable strain.

(ii) Intermittent welding applied to add inside and outside attachments on boilers provided that the welds do not exceed 6 mm in throat thickness and 50 mm in length having an interval of 50 mm and more.

5.7.4 Stress relieving for pressure vessels

(a) Pressure vessels of Group I are to be subjected to post weld heat treatment for stress relieving after all fittings such as nozzles, flanges, compensating plates, etc. have been welded in place.

(b) Pressure vessels of Group II may be exempted from stress relieving except the following cases:

(i) Where the thickness of shell plates exceeds 30 mm, or

(ii) Where the thickness of shell plates is not less than 16 mm and is greater than $\frac{D}{120} + 10$ mm,

in which D is the inside diameter of shell in mm.

(c) Notwithstanding the requirements in 5.7.4(a) and (b) above, the mechanical stress relieving by pressurizing for pressure vessels made of carbon steel or C-Mn steel may be employed as an alternative to the post weld heat treatment with the approval of the Society subject to the following conditions:

(i) Complicated welded parts of pressure vessels, such as nozzles, are to be heat treated before they are welded to large parts of the pressure vessels.

(ii) The plate thickness is not to exceed 40 mm.

(iii) A detailed stress analysis is made to ascertain that the maximum primary membrane stress during the mechanical stress relieving closely approaches, but does not exceed, 90% of the yield stress of the material. Strain measurements during the stress relief pressurization may be required by the Society for verifying the calculations.

(iv) The procedure for mechanical stress relieving is to be submitted for approval by the Society prior to the work is commenced.

(d) Where pressure vessels are made of materials having superior notch toughness, stress relieving may be omitted when specially approved by the Society in a particular case.

(e) The following welded connections may be added to a pressure vessel which has been post weld stress relieved without further stress relieving:

(i) For carbon steels and C-Mn steels

(1) Where fittings with inside diameter not exceeding 50 mm are added by fillet welding with throat thickness of 12 mm and under.

(2) Where fittings not subjected to the pressure are added by fillet welding with throat thickness of 12 mm and under.

(3) Where parts are stud welded.

(ii) For welds of other materials except those specified in 5.7.4(e)(i) above, the omission of further stress relieving is to be specially approved by the Society. In this case, appropriate preheating is to be carried out during the welding.

5.7.5 Workmanship tests of welding

(a) Applications

(i) Longitudinal welding joints on the shell of Groups I and II Boilers and Pressure Vessels are to be subjected to a satisfactory workmanship test by method of butt weld test.

(ii) Workmanship test for circumferential joints is not required, except in cases where a boiler has circumferential joints only, or a boiler or pressure vessel where the welding process of circumferential joints is significantly different from that used for the longitudinal joint.

~~(b) Preparation of test assemblies~~

~~(i) One set of test assembly is to be prepared for the longitudinal joints and, if required, for the circumferential joints on each boiler or pressure vessel. In cases where the joints are welded in significantly different process or in different construction, one set of test assembly for each joint is to be prepared.~~

~~(ii) Where a number of similar pressure vessels of Group II are produced at same time, only one set of test assembly is required to be prepared for each 30 meters of the combined total length of longitudinal and circumferential welding joints. In this case, the plates adopted in this lot of pressure vessels are not to vary by more than 5 mm in thickness, and plate for test assembly is to be taken from the thickest one.~~

~~(iii) The plates used for preparing test assembly are to be taken from the shell plate or from the plate in same charge and same heat to that adopted for the shell.~~

~~(iv) The butt weld test assembly as shown in Fig. XII 2-1 (Chapter 2 of this Part) with sufficient dimensions for preparing the necessary test specimens as required in Table XII 5-7 is to be attached to the shell plate in such a manner that edges to be welded are a continuation and simulation of corresponding edges of the shell joints. The welding process, procedure and technique are to be same as those adopted in the welding of the shell joints.~~

~~(v) Upon completion of welding, the test assembly is to be heat treated in same furnace and same manner with the boiler or pressure vessel, for which the post weld heat treatment or stress relieving is required. The wrapped test assembly is to be straightened before being subjected to heat treat.~~

~~(c) Test Requirements~~

~~The necessary test specimens are to be taken from each test assembly and subjected to a satisfactory test in compliance with the requirements given in 1.3, 1.4 and Table XII 5-7 of this Part.~~

~~Table XII 5-7~~
~~Workmanship Tests of Welding for Boilers and Pressure Vessels~~

~~Test Items~~	~~No. of Test Specimen Required~~		~~Test Requirements~~
	~~Group I~~	~~Group II~~	
~~Transverse Tensile Test~~	~~One specimen (Fig. XII 1-1)~~	~~One specimen (Fig. XII 1-1)~~	~~1.To comply with the requirements given in 1.3.2(b) of this Part.~~ ~~2.Results of tensile strength is not to be less than the specified min. tensile strength given for the plate material adopted.~~ (1)
~~Bending Test~~	(2)	~~Not required~~	~~To comply with the requirements given in 1.3.3 of this Part.~~
~~Impact Test~~	~~One set of three specimens (Fig. XII 1-3)~~ (3)	~~One set of three specimens (Fig. XII 1-3)~~ (3)	~~1.To comply with the requirements given in 1.3.4 of this Part.~~ ~~2.The average of absorbed energy and the test temperature are to comply with the requirements given for the plate material adopted.~~
~~Macro-etching Examination~~	~~Two transverse section~~	~~Not required~~	~~To comply with the requirements given in 1.4.2 of this Part.~~

~~Notes:~~

~~(1) If the tensile test specimen breaks at the base metal having a test result more than 95% of the specified min. tensile strength of the plate material adopted, the test may be considered as satisfactory, provided that the test specimen shows no sign of defect in the welded joint.~~

~~(2) No. of bending test specimens for Group I Boilers and Pressure Vessels are to be as follows:~~

~~Plate Thickness ≤ 19 mm : 1 Face and 1 root bending test specimens~~

~~Plate Thickness > 19 mm : 1 Side bending test specimen~~

~~(3) Where the impact test for plate material adopted is not required, the impact test in this workmanship test is also not necessary.~~

~~5.7.6 Non-destructive examinations~~

~~(a) The butt weld joints of the following boilers and pressure vessels are to be radiographically examined in full length:~~

~~(i) Both longitudinal and circumferential joints of Group I Boilers and Pressure vessels.~~

~~(ii) Longitudinal joints of Groups II and III Boilers or Pressure Vessels where the joint design is based on the use of joint efficiency for which the full radiographic examination is to be performed as given in Table V 2-2 of Part V.~~

~~(b) For Group II and III Boilers or Pressure Vessels where the longitudinal joint design is based on the use of joint efficiency for which the spot radiographic examination is to be performed as given in Table V 2-2 of Part V, the longitudinal butt joints are to be spot radiographically examined at least 20% of the total length of the joints (minimum 300 mm) together with the portions of circumferential joints across longitudinal joints.~~

~~(c) Surfaces of the weld on both the inside and outside are to be dressed smoothly by any mechanical process to permit an accurate radiographic examination. The finished surface of the reinforcement of all welded joints may be flushed with the plate or may have a reasonably uniform crown not to exceed the thickness as shown in Table XII 5-8.~~

~~Table XII 5-8~~
~~Thickness of Welding Reinforcement for Radiographic Examination of Boilers and Pressure Vessels~~

~~Plate Thickness t (mm)~~	~~Thickness of Reinforcement (mm)~~	
	~~Double butt welded joint~~	~~Single butt welded joint~~
~~$t \leq 12$~~	~~1.5~~	~~1.5~~
~~$12 < t \leq 25$~~	~~2.5~~	~~1.5~~
~~$25 < t$~~	~~3.0~~	~~1.5~~

~~(d) The radiographic technique employed is to be such that the smallest diameter hole visible in the radiographic is not to exceed 3% of the weld thickness for welds not exceeding 50 mm thick, or 2.5% for welds exceeding 50 mm thick. Steps are to bear these proportions to the weld thickness radiographed, and the radiographic technique is to be capable of revealing changes of metal thickness of these percentages.~~

~~(e) The radiograph is to be marked in such a way that the corresponding portion of the welded joint can be readily and accurately identified.~~

~~(f) The radiograph is to be examined by the Surveyor on original films.~~

~~(g) Ultrasonic examination may be accepted as an alternative to radiographic examination. Supplementary examination by radiography at selected locations may be required in certain cases.~~

~~(h) For important welds other than those specified in 5.7.6(a) of Part XII, non-destructive examinations are to be carried out as considered appropriate.~~

~~(i) For carbon and carbon-manganese steel with thicknesses greater than 30 mm and for alloy steels, the non-destructive examination is normally to be carried out not earlier than 48 hours after completion of the welds in question. For carbon and carbon-manganese steels with thicknesses 30 mm and less the time limit may be reduced to 24 hours.~~

~~(j) The soundness of the weld is to be complied, unless otherwise specified, with ISO 5817 level B for ferrous materials or ISO 10042 level B for aluminum alloy, or equivalent specifications.~~

~~5.7.7 Repairs to welded joints~~

~~(a) For fully radiographically examined boilers or pressure vessels where reveal unacceptable defects in the welded joints, the defects are to be repaired and re-examined by radiography until Surveyor's satisfaction.~~

~~(b) For spot radiographically examined boilers or pressure vessels where reveal unacceptable defects in a welded joint, at least 2 further radiographs are to be made in the length of weld represented by the first radiograph in locations selected by the Surveyor. If these reveal no further unacceptable defects, the defects revealed by the first radiograph are to be repaired and re-examined by radiography until Surveyor's satisfaction. If check radiographs reveal unacceptable defects, either.~~

~~(i) the whole length of weld represented is to be cut out and rewelded and then subjected to spot radiography as if it were a new weld, or~~

~~(ii) the whole length of weld represented is to be radiographed, and then such unacceptable defects are repaired and shown by radiograph to have been eliminated.~~

~~5.8 Welding of Piping~~

~~5.8.1 General~~

~~(a) Manual or semi-automatic electric arc welding is to be used for butt joints in pipes-to-pipes, for branch pieces attached to pressure pipes and for the attachment of pipe flanges. Oxy-acetylene welding may also be used, but, in general, is switchable only for butt joints in pipe not exceeding 100 mm in nominal diameter or 9.5 mm in wall thickness.~~

~~(b) Welding in pipe lines is to be done in the shop as far as practicable. Where joints are made in the installation on board ships, the piping is to be arranged in positions accessible for proper preheating, welding, heat treatment and examination of the joints.~~

~~(c) Preheating is to be employed when necessitated by dimensions and composition of materials to be welded. Carbon steel piping 12 mm thick and over is to be preheated to and held at a temperature of at least 50 °C when the room temperature is below 10°C. Alloy steel piping is to be subjected to special consideration.~~

~~(d) The welding procedure proposed for the attachment of flanges, valve chests and other fittings to pipes, pipes-to-pipes and the fabrication of branch pieces, whether in carbon or alloy steel, is to be approved by the Society.~~

~~5.8.2 Stress relieving~~

~~(a) All Group I and II pipes and fabricated branch pieces of carbon and C-Mn steels having a wall thickness exceeding 9.5 mm, or all alloy steels except for C-Mn steels are to be stress relieved on completion of welding, or after being heated for forming or bending operation, or after being cold bent to a radius less than 3.5 times the nominal diameter measured at the centerline of the pipe.~~

~~(b) In the case of welded pipe connections requiring stress relieving, adjacent pipes or fittings are to be heated in a circumferential band at least 3 times the width of the widest of the welding groove, but not less than twice the width of the weld reinforcement. Other methods of stress relieving will be considered on submission of full details.~~

~~(c) Copper pipes are to be properly annealed before being installed on board ships, if required.~~

~~5.8.3 Non-destructive examinations~~

~~(a) Butt weld and fillet weld joints on Groups I and II piping systems are to be subjected to non-destructive examinations in accordance with the requirements given in Table XII 5-9.~~

Table XII 5-9
Non-destructive Examinations for Pipe Welding

Pining Group	Nominal Diameter of Pipe	Extent of Examinations	
		Butt Joints	Fillet Joints
		RT or UT	MT or PT
I	> 65 mm	Full	Full
	≤ 65 mm	Random	Random
II	> 90 mm	Random	Random
	≤ 90 mm	Not required	Not required

Where:
RT : Radiographic examination.
UT: Ultrasonic examination.
MT: Magnetic particle examination.
PT: Liquid penetrant examination.

Note: Random examination is to be at least 20% of the joints.

(b) The Society may require other particular non-destructive examinations considering welding procedures, welding materials or pipe materials.

(c) The repair of defects revealed during non-destructive examination is to be carried out according to agreement with the Surveyor. All such weld repairs are to be examined using the relevant test method.

5.9 Welding of Clad Steel Plates

5.9.1 General

These requirements specify welding of steel plates with austenitic stainless steel cladding.

5.9.2 Welding methods - deposited metal

(a) For welding of steel plates with austenitic stainless steel cladding, only electrodes approved by the Society are to be used, and welding is to be carried out only by certified welders.

(b) The welding may be carried out by means of shielded metal-arc welding, automatic or semi-automatic arc welding under inert gas and/or flux or a combination of these methods.

(c) The weld joint is to have the same resistance to corrosion as the cladding metal, and the corrosion resistant deposited metal is to have at least the same thickness as the cladding metal.

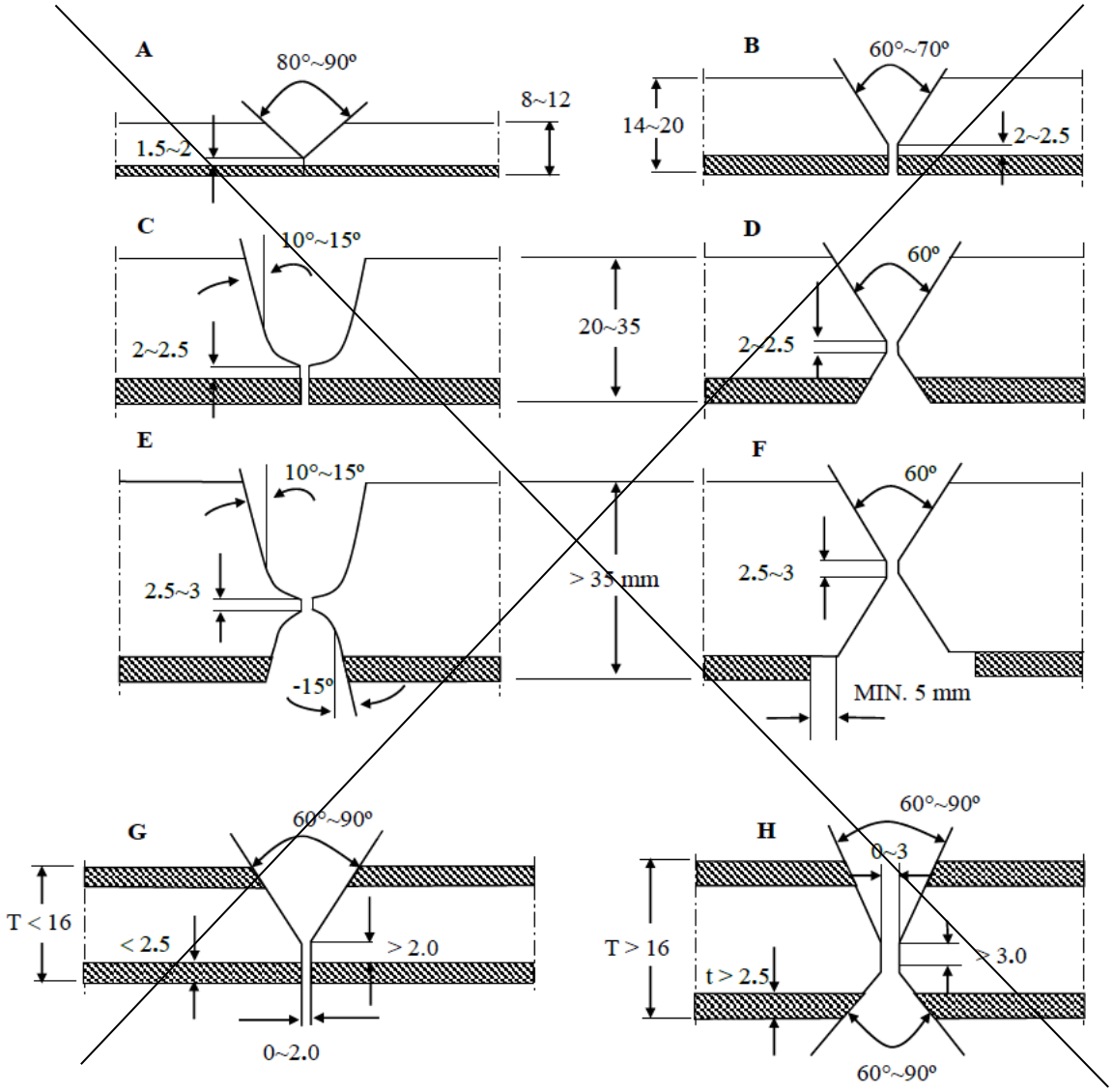
(d) The chemical composition of the weld metal in the top layer on the clad side is to correspond to the composition of the cladding metal. The cladding deposited by welding is to have at least the same thickness as the cladding on the original plate.

5.9.3 Groove preparation

(a) Proper groove shape in connection with correct welding sequence is to be employed. The edges are to be prepared as shown in Fig. XII 5-4 with a cutting tool or by grinding.

(b) Clad steel may be flame cut provided this is done from the base plated side. It is recommended that the cutting face is removed in a depth of about 2 mm. When shearing is used, the cladding side must face upwards.

~~(c) If there are alignment difficulties or if the welded connection is highly stressed, an edge preparation involving the removal of the cladding, adjacent to the weld is recommended.~~



~~Fig. XII 5-4~~
~~Examples on Most Commonly Used Grooves~~

~~5.9.4 Welding procedure~~

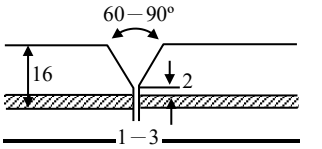
~~(a) When welding clad materials, mixing of base metal and weld deposit, as well as mixing of the two types of high alloyed weld deposit is to be held at a minimum. Low welding current and small welding material dimensions are to be used. The degree of dilution is preferably to be kept below 30%. The degree of dilution is defined as the amount of base metal in the weld metal.~~

~~(b) The use of low-alloyed or non-alloyed welding materials on the cladding is not allowed.~~

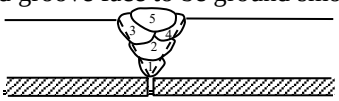
~~(c) The welding sequence is to be in accordance with Fig. XII 5-5. At least two layers of the alloyed weld metal are to be deposited when welding the backing from the clad steel side, even if it is necessary to chip or grind off part of the first stainless bead to make room for the second pass. At least, the first bead is to be made with an over-alloyed welding material.~~

~~(d) The normal strength steel backing is as far as possible to be welded before the stainless cladding and is to be welded with suitable normal strength steel welding material. Care must be taken to prevent the root bead from penetrating into the cladding. Tack welds are to be of sufficient size, have full penetration and an even surface, so that they may be covered by the first weld bead without removal. For the top layer on the backing only extensively dried, extra-low hydrogen type of electrodes are to be used.~~

~~(e) When welding pipes where there is access only from the outside, the entire cross-section is to be built up by alloyed weld metal corresponding to the cladding. The sides of the groove are preferably to be covered with an over-alloyed welding material (buttering) before joining.~~

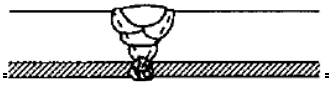


~~Weld groove face to be ground smooth.~~

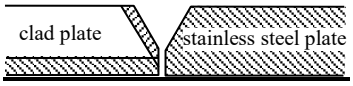


~~Root bead (1) of normal strength steel is not to penetrate the cladding.~~

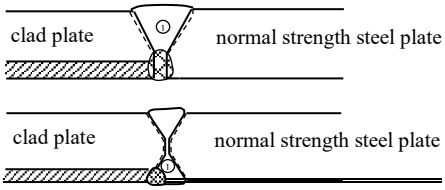
~~The root bead is back gauged or ground.~~



~~First bead on the clad side to be welded with an over alloyed welding material, top layer to match the composition of the cladding.~~

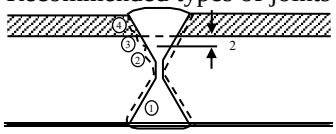


~~Butt weld between clad plate and stainless steel plate: The groove edge on the clad plate is buttered with an over alloyed welding material, the joint may then be welded with a welding material matching the stainless steel.~~



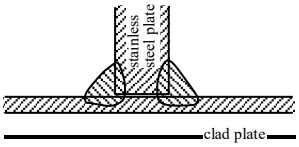
~~Butt weld between clad plate and normal strength steel plate: The cladding is welded with an over alloyed type of welding material.~~

~~Recommended types of joints~~

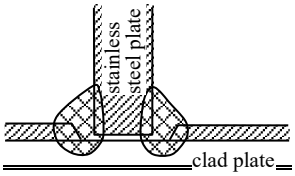


~~③ to be welded with an over alloyed welding material.~~

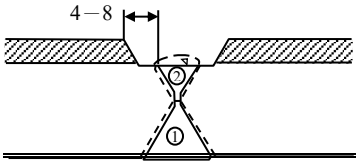
~~④ to be welded with a welding material matching the composition of the cladding.~~



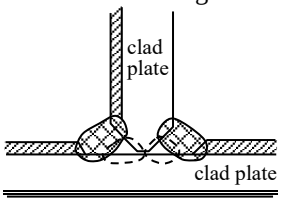
~~Only to be used in assemblies subjected to low stresses: Welding material to match the cladding.~~



~~To be used in assemblies subject to high stresses: Welding material to be of over alloyed type to compensate for the mixing with normal strength steel backing.~~



~~Backing to be ground back enough to give room for at least two high alloyed layers.~~



~~Assembly subjected to high stresses: Root beads can be welded with over alloyed welding materials and the top layer with ordinary stainless steel welding material, or root bead is welded with normal strength steel welding material and the top layer with over alloyed welding material.~~

~~Fig. XII 5-5~~
~~Examples on Welding Sequence~~

Chapter 5 Welding Constructions

5.1 General Welding Requirements

5.1.1 Scope

(a) This Chapter specifies requirements for fabrication and welding during construction and repair of ships or other marine structures, and their associated pressure vessels, machinery, equipment, components and products intended for use in these structures.

(b) The requirements for fabrication and welding during construction and repair of tanks intended for transport or storage of liquefied gases are given in Part III, Chapter 4 of the Rules.

(c) The requirements relate to fusion welding. Special consideration will be given to the use of other welding processes based on these requirements.

(d) It is the responsibility of the manufacturer to ensure compliance with all aspects of these Rules and inform the Surveyor of any deviations that have occurred. All deviations are to be recorded as non-compliances along with the corrective actions taken and failure to do this is considered to render the fabrication to be in non-compliance with the Rules.

(e) Welded constructions that comply with National or International specifications may be accepted to the satisfaction of the Surveyor, provided that these specifications give reasonable equivalence to the requirements of this Chapter.

(f) All welded construction is to be to the satisfaction of the Surveyor.

5.1.2 Design

(a) Prior to commencing any work, the component to be manufactured is to be subjected to design review and approval in accordance with the requirements of the Rules.

(b) The material characteristics that are affected by welding, particularly the loss of strength (e.g. in precipitation or strain hardened aluminum alloys) are to be considered in the design. The weld joints in such materials are to be arranged such that they are in areas of lower stress.

5.1.3 Materials

(a) Materials used in welded construction are to be manufactured at works approved by the Society. The use of materials from alternative sources will be subject to agreement of the Surveyor and satisfactory verification testing.

(b) Materials are to be supplied and certified in accordance with the requirements in Part XI of the Rules.

(c) Materials used in welded construction are to be readily weldable and are to have proven weldability, unless requirements are agreed with the Society in advance.

(d) Where the construction details are such that materials are subject to through thickness strains, consideration is to be given to using material with specified through thickness properties as specified in 3.8 of Part XI of the Rules.

(e) When ordering materials for construction, consideration is to be taken of the possible degradation of properties during fabrication or post-weld heat treatment. Where these materials are used, consideration is to be given to additional test requirements being specified to the supplier.

(f) The identity of materials is to be established by way of markings etc, during fabrication, so that traceability to the original manufacturer's certificate is maintained.

(g) Pre-fabrication shop primers may be applied prior to welding, provided that they are of an approved type and have been tested to demonstrate that they have no deleterious effects on the completed weld.

(h) Where it is proposed to weld forgings and/or castings, full details of the joint details, welding procedures and post-weld heat treatments are to be submitted for consideration.

5.1.4 Requirements for manufacture and workmanship

(a) The welding workshops are to be assessed by the Surveyor for their capability to produce work of the required quality in accordance with the requirements specified for the type of construction, see 5.2 to 5.5.

(b) Where structural components are to be assembled and welded in works sub-contracted by the builder, the Surveyor is to inspect the sub-contractor's works to ensure that compliance with the requirements of this Chapter is achieved.

(c) The manufacturer is to provide a system of regular supervision of all welding, by suitably qualified and experienced personnel.

(d) Welding is to be performed in covered workshops as far as practicable. Where this is not possible, provision is to be made in the welding area to give adequate protection from wind, rain and cold, etc.

(e) Where required, arrangements are to be such as to permit adequate ventilation and access for preheating, and for the satisfactory completion of all welding operations.

(f) The location of welding connections and sequences of welding are to be arranged to minimise distortion and the build up of residual stresses. Welded joints are to be so arranged as to facilitate the use of downhand welding wherever possible.

(g) In the case of repairs to existing structures or components, care is to be exercised when attaching fit-up aids by welding to ensure that the base materials in way of the attachments are of weldable quality.

(h) In order to prevent cross-contamination of different material types, the welding of carbon steel materials is to be in areas segregated from that used for either austenitic or non-ferrous materials, see 5.7 of this Chapter.

5.1.5 Cutting of materials

(a) Materials may be cut to the required dimensions by thermal means, shearing or machining in accordance with the manufacturing drawings or specifications.

(b) Cold shearing is not to be used on materials in excess of 25 mm thick. Where used, the cut edges that are to remain un-welded are to be cut back by machining or grinding for a minimum distance of 3 mm.

(c) Material, which has been thermally cut, is to be free from excessive oxides, scale and notches.

(d) All cut edges are to be examined to ensure freedom from material and/or cutting defects. Visual examination may be supplemented by other techniques.

(e) Thermal cutting of alloy and high carbon steels may require the application of preheat, and special examination of these cut edges will be required to ensure no cracking. In these cases, the cut edge is to be machined or ground back a distance of at least 2 mm, unless it has been demonstrated that the cutting process has not damaged the material.

(f) Any material damaged in the process of cutting is to be removed by machining, grinding or chipping back to sound metal. Weld repair may only be performed with the agreement of the Surveyor.

5.1.6 Forming and bending

(a) Plates, pipes, etc. may be formed to the required shape by any process which does not impair the quality of the material.

(b) Where hot forming is employed the manufacturer is required to demonstrate that the forming procedure is compliant with a recognised National or International Standard or shall demonstrate by appropriate qualification tests that the material properties remain acceptable in the ‘as formed’ condition.

(c) Materials that are cold formed, such that the permanent strain exceeds 10%, or formed to a diameter to thickness ratio less than 10, are to be subjected to a subsequent softening heat treatment in accordance with the material manufacturers recommendations, unless it is demonstrated by testing that the material properties are acceptable in the ‘as formed’ condition.

(d) As far as practicable, forming is to be performed by the application of steady continuous loading using a machine designed for that purpose. The use of hammering, in either the hot or cold condition is not to be employed.

(e) Material may be welded prior to forming or bending, provided that it can be demonstrated that the weld mechanical properties are not impaired by the forming operation. All welds subjected to bending are to be inspected on completion to ensure freedom from surface breaking defects.

5.1.7 Assembly and preparation for welding

(a) Excessive force is not to be used in fairing and closing the work. Where excessive root gaps exist between surfaces or edges to be joined, corrective measures are to be adopted.

(b) Provision is to be made for retaining correct alignment during welding operations in accordance with the approved manufacturing specifications and welding procedures.

(c) Tack welds are to be avoided as far as practicable. When used, tack welds are to be of the same quality as the finished welds, made in accordance with approved welding procedures, and where they are to be retained as part of the finished weld, they are to be clean and free from defects.

(d) Generally, tack welds are not to be applied in lengths of less than 30 mm for mild steel grades and aluminium alloys, and 50 mm for higher tensile steel grades. Smaller tack welds may be accepted for steels, provided that the carbon equivalent of the materials being welded is not greater than 0.36%.

(e) Where deep penetration welding is used (see 5.2.4(f) of this Chapter), welding procedure tests are to demonstrate that the specified degree of penetration is achieved in way of tack welds left in place.

(f) Where temporary bridge pieces or strong-backs are used, they are to be of similar materials to the base materials and welded in accordance with approved welding procedures.

(g) Any fit-up aids and tack welds, where welded to clad materials, are to be attached to the base material and not to the cladding.

(h) Surfaces of all parts to be welded, are to be clean, dry and free from rust, grease, debris and other forms of contamination.

(i) When misalignment of structural members either side of bulkheads, decks etc. exceeds the agreed tolerance, the misaligned item is to be released, realigned and rewelded in accordance with an approved procedure.

5.1.8 Welding equipment and welding consumables

(a) Welding plant and equipment is to be suitable for the purpose intended and properly maintained, taking into account relevant safety precautions.

(b) Suitable means of measuring the welding parameters (i.e. current, voltage and travel speed) are to be available. Electrical meters are to be properly maintained and have current calibrations.

(c) Welding consumables are to be suitable for the type of joint and grade of material to be welded, and in general, are to be approved by the Society in accordance with Chapter 4 of this Part.

(d) Special care is to be taken in the distribution, storage and handling of all welding consumables. They are to be kept in heated dry storage areas with a relatively uniform temperature in accordance with the consumable manufacturer’s recommendations. Condensation on the metal surface (e.g. wire electrodes and studs) during storage and use is to be avoided.

(e) Prior to use, welding consumables are to be dried and/or baked in accordance with the consumable manufacturer’s recommendations.

(f) Satisfactory storage and handling facilities for consumables are to be provided close to working areas and the condition of welding consumables are to be subject to regular inspections.

5.1.9 Welding procedure and welder qualifications

(a) Welding procedures are to be developed by the manufacturer for all welding, include weld repairs, and are to be capable of achieving the mechanical property requirements and non-destructive examination quality appropriate to the work being undertaken.

(b) Welding procedures are to be established for the welding of all joints and are to be qualified by testing in accordance with Chapter 2 of this Part. The welding procedures are to give details of the welding process, type of consumable, joint preparation, welding position and filler metals to be used.

(c) The proposed welding procedures are to be approved by the Society prior to construction.

(d) All welders and welding operators are to be qualified in accordance with the requirements of Chapter 3 of this Part. Qualification records to demonstrate that welding personnel have the skills to achieve the required standard of workmanship are to be available to the Surveyor.

5.1.10 Welding during construction

(a) Materials to be assembled for welding are to be retained in position by suitable means such that the root gaps and alignment are in accordance with the approved manufacturing specifications and welding procedures.

(b) Surfaces of all parts to be welded, are to be clean, dry and reasonably free from rust, scale and grease.

(c) Preheat is to be applied, as specified in the approved welding procedure, for a distance of at least 75 mm from the joint preparation edges. The method of application and temperature control are to be such as to maintain the required level throughout the welding operation.

(d) When the ambient temperature is 0°C or less, or where moisture resides on the surfaces to be welded, due care is to be taken to preheat the joint to a minimum of 20°C, unless a higher preheat temperature is specified.

(e) Where tack welds are to be removed from the root of the weld joint, this is to be carried out such that the surrounding material and joint preparation is not damaged.

(f) The welding arc is to be struck on the parent metal which forms part of the weld joint or on previously deposited weld metal.

(g) Where the welding process used is slag forming (e.g. manual metal arc, submerged arc, etc.) each run of deposit is to be cleaned and free from slag before the next run is applied.

(h) Full penetration welds are to be made from both sides of the joint as far as practicable. Prior to welding the second side, the weld root is to be cleaned, in accordance with the requirements of the approved welding procedure, to ensure freedom from defects. When air-arc gouging is used, care is to be taken to ensure that the ensuing groove is slag and oxide free and has a profile suitable for welding.

(i) Where welding from one side only, care is to be exercised to ensure the root gap is in accordance with the approved welding procedure and the root is properly fused.

(j) Particular care is to be exercised in welding in the vertical position with direction of travel downward (Vd) to avoid welding defects. The use of solid wire gas metal arc (GMAW) process in the vertical down position is to be avoided.

(k) Welding is to proceed systematically with each welded joint being completed in correct sequence without undue interruption.

(l) After welding has been stopped for any reason, care is to be taken in restarting to ensure that the previously deposited weld metal is thoroughly cleaned of slag and debris, and preheat has been re-established.

(m) Care is to be taken to avoid stress concentrations such as sharp corners or abrupt changes of section, and completed welds are to have an even contour, blending smoothly with the base materials. The weld shape and size is to be in accordance with that specified in the approved drawings or specifications.

(n) Welded temporary attachments used to aid construction are to be removed carefully by grinding, cutting or chipping. The surface of the material is to be finished smooth by grinding followed by crack detection.

(o) Where fabricated and welded components require to be machined, all major welding operations are to be completed prior to final machining.

(p) Welding to parts which are subjected to rotating fatigue (e.g. shafts) is not generally permitted.

(q) Welding onto parts that have been hardened for wear resistance or strength (e.g. gear teeth) is not permitted.

(r) Where welding of clad ferritic steel plates is to be undertaken, the clad materials are to be ground back from the prepared edge by at least 10 mm. In general, the ferritic materials are to be welded prior to welding of the cladding material.

5.1.11 Non-destructive examination of welds

(a) Non-destructive examinations are to be made in accordance with approved written procedures and shall comply with the general NDE requirements as per 1.4.3 of this Part and IACS UR W33, as applicable.

(b) Non-destructive examinations are to be undertaken by qualified personnel as per 1.4.3(c) of this Part and IACS UR W33 & W34, as applicable.

(c) Effective arrangements are to be provided by the manufacturer for the inspection of finished welds to ensure that all welding, and where necessary, all post-weld heat treatment, has been satisfactorily completed.

(d) Welds are to be clean and free from paint at the time of visual inspection unless specified otherwise in the following Sections.

(e) The weld surface finish is to ensure accurate and reliable detection of defects. Where the weld surface is irregular or has other features likely to interfere with the interpretation of non-destructive examination, the weld is to be ground or machined.

(f) Prior to inspection, welded temporary attachments and lifting eyes used to aid construction are to be removed carefully by grinding, cutting or chipping or other approved means. The surface of the material is to be finished smooth by grinding followed by crack detection. Any defects caused in the removal process are to be repaired and re-inspected.

(g) For welds in steels with specified yield strength less than 420 N/mm^2, and with carbon equivalent (C_{eq}) less than or equal to 0.41% , NDE may be performed as soon as the test assembly has cooled to ambient temperature. For the steels shown in Table XII 5-1 the following cooling times are to be observed prior to the application of non-destructive examination to completed welding.

Table XII 5-1
Cooling Times Prior to Non-Destructive Examination

Type of steel	Cooling time prior to applying NDE (after all welds have reached ambient temperature and after any applicable post-weld heat treatment)
Specified Yield strength < 420 N/mm^2 and $C_{eq} \leq 0.41$	On welded structure reaching ambient temperature
420 N/mm^2 ≤ Specified Yield strength ≤ 690 N/mm^2	Not before 48 hours after completion of welding
Specified Yield strength > 690 N/mm^2	Not before 72 hours after completion of welding

Notes:
(1) At the discretion of the Surveyor, the 72 hour interval may be reduced to 48 hours for radiographic or ultrasonic inspection, provided there is no indication of delayed cracking, and a complete visual and random magnetic particle or penetrant inspection to the satisfaction of the Surveyor is conducted 72 hours after welds have been completed and cooled to ambient temperature.
(2) Regardless of yield strength, consideration is to be given to requiring a delayed inspection where evidence of delayed cracking has been observed in production welds.
(3) At the discretion of the Surveyor, a longer interval and/or additional random inspection at a later period may be required, for example, in case of high thickness welds.

(h) Non-destructive examinations are to be performed in accordance with the requirements of the Rules. Examinations are to be in accordance with agreed written procedures prepared by the manufacturer or ship builder.

(i) The Surveyor may request additional inspections where there is reason to question the quality of workmanship, or where the weld is part of a complicated fabrication where there is high restraint or high residual stresses.

(j) Welds are to be examined after completion of any post-weld heat treatment.

(k) Where weld defects are discovered, the full extent is to be ascertained by applying additional non-destructive examinations where required. Unacceptable defects are to be completely removed and, where necessary, weld repaired in accordance with the relevant Sections of this Chapter. The repairs are to be re-inspected using the same technique as the original inspection.

(l) Results of non-destructive examinations are to be recorded and evaluated by the constructor on a continual basis in order that the quality of welding can be monitored. These records are to be available to the Surveyor.

(m) The constructor is to be responsible for the review, interpretation, evaluation and acceptance of the results of NDE. Reports stating compliance or otherwise with the criteria established in the inspection procedure are to be issued. Reports are to comply, as a minimum, with the NDE requirements of 1.4.3 of this Part.

(n) The extent of applied non-destructive examination is to be increased when warranted by the analysis of previous results.

(o) Ultrasonic testing of welds in austenitic and duplex stainless steels requires specific procedures, appropriately qualified personnel and suitable equipment including angle-compression wave and creep wave probes, in addition to the above requirements.

(p) In general, start/stop points in welds made using automatic welding processes (i.e. welding in which all welding operations are performed without welding operator intervention during the process and manual adjustment of welding parameters by the welding operator is not possible) are to be examined using radiographic or ultrasonic inspection, except for internal members where the extent of testing is to be agreed with the Surveyor.

(q) Consideration may be given for a reduction in inspection frequency for welds where volumetric inspection and the quality assurance techniques applied indicate satisfactory quality.

(r) Where the Surveyor becomes aware that an NDE location has been repaired without a record of the original defect, the shipyard is to carry out additional examinations on areas adjacent to the repaired area, to the satisfaction of the Surveyor.

(s) Where post-weld heat treatment (PWHT) is carried out, the requirement for testing after a delay period may be relaxed, at the discretion of the Surveyor.

5.1.12 Routine weld tests

(a) Routine or production weld tests may be specified as a means of monitoring the quality of the welded joints. This type of quality control test is generally specified for pressure vessel and LNG construction but may be used for other types of welded fabrication.

(b) Routine weld tests may be requested by the Surveyor where there is reason to doubt the quality of workmanship.

(c) Where routine weld tests have been agreed, they are to be performed in accordance with the general requirements for the type of construction, see 5.3 and 5.4 of this Chapter.

5.1.13 Rectification of material defects

(a) Repair of defects found in base materials is not to be carried out without the prior approval of the Surveyor.

(b) In general, surface defects in the material may be removed by grinding, chipping, etc. provided the remaining material thickness is not reduced below the minimum thickness tolerance, and the area is ground to blend in smoothly with the surrounding material.

(c) Confirmation that the defect has been removed is required by performing visual examination, augmented by either magnetic particle or dye penetrant examination techniques.

(d) Surface defects, which cannot be repaired by the above method, may be repaired by welding where permitted by Part XI, Chapter 3 to Chapter 11 of the Rules. Such repairs are to be performed in accordance with the requirements of this Section and those specified in Part XI, Chapter 3 to Chapter 11 of the Rules.

(e) Any defects in the structure resulting from the removal of temporary attachments are to be prepared, efficiently welded and ground smooth so as to achieve a defect free repair.

5.1.14 Rectification of distortion

(a) Fairing, by linear or spot heating, to correct distortions due to welding, may be carried out. In order to ensure that the properties of the material are not adversely affected, approved procedures are to be utilised. On completion of such processes, visual examination of all heat affected areas in the vicinity is to be carried out to ensure freedom from cracking.

(b) When misalignment of members exceeds the agreed tolerance, the misaligned item is to be cut apart, realigned and rewelded in accordance with an approved procedure.

5.1.15 Rectification of welds defects

(a) Where repairs are extensive the manufacturer is to investigate the reason for the defects and take the necessary actions to prevent recurrence. In addition, consideration is to be given to the sequence of repairs and to providing temporary supports to prevent misalignment or collapse. When unacceptable indications are found, additional areas of the same weld length are to be examined unless it is agreed with the Surveyor and the manufacturer that the indication is verified as being isolated.

(b) Cracks are to be reported to the Surveyor and the cause established prior to undertaking weld repairs.

(c) Defects may be removed by grinding, chipping or thermal gouging. Where thermal gouging is used, the repair groove is to be subsequently ground clean to remove oxides and debris. The groove is to have a profile suitable for welding.

(d) Prior to commencing repair welding, it is to be confirmed that no defect exists on the prepared surface by performing visual examination, augmented by either magnetic particle or dye penetrant examination techniques.

(e) Repair welding is to be performed using approved welding procedures.

(f) Completed repairs are to be re-examined by the non-destructive examination method(s) that detected the original defect and are to confirm that the original defect has been removed.

(g) Where the component or structure has been subjected to post-weld heat treatment prior to weld repair, this is to be repeated after completion of all repair welding.

(h) Where non-destructive examination reveals that the original defect has not been successfully removed, one more repair attempt may be performed.

(i) The manufacturer is to monitor the quality of welding and maintain records of welding repairs and take the necessary corrective actions where repair rates are outside normal limits.

(j) All radiographs exhibiting non-conforming indications are to be brought to the attention of the Surveyor, and such welds are to be repaired and re-inspected as required by the procedures and the test plans. When non-conforming indications are observed at the end of the radiograph, additional radiographic inspection will generally be required to determine their extent. As an alternative measure, the manufacturer may, upon agreement with the Surveyor, excavate and repair the affected welds to fully determine the extent of defects.

(k) The manufacturer is to monitor and record the repair rate and take such corrective actions as are required and identified by the Quality Assurance system.

5.1.16 Post-weld heat treatment

(a) On completion of welding, post-weld heat treatment may be required depending on the type of welded construction, the material type and thickness as specified by the relevant Parts or Sections of the Rules.

(b) In general, heat treatment after welding is to be a stress relief treatment in order to reduce residual stresses introduced by welding and is generally applicable to ferritic steels. Where other types of heat treatment (e.g. normalising, solution annealing) are proposed, demonstration of acceptable mechanical properties of the weldment are to be confirmed by a welding procedure test which includes a simulated heat treatment.

(c) Parts are to be properly prepared for heat treatment. Machined surfaces (e.g. flange faces, screw threads, etc.) are to be protected against scaling and sufficient temporary supports provided to prevent distortion or collapse of the structure.

(d) Details of the heat treatment to be applied, soaking time and temperature, heating and cooling rates, etc. are to be submitted for review prior to commencing.

(e) Post-weld heat treatment is to be carried out in a purpose built furnace which is efficiently maintained. In special cases, where the configuration of the component is such that thermal stresses during heating and cooling can be minimised, local postweld heat treatment may be used. This would not normally apply to the complex geometry of cast materials during manufacture within the foundry environment.

(f) In all cases, the heat treatment facilities and arrangements are to be capable of controlling the temperature throughout the heat treatment cycle and adequate means of measuring and recording the component temperature are to be provided. Thermocouples are to be attached so they are in contact with the component.

(g) Unless specified otherwise, stress relief heat treatment is to be carried out by means of controlled heating from 300°C, to the soak temperature, holding within the prescribed soaking temperature range for the time specified (usually 1 hour per 25 mm of weld thickness) followed by controlled cooling to below 300°C.

(h) Where post-weld stress relief is specified for welded constructions that contain joints between different materials (e.g. ferritic to austenitic steels), the details of the materials, welding procedures and heat treatment cycle to be applied are to be submitted for special consideration and approval.

(i) Non-destructive examination of welds is to be performed after completion of any heat treatment.

5.1.17 Certification

(a) Products or components are not to be considered complete until all the requirements of the construction specification have been met and all activities have been completed.

(b) Upon completion of the works, the manufacturer is to provide documentation which indicates that:

(i) All welds are complete and there are no outstanding repairs.

(ii) The appropriate post-weld heat treatments have been performed.

(iii) Appropriate destructive tests have been performed.

(iv) Proof testing of welds has been performed.

(c) Before the test certificates or shipping statements are signed by the Surveyor, the manufacturer is required to provide a written declaration stating that the product is in accordance with the requirements of 5.1.17(b) above.

5.2 Specific Requirements for Ship Hull Structure and Machinery

5.2.1 Scope

(a) The requirements of this Section apply to the construction of ships, including hull structure, superstructure and deckhouses, components forming part of the ship structure and its machinery (excluding pressure vessels equipment and piping, see 5.4). These requirements are in addition to the general welding requirements specified in 5.1.

(b) The shipyard and manufacturer's works are to be assessed to give assurance that they have the facilities, equipment, personnel and quality control procedures to produce work of the required quality.

5.2.2 Welding consumables

(a) Welding consumables used for hull construction are to be approved in accordance with Chapter 4 of this Part and are to be suitable for the type of joint and grade of material to be welded.

(b) Steel welding consumable approvals, up to and including Grade Y40, and Y47, are considered acceptable for hull construction in line with Table XII 5-2 of this Part, and the following:

(i) Consumables up to Grade Y are acceptable for welding steels up to 2 strength levels below that for which the approval applies, e.g. a consumable with approval grading 3Y is acceptable for welding EH36, and EH32 higher strength steels and grade E normal strength steel.

(ii) Consumables for Grade Y40 are acceptable for welding steels up to two strength levels below that for which the approval applies. Consumables for Grade Y47 are acceptable for welding steels up to one strength level below that for which the approval applies.

(iii) Consumables with an approved impact toughness grading are acceptable for welding steels with lower specified impact properties subject to (a) above, e.g. a consumable with approval grading 3Y is acceptable for welding EH, DH and AH materials.

(iv) For welding steels of different grades or different strength levels, the welding consumables may be of a type suitable for the lesser grade or strength being connected. The use of a higher grade of welding consumable may be required at discontinuities or other points of stress concentration.

(v) In additional to 2.1.2 of Chapter 2 of this Part, other variables may need to be recorded depending on the particular welding process or application and are to be agreed with the Surveyor, for example the peak and base current and cycle times for pulse welding, electrode type and nozzle size for GTAW welding, etc.

(c) In general, the use of preheating and hydrogen controlled welding consumables for welding of ship steels up to strength grade H40 is to be in accordance with Table XII 5-3. The carbon equivalent is to be calculated from the ladle analysis using the formula given below:

$$\text{Carbon equivalent} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

Preheat and the use of low hydrogen controlled consumables will be required for welding of steel grades higher than Grade H40.

(d) All aluminium alloy welding consumables are to be approved in accordance with Chapter 4 and are suitable for welding the grades of material as shown in Table XII 4-14 of this Part.

(e) All austenitic stainless steel and duplex stainless steel welding consumables are to be approved in accordance with Chapter 4 and Table XII 5-4.

Table XII 5-2 has been amended as follows:

Table XII 5-2
Application of Welding Materials for Hull Constructions

Grade of Welding Materials to be Applied	Grade of Steel to be Welded
1	A
2	A, B or D
3	A, B, D or E
1Y	A, AH32 or AH36
2Y	A, B, D, AH32, AH36, DH32 or DH36
3Y	A, B, D, E, AH32, AH36, DH32, DH36, EH32 or EH36
4Y	A, B, D, E, AH32, AH36, DH32, DH36, EH32, EH36, FH32 or FH36
2Y40	A, B, D, AH32, AH36, AH40, DH32, DH36 or DH40
~~2Y47~~	~~AH40, DH40, AH47 or DH47~~
3Y40	A, B, D, E, AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36 or EH40
3Y47	AH40, DH40, EH40, AH47, DH47 or EH47
4Y40	A, B, D, E, AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36 or FH40
~~4Y47~~	~~AH40, DH40, EH40, FH40, AH47, DH47, EH47or FH47~~
5Y40	A, B, D, E, AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36 or FH40
3Y42	AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, A420 or D420
3Y46	AH40, DH40, EH40, A420, D420, A460 or D460
3Y50	A420, D420, A460, D460, A500 or D500
3Y55	A500, D500, A550 or D550
3Y62	A550, D550, A620 or D620
3Y69	A620, D620, A690 or D690
3Y89	A890, D890
3Y96	A890, D890, A960 or D960
4Y42	AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36, FH40, A420, D420 or E420
4Y46	AH40, DH40, EH40, FH40, A420, D420, E420, A460, D460 or E460
4Y50	A420, D420, E420, A460, D460, E460, A500, D500 or E500
4Y55	A500, D500, E500, A550, D550 or E550
4Y62	A550, D550, E550, A620, D620 or E620
4Y69	A620, D620, E620, A690, D690 or E690
4Y89	A890, D890, E890
4Y96	A890, D890, E890, A960 or D960, E960
5Y42	AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36, FH40, A420, D420, E420 or F420
5Y46	AH40, DH40, EH40, FH40, A420, D420, E420, F420, A460, D460, E460 or F460
5Y50	A420, D420, E420, F420, A460, D460, E460, F460, A500, D500, E500 or F500
5Y55	A500, D500, E500, F500, A550, D550, E550 or F550
5Y62	A550, D550, E550, F550, A620, D620, E620 or F620
5Y69	A620, D620, E620, F620, A690, D690, E690 or F690

Notes:

(1) For the joining of different grade of same strength level steels, welding materials suitable for the lower grade of steels are generally acceptable except at discontinuities or other points of stress concentration.

(2) For the joining of steels of different strength level, welding materials suitable for the lower strength level of steels are generally acceptable provided that adequate means for preventing cracks are considered.

Table XII 5-3
Preheat and Consumable Requirements for Welding of Carbon and Carbon Manganese Steels up to Strength Grade H40

Carbon equivalent C_{eq}	Preheat	Hydrogen controlled consumables
$C_{eq} \leq 0.41\%$	Not required	Not required (3)
$0.41\% < C_{eq} \leq 0.45\%$	Not required (1), (2)	Required
$0.45\% < C_{eq}$	Required	Required

Notes:
(1) Preheat may need to be applied in order to meet the maximum hardness values given in the following:
(a) The maximum hardness value is not to exceed 350 HV for steel grade EH47 and 380 HV for steel grades EH47-BCA1 and EH47-BCA2.
(b) For all other steel grades, the maximum hardness value is not to exceed 350 HV for steels with a specified minimum yield strength up to ≤ 420 N/mm^2, nor exceed 420 HV for steels with a specified minimum yield strength in the range 420 N/mm^2 to 690 N/mm^2.
(2) Under conditions of high restraint or low ambient temperature preheat may need to be applied.
(3) Hydrogen controlled consumables may need to be considered for welding of (a) Thicker materials (i.e. > 35 mm). (b) Higher strength materials. (c) Welds subject to high restraint.

Table XII 5-4
Welding of Austenitic Stainless and Duplex Stainless Steels - Consumable Requirements

Consumable approval grade	Suitable for welding material alloy grades
Austenitic stainless steels	
S321	S321
S347	S347 and S321
Austenitic stainless steel – Low carbon	
S304L	S304L
S304LN	S304LN and S304L
S316L	S316L and S304L
S316LN	S316LN, S316L, S304LN and S304L
S317L	S317L, S316LN, S316L, S304LN and S304L
S317LN	S317LN, S317L, S316LN, S316L, S304LN and S304L
Duplex stainless steels	
S329J3L	S329J3L
S329J4L	S329J4L

5.2.3 Welding procedure and welder qualifications

Welding procedures and welder qualifications are to be tested and approved in accordance with the requirements of Chapter 2 and Chapter 3 of this Part.

5.2.4 Construction and workmanship

(a) Weld preparations and openings may be formed by thermal cutting, machining or chipping. Chipped surfaces that will not be subsequently covered by weld metal are to be ground smooth.

(b) Prior to welding, the alignment of plates and stiffeners forming part of the hull structure is to be in accordance with the tolerances specified in the relevant part of the Rules.

(c) When welding from one side only, care is to be exercised to ensure the root gap and fit up are in accordance with the approved welding procedure and the root is properly fused.

(d) Where it is proposed to use permanent backing strips, the intended locations and welding procedures are to be submitted for consideration.

(e) Temporary backing strips may be used provided they are in accordance with approved welding procedures and are subsequently removed on completion of welding.

(f) The outer surfaces of completed welds are to blend smoothly with the base materials and provide a smooth transition and gradual change of section.

(g) Weld joints in parts of oil engine structures that are stressed by the main gas or inertia loads are to be designed as continuous full penetration welds. They are to be arranged so that welds do not intersect, and that welding can be effected without difficulty.

(h) When modifications or repairs have been made which result in openings having to be closed by welded inserts, particular care is to be given to the fit of the insert and the welding sequence. The welding is also to be subject to non-destructive examination.

(i) Where welding of aluminum alloy is employed, the following additional requirements are to be complied with so far as they are applicable:

(i) Welding is to be performed by fusion welding using inert gas or tungsten inert gas process or by the friction stir welding process. Where it is proposed to use other welding processes, details are to be submitted for approval.

(ii) The weld joint surfaces should be scratch brushed, preferably immediately before welding, in order to remove oxide or adhering films of dirt, filings, etc.

(j) For steel grades EH47, EH47-BCA1 and EH47-BCA2, the following additional requirements are applicable:

(i) When the ambient temperature is 5°C or less, or where moisture resides on the surfaces to be welded, due care is to be taken to preheat the joint to a minimum of 50°C, unless a higher preheat temperature is specified. Alternative preheat requirements will be specially considered where P_{cm} of the material being welded is less than or equal to 0.19 and the air temperature is below 5°C but above 0°C.

(ii) The tack length may be 25 mm where P_{cm} of the material being welded is less than or equal to 0.19.

5.2.5 Butt welds

(a) Where the ship hull is constructed of plates of different thicknesses, the thicker plates are to be chamfered in accordance with the approved plans. In all cases the chamfer is not to exceed a slope of 1 in 3 so that the plates are of equal thickness at the weld seam. Alternatively, if so desired, the width of the weld may be included as part of the smooth taper to the thicker plate provided the difference in thickness is not greater than 3 mm.

(b) Where stiffening members are attached by continuous fillet welds and cross completely finished butt or seam welds, these are to be made flush in way of the fillet weld. Similarly for butt welds in webs of stiffening members, the butt weld is to be complete and generally made flush with the stiffening member before the fillet weld is made. Where these conditions cannot be complied with, a scallop is to be arranged in the web of the stiffening member, see Fig. XII 5-1. Scallops are to be of such a size and in such a position that a satisfactory weld can be made.

Fig. XII 5-1 has been added as follows:

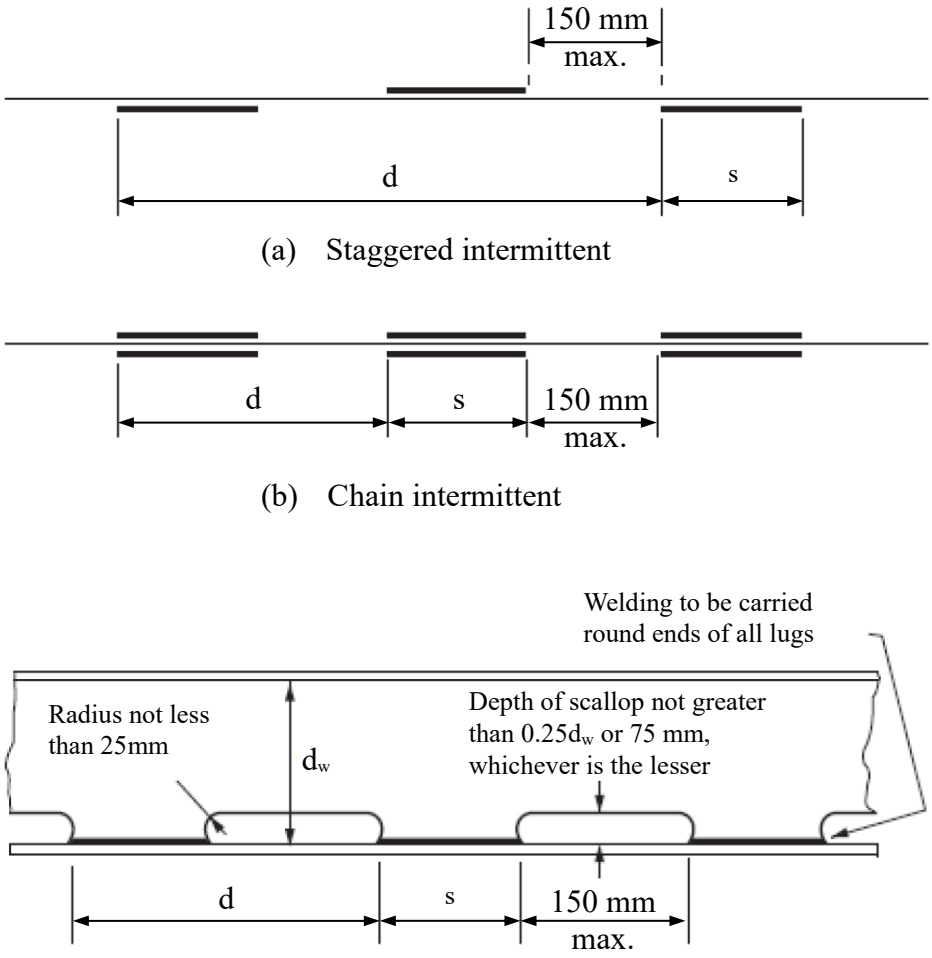


Fig. XII 5-1
Weld Dimensions and Types

5.2.6 Lap connections

Overlaps are generally not to be used to connect plates which may be subjected to high tensile or compressive loading and alternative arrangements are to be considered. However, where plate overlaps are adopted, the width of the overlap is not to exceed four times, nor be less than three times the thickness of the thinner plate and the joints are to be positioned to allow adequate access for completion of sound welds. The faying surfaces of lap joints are to be in close contact and both edges of the overlap are to have continuous fillet welds.

5.2.7 Closing plates

(a) For the connection of plating to internal webs, where access for welding is not practicable, the closing plating is to be attached by continuous full penetration welds or by slot fillet welds to face plates fitted to the webs. Slots are to have a minimum length of 90 mm and a minimum width of twice the plating thickness, with well rounded ends. Slots cut in plating are to be smooth and clean and are to be spaced not more than 230 mm apart, centre to centre. Slots are not to be filled with welding.

(b) For the attachment of rudder shell plating to the internal stiffening of the rudder, slots are to have a minimum length of 75 mm and, in general, a minimum width of twice the side plating thickness. The ends of the slots are to be rounded and the space between them is not to exceed 150 mm.

5.2.8 Stud welding

Where permanent or temporary studs are to be attached by welding to main structural parts in areas subject to high stress, the proposed location of the studs and the welding procedures adopted are to be approved.

5.2.9 Fillet welds

(a) The size of fillet welds is to comply with the requirements given in Table XII 5-5. Tee-joint fillet welds are to have at least the size of double continuous or intermittent welding as given in Table XII 5-6.

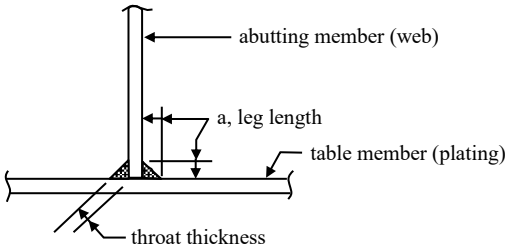
(b) In case of oil tanker, special requirements of fillet weld for cargo space as given in Table XII 5-7 are also to be complied with.

(c) T-connections are generally to be made by fillet welds on both sides of the abutting plate, the dimensions and spacing of which are shown in Fig. XII 5-1. Where the connection is highly stressed, deep penetration or full penetration welding may be required. Where full penetration welding is required, the abutting plate may be required to be bevelled.

(d) Where intermittent welding is used, the welding is to be made continuous in way of brackets, lugs and scallops and at orthogonal connections with other members.

Table XII 5-5 ~~XII 5-3~~
Size of Fillet Welds for Hull Constructions

Thickness of Plate to be Welded (t) (mm)	Min. Leg Length of Fillet Welds (a) (mm)				
	Type 1	Type 2	Type 3	Type 4	Type 5
Up to 5	4.0	4.0	3.5	3.5	3.0
6	4.5	4.0	4.0	3.5	3.0
7	5.5	5.0	4.5	4.0	3.5
8	6.0	5.5	5.0	4.0	4.0
9	6.5	6.0	5.0	4.5	4.0
10	7.5	6.5	5.5	4.5	4.5
11	|	7.0	6.0	5.0	4.5
12	|	|	6.0	5.5	5.0
13	|	|	|	5.5	5.0
14	|	|	|	6.0	5.0
15	|	|	|	6.0	5.5
16	|	|	|	|	5.5
17	0.72t	0.625t	|	|	5.5
18	|	|	|	|	6.0
19	|	|	0.5t	|	6.0
20	|	|	|	0.4t	6.0
21	|	|	|	|	|
22	|	|	|	|	|
23	|	|	|	|	0.3t
24	|	|	|	|	|
25	|	|	|	|	|



Notes:
1. Except otherwise specified, the leg length of the fillet weld is to be determined by the lesser thickness of the two members being joined.
2. The throat thickness of the weld is not to be less than 70% of the leg length.
3. For plates exceeding 25 mm in thickness, on which the fillet size is based, the leg length is to be specially considered.
4. Where the difference in thickness of the two members joined is considerable, the leg length of the fillet weld is to be specially considered.

Table XII 5-6 ~~XII 5-4~~
Fillet Welds for Hull Constructions

Connection of Structural Members			Fillet Welds	
			Double Continuous	Intermittent
			Type of fillet weld size	Pitch (S) (All with 75 mm long of Type 2 filled weld)
A. GENERAL APPLICATIONS				
1. Watertight or oiltight boundaries			3	
2. Stiffening members	(a) Top face plating	(i) In tanks	5 (3)	250
		(ii) Clear of tanks		300
	(b) End attachments (4)	(i) Unbracketed	2	
		(ii) Bracketed	3	
3. Longitudinal strength members	(a) End connections (4)	(i) Clipped	1	
		(ii) Bracketed	2	
B. SINGLE BOTTOM				
1. Floor plates	(a) To shell	(i) In strengthened bottom forward, peaks and deep tanks		200
		(ii) Elsewhere		300
	(b) End connections	(i) To side shell or long'l bulkhead	3	
		(ii) To center or side keelsons	4	
	(c) To face plate	(i) In engine room		200
		(ii) Elsewhere		300
2. Center keelson	(a) To plate keel	(i) In strengthened bottom forward	4	
		(ii) Elsewhere		200
	(b) To face plate			
3. Side keelsons	(a) To shell	(i) In strengthened bottom forward		200
		(ii) Elsewhere		300
	(b) To face plate	(i) In engine room		200
		(ii) Elsewhere		300
4. Bottom frames	(a) To shell	(i) In strengthened bottom forward	5 (3)	200
		(ii) Elsewhere		as A, 2 (a)
C. DOUBLE BOTTOM				
1. Solid floors	(a) To shell	(i) In strengthened bottom forward and peaks		200
		(ii) Elsewhere		300
	(b) To inner bottom	(i) In engine room	3	
		(ii) In strengthened bottom forward		200
		(iii) Elsewhere		300
	(c) To center or side girders		4	
	(d) Ends to margin plate or bilge shell		3	
	(e) Boundaries of floor under bulkhead		3	
	(f) Stiffeners	(i) On tank end floor or floor under bulkhead	4 (3)	150
		(ii) Elsewhere	5 (3)	as A, 2 (a)
2. Open floors	(a) Bottom frame or reverse frame to shell or inner bottom			as A, 2 (a)
	(b) Struts	(i) To girders	5	
		(ii) To bottom or reverse frames	3	

(To be continued)

Table XII 5-6 ~~XII 5-4~~
(Continued)

3. Longitudinal frames and intermediate frames	(a) To shell	(i) In strengthened bottom forward	5 (3)	200
		(ii) Elsewhere		as A, 2 (a)
	(b) To inner bottom	(i) In engine room	5 (3)	200
		(ii) Elsewhere		as A, 2 (a)
4. Center girder	(a) To shell	(i) In strengthened bottom forward	3	
		(ii) Elsewhere	5	
	(b) To inner bottom	(i) In engine room	3	
		(ii) Elsewhere	5	
5. Side girders	(a) To shell	(i) In strengthened bottom forward		200
		(ii) Elsewhere		300
	(b) To inner bottom	(i) In engine room		200
		(ii) Elsewhere		300
6. Brackets	(a) To girders		4	
	(b) To margin plate or bilge shell		3	
D. FRAMES				
1. Bottom frames	(a) To bottom shell	(i) In strengthened bottom forward	5 (3)	200
		(ii) Elsewhere		as A, 2 (a)
2. Side frames	(b) To side shell	(i) In peaks	5	
		(ii) Elsewhere	as A, 2 (a)	
E. PRIMARY SUPPORTING MEMBERS (GIRDERS, STRINGERS, TRANSVERSE WEBS)				
1. Web plates	(a) To plating	(i) Stringers in peaks	3	
		(ii) Elsewhere	5 (3)	200
	(b) To face plate	(i) When face plate sectional area ≤ 65 cm^2		250
		(ii) When face plate sectional area > 65 cm^2		200
2. End attachments (4)	(a) Clipped		2	
	(b) Bracketed		3	
F. BULKHEADS (including boundary bulkheads of superstructures and deck houses)				
1. Plating	(a) Tight boundaries		3	
	(b) Elsewhere		5	
G. DECK				
1. Boundary of plating	(a) Tight boundaries, strength deck, exposed deck		3	
	(b) Elsewhere		5	
H. HATCHWAYS				
1. Hatch coaming, hatch side girder and hatch end beams	(a) To deck		3	
	(b) To face plate		3	
	(c) Stays		4	
2. Hatch covers	(a) Plating	(i) Tight boundaries	3	
		(ii) Elsewhere		250
	(b) Stiffners, webs	(i) To plating		
		(ii) To face plate		
I. ENGINE SEATINGS (5)				
1. For main engine, thrust bearing and major auxiliaries			2	
2. For boiler and other auxiliaries			3	

(to be continued)

Table XII 5-6 ~~XII 5-4~~
(Continued)

J. RUDDER			
1. Horizontal webs	(a) To side plating		150
	(b) To vertical webs	5	
	(c) To main piece	3	
2. Vertical webs	(a) To side plating		150
	(b) To top and bottom plates	3	
3. Main piece	(a) To side plating	2	
	(b) To top and bottom casting	Full penetration welds	
4. Side plating slot welding (6)		2	

Notes:

(1) The structure connection in way of stress concentrated portions are to be double continuously welded in an ample length with the fillet size at least of Type 3.

(2) Where double continuous welding is intended to be substituted for intermittent welding, 150 mm in pitch of intermittent weld may be substituted by Type 4 double continuous weld, and 200 mm and more in pitch may be by Type 5.

(3) For stiffening members and primary supporting members, where the thickness of the web exceeds the thickness of the plating, the welding is to be double continuous with the fillet size based on the thickness of the plating or based on the half thickness of the web, whichever is the greater.

(4) For longitudinal strength members, stiffening members and primary supporting members, the welding of end connections is to be such that the area of welding is not less than the cross-sectional area of the members.

(5) Where hull structural members form or adjoint to engine seatings, the welding requirements of item I are to be applied.

(6) The fillet size of slot welding is to be based on the thickness of the rudder side plating.

(7) The welding requirements for structure connections other than those specified in this table are to be specially considered.

(8) For special requirements of oil tankers, see Table XII 5-7 ~~XII 5-5~~.

Table XII 5-7 ~~XII 5-5~~
Special Requirements of Fillet Weld for Cargo Spaces of Oil Tankers

Connection of Structural Members			Fillet Welds	
			Double Continuous	Intermittent
			Type of fillet weld size	Pitch (S) (All with 75 mm long of Type 2 filled weld)
A. PRIMARY SUPPORTING MEMBERS				
1. Web plates	(a) To plating (2)	(i) Bottom	2	
		(ii) Else wheres	3	
	(b) To face plate			150
2. End connections	(See Note 4 in Table XII 5-5 ~~XII 5-3~~)		2	
B. BULKHEADS				
1. Boundaries of oiltight bulkheads	(a) Longitudinal bulkheads		2	
	(b) Transverse bulkheads	(i) Bottom	2	
		(ii) Elsewhere	3	
2. Boundaries of non-tight bulkheads	(a) As a primary supporting member		as A, 1 (a)	
	(b) Elsewhere		5	
C. SECONDARY SUPPORTING MEMBERS (Stiffening members)				
1. To bottom shell			5	
2. To elsewhere			as A, 2 in Table 5-6 ~~XII 5-4~~	
3. End attachments				

Notes:
(1) The requirements in this table are to be also applied to the ballast spaces in cargo spaces region.
(2) In case the shearing force over the mid-half span of the primary supporting member is comparatively small, the fillet size within the mid-half span may be reduced provided with the web is of the same depth clear of end brackets and of same thickness throughout the length of the members.

5.2.10 Post-weld heat treatment

(a) This section determines the requirements for post-weld stress relief heat treatment when applied to ship structure and associated machinery.

(b) Post-weld stress relief heat treatment is applied to improve resistance to brittle fracture or fatigue performance. It is to be applied when the thickness limits stated in Table XII 5-8 are exceeded.

Table XII 5-8
Post-weld Stress Relief Heat Treatment Thickness Limits

Typical Application	Load Conditions (1)	Material Grade (2)	Typical Application (3)
Ship structure	Fatigue non-critical / critical	Normal strength (A - E), Higher strength (AH32 - FH40, [Excluding EH47])	150
Ship structure	Fatigue non-critical / critical	Higher strength (EH47)	100
Machinery	Fatigue non-critical	Extra high strength (A420 - F690)	140
Machinery	Fatigue critical	Extra high strength (A420 - F460)	100
Machinery	Fatigue critical	Extra high strength (A500 - F690)	65
Ship structure/ Machinery	Any	Other material grades	Subject to special consideration

Notes:

(1) Fatigue analysis shall be approved by design appraisal according to relevant rules for each application.

(a) Fatigue non-critical – Design assessment confirms that there are cyclic stresses but the fatigue life is reasonably greater than the design fatigue life and it is anticipated that fatigue crack initiation and propagation are unlikely to occur.

(b) Fatigue critical – Design assessment confirms that there are cyclic stresses and the estimated fatigue life meets the design requirements but it is not significantly higher. It is anticipated that fatigue crack initiation and propagation are likely to occur.

(2) Where steel grades based on national and international standards are specially agreed for construction, they are to be procured from the Society approved works which hold current approval for the Society equivalent grade and the same delivery condition as the steel to be procured.

(3) For all applications where material thickness is greater than 65 mm (or greater than 100 mm for EH47), 100% surface and volumetric non-destructive examination of welds is required.

(c) Post-weld heat treatment is to be applied to the following types of welded construction:

(i) Welding of steel castings where the thickness of the casting at the weld exceeds 30 mm, except where castings are directly welded to the hull structure.

(ii) Engine bedplates except for engine types where the bedplate as a whole is not subjected to direct loading from the cylinder pressure. For these types, only the transverse girder assemblies need to be stress relieved.

(iii) Welding of gear wheels.

(iv) Welding of gear cases associated with main or auxiliary engines, see Part IV, Chapter 5, Gearing and Couplings of the Rules.

(d) Consideration is to be given to applying post-weld heat treatment for all thicknesses of complicated weld joints where there are high stress concentrations.

(e) Where required, heat treatment is to be performed in accordance with the requirements specified in 5.1.16 of this Chapter and Table XII 5-16.

(f) Special consideration may be given to omit the required post-weld heat treatment. Evaluation is to be based on critical engineering assessment involving fracture mechanics testing and proposals are to be submitted which include full details of the application, materials, welding procedures, inspection procedures, design temperature and stresses, fatigue loads and cycles. Evidence will be required to demonstrate that the inspection techniques and procedures to be employed are able to detect flaws to the sizes and tolerances (of length, through-wall height and through-wall position), as determined from the fracture mechanics (and or fatigue) calculations. Alternative procedures for the omission of post-weld heat treatment will be subject to special consideration.

5.2.11 Tolerances

(a) Tolerances after welding are to be in accordance with the relevant Part of the Rules.

(b) Distortion which has resulted from welding may be corrected by spot heating in accordance with 5.1.14 of this Chapter.

5.2.12 Non-destructive examination of steel welds

(a) All finished welds are to be sound and free from cracks and substantially free from lack of fusion, incomplete penetration, porosity and slag. The surfaces of welds are to be reasonably smooth and substantially free from undercut and overlap. Care is to be taken to ensure that the specified dimensions of welds have been achieved and that both excessive reinforcement and under-fill of welds is avoided.

(b) Welds forming part of the hull and superstructure may be coated with a thin layer of protective primer prior to inspection provided it does not interfere with inspection and is removed, if required by the Surveyor, for closer interpretation of possible defective areas.

(c) All welds are to be visually inspected by personnel designated by the builder. Visual inspection of all welds may be supplemented by other non-destructive examination techniques in cases of unclear interpretation, as considered necessary. The acceptance criteria for visual testing are given in Table XII 5-9 .

Table XII 5-9
Acceptance Criteria for Visual Testing, Magnetic Particle and Liquid Penetrant Testing

<table>
<tr><td>Surface discontinuity</td><td>Classification according to ISO 6520-1</td><td colspan="2">Acceptance Criteria</td></tr>
<tr><td>Crack</td><td>100</td><td colspan="2">Not accepted</td></tr>
<tr><td>Lack of fusion</td><td>401</td><td colspan="2">Not accepted</td></tr>
<tr><td>Incomplete root penetration in butt joints welded from one side</td><td>4021</td><td colspan="2">Not accepted</td></tr>
<tr><td rowspan="7">Surface pore</td><td rowspan="7">2017</td><td colspan="2">Visual inspection</td></tr>
<tr><td colspan="2">Thickness (t)</td></tr>
<tr><td>0.5 mm < t ≤ 3.0 mm
Not permitted</td><td>3.0 mm < t
Butt welds: d ≤ 0.2 t (max. of 2.0 mm)
Fillet welds: d ≤ 0.2 a (max. of 2.0 mm) (4), (5), (6)</td></tr>
<tr><td colspan="2">Liquid penetrant inspection</td></tr>
<tr><td colspan="2">Single pore indication diameter d ≤ 6 mm (1), (2), (3), (4)</td></tr>
<tr><td colspan="2">Magnetic particle inspection</td></tr>
<tr><td colspan="2">Single pore diameter d ≤ 3 mm (1), (3), (4)
d = major axis of dimension</td></tr>
<tr><td rowspan="4">Undercut</td><td rowspan="4">5011 (Continuous)
5012 (Intermittent)</td><td>Thickness (t)</td><td></td></tr>
<tr><td>0.5 mm < t ≤ 3.0 mm</td><td>3.0 mm < t</td></tr>
<tr><td>Short impertections only (7), (8)
h ≤ 0.1 t (9)</td><td>Short impertections only (7), (8)
h ≤ 0.1 t (max. 0.5 mm) (9)</td></tr>
<tr><td colspan="2">Smooth transition to parent material is required and imperfection is not to be regarded as systematic.</td></tr>
</table>

Notes:
(1) A pore is defined as an indication having a length less than or equal to three times its width.
(2) A penetrant indication refers to the size of the bleed out from the discontinuity resulting in the indication.
(3) Indications that are approximately in line, which are separated by less than the length of the smaller indication, are to be considered as a single indication.
(4) d = diameter.
(5) t = thickness of thinner material.
(6) a = Throat thickness.
(7) For either continuous or intermittent undercut, only short imperfections are allowed.
(8) The definitions of short imperfections are as follows:
- For welds 100 mm long or longer:
  Imperfections whose total length is not greater than 25 mm in the 100 mm of the weld which contains the greatest number of imperfections.
- For welds less than 100 mm long:
  Imperfections whose total length is not greater than 25 % of the length of the weld.

(9) h = Height or width of imperfection.

(d) In addition to visual inspection, where required by either the Society Rules, the NDE checkpoint plan, the contract inspection and test plan, or as warranted for further testing either by the manufacturer or the Surveyor, welded joints are to be examined using any one or a combination of ultrasonic, radiographic, magnetic particle, eddy current, dye penetrant or other acceptable methods appropriate to the configuration of the weld.

(e) The method to be used for the volumetric examinations of welds is the responsibility of the builder, however, the following technical considerations shall be noted for the choice concerning the selected method:

(i) For full penetration butt welds, the use of advanced NDE (ANDE) methods may be used in lieu of (or complementary to) existing ultrasonic or radiographic testing methods. These methods may additionally be used on other weld configurations, with some limitations, as specified in Table XII 5-13.

(ii) Radiography (using film or RT-D methods) may be used for the examination of welds for any thickness range, as applicable to the penetrating capability of the radiation energy and the radiation source, and within any limits as identified in the procedure in order to achieve the specified quality level. The applicable material and joint types are given in Table XII 5-13.

(iii) Ultrasonic testing may be used for the examination of welds, generally for 8 mm thickness or greater, and advanced methods (such as PAUT or TOFD) for thicknesses of 6 mm or greater (as appropriate). The applicable material and joint types are given in Table XII 5-13.

(iv) Where there is a requirement for enhanced NDE acceptance criteria to be applied to thick plate sections in the hatch coaming region of container ships, the requirement is to be carried out in accordance with the appropriate standard. This derived acceptance criteria are project specific, and the acceptance criteria stated in Table XII 5-11 is not applicable.

(f) The acceptance criteria for volumetric weld testing as applied to the appropriate methods are given in the following tables:

(i) Radiographic testing (including RT-D): Table XII 5-10.

(ii) Ultrasonic testing and PAUT (based on length and amplitude of indications): Table XII 5-11.

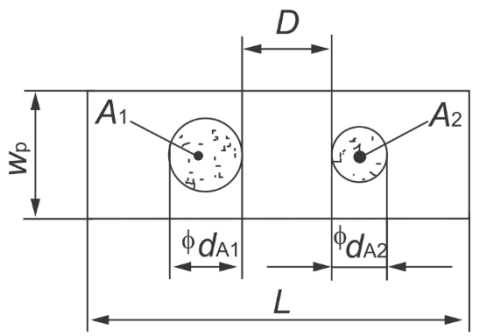
(iii) TOFD testing (based on length and height of indications): Table XII 5-12. See also Fig. XII 5-5 for the general approach to acceptance/rejection and interpretation of signal parameters. Other acceptance criteria, including project specific acceptance criteria, are to be specially agreed with the Society.

Table XII 5-10
Acceptance Criteria for Radiographic Testing

Discontinuity	Classification according to I SO 6520-1	Acceptance criteria
Crack	100	Not permitted
Lack of fusion	401	Acceptable up to but only intermittently and not breaking the surface, $\sum l \leq 25$ mm, L = 100 mm (1), (2), (8), (9)
Lack of penetration	402	Not permitted
Slag inclusions, Flux inclusions, & Oxide inclusions	301, 302 & 303	h < 0.3 s (max 3.0 mm) $\sum l \leq$ s, (max 50 mm) L = 100 mm (1), (2), (4), (5), (8)
Porosity & Gas pore (Single Layer)	2011 & 2012	A ≤ 1.5 % d ≤ 0.3 s (max 4.0 mm) L = 100 mm (1), (3), (5), (6), (7)
Porosity & Gas pore (Multi-Layer)	2011 & 2012	A ≤ 3.0 % d ≤ 0.3 s (max 4.0 mm) L = 100 mm (1), (3), (5), (6), (7)
Linear porosity	2014	$l \leq$ s, max 50 mm d ≤ 0.3 s (max 3.0 mm) L = 100 mm (1), (2), (5), (6), (10)
Clustered (localised) porosity	2013	$d_A \leq W_p$ (max 20 mm) L = 100mm (1), (3), (7), (10), (11)
Elongated cavity & wormholes	2015 & 2016	h < 0.3 s (max 3.0 mm) $\sum l \leq$ s, (max 50 mm) L = 100 mm (1), (4), (5), (8), (10)
Shrinkage cavity (other than crater pipes)	202	Not permitted
Crater pipe	2024	Not permitted
Metallic inclusions other than copper	304	$l \leq$ 0.3 s, (max 3.0 mm) (2), (5)
Copper inclusions	3042	Not permitted

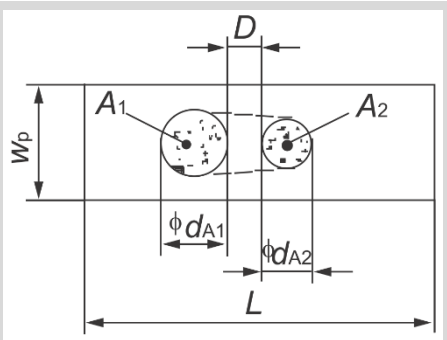
Notes:
(1) L = Any 100 mm testing length within the radiograph.
(2) l = Length of indication (mm).
(3) A = Sum of projected areas of indications related to L x W_p, in %.
(4) h = Width of indication, the width or height of surface imperfection (mm).
(5) s = Nominal Butt weld thickness (mm).
(6) d = Diameter of pore (mm).
(7) W_p = Width of weld (mm).
(8) $\sum l$ = Summary length of imperfections within L (mm).
(9) If the length of the weld is below 100 mm then the maximum length of indications is not to exceed 25% of that weld.
(10) For details regarding the sum of acceptable areas for porosity, see Fig. XII 5-2 Sum of Acceptable Areas for Radiography.
(11) d_A = Diameter of pore envelope

Clustered porosity, D > d_{A2}



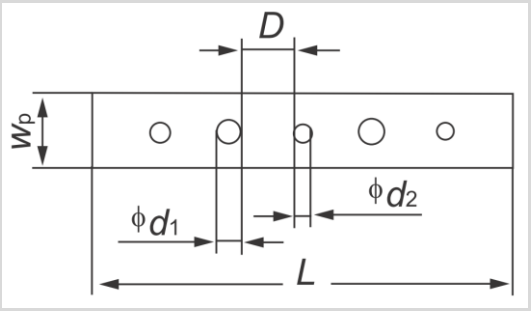
The sum of the different pore areas related to the evaluation area L x W_p

Clustered porosity, D < d_{A2}



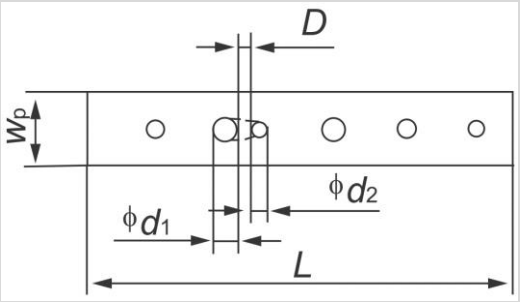
If D is less than d_{a1} or d_{a2} , whatever is smaller, an envelope surrounding the porosity area $A_1 + A_2$ shall be considered as one area.

Linear porosity, D > d_2



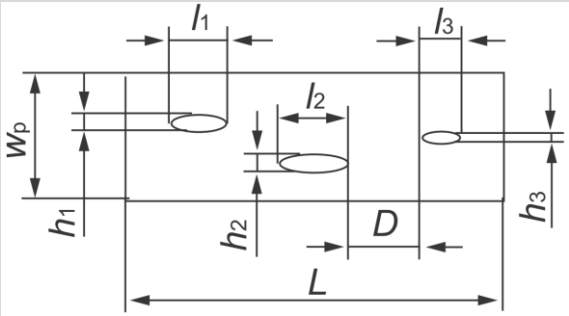
The sum of the different pore areas ($D_1^2 \pi/4 + D_2^2 \pi/4$) related to the evaluation area L x W_p

Linear porosity, D < d_2



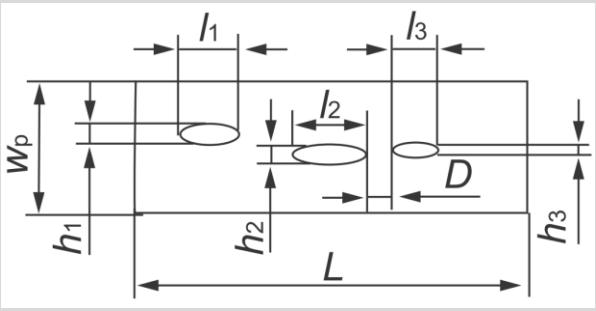
If D is smaller than the smaller diameter of one of the neighboring pores, the full connected area of the two pores is to be taken into the sum of imperfections

Elongated cavities and wormholes D > l_3



The sum of the length of indications $\sum l$ shall be determined for each testing length

Elongated cavities and wormholes D < l_3

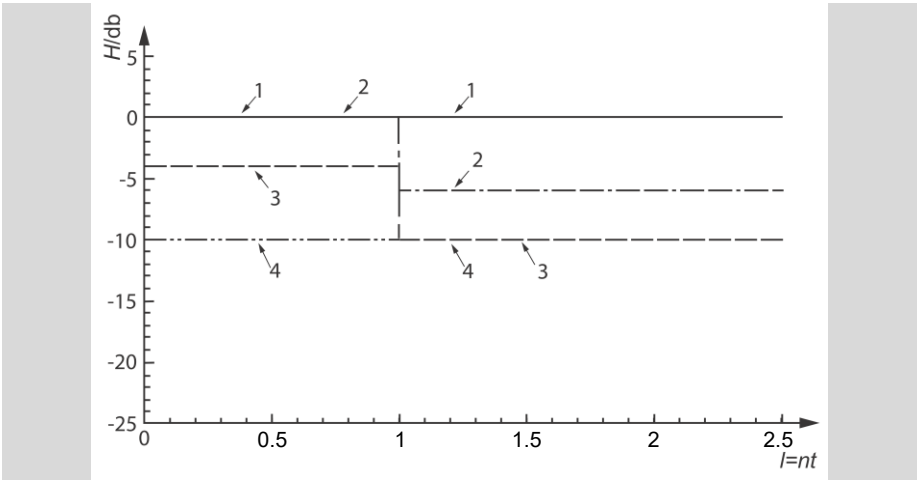


If D is smaller than the shorter length of one of the neighbouring imperfections, the full connection of the two imperfections is to be taken the sum of the imperfections.

Fig. XII 5-2
Sum of Acceptable Areas for Radiography

Table XII 5-11
Acceptance Criteria for Ultrasonic and Phased Array Testing

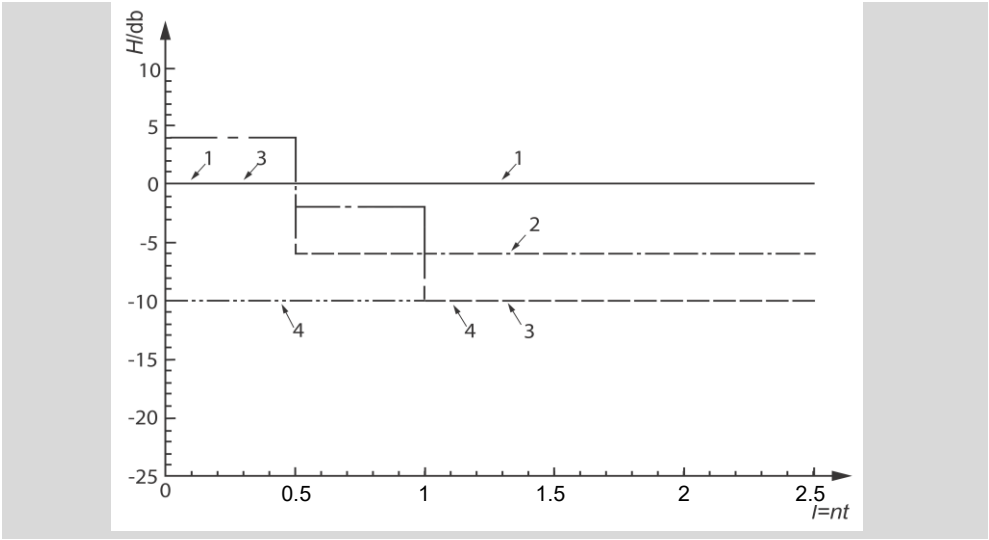
Thicknesses (t) 8 mm – 15 mm
• Indications resulting in signal amplitudes in excess of the reference level (H_0) are unacceptable regardless of length. • Indications resulting in signal amplitudes above the reference level H_0 -6 dB, and up to the reference level (H_0), are acceptable providing their length does not exceed the material thickness. • Indications resulting in signal amplitudes up to H_0 -6 dB are acceptable regardless of their length.
Thicknesses (t) 15 mm – 100 mm
• Indications resulting in signal amplitudes in excess of the reference level H_0 +4 dB are unacceptable regardless of length. • Indications resulting in signal amplitudes above H_0 -2 dB and up to H_0 + 4 dB can only have a length equal to, or less than, the half material thickness. • Indications resulting in signal amplitudes above H_0 -6 dB and up to H_0 -2 dB can only have a length equal to, or less than, the material thickness. • Indications resulting in signal amplitudes of H_0 -6 dB are acceptable regardless of their length.
Notes: (1) For depiction and definition of reference level (H_0), see Fig. XII 5-3 Acceptance level for thicknesses 8 mm to 15 mm and Fig. XII 5-4 Acceptance level for thicknesses 15 mm to 100 mm. (2) For indications exceeding the evaluation level, see Fig. XII 5-3 Acceptance level for thicknesses 8 mm to 15 mm and Fig. XII 5-4 Acceptance level for thicknesses 15 mm to 100 mm. For definition, the length of any discontinuity is to be determined using maximum echo amplitude. (3) Grouping of discontinuities based on length and separation of individually acceptable discontinuities producing amplitudes above the recording level, for definition (see Fig. XII 5-3 Acceptance level for thicknesses 8 mm to 15 mm and Fig. XII 5-4 Acceptance level for thicknesses 15 mm to 100 mm). The length of the grouping is not to be used for further grouping. (4) For evaluation, a group of discontinuities is to be considered as a single one if: (a) the distance along the weld axis (dx) between two discontinuities is less than twice the length of the longer discontinuity; (b) the distance (dy) across the weld axis between two discontinuities is less than half of the thickness but not more than 10 mm; and (c) the distance (dz) vertically between two discontinuities is less than half of the thickness but not more than 10 mm. (5) The combined length of the group of two discontinuities is $l_{12} = l_1 + l_2 + dx$. The combined length l_{12} and the larger maximum amplitude of the two discontinuities is then to be assessed against the applicable acceptance level. (6) The length of a single acceptable discontinuity above the recording level is to be evaluated by assessing the cumulative length of all individually acceptable discontinuities above the recording level, given as the sum of the lengths of both single and linearly aligned discontinuities of combined length within a given weld length. For any section of weld length $l_w = 6t$, the maximum cumulative length l_c of all individually acceptable discontinuities above the recording level is not to exceed 30% of l_w. (7) Guidance on the information provided above can be referenced in ISO 11666.



Key:
1. Reference level (H_0): Level defined by the echo amplitude of a defined reference reflector, i.e. 3 mm diameter side drilled hole across the thickness range of the weld being tested.
2. Acceptance level: Level defining limits for acceptance regarding echo height, related to length, position, number of indications or size.
3. Recording level: Level above which every echo is to be reported.
4. Evaluation level: Level above which every echo has to be evaluated or needs supplementary examination if further echo signal clarification is required.

H = amplitude level *l* = Indication length n = Multiplier of t t = thickness

Fig. XII 5-3
Acceptance Level for Thicknesses 8 mm to 15 mm



Key:
1. Reference level (H_0): Level defined by the echo amplitude of a defined reference reflector, i.e. 3mm diameter side drilled hole across the thickness range of the weld being tested.
2. Acceptance level: Level defining limits for acceptance regarding echo height, related to length, position, number of indications or size.
3. Recording level: Level above which every echo is to be reported.
4. Evaluation level: Level above which every echo has to be evaluated or needs supplementary examination if further echo signal clarification is required.

H = amplitude level *l* = Indication length n = Multiplier of t t = thickness

Fig. XII 5-4
Acceptance Level for Thicknesses 15 mm to 100 mm

Table XII 5-12
Acceptance Criteria for TOFD Testing

Thickness range (2)	Acceptable length and height of indications		
	Maximum acceptable length if $h < h_2$ l_{max} (mm) (3), (5), (6), (7), (8)	Maximum acceptable height if $l \leq l_{max}$ h_2 (for embedded discontinuities) (mm) (3), (6), (7), (8)	Maximum acceptable height if $l > l_{max}$ h_1 (mm) (3), (4), (6), (7), (8)
6 mm $< t \leq$ 15 mm	t	2	1
15 mm $< t \leq$ 50 mm	t	4	1
50 mm $< t \leq$ 100 mm	50	5	2
100 mm $< t$	60	6	3

Notes:

(1) These acceptance criteria are generally based on ISO 15626 level 2 (for embedded discontinuities). See Fig. XII 5-5 General Scheme for Acceptance Conditions for an overview of acceptance criteria. Further guidance can be referenced within ISO 15626.

(2) Nominal plate thickness. For welds joining two different thickness plates, the thinnest plate is to be taken as the thickness.

(3) When indications from surface-breaking discontinuities are detected, different techniques or methods are to be applied to determine the type or nature of the discontinuity. Using these general (not ECA) acceptance criteria, planar discontinuities such as lack of fusion, lack of penetration, or cracks, are not acceptable if they are surface breaking. If it is not possible to apply other techniques or methods, or accurately determine the type or nature of the discontinuity, then all indications from surface-breaking discontinuities are to be considered as unacceptable.

(4) Indications with heights less than h_1 are not to be considered.

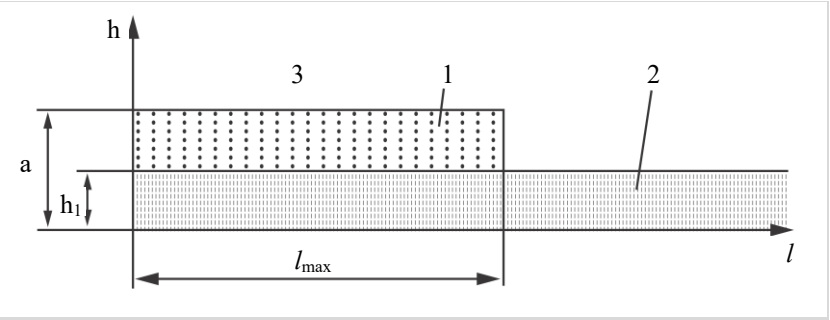
(5) The sum of the lengths of the individual indications with height larger than h_1 measured along the weld over a length of 12 t is to be less than or equal to 4.0 t, with a maximum of 200 mm.

(6) For evaluation, a group of indications is to be considered as a single one if:

- The distance between two individual indications along the weld is less than the length of the longer indication.
- The distance between two individual indications in the thickness direction of the weld is less than the height of the higher indication.

(7) In case of an indication with varying height, the maximum local height, h, shall be used.

(8) Point-like indications and indications with height smaller than h_1 are not considered for grouping of indications. Further guidance of the grouping of heights (and local heights), lengths and distance between indications can be referenced in ISO 15626.



Key:
1 acceptance for $l \leq l_{max}$
2 acceptance for $l > l_{max}$
3 Rejection
h_1 Maximum acceptable height for any discontinuity if $l > l_{max}$
a height (h_2) for embedded discontinuities

Fig. XII 5-5
General Scheme for Acceptance Conditions

Table XII 5-13
Applicable Methods for Testing of Materials and Weld Joints

Materials and weld joints	Parent material thickness	Applicable volumetric NDE test methods (1), (2)
Ferritic and austenitic stainless steel butt welds with full penetration	Thickness < 6 mm	RT, RT-D
	6 mm ≤ thickness < 8 mm	RT, RT-D, PAUT , TOFD
	8 mm ≤ thickness	RT, RT-D, PAUT (3)
Ferritic and austenitic stainless steel tee joints and corner joints with full penetration	6 mm ≤ thickness < 8 mm	RT, RT-D, PAUT (3)
	8 mm ≤ thickness	RT, RT-D, UT, PAUT (3)
Ferritic cruciform joints with full penetration	6 mm ≤ thickness < 8 mm	RT, RT-D, PAUT (3)
	8 mm ≤ thickness	RT, RT-D, UT, PAUT (3)
Ferritic tee joints, corner joints and cruciform joints without full penetration and fillet welds	All	UT, PAUT, RT (3), (4)

Notes:
(1) The method abbreviations are defined in the appropriate sections of IACS UR W33.
(2) TOFD is only applicable to ferritic welds.
(3) RT and RT-D may be applied; however, it is noted that for these configurations, there may be limitations.
(4) UT and PAUT may be used to check the extent of penetration in tee, corner and cruciform joints.

(g) Checkpoints examined at the pre-assembly stage are to include ultrasonic testing on examples of the stop/start points of automatic welding and magnetic particle inspection of weld ends.

(h) Checkpoints examined at the assembly stage are generally to be selected from those welds intended to be examined as part of the agreed quality control programme to be applied by the builder. The locations and number of checkpoints are to be approved by the Surveyor.

(i) Where components of the structure are subcontracted for fabrication, the same inspection regime is to be applied as if the item had been constructed within the main contractor’s works. In these cases, particular attention is to be given to highly loaded fabrications (such as stabiliser fin boxes) forming an integral part of the hull envelope.

(j) Particular attention is to be paid to highly stressed items. Magnetic particle inspection is to be used at ends of fillet welds, T-joints, joints or crossings in main structural members and at stern frame connections.

(k) Special attention is to be given to the examination of plating in way of lifting eye plate positions to ensure freedom from cracks. This examination is not restricted to the positions where eye plates have been removed, but includes the positions where lifting eye plates are permanent fixtures.

(l) Checkpoints for volumetric examination are to be selected so that a representative sample of welding is examined.

(m) Typical locations for volumetric examination and number of checkpoints to be taken are given in the relevant Sections of the Rules. A list of the proposed items to be examined is to be submitted for approval.

(n) For the hull structure of refrigerated spaces, and of ships designed to operate in low air temperatures, the extent of nondestructive examination will be specially considered. For non-destructive examination of gas carriers see CR Guidelines for Ships Carrying Liquefied Gases in Bulk.

(o) For all ship types, the builder is to carry out random non-destructive examination at the request of the Surveyor.

(p) Results of non-destructive examinations made during construction are to be recorded and evaluated by the builder on a continual basis in order that the quality of welding can be monitored. These records are to be available to the Surveyor.

(q) The extent of applied non-destructive examinations is to be increased when warranted by the analysis of previous results.

5.2.13 Weld repairs

(a) The full extent of any weld defect is to be ascertained by applying additional non-destructive examination where required. Unacceptable defects are to be completely removed and, where necessary, re-welded and re-examined in accordance with the requirements given in of 5.1.15 of this Chapter.

(b) During the assembly of large components, root gaps in excess of those specified in the approved welding procedure may be rectified by welding.

(c) Rectification of wide root gaps in butt welds, up to a maximum gap of 16 mm, may be performed provided that the length of these areas is small in relation to the whole weld length. Repairs may be executed by applying weld buttering layers to one edge of the weld joint, followed by machining or grinding to return the root opening to the required dimensions. The weld buttering and filling of the joint are to be in accordance with welding procedures qualified in accordance with Chapter 2 of this Part.

(d) For sub-assemblies, rectification of wide root gaps may be performed using a backing strip, provided that it is removed on completion of the welding.

(e) Rectification of wide root gaps in fillet welds may be carried out as follows:

(i) where the root gap, g, is in excess of 3 mm, but not greater than 5 mm, the fillet leg length, z, may be increased by g – 2.0 mm;

(ii) where the root gap is in excess of 5 mm, the joint detail may be changed into a full penetration weld.

(f) Where repair welds are made using small weld beads, suitable precautions (including preheat) are to be taken to avoid high hardness and possible cold cracking.

5.3 Specific Requirements for Fabricated Steel Sections

5.3.1 Scope

(a) Fabricated steel sections are items used in place of rolled sections and as such will not be regarded as subassemblies. Products regarded as sub-assemblies are subject to requirements of welded construction specified in 5.2 of this Chapter.

(b) The requirements for structural steel sections are based on these being manufactured from flat products by automatic welding and intended for use in the construction of ships and other marine structures.

(c) Fabricated steel sections are to be manufactured in accordance with the requirements of this Section and the general requirements of 5.1 of this Chapter.

(d) In all cases, sections are to be manufactured at works, which have been assessed and approved in accordance with Chapter 2 of CR Guidelines for Survey of Products for Marine Use.

5.3.2 Dimensions and tolerances

(a) Products are to conform dimensionally to the provisions of an acceptable National or International Standard.

(b) The minimum throat thickness of fillet welds is to be determined from:
Throat thickness = 0.34t but not to be taken as less than 3 mm
where
t = plate thickness of the thinner member to be joined (generally the web).

(c) Unless agreed otherwise, the leg length of the weld is to be not less than 1.4 times the specified throat thickness.

5.3.3 Identification of products

(a) Every finished item is to be clearly marked by the manufacturer in at least one place with the following particulars:

(i) The manufacturer’s name or trade mark.

(ii) Identification mark for the grade of steel.

(iii) Identification number and/or initials which will enable the full history of the item to be traced.

(iv) Where required by the purchaser, the order number or other identification mark.

(v) The the Society’s mark Ⓡ.

(vi) The Surveyor’s personal stamp.

The above particulars, but excluding the manufacturer’s name or trade mark where this is embossed on finished products, are to be encircled with paint or otherwise marked so as to be easily recognisable.

(b) In the event of any material bearing the Society's brand failing to comply with the test requirements, the brand is to be removed or unmistakably defaced, see also Part XI, 1.6 of the Rules.

5.3.4 Manufacture and workmanship

(a) For cut edges that are to remain unwelded, it is to be demonstrated that the plate preparation procedures used are able to achieve edges that are free from cracks or other deleterious imperfections.

(b) Where assembly jigs and devices are used to bring the web into contact with the flanges and hold these in place during welding, means are to be provided to ensure that the degree of contact is maintained until welding is complete.

(c) Welding procedures are to be established for the welding of all joints including weld repairs and are to be approved in accordance with Chapter 2 of this Part. Welders are to be approved in accordance with Chapter 3 of this Part, and qualification records are to be available to the Surveyor.

(d) The welding consumables used are to be approved in accordance with Chapter 4 of this Part and are to be suitable for the type of joint and grade of steel as described in 5.2.2 of this Chapter. For joining steel of different tensile strengths, the consumables are to be suitable for the tensile strength of the component considered in the determination of weld size.

(e) The application of preheat and the use of low hydrogen welding consumables are to be in accordance with the requirements of 5.2.2 of this Chapter.

(f) Welding is to be double continuous fillet welding or full penetration welding as specified in the approved plans.

5.3.5 Non-destructive examination

(a) Surface inspection and verification of dimensions are the responsibility of the manufacturer and are to be carried out on all materials prior to despatch. Acceptance by the Surveyor of material later found to be defective does not absolve the manufacturer from this responsibility.

(b) The Surveyor will carry out checks to ensure that the weld size and profile are in accordance with the manufacturing specification and the manufacturer’s Quality Control Procedures.

(c) The manufacturer is to examine the welds by magnetic particle or dye penetrant methods. The length examined is to be 200 mm at each end, for each length cut for delivery.

(d) If cracks are revealed, these are to be reported to the Surveyor and the whole of the length is to be examined by magnetic particle or dye penetrant methods. Corrective action in respect of the manufacturing process, and repairs are to be as indicated in the manufacturers' Quality Control Manual.

(e) The weld defect is not to exceed the acceptance levels given in Table XII 5-9.

5.3.6 Routine weld tests

(a) One production batch test is required for every 500 m of fabricated section manufactured, or fraction thereof. From each batch test, 2 samples are to be removed, one from near the beginning of the production run and one from near the end. From each of these test samples 1 macro specimen and 1 fracture test specimen are to be taken.

(b) The macro specimens are to be prepared and etched to demonstrate freedom from unacceptable defects and that the weld penetration is in accordance with the manufacturing specification. The fracture specimens are to be broken, one for each side of the fillet welds and the fractured surfaces examined for compliance with the requirements of Table XII 5-10.

(c) Where the welding procedure used has employed the deep penetration technique, the amount of root penetration is to be measured on the macro specimen and is not to be less than that demonstrated during welding procedure approval testing.

(d) For the purposes of this Section, a batch is to consist of products of only one size and grade of material.

5.3.7 Certification and records

(a) Each test certificate is to include the following particulars:

(i) Purchaser's name and order number.

(ii) Where known, the contract number for which the material is intended.

(iii) Address to which material is despatched.

(iv) Description and dimensions of the product.

(v) Specification or grade of the steel.

(vi) Identification number and/or initials.

(vii) Cast number and chemical composition of ladle samples of constituent plates.

(viii) Mechanical test results of constituent plates.

(ix) Condition of supply when other than as-rolled.

(x) Make and brand of welding consumables.

(b) Test certificates or shipping statements may be signed by the Surveyor, provided the documentation requirements of 5.1.17 Certification of this Chapter are satisfied. The following form of declaration will be accepted if stamped or printed on each test certificate or shipping statement with the name of the works and signed by an authorised representative of the manufacturer: 'We hereby certify that the material has been made by an approved procedure in accordance with the Rules'.

(c) The manufacturer is to maintain records by which sources of material can be identified together with the results of all inspections and tests.

5.4 Specific Requirements for Fusion Welded Pressure Vessels

5.4.1 Scope

(a) The requirements of this Section apply to fusion welded pressure vessels and process equipment, heating and steam raising boilers, and steam or gas turbine rotors and cylinders and are in addition to those requirements referred to in 5.1 of this Chapter.

(b) The allocation of pressure vessel Group is determined from the design criteria in Table V 1-2 of Part V. Prior to commencing construction, the design of the vessel is to be approved. Construction requirements for turbine rotors and cylinders are to be in accordance with Group II, unless a higher Group is specified in the approved plans.

(c) Pressure vessels will be accepted only if manufactured by firms equipped and competent to undertake the quality of welding work required for the Group of vessel proposed. The manufacturer's works are to be approved in accordance with the requirements specified in 2.1 of this Part.

(d) The term 'fusion weld', for the purpose of these requirements, is applicable to welded joints made by manual, semiautomatic, or automatic electric arc welding processes. Special consideration will be given to the proposed use of other fusion welding processes.

5.4.2 Cutting and forming of shells and heads

(a) Cut or chipped surfaces which will not be subsequently covered by weld metal are to be ground smooth.

(b) Shell plates and heads are to be formed to the correct contour up to the extreme edge of the plate.

(c) Vessels manufactured from carbon or carbon manganese steel plates (see Chapter 4 of Part XI), which have been hot formed or locally heated for forming, are to be re-heat treated in accordance with the original supplied condition on completion of this operation. Vessels formed from plates supplied in the as-rolled condition are to be heat treated in accordance with the material manufacturer's recommendations.

(d) Subsequent heat treatment will not be required where steels are supplied in the as-rolled, normalised or normalised and controlled rolled condition, or hot forming is carried out entirely at a temperature within the normalising range.

(e) For alloy steel vessels where hot forming is employed, the plates are to be heat treated on completion in accordance with the material manufacturer's recommendations.

(f) Where plates are cold formed, subsequent heat treatment is to be performed where the internal radius is less than 10 times the plate thickness. For carbon and carbon manganese steels this heat treatment may be a stress relief heat treatment.

(g) In all cases where hot forming is employed, and for cold forming to a radius less than 10 times the thickness, the manufacturer is required to demonstrate that the forming process and subsequent heat treatments result in acceptable properties.

5.4.3 Fitting of shell plates and attachments

(a) The location of welded joints is to be such as to avoid intersecting butt welds in the vessel shell plates. The attachment of nozzles and openings in the vessels are to be arranged to avoid main shell weld seams.

(b) The surfaces of the plates at the longitudinal or circumferential seams are not to be out of alignment with each other, at any point, by more than 10% of the plate thickness. In no case is the misalignment to exceed 3 mm for longitudinal seams, or 4 mm for circumferential seams.

(c) Where a vessel is constructed of plates of different thicknesses (tube plate and wrapper plate), the plates are to be so arranged that their centrelines form a continuous circle.

(d) For longitudinal seams, the thicker plate is to be equally chamfered inside and outside by machining over a circumferential distance not less than twice the difference in thickness, so that the plates are of equal thickness at the longitudinal weld seam. For the circumferential seam, the thickest plate is to be similarly prepared over the same distance longitudinally.

(e) For the circumferential seam, where the difference in the thickness is the same throughout the circumference, the thicker plate is to be reduced in thickness by machining to a taper for a distance not less than four times the offset, so that the two plates are of equal thickness at the weld joint. A parallel portion may be provided between the end of the taper and the weld edge preparation; alternatively, if so desired, the width of the weld may be included as part of the smooth taper to the thicker plate.

(f) All attachments (lugs, brackets, reinforcing plates, etc.) are to conform to the shape of the surface to which they are attached.

5.4.4 Welding

(a) Welding procedures are to be established for all welds joining pressure containing parts and for welds made directly onto pressure containing parts. Welding procedures are to be based on qualification tests performed in accordance with Chapter 2 of this Part.

(b) In all cases where tack welds, in the root of the weld seam, are used to retain plates or parts in position prior to welding, they are to be removed in the process of welding the seam.

(c) Steel backing strips may be used for the circumferential seams of Group II and Group III pressure vessels and are to be the same nominal composition as the plates to be welded.

(d) Fillet welds are to be made to ensure proper fusion and penetration at the root of the fillet. At least two layers of weld metal are to be deposited at each weld affixing branch pipes, flanges and seatings.

(e) The outer surface of completed welds is to be at least flush with the surface of the plates joined, and any weld reinforcement is to provide a smooth transition and gradual change of section with the plate surface.

(f) Where attachment of lugs, brackets, branches, manhole frames, reinforcement plates and other members are to be made to the main pressure shell by welding, this is to be to the same standard as required for the main vessel shell construction.

(g) The main weld seams and all welded attachments made to pressure containing parts are to be completed prior to post weld heat treatment.

(h) The finish of welds attaching pressure parts and non-pressure parts to the main pressure shell is to be such as to allow satisfactory examination of the welds. In the case of Group I and Group II pressure vessels, these welds are to be ground smooth, if necessary, to provide a suitable finish for examination.

5.4.5 General requirements for routine weld production tests

(a) Routine weld production tests are specified as a means of monitoring the quality of the welded joints and are required for pressure vessel Group I and Group II.

(b) Routine production test plates are required during the manufacture of vessels and as part of the initial approval test programme for Group I vessel manufacturers.

(c) Routine production weld tests are not required for Group III pressure vessels unless there are doubts about the weld quality where check tests may be requested by the Surveyor.

(d) Routine production test plates are not required for circumferential seams of cylindrical pressure vessels. Spherical vessels are to have one test plate prepared having a welded joint which is a simulation of the circumferential seams.

(e) Routine production weld tests may be requested by the Surveyor where there is reason to doubt the quality of workmanship.

5.4.6 Production test plate assembly requirements

(a) Two test plates and one complete test assembly, of sufficient dimensions to provide all the required mechanical test specimens is to be prepared for each vessel and is to be welded as a continuation and simulation of the longitudinal weld joint.

(b) For Group II vessels, where a large number are made concurrently at the same works using the same welding procedure and the plate thicknesses do not vary by more than 5 mm, one test may be performed for each 37 m of longitudinal plus circumferential weld seam. In these cases the thickness of the test plate is to be equal to the thickest shell plate used in the construction.

(c) Where the vessel size or design results in a small number of longitudinal weld seams, one test assembly may be prepared for testing provided that the welding details are the same for each seam.

(d) Test plate materials are to be the same grade, thickness and supply condition and from the same cast as that of the vessel shell. The test assembly is to be welded at the same time as the vessel weld to which it relates and is to be supported so that distortion during welding is minimised.

(e) As far as practicable, welding is to be performed by different welders where there is a requirement for several routine tests to be welded.

(f) The test assembly may be detached from the vessel weld only after the Surveyor has performed a visual examination and has added his mark or stamp. Straightening of test welds prior to mechanical testing is not permitted.

(g) Where the pressure vessel is required to be subjected to post-weld heat treatment, the test weld is to be heat treated, after welding, in accordance with the same requirements. This may be performed separately from the vessel.

5.4.7 Inspection and testing

(a) The test weld is to be subjected to the same type of non-destructive examination and acceptance criteria as specified for the weld seam to which the test relates. Non-destructive examination is to be performed prior to removing specimens for mechanical testing, but after any post-weld heat treatment.

(b) The test weld is to be sectioned to remove the number and type of test specimens for mechanical testing as given in 5.4.8 below.

5.4.8 Mechanical requirements

(a) The routine production test assembly is to be machined to provide the following test specimens:

(i) Tensile.

(ii) Bend.

(iii) Hardness.

(iv) Impact (see Table XII 5-14).

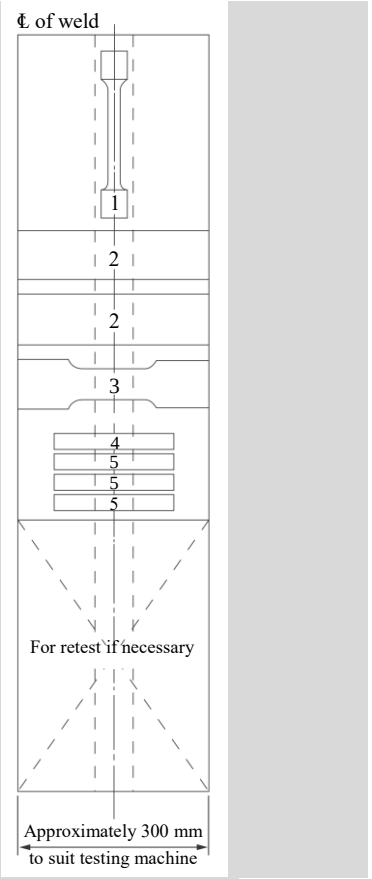
(v) Macrograph and hardness survey of full weld section.

(b) One set of specimens for mechanical testing are to be removed, as shown in Fig. XII 5-6 or Fig. XII 5-7 as appropriate for the Group of approval. Impact tests are to be removed and tested where required by Table XII 5-14.

Table XII 5-14
Impact Test Requirements

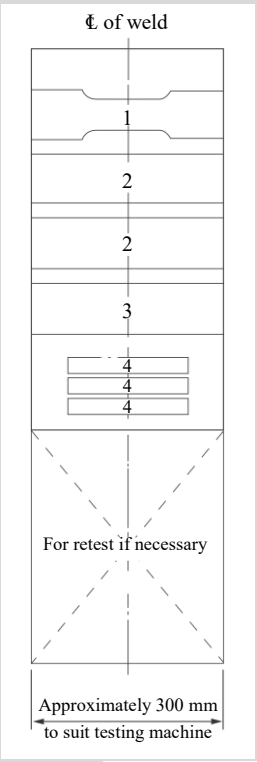
Pressure vessel Group	Minimum design temperature	Plate material thickness t	Impact test temperature
Group I (1)	– 10°C or above	All	5°C below the minimum design temperature or 20°C, whichever is the lower
		$t \leq 20$ mm	5°C below the minimum design temperature
All Groups	Below – 10°C	20 mm $< t \leq$ 40 mm	10°C below the minimum design temperature
		Over 40 mm	Subject to special consideration

Note:
(1) Impact testing is not required for Group II and Group III.



1. All weld metal tensile test specimen.
2. Bend test specimens.
3. Tensile test for joints.
4. Macro-test specimen.
5. Charpy V-notch impact.
   (For all Group I pressure vessels and other Groups of pressure vessels where the minimum design temperature is below –10°C).

Fig. XII 5-6
Routine Weld Test - Test Specimens for Group I and Group II



1. Tensile test for joints.
2. Bend test specimens.
3. Nicked bend test speimen.
4. Charpy V-notch impact test specimens (if required by Table XII 5-14 Impat Test Requirements)

Fig. XII 5-7
Routine Weld Test - Test Specimens for Group III

(c) Longitudinal tensile test for weld metal

An all-weld metal longitudinal tensile test is required. For thicknesses in excess of 20 mm, where more than one welding process or type of consumable has been used to complete the joint, additional longitudinal tests are required from the respective area of the weld. This does not apply to the welding process or consumables used solely to deposit the root weld. Specimens are to be tested in accordance with the following requirements:

(i) The diameter and gauge length of the test specimen is to be in accordance with 1.3 of this Part.

(ii) For carbon and carbon-manganese steels the tensile strength of the weld metal is to be not less than the minimum specified for the plate material and not more than 145 N/mm^2 above this value. The percentage elongation, A, is to be not less than that given by:
$A = (980-R)/21.6$ but not less than 80% of the minimum elongation specified for the plate
where R is the tensile strength, in N/mm^2, obtained from the all weld metal tensile tests.

(iii) For other materials the tensile strength and percentage elongation is not to be less than that specified for the base materials welded.

(d) Transverse tensile test for joint

Transverse tensile test specimens are to be removed and tested in accordance with the following requirements:

(i) One reduced section tensile test specimen is to be cut transversely to the weld to the dimensions shown in 1.3 of this Part and the weld reinforcement is to be removed.

(ii) In general, where the plate thickness exceeds 30 mm, or where the capacity of the tensile test machine prevents full thickness tests, each tensile test may be made up of several reduced section specimens, provided that the whole thickness of the weld is subjected to testing.

(iii) The tensile strength obtained is to be not less than the minimum specified tensile strength for the plate material, and the location of the fracture is to be reported.

(e) Transverse bend test

The bend test specimens are to be removed and tested in accordance with the following requirements:

(i) Two bend test specimens of rectangular section are to be cut transversely to the weld, one bent with the outer surface of the weld in tension (face bend), and the other with the inner surface in tension (root bend).

(ii) The specimen dimensions are to be in accordance with 1.3 of this Part.

(iii) Each specimen is to be mounted on roller supports with the centre of the weld midway between the supports. The former is to have a diameter specified in 1.3 of this Part.

(iv) After bending through an angle of at least 180° there is to be no crack or defect exceeding 1.5 mm measured across the specimen or 3 mm measured along the specimen. Premature failure at the edges of the specimen is not to be cause for rejection, unless this is associated with a weld defect.

(f) Macro-specimen and hardness survey

A macro examination specimen is to be removed from the test assembly near the end where welding started. The specimen is to include the complete cross-section of the weld and the heat affected zone. The specimen is to be prepared and examined in accordance with the following requirements:

(i) The cross-section of the specimen is to be ground, polished and etched to clearly reveal the weld runs, and the heat affected zones.

(ii) The specimen is to show an even weld profile that blends smoothly with the base material and have satisfactory penetration and fusion, and an absence of significant inclusions or other defects.

(iii) Where there is doubt in the condition of the weld as shown by macro-etching, the area concerned is to be microscopically examined.

(iv) For carbon, carbon manganese and low alloy steels, a Vickers hardness survey is to be performed on the macro-specimen using either a 5 kg or 10 kg load. Testing is to include the base material, the weld and the heat affected zone. Hardness scans on the crosssection are to be performed as specified in Fig. XII 2-5. The maximum recorded hardness is to not exceed 350 HV.

(g) Charpy V-notch impact test

Charpy V-notch impact test specimens are to be prepared and tested as required by Table XII 5-14 and in accordance with the following requirements:

(i) The dimensions and tolerances of the specimens are to be in accordance with 1.3 of this Part.

(ii) Charpy V-notch impact specimens and are to be removed with the notch perpendicular to the plate surface.

(iii) Specimens are to be removed for testing from the weld centreline and the heat affected zone (fusion line and fusion line + 2 mm locations) detailed in Fig. XII 2-2 (heat input ≤ 50 kJ/cm) or Fig. XII 2-4 (heat input > 50 kJ/cm) in Chapter 2, as appropriate. Heat affected zone impact tests may be omitted where the minimum design temperature is above +20°C.

(iv) For thicknesses in excess of 20 mm, where more than one welding process or type of consumable has been used to complete the joint, impact tests are required from the respective areas of the weld. This does not apply to the welding process or consumables used solely to deposit the root weld.

(v) The average energy of a set of three specimens is not to be less than 27 J or the minimum specified for the base material, whichever is the higher. The minimum energy for each individual specimen is to meet the requirements given in 1.5.2(b) of Part XI.

(h) Nick break bend tests

A nick bend or fracture test specimen is to be a minimum of 100 mm long measured along the weld direction and is to be tested in accordance with and meet the requirements of the following:

(i) The specimen is to have a slot cut into each side along the centreline of the weld and perpendicular to the plate surface.

(ii) The specimen is to be bent along the weld centreline until fracture occurs and the fracture faces are to be examined for defects. The weld is to be sound, with no evidence of cracking or lack of fusion or penetration and be substantially free from slag inclusions and porosity.

5.4.9 Failure to meet requirements

(a) Where any test specimen fails to meet the requirements, additional specimens may be removed and re-tested in accordance with 2.6 of this Part.

(b) Where a routine weld test fails to meet requirements, the welds to which it relates will be considered as not having met the requirements. The reason for the failure is to be established, and the manufacturer is to take such steps as necessary to either

(i) Remove the affected welds and have them re-welded, or

(ii) Demonstrate that the affected production welds have acceptable properties.

5.4.10 Post-weld heat treatment

(a) Fusion welded pressure vessels, where indicated in Table XII 5-15, are to be heat treated on completion of the welding of the seams and of all attachments to the shell and ends, and before the hydraulic test is carried out.

Table XII 5-15
Post-weld Heat Treatment Requirements

Type of steel	Plate thickness above which post-weld heat treatment (PWHT) is required	
	Steam raising plant	Other pressure vessels
Carbon and carbon/manganese steels without low temperature impact values	20 mm	30 mm
Carbon and carbon/ manganese steels with low temperature impact values	20 mm	40 mm
Other alloy steels	Subject to special consideration	

(b) Tubes which have been expanded into headers or drums may be seal welded without further post-weld heat treatment.

(c) Steam and gas turbine cylinders and rotors are to be subjected to post-weld heat treatment irrespective of thickness.

(d) Where the weld attaches parts of different thicknesses, the thickness to be used when applying the requirements for post-weld heat treatment is to be either the thinner of the two plates for butt welded connections, or the thickness of the shell for welds to flanges, tubeplates and similar connections.

(e) Care is to be exercised to provide drilled holes in double reinforcing plates and other closed spaces prior to heat treatment.

5.4.11 Basic requirements for post-weld heat treatment of fusion welded pressure vessels

(a) Recommended soaking temperatures and soak durations for post-weld heat treatment are given in Table XII 5-16 for different materials. Where other materials are used for pressure vessel construction, full details of the proposed heat treatment are to be submitted for consideration.

Table XII 5-16
Post-weld Soak Temperatures and Times

Material type	Soak temperature (°C)	Soak period
Carbon and carbon/ manganese grades	580–620	1 hour per 25 mm of thickness, minimum 1 hour
Note: (1) For materials supplied in the tempered condition, the post-weld heat treatment temperature is to be lower than the material tempering temperature.		

(b) Where pressure vessels are of dimensions that the whole length cannot be accommodated in the furnace at one time, the pressure vessels may be heated in sections, provided that sufficient overlap is allowed to ensure the heat treatment of the entire length of the longitudinal seam.

(c) Where materials other than those detailed in Table XII 5-16 are used or where it is proposed to adopt special methods of heat treatment, full particulars are to be submitted for consideration. In such cases, it may be necessary to carry out tests to show the effect of the proposed heat treatment.

5.4.12 Non-destructive examination of welds

Non-destructive examinations (NDE) of pressure vessel welds are to be carried out in accordance with the general NDE requirements as per 1.4.3 of this Part.

5.4.13 Extent of NDE for Group I pressure vessels

(a) All butt welded seams in drums, shells, headers and test plates, together with tubes or nozzles with outside diameter greater than 170 mm, are subject to 100% volumetric and surface crack detection inspections.

(b) For circumferential butt welds in extruded connections, tubes, headers and other tubular parts with an outside diameter of 170 mm or less, at least 10% of the total number of welds is to be subjected to volumetric examination and surface crack detection inspections.

(c) Full penetration tube sheet to shell welds are to be subjected to 10% volumetric examination and 10% surface inspection, prior to the installation of the tubes.

(d) In addition to the acceptance limits stated in Table XII 5-9 to Table XII 5-11, no cracks, lack of fusion, or lack of penetration is permitted.

(e) When an unacceptable indication is detected, the full length of the weld is to be subjected to 100% examination by the same method, testing conditions and acceptance criteria.

(f) The NDE requirements given in 1.4.3 of this Part are to be complied with.

5.4.14 Extent of NDE for Group II pressure vessels

(a) For Group II pressure vessels, volumetric and surface crack detection inspections are to be applied at selected regions of each main seam. At least 10% of each main seam is to be examined together with the full length of each welded test plate. When an unacceptable indication is detected, at least two additional check points in the seam are to be selected by the Surveyor for examination using the same inspection method. Where further unacceptable defects are found either:

(i) the whole length of weld represented is to be cut out and re-welded and re-examined as if it was a new weld with the test plates being similarly treated, or

(ii) the whole length of the weld represented is to be re-examined using the same inspection methods.

(b) Butt welds in furnaces, combustion chambers and other pressure parts for fired pressure vessels under external pressure, are to be subject to spot volumetric examination. The minimum length for each check point is to be 300 mm.

(c) The extent of NDE for turbine cylinders and rotors is to be agreed with the Surveyor.

(d) The requirements of 5.4.13(c), 5.4.13(d) and 5.4.13(e) of this Chapter apply to Group II pressure vessels.

5.4.15 NDE method

Volumetric examinations may be made by radiographic or ultrasonic testing, including Advanced NDE (ANDE) methods, and all applicable thickness ranges appropriate to the method, as described in 5.2.12 of this Chapter. The preferred method for surface crack detection in ferrous metals is magnetic particle inspection. The preferred method for nonmagnetic materials is liquid penetrant inspection.

5.4.16 Evaluation and reports

The manufacturer is to be responsible for the review, interpretation, evaluation and acceptance of the results of NDE. Reports stating compliance, or non-compliance, with the criteria established in the inspection procedure are to be issued. Reports are to comply, as a minimum, with the requirements of 5.2.12 of this Chapter.

5.4.17 Repair to welds

(a) Where non-destructive examinations reveal unacceptable defects in the welded seams, they are to be repaired in accordance with 5.1.15 of this Chapter and are to be shown by further non-destructive examinations to have been eliminated.

(b) In the case where spot radiography has revealed unacceptable defects, the requirements of 5.4.14(a) of this Chapter apply.

5.5 Specific Requirements for Pressure Piping

5.5.1 Scope

(a) Fabrication of piping is to be carried out in accordance with the requirements of this Section and the general requirements given in 5.1 of this Chapter, unless more stringent requirements have been specified.

(b) Piping systems are to be constructed in accordance with the approved plans and specifications.

(c) Fabricated piping will be accepted only if manufactured by firms that have demonstrated that they have the facilities and equipment and are competent to undertake the quality of welding required for the Class of pipework proposed.

5.5.2 Manufacture and workmanship

(a) Pipe welding may be performed using manual, semi-automatic or fully automatic electric arc processes. The use of oxyacetylene welding will be limited to Class III piping in carbon steel or carbon/manganese material that is not for carrying flammable fluids and limited to butt joints in pipes not exceeding 100 mm diameter or 9.5 mm thickness.

(b) Welding of piping, including attachment welds directly to pressure retaining parts is to be performed in accordance with approved welding procedures that have been qualified in accordance with Chapter 2 of this Part.

(c) Where the work involves a significant number of branch connections, tests will be required to demonstrate that the type of joint(s) and welding techniques employed are capable of achieving the required quality.

(d) Where pressure piping is assembled and butt welded in situ, the piping is to be arranged well clear of adjacent structures to allow sufficient access for preheating, welding, heat-treatment and non-destructive examination of the joints.

(e) Alignment of pipe butt welds is to be in accordance with Table XII 5-17 unless more stringent requirements have been agreed. Where fusible inserts are used, the alignment is to be within 0.5 mm in all cases.

Table XII 5-17
Pipe Butt Weld Alignment Tolerances

Pipe size	Maximum permitted misalignment
D < 150 mm and t ≤ 6 mm	1.0 mm or 25% of t, whichever is the lesser
D < 300 mm and t ≤ 9.5 mm	1.5 mm or 25% of t, whichever is the lesser
D ≥ 300 and t > 9.5 mm	2.0 mm or 25% of t, whichever is the lesser
where D = pipe internal diameter t = pipe wall thickness	

(f) The number of welds is to be kept to a minimum. The minimum separation between welds, measured toe-to-toe, is to be not be less than 75 mm. Where it is not possible to achieve this, adjacent welds are to be subjected to surface crack detection NDE.

(g) Welding consumables and fusible root inserts, where used, are to be suitable for the materials being joined.

(h) Acceptable methods of flange attachment are to be used, see Fig. VI 2-2 in Part VI of the Rules. Where backing rings are used with flange type (A) they are to fit closely to the bore of the pipe and be removed after welding. The rings are to be made of the same material as the pipes.

(i) Where socket welded fittings are employed, the diametrical clearance between the outside diameter of the pipe and the base of the fitting is not to exceed 0.8 mm, and a gap of approximately 1.5 mm is to be provided between the end of the pipe and the internal step at the bottom of the socket.

(j) For welding of carbon, carbon/manganese and low alloy steels, the preheat to be applied will be dependent on the material grade, thickness and hydrogen grading of the welding consumable in accordance with Table XII 5-18 , unless welding procedure testing indicates that a higher level is required.

Table XII 5-18
Welding Preheat Levels for Piping

Material Grade	Thickness, t (mm) (3)	Minimum preheat temperature (°C) (1)	
		Non-low H_2	Low H_2 (2)
Carbon and carbon/ manganese grades: 320 and 360	t ≤ 15	50	10
	t ≥ 15	100	50
Carbon and carbon/ manganese grades: 410, 460 and 490	t ≤ 15	75	20
	t ≥ 15	150	100

Notes:
(1) Where the ambient temperature is 0°C or below, pre-warming of the weld joint is required in all cases.
(2) Low hydrogen process or consumables are those that have been tested and have achieved a grading of H15 or better (see Chapter 4 of this Part).
(3) t = the thickness of the thinner member for butt welds, and the thicker member for fillet and branch welds.

(k) Welding without filler metal is generally not permitted for welding of duplex stainless steel materials.

(l) All welds in high pressure, high temperature pipelines are to have a smooth surface finish and even contour; and where necessary, made smooth by grinding.

(m) Check tests of the quality of the welding are to be carried out periodically.

5.5.3 Heat treatment after bending of pipes

(a) After forming or bending of pipes, the heat treatments specified in this Section are to be applied unless the pipe material manufacturer specifies or recommends other requirements.

(b) Generally, hot forming is to be carried out within the normalising temperature range. When carried out within this temperature range, no subsequent heat treatment is required for carbon and carbon/manganese steels. For alloy steels, a subsequent stress relieving heat treatment in accordance with 5.1.16 at the temperatures and times specified in Table XII 5-19 is required, irrespective of material thickness.

(c) When hot forming is performed outside the normalising temperature range, a subsequent heat treatment in accordance with Table XII 5-20 is required.

(d) After cold forming to a radius (measured at the centreline of the pipe) of less than four times the outside diameter, heat treatment in accordance with Table XII 5-20 is required.

(e) Bending procedures and subsequent heat treatment for other alloy steels will be subject to special consideration.

5.5.4 Post-weld heat treatment

(a) Post-weld heat treatment is to be carried out in accordance with the general requirements specified in 5.1.16 and 5.4.10 of this Chapter.

(b) The thickness limits, the recommended soaking temperatures and periods, for application of post-weld heat treatment are given in Table XII 5-19.

(c) Where the use of oxy-acetylene welding is proposed, due consideration is to be given to the need for normalising and tempering after such welding.

Table XII 5-19
Post-weld Heat Treatment Requirements for Piping

Material Grade	Thickness for which post-weld heat treatment is required	Soak temperature (°C) (2)	Soak period
Carbon and carbon/ manganese grades: 320, 360, 410, 460, 490	Over 30 mm	580–620	1 hour per 25 mm of thickness, 320, 360, 410, 460, 490 minimum of 1 hour

Notes:
(1) Heat treatment may be omitted for thicknesses up to 8 mm and diameters not exceeding 100mm and minimum service temperature 450°C provided that welding procedure tests have demonstrated acceptable properties in the as welded condition.
(2) For materials supplied in the tempered condition, the post weld heat treatment temperature is to be at least 20°C less than the material tempering temperature.

Table XII 5-20
Heat Treatment after Bending of Pipes

Type of steel	Heat treatment required
Carbon and carbon/ manganese: Grades 320, 360, 410, 460 and 490	Normalise at 880 to 940°C
Other alloy steels	Subject to special consideration

5.5.5 Non-destructive examination

(a) Non-destructive examination of pipe welds is to be carried out in accordance with the general requirements of 5.1.11 of this Chapter and the following.

(b) Butt welds in Class I pipes with an outside diameter greater or equal to 75 mm are to be subject to 100% volumetric and visual inspections. Consideration is to be given to the extent and method of testing applied to butt welds in Class I pipes with an outside diameter less than 75 mm.

(c) Butt welds in Class II pipes are to be subjected to at least 10% random volumetric inspections when the outside diameter is 100 mm and greater.

(d) NDE for Class II pipes with a diameter less than 100 mm is to be at the discretion of the Surveyor.

(e) Non-destructive examination procedures, methods and the evaluation of reports are to be in accordance with 5.4.15 and 5.4.16 of this Chapter.

(f) Fillet welds on flange pipe connections of Class I pipes are to be examined by surface crack detection methods.

(g) Weld acceptance criteria shall be in accordance with 5.4.13 of this Chapter.

5.5.6 Repairs to pipe welds

(a) Where non-destructive examinations reveal unacceptable defects in a weld, the defects are to be removed and repaired in accordance with 5.1.15 of this Chapter. Completed repairs are to be shown by further non-destructive examination to have eliminated the defects.

(b) For pipes with diameter less than 88 mm and where unacceptable defects have been found during non-destructive examination, consideration is to be given to cutting the weld out completely, re-making the weld preparation and re-welding as a new joint (because of the difficulty of making small repairs).

(c) Where repeated weld repairs have to be made to a weld, only two such attempts are to be permitted, thereafter the weld is to be cut apart and removed, and re-welded as a new joint.

(d) Where piping requires post-weld heat treatment weld, repairs to the pressure retaining parts are to be subjected to a subsequent heat treatment. Similarly, where welding is conducted after pressure testing, a further pressure test is to be required unless specific exemption has been agreed.

5.6 Repair of Existing Ships by Welding

5.6.1 Scope

(a) This Section specifies requirements for repairs made by welding after introduction into service. This Section includes defects to hull structures, machinery, equipment and components. It also includes replacement of structure due to damage or corrosion. These requirements are in addition to those specified in the preceding Sections of this Chapter.

(b) These requirements apply unless the original builder or manufacturer has specified alternative requirements.

5.6.2 Materials used for repairs

(a) Permanent materials used in the repair are to be in accordance with 5.1.3 of this Chapter.

(b) Prior to commencing any welding, the material grades present in the original structure in way of the repair are to be determined. Where the materials cannot be identified from the ship records, test samples may be removed for chemical analysis and mechanical testing in order to determine the material grades.

(c) Temporary materials that are to be welded to the main structure to assist in executing the repairs, but removed on completion, are to be of weldable quality.

5.6.3 Workmanship

(a) A repair method is to be established by the shipyard or repair yard and is to be agreed by the Surveyor prior to commencing any repair work.

(b) The removal of crack-like defects is to be confirmed by visual examination and surface crack detection NDE. This may be augmented by ultrasonic examination where several defects are reported at different depths at the same location.

(c) The weld joint or groove shape used for the repair is to have a profile suitable for welding.

(d) The weld area is to be carefully cleaned, in particular, where the material surface has been painted or has been subjected to an oily or greasy environment.

5.6.4 Non-destructive examination

(a) On completion of welding and any post-weld heat treatment, repair welds are to be subjected to the type and extent of NDE and assessed in accordance with the acceptance criteria specified for the original construction.

(b) Where the original construction specification did not specify NDE, the completed welds are to be, as a minimum, subject to visual examination. Consideration of other NDE techniques is to take due cognisance of the location or the repair within the ship.

(c) Where spot NDE is applied and defects are found, the extent of NDE is to be increased to include an equal amount of weld length. Where this reveals unacceptable defects, either the whole weld will be rejected or the extent of inspection increased to 100% examination.

(d) The acceptance criteria to be applied are to generally be in accordance with the original build specification. Where conflict of requirements exist, the NDE acceptance limits for welding procedure tests specified in 1.4.3 of this Part may be used as a minimum requirement. Assessment of results is to be in accordance with ISO 5817 Level B except for excess convexity and excess throat thickness where Level C will apply. Linear porosity is not permitted.

5.6.5 Repairs to Welds Defects

Where NDE reveals unacceptable defects, these are to be repaired in accordance with 5.1.15 of this Chapter.

5.7 Austenitic and Duplex Stainless Steel – Specific Requirements

5.7.1 Scope

(a) This Section specifies requirements for the fabrication and welding of austenitic and duplex stainless steels, and is in addition to those detailed above.

(b) Fabrication and welding of these materials is to be in designated areas which are separated from those used for other materials, such as carbon steels and copper alloys. Where work is performed in the same workshop as other materials, adequate barriers or screening are to be provided to prevent cross-contamination of different material types.

(c) All tools and equipment used are to be suitable for use on stainless steel materials. The use of tools or equipment made of carbon steel materials is to be avoided. It is permissible to use carbon steel tools provided that the surfaces that come into contact with the austenitic and duplex stainless materials are protected with an austenitic or nickel base alloy.

5.7.2 Design

Care is to be exercised in the weld design to prevent crevice corrosion from occurring, particularly where austenitic materials are used. In this respect fillet welds and partial penetration welds are to be continuous and welded on both sides of the joint.

5.7.3 Forming and bending

(a) Materials that are cold formed, such that the total strain exceeds 15% (i.e. where the formed diameter to thickness ratio is less than 6:1) are to be subjected to a subsequent softening heat treatment in accordance with the material manufacturers recommendations, unless it is demonstrated by testing that the material properties are acceptable in the 'as formed' condition.

(b) Materials may be hot formed provided that a subsequent softening heat treatment is carried out. The forming process and the subsequent heat treatment are to be in accordance with the material manufacturer's recommendations.

5.7.4 Fabrication and welding

(a) Welding may be performed using shielded manual arc welding (SMAW), gas tungsten arc welding (GTAW), MIG/MAG welding (GMAW), flux cored arc welding (FCAW), plasma arc welding (PAW) and submerged arc welding (SAW). The use of other welding processes will be subject to special consideration and will require submission of the process details, consumables and the weld properties achieved.

(b) Misalignment may be corrected by the application of steady even force (e.g. using hydraulic or screw-type clamps). Hammering or heating is not permitted.

(c) For full penetration welds, a backing or shielding gas is to be provided to prevent oxidation of the root weld. The backing gas is to be maintained until completion of, at least, the root and first fill layer. The backing gas may be omitted where the weld is back gouged or ground to remove the root weld.

(d) Shielding and backing gases are to be an inert type of high purity and oxygen free.

(e) For welding of duplex stainless, the use of backing gases that contain up to 2% nitrogen is permitted.

(f) Welding of duplex stainless steels without filler metal is generally not permitted.

(g) Degreasing agents, acid solutions, washing water etc. used for cleaning and any marking crayons and paints used are to be free of chlorides.

5.7.5 Repairs

Correction of distortion by the application of heat is not permitted.

5.8 Specific Requirements for Welded Aluminium

5.8.1 Scope

(a) This Section specifies requirements for the fabrication and welding of aluminium alloys, and is in addition to those detailed in this Chapter.

(b) Fabrication and welding of these materials is to be in designated areas which are separated from those used for other materials, such as carbon steels, stainless steels and copper alloys. Where work is performed in the same workshop as other materials, adequate barriers or screening are to be provided to prevent cross-contamination of different material types.

(c) All tools and equipment used are to be suitable for use on aluminium alloy materials. The use of tools made of carbon steel materials is to be avoided where possible.

5.8.2 Forming and bending

Aluminium alloys are to be subject to cold forming and cold bending only.

5.8.3 Fabrication and welding

(a) Welding may be performed using gas tungsten arc welding (GTAW) or metal inert gas welding (GMAW), MIG/MAG welding (GMAW), or variants thereof. The use of other welding processes such as friction stir welding (FSW) will be subject to special consideration and will require submission of the process details, consumables and the weld properties achieved.

(b) A comparison of the mechanical properties for selected welded and unwelded alloys is given in Table XII 5-21.

Table XII 5-21
Minimum Mechanical Properties for Aluminum Alloys

Alloy	Condition		0.2% proof stress, N/mm^2		Ultimate tensile strength, N/mm^2	
			Unwelded	Welded (4)	Unwelded	Welded (4)
5083	O/H111		125	125	275	275
	H112		125	125	275	275
	H116/H321		215	125	305	275
5383	O/H111		145	145	290	290
	H116/H321		220	145	305	290
5086	O/H111		100	95	240	240
	H112		125 (2)	95	250 (2)	240
	H116/H321		195	95	275	240
5059	O/H111		160	160	330	330
	H116/H321		260	160	360	300
5456	O		125	125	285	285
	H116		200 (5)	125	290 (5)	285
	H321		215 (5)	125	305 (5)	285
5754	O/H111		80	80	190	190
6005A (1)	T5/T6	Extruded: Open Profile	215	100	260	160
		Extruded: Closed Profile	215	100	250	160
6061 (1)	T5/T6	Rolled	240	125	290	160
		Extruded: Open Profile	240	125	260	160
		Extruded: Closed Profile	205	125	245	160
6082	T5/T6	Rolled	240	125	280	190
		Extruded: Open Profile	260	125	310	190
		Extruded: Closed Profile	240	125	290	190

Notes:
(1) These alloys are not normally acceptable for application in direct contact with sea-water.
(2) See also Table XI 11-2 Mechanical Properties for Rolled Aluminum Alloy Products, 3 mm ≤ t ≤ 50 mm or Table XI 11-3 Mechanical Properties for Extruded Aluminum Alloy Products, 3 mm ≤ t ≤ 50 mm of Part XI.
(3) The mechanical properties to be used to determine scantlings in other types and grades of aluminum alloy manufactured to National or proprietary Standards and specifications are to be individually agreed with the Society, see also 11.2.1(c) of Part XI.
(4) Where detail structural analysis is carried out, 'unwelded' stress values may be used away from heat affected zones and weld lines, see also 2.1.1(a) of Part III of the Rules for High Speed Craft.
(5) For thickness less than 12.5 mm, the minimum unwelded 0.2% proof stress is to be taken as 230 N/mm^2 and the minimum tensile strength is to be taken as 315 N/mm^2.

(c) Misalignment may be corrected by the application of steady even force (e.g. using hydraulic or screw-type clamps). Hammering or heating is not permitted.

(d) Correction of distortion by the application of heat is not permitted.

5.8.4 Non-destructive examination

(a) The requirements of 5.1.11 and 5.2.12 of this Chapter apply with the following additional provisions;

(i) For full penetration butt welds, the use of advanced NDE (ANDE) methods may be used in lieu of (or complementary to) existing radiographic film testing methods. These methods may additionally be used on other weld configurations, with some limitations, as specified in Table XII 5-24.

(ii) The acceptance criteria for surface imperfections of aluminium welds are to be in accordance with Table XII 5-22.

(iii) The acceptance criteria for internal imperfections of aluminium welds using RT and RT-D methods are to be in accordance with Table XII 5-23 Radiographic Acceptance Criteria for Internal Imperfections of Aluminium.

(iv) The acceptance criteria for internal imperfections of aluminium welds using PAUT (based on length and amplitude) are to be in accordance with Table XII 5-11.

(v) The acceptance criteria for internal imperfections of aluminium welds using TOFD are to be in accordance with Table XII 5-12.

(vi) Other acceptance standards may be used upon agreement with the Society.

(b) Alternative NDE acceptance criteria will be subject to special consideration provided that they are equivalent to these requirements.

Table XII 5-22
Acceptance Criteria for Surface Imperfections of Aluminum

Surface discontinuity	Classification according to ISO 6520-1	Acceptance criteria
Crack	100	Not permitted
Lack of fusion	401	Not permitted
Incomplete root penetration in butt joints welded from one side	4021	Not permitted
Surface pore	2017	$d \leq 0.3s$ or 0.3a or 1.5 mm (whichever is the lesser)
Linear porosity (1)	2014	Not permitted
Uniformly distributed porosity (2)	2018	$\leq$ 1% of area
Clustered porosity	2013	Not permitted
Continuous undercut	5011	$h \leq 0.1t$ or 0.5 mm (whichever is the lesser)
Intermittent undercut	5012	$h \leq 0.1t$ or 1.0 mm (whichever is the lesser)
Excess weld metal (3)	502	$h \leq 1.5$ mm + 0.15b or 8 mm (whichever is the lesser)
Excess penetration	504	$h \leq 4$ mm
Root concavity (3)	515	$h \leq 0.1t$ or 1.0 mm (whichever is the lesser)
Linear misalignment (4), (5)	507	$h \leq 0.1t$ or 1.0 mm (whichever is the lesser)
Angular misalignment	508	(6)

Symbols:
- a = nominal throat thickness of a fillet weld
- b = width of weld reinforcement
- d = diameter of a gas pore
- h = height or width of an imperfection
- s = nominal butt weld thickness
- t = wall or plate thickness (nominal size)

Notes:
(1) For these acceptance criteria, linear porosity is to be considered as three aligned gas pores in a length of 25 mm.
(2) To be in accordance with EN ISO 10042.
(3) A smooth transition is required.
(4) Linear misalignment is to be a maximum of 0.5 mm in highly stressed areas. For other areas, the linear misalignment is to be a maximum of 1.0 mm locally, where the sum of the length of imperfection is not more than 10% of the weld length.
(5) The limits for linear misalignment relate to deviations from the correct position. Unless otherwise specified, the correct position is that when the centerlines coincide.
(6) Angular misalignment shall be mutually agreed between the designer and the fabricator.

Table XII 5-23
Radiographic Acceptance Criteria for Internal Imperfections of Aluminum

Internal discontinuity	Classification according to ISO 6520-1	Acceptance criteria (1), (2)
Crack	100	Not permitted
Lack of fusion	401	Not permitted
Incomplete penetration	402	Not permitted
Gas pores	2011	$d \leq 0.3s$ or $0.3a$ or 5 mm max (whichever is the lesser)
Linear porosity	2014	Assess as lack of fusion
Uniformly distributed porosity (3)	2012	$0.5 < t < 3$ mm $\leq 2\%$ of area L = 100 mm $3 < t < 12$ mm $\leq 4\%$ of area L = 100 mm $12 < t < 30$ mm $\leq 6\%$ of area L = 100 mm 30 mm $< t \leq 8\%$ of area L = 100 mm
Clustered (localized) porosity (3)	2013	$d_A \leq 20$ mm or d_A max $\leq w_p$ (whichever is the lesser)
Elongated cavity and wormholes (3)	2015 2016	$l \leq 0.3s$ or 4 mm max (whichever is the lesser)
Oxide inclusion	303	$l \leq 0.5s$ or 5 mm max (whichever is the lesser)
Tungsten inclusion	3041	$l \leq 0.3s$ or 4 mm max (whichever is the lesser)
Copper inclusion	3042	Not permitted

Symbols:

- d = diameter of a gas pore
- s = nominal butt weld thickness
- t = material thickness
- w_p = width of weld
- d_A = diameter of area surrounding gas pores
- l = length of imperfection in longitudinal direction of weld
- L = any 100 mm testing length, in (mm)

Notes:

(1) Any two adjacent imperfections separated by a distance smaller than the major dimension of the smaller imperfection shall be considered as a single imperfection.

(2) Indications shall not be divided into different ranges L.

(3) Further guidance regarding determination of porosity areas and summation of acceptable areas may be referenced within the informative annexes of ISO 10675-2

Table XII 5-24
Applicable Methods for the Testing of Aluminum Weld Joints

Materials and weld joints	Parent material thickness	Applicable volumetric NDE test methods (1), (2)
Aluminum butt welds with full penetration	Thickness < 6 mm	RT, RT-D
	Thickness ≥ 6 mm	RT, RT-D, PAUT, TOFD
Aluminum tee joints and corner joints with full penetration	Thickness ≥ 6 mm	RT, RT-D, PAUT (3)
Aluminum cruciform joints with full penetration	Thickness ≥ 6 mm	PAUT

Notes:
(1) The method abbreviations are defined in the following:
RT : Radioscopic testing.
RT-D : Digital Radiography (a term for digital radiographic testing and image storage, other than film radiography. This method utilizes digital detectors).
PAUT : Phased Array Ultrasonic Testing.
TOFD : Time of Flight Diffraction (an ultrasonic testing method).
(2) Ultrasonic testing may be specially considered upon agreement with the Society.
(3) RT and RT-D may be applied; however, it is noted that for these configurations, there may be limitations.

5.9 Friction Stir Welding Requirements for Aluminium Alloys

5.9.1 Scope

(a) The requirements of this Section apply to the application of Friction Stir Welding (FSW) during construction.

(b) Prior to welding, the friction stir welding equipment is to have been demonstrated as being suitable for use.

(c) Qualified welding procedures that have been approved by the Society are required. Procedures to ISO 25239-4 that are endorsed by another Classification Society may be accepted if they are to the satisfaction of the attending Surveyor.

(d) Welding operators are to be qualified to ISO 25239-3 standard. Where qualifications have been certified by another Classification Society, acceptance of the qualifications will be subject to document review and demonstration of knowledge of the FSW process and function of the FSW installation.

5.9.2 Production quality control

(a) The general requirements for quality control are specified in ISO 25239-5.

(b) Unless otherwise specified in relevant parts of the Rules, the following production tests will be required.

(c) A production test is required when there is a change in procedure, a change in tooling, after equipment repairs or modifications, after deviation from optimum parameters are detected, when defects are identified by non-destructive testing, after continuous welding of every 100 m length during a single shift and with a maximum interval between procedure tests of 8 hours. For butt welds the production tests are to consist of 100% visual examination, two face bend tests, two root bend tests and one macro section. For thicknesses exceeding 12 mm, sets of face and bend tests may be replaced by side bend tests. For test assembly, see Fig. XII 5-8. The production tests for other joint geometry are to be agreed between the Surveyor and the fabricator.

(d) As an automated process, all essential variables are to be recorded by the FSW system. The welding operator is responsible for ensuring that the system continues to produce welds that are in compliance with the qualified procedure. The Surveyors are to be informed when the system exceeds the operating parameters. The Surveyors are periodically to review the welding records.

(e) Production welds are to be subject to 100% visual examination by the fabricator and be subject to random checking by the Surveyor.

(f) Surface and volumetric NDE testing is to be conducted on production welds at a frequency of two per welded panel or one every 100 m of weld, whichever is the greater.

(g) Assessment of imperfections is to be in accordance with ISO 25239-5 Annex A and the requirements of Table XII 5-23.

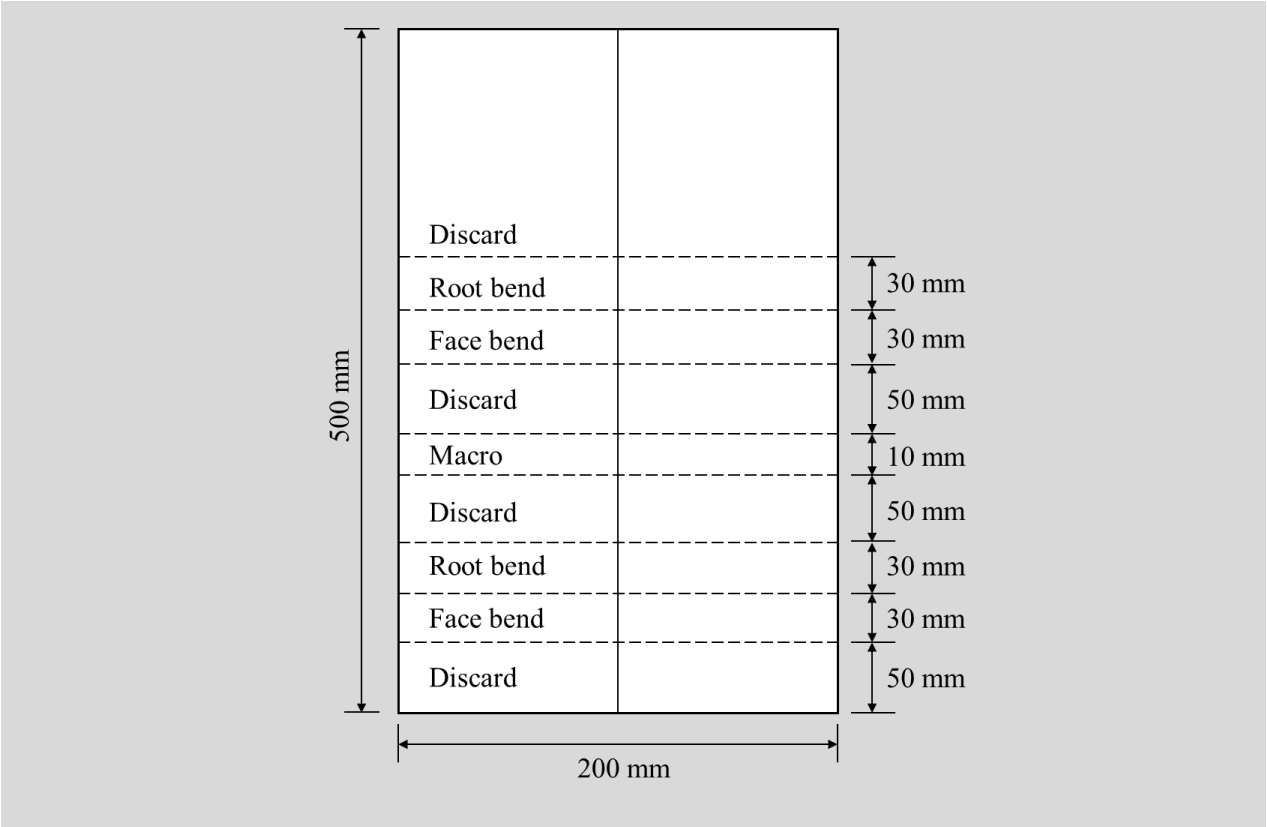


Fig. XII 5-8
Production Test Assembly for Friction Stir Welds

5.9.3 Repair

(a) All defective welds are to be reported to the Surveyor.

(b) The manufacturer is to have an approved procedure for the repair of defective welds.

(c) Weld repairs are to be conducted by qualified welders or welding operators in accordance with qualified weld procedures. Welding procedures and welders/operators are to be qualified in accordance with the requirements of Chapter 2 and Chapter 3 of this Part as appropriate to the welding process used for the weld repair.

(d) All repairs are to be subject to 100% visual, surface and volumetric NDE.

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022"

PART XIV GOAL-BASED SHIP CONSTRUCTION STANDARDS (GBS) SHIPS

List of major changes in Part XIV from 2022 edition

2.8.3	New
4.2.5	Revised

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 2 Complements to CSR-H

Paragraph 2.8.3 has been amended as follows:

2.8 Direct Loads Assessment

2.8.1 The sloshing pressures defined in the CSR-H does not include the effect of impact pressures due to high velocity impacts with tank boundaries or internal structures. For tanks with a maximum effective sloshing breadth, b_{slh}, greater than 0.56 B or a maximum effective sloshing length, l_{slh}, greater than 0.13 L at any filling level from 0.05 h_{max} to 0.95 h_{max}, a separate impact assessment is to be carried out in accordance with Chapter 33 of Part II of the Rules. See CSR-H Part 1 Ch.4 Sec.6 for the definitions of the above-mentioned symbol.

2.8.2 Seakeeping design motions and loads assessment for hull forms outside the limits specified in CSR-H Part 1 Ch. 1 Sec. 2 [3] and Sec. 3 [6.2], CR Internal Guidance IG-RES-XIV-002 is to be applied for seakeeping motions and loads assessment.

2.8.3 The equivalency to the Rules of alternative methods used for the design and the determination of scatlings shall be assessed following IACS Rec. 165.

Chapter 4 Design Transparency

Paragraph 4.2.5 has been amended as follows:

4.2 Ship Construction File (SCF)

4.2.5 In addition to the requirements of 4.2.1 to 4.2.4, the requirements of the IACS UR Z23/10 "Ship Construction File" and the IACS UR Z10.2, UR Z10.4 or UR Z10.5/6 "Documentation On Board" are to be conformed.

AMENDMENT TO "THE RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF STEEL SHIPS 2022"

PART XV HULL CONSTRUCTION AND EQUIPMENT FOR SHIPS LESS THAN 90 M IN LENGTH

List of major changes in Part XV from 2022 edition

6.3.2(b)	Revised
12.1.1(d)	New
12.4.1(a)	Revised
25.2	Revised
Fig. XV 25-1~25-3	Revised
25.8.2~5.8.3	Revised
Fig. XV 25-1	Renumbered

Rules for the Construction and Classification of Steel Ships 2022 have been partly amended as follows:

Chapter 6 Frames

Paragraph 6.3.2(b) has been amended as follows:

6.3 Transverse Hold Frames

6.3.2 Scantlings of transverse hold frames

(b) For the frames under transverse web beams supporting deck longitudinals, the section modulus is to be obtained as in 6.3.2(a), but not to be taken as less than that obtained from the following formula:

$$2.4\mathrm{Kn}\left[0.17 + \frac{\mathrm{h}_1}{9.81\mathrm{h}}\left(\frac{l_1}{l}\right)^2 - 0.1\frac{l}{\mathrm{h}}\right]\mathrm{Sh}\,l^2 \qquad \mathrm{cm}^3$$

where:

K	=	Material factor as specified in 1.4.1(b)(i) of this Part.
n	=	Ratio of transverse web beam spacing to frame spacing.
h_1	=	Deck load, in kN/m^2, stipulated in ~~9.2~~12.1 of this Part for the deck beam at the top of frame.
l_1	=	Total length, in m, of the transverse web beam.
S, *l* and h	=	As specified in 6.3.2(a) of this Chapter.

Chapter 12 Decks

Paragraph 12.1.1(d) has been amended as follows:

12.1 Value of Deck Load h

12.1.1 Value of h

(a) Deck load h (kN/m^2) for decks intended to carry ordinary cargoes or stores is to be in accordance with the following (i) through (iii).

(i) The standard value (kN/m^2) for h is given by taking 7 times the tween deck height (m) at side of the space or the height (m) from the deck concerned to the upper edge of the hatch coaming of the deck above as the height of the cargo and multiplying it by 7. However, h may be specified as the maximum design cargo weight per unit area of deck (kN/m^2). In this case, the value of h is to be determined by considering the height of the loaded cargo.

(ii) Where timber and/or other cargoes are intended to be carried on the weather deck, h is to be the maximum design cargo weight per unit area of deck (kN/m^2), or the value specified in 12.1.1(b) of this Chapter, whichever is greater.

(iii) Where cargoes are suspended from the deck beams or deck machinery is installed, h is to be suitably increased.

……

(c) On the first and second tiers above the freeboard deck, h is to be 12.8 for enclosures of superstructure decks and of top of deckhouses in accommodation or navigation spaces.

(d) Deck loads h (kN/m^2) on non-exposed decks and platforms are to be defined by the designer without being less than 3.0 (kN/m^2) for accommodation decks and 10.0 (kN/m^2) for other decks and platforms.

Paragraph 12.4.1(a) has been amended as follows:

12.4 Deck Plating

12.4.1 Thickness of deck plating

(a) The thickness of deck plating is not to be less than that obtained from the formula in 12.4.1(a)(i) or 12.4.1(a)(ii) as below. However, within enclosed spaces such as superstructures and deckhouses, the thickness may be reduced by 1 mm.

(i) The thickness of strength deck plating:

(1) Outside the line of openings for the midship part with longitudinal beams

$1.47S\sqrt{h} + 2.5$ mm, but not less than 5.0mm

where:

S = Spacing (m) of longitudinal beams

h = Deck load (kN/m^2) specified in 12.1 of this Chapter

(2) Outside the line of openings for the midship part with transverse beams

$1.63S\sqrt{h} + 2.5$ mm, but not less than 5.0mm

where:

S = Spacing (m) of transverse beams

h = Deck load (kN/m^2) specified in 12.1 of this Chapter

(3) Elsewhere

$1.25S\sqrt{h} + 2.5$ mm, but not less than 5.0mm

where:

S = Spacing (m) of longitudinal beams

h = Deck load (kN/m^2) specified in 12.1 of this Chapter

(ii) The thickness of deck plating other than the strength deck is to be specified in the following:

$1.25S\sqrt{h} + 2.5$ mm, but not less than 5.0mm

where:

S = Spacing (m) of longitudinal beams

h = Deck load (kN/m^2) specified in 12.1 of this Chapter

Chapter 25 Equipment

25.2 Equipment Number

Paragraph 25.2 hasbeen amended as follows:

25.2.1 The equipment given in Table XV 25-1 is based on the "Equipment Number", EN, which is to be calculated as follows:

$$EN = \Delta^{\frac{2}{3}} + 2(hB~~H~~ + S_{fun}) + 0.1A$$

where:

Δ	=	Molded displacement to the summer load waterline, in ton.
B	=	Breadth of ship, in m, as specified in 1.5.3 of this Part.
~~H and A~~	~~=~~	~~Values specified in the following (a), (b) and (c)~~

~~(a) H is the value obtained from the following formula:~~

~~$H = a+H'$~~

~~where:~~

~~a~~	~~=~~	~~Vertical distance amidships from the designed maximum load line to the top of uppermost continuous deck beam at side, in m.~~
~~H'~~	~~=~~	~~Height, in m, from the uppermost continuous deck to the top of uppermost superstructures or deckhouses having a breadth greater than 0.25B.~~

~~In calculation of H', sheer and trim may be neglected. Where a deckhouse having a breadth greater than 0.25B is located above a deckhouse with a breadth of 0.25B or less, the narrow deckhouse may be ignored.~~

~~(b) A is the value obtained from the following formula:~~

~~$A = aL+\Sigma H''l$~~

~~where:~~

~~a~~	~~=~~	~~Value specified in (a) above.~~
~~L~~	~~=~~	~~Length of ship specified in 1.5.1 of this Part.~~
~~$\Sigma H''l$~~	~~=~~	~~Sum of products of the height H'', in m and length *l*, in m of superstructures, deckhouses or trunks which are located above the uppermost continuous deck within L and also have a breadth greater than B/4 and a height greater than 1.5 m.~~

~~(c) In the application of (a) and (b), screens and bulwarks more than 1.5 m in height are to be regarded as parts of superstructure or deckhouse.~~

h	=	Effective height, in m, from the summer load waterline to the top of the uppermost house, in m.
		$h=a+\Sigma h_i$
a	=	Vertical distance amidships from the summer load waterline to the top of uppermost continuous

deck beam at side, in m.

h_i = Heights, in m, at centerline of superstructure and each tier of deck-houses having a breadth greater than 0.25B. For the lowest tier h_1 is to be measured at centerline from the upper deck or from a notional deck line where there is local discontinuity in the upper deck, see Fig. XV 25-1 below for an example.

S_{fun} = Effective front projected area of the funnel, in m², defined as:

$S_{fun} = A_{FS} - S_{shield}$

A_{FS} = Front projected area of the funnel, in m², calculated between the upper deck at centerline, or notional deck line where there is local discontinuity in the upper deck, and the effective height h_F. A_{FS} is taken equal to 0 if the funnel breadth is less than or equal to 0.25B at all elevations along the funnel height.

h_F = Effective height of the funnel, in m, measured from the upper deck at centerline, or notional deck line where there is local discontinuity in the upper deck, and the top of the funnel. The top of the funnel may be taken at the level where the funnel breadth reaches 0.25B.

S_{shield} = The section of front projected area A_{FS}, in m², which is shielded by all deck houses having breadth greater than 0.25B. If there are more than one shielded section, the individual shielded sections i.e $S_{shield1}$, $S_{shield2}$ etc as shown in Fig. XV 25-2 to be added together. To determine S_{shield}, the deckhouse breadth is assumed B for all deck houses having breadth greater than 0.25B as shown for $S_{shield1}$, $S_{shield2}$ in Fig. XV 25-2.

A = Side projected area, in m², of the hull, superstructures, houses and funnels above the summer load waterline which are within the equipment length of the ship and also have a breadth greater than 0.25B. The side projected area of the funnel is considered in A when A_{FS} is greater than 0. In this case, the side projected area of the funnel should be calculated between the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the effective height h_F.

Fig. XV 25-1~25-3 have been amended as follows:

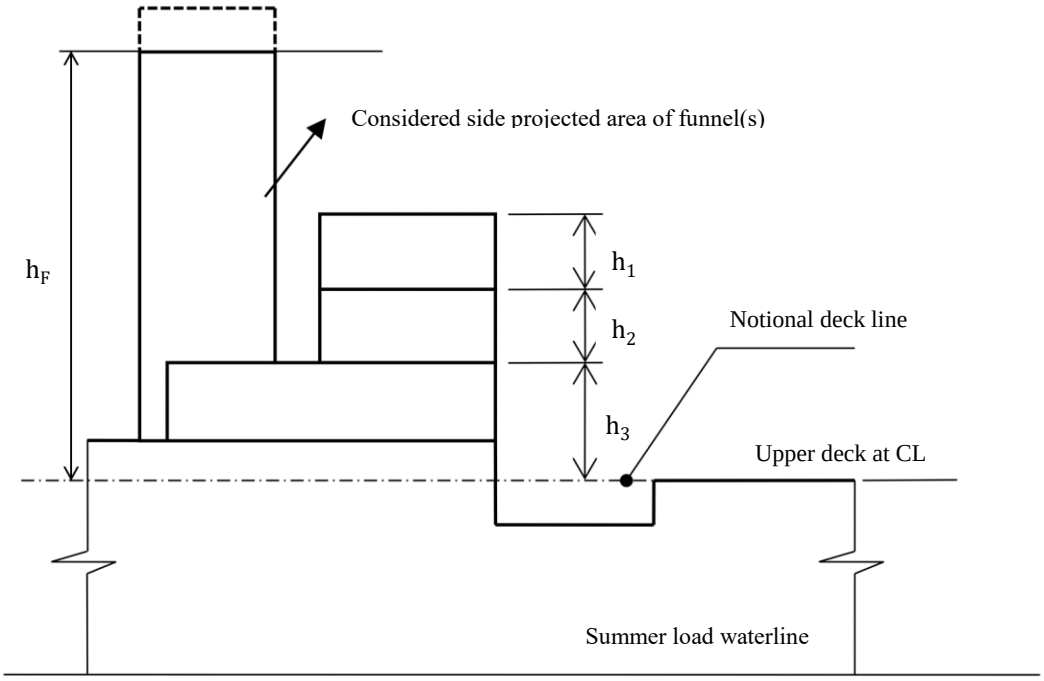


Fig. XV 25-1
Effective Height

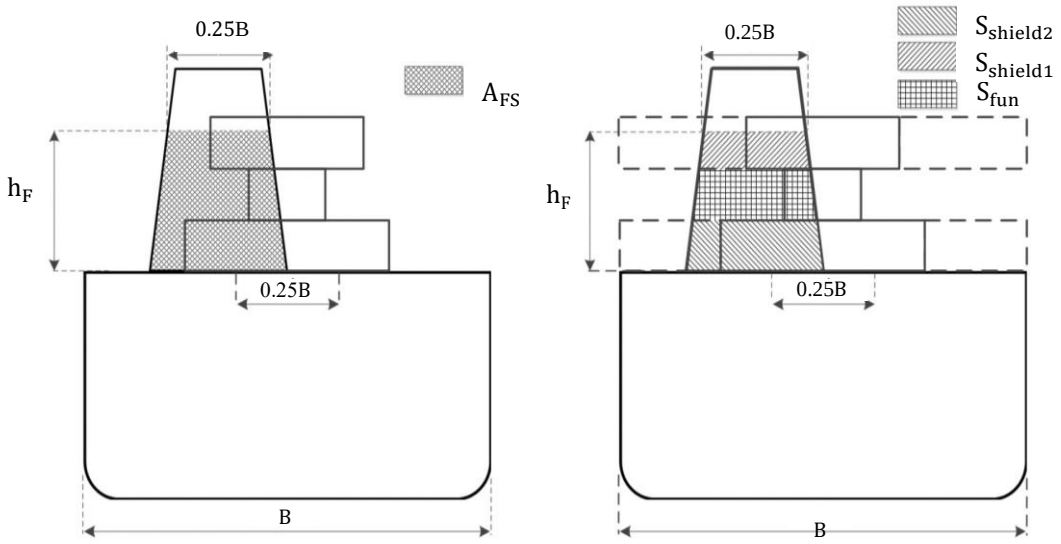


Fig. XV 25-2
Front Projected Area of Funnel

Notes:

(1) When calculating of h, sheer, camber and trim are to be neglected. i.e. h is the sum of freeboard amidships plus the height (at centerline) of each tier of houses having a breadth greater than 0.25B.

(2) If a deckhouse having a breadth greater than 0.25B is located above a deckhouse with a breadth of 0.25B or less, then the wide deckhouse is to be included, but the narrow deckhouse ignored.

(3) Screens or bulwarks 1.5 m or more in height are to be regarded as parts of superstructure or deckhouse when calculating h and A. The height of the hatch coamings and that of any deck cargo, such as containers, may be disregarded when determining h and A. With regard to determining A, when a bulwark is more than 1.5 m high, the area shown in Fig. XV 25-3 as A_2 is to be included in A.

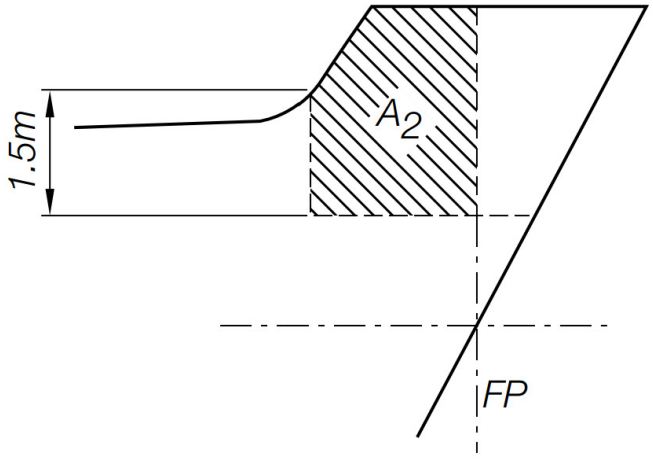


Fig. XV 25-3
Effective Area for Screens, Bulwarks, etc.

(4) The equipment length of the ship is the length between perpendiculars but is not to be less than 96% nor greater than 97% of the extreme length on the summer load waterline (measured from the forward end of the waterline).

(5) When several funnels are fitted on the ship, the above parameters are taken as follows:

h_F = Effective height of the funnel, in m, measured from the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the top of the highest funnel. The top of the highest funnel may be taken at the level where the sum of each funnel breadth reaches 0.25B.

A_{FS} = Sum of the front projected area of each funnel, in m², calculated between the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the effective height h_F. A_{FS} is to be taken equal to 0 if the sum of each funnel breadth is less than or equal to 0.25B at all elevations along the funnels height.

A = Side projected area, in m^2, of the hull, superstructures, houses and funnels above the summer load waterline which are within the equipment length of the ship. The total side projected area of the funnels is to be considered in the side projected area of the ship, A, when A_{FS} is greater than 0. The shielding effect of funnels in transverse direction may be considered in the total side projected area, i.e., when the side projected areas of two or more funnels fully or partially overlap, the overlapped area needs only to be counted once.

25.2.2 Equipment for tug

For tugs, the term 2 hB~~H~~ specified in 25.2.1 above for calculating "Equipment Number", EN, is to be substituted by the following formula:

$$2\ (a\ B + \Sigma\ h_i ~~H"~~\ b_i)$$

where:

a = As specified in the 25.2.1 ~~(a) above~~ of this Chapter.

B = As specified 25.2.1 of this Chapter.

h_i = As specified 25.2.1 of this Chapter.

b_i = The breadth, in m, of the widest superstructure or deckhouse of each tier having a breadth greater than 0.25B.

~~ΣH" b = Sum of the products of the height H", in m and the breadth b, in m of each widest superstructure and deckhouse which have a breadth greater than B/4 and are located above the uppermost continuous deck.~~

Paragraph 25.8.2 has been amended as follows:

25.8 Towing and Mooring Fittings

25.8.2 Towing fittings

(a) Arrangement of towing fittings

(i) Towing fittings are to be located on longitudinals, beams or girders, which are parts of the deck construction so as to facilitate efficient distribution of the towing load.

(ii) When towing fittings cannot be located as specified in 25.8.2(a)(i) above, towing fittings are to be arranged on reinforced members.

(b) Design load

Design load, see Fig. XV 25-~~1~~4 of this Chapter, for towing fittings and their supporting structures (hereinafter referred to as "design load on fittings" (see Fig. XV 25-~~1~~4 of this Chapter) in this paragraph) are to be as specified in 25.8.2(b)(i) to 25.8.2(b)(vi) below:

(i) For normal towing operations (e.g. harbour / manoeuvring), the design load on the line (see Fig. XV 25-~~1~~4 of this Chapter) is to be 1.25 times the intended maximum towing load.

(ii) For other types of towing (e.g. escort), the design load on the line (see Fig. XV 25-~~1~~4 of this Chapter) is to be the breaking strength of the towing line specified in Table XV 25-1 of this Chapter according to the equipment number determined in 25.2 of this Chapter.

(iii) The design load on fittings is to take into account all acting loads.

(iv) The point where the towing force acts on towing fittings is to be taken as the attachment point of the towing line.

(v) The design load on fittings is to take into account the total design load on the line specified in 25.8.2(b)(i) and 25.8.2(b)(ii) above, but need not exceed twice the design load on the line.

(vi) If the design load on fittings specified in 25.8.2(b)(ii) to 25.8.2(b)(v) above is less than the intended towing load stipulated in the construction specifications for the towing fittings and their supporting structures used for towing operations specified in 25.8.2(b)(ii) above, the design load on fittings is to be not less than the intended towing load.

(c) Selection of towing fittings

Towing fittings are generally to be specified according to standards approved by the Society.

.....

Paragraph 25.8.3 has been amended as follows:

25.8.3 Mooring fittings

(a) Arrangement of mooring fittings

(i) Mooring fittings are to be located on longitudinals, beams or girders, which are parts of the deck construction so as to facilitate efficient distribution of the mooring load.

(ii) When mooring fittings cannot be located as specified in 25.8.3(a)(i) above, the mooring fittings are to be arranged on reinforced members.

(b) Design load

Design load for mooring fittings and their supporting structures (hereinafter referred to as "designed load on fittings"(see Fig. XV 25-~~1~~4 of this Chapter) in this paragraph) are to be as specified in 25.8.3(b)(i) to 25.8.3(b)(vii) below:

(i) The design load on the line (see Fig. XV 25-~~1~~4 of this Chapter) is to be 1.25 times the breaking strength of the mooring line specified in Table XV 25-1 of this Chapter according to the equipment number determined in 25.2 of this Chapter.

(ii) The design load on fittings is to take into account all acting loads.

(iii) The point where the mooring force acts on mooring fittings is to be taken as the attachment point of the mooring line.

(iv) The design load on fittings is to take into account the total design load on the line specified in 25.8.3(b)(i) of this Chapter (see Fig. XV 25-~~1~~4 of this Chapter), but need not exceed twice the design load on the line.

(v) If the design load on fittings specified in 25.8.3(b)(i) to 25.8.3(b)(iv) of this Chapter is less than 1.25 times the intended mooring load stipulated in the construction specifications for the mooring fittings and their supporting structures used for mooring operations specified in 25.8.3(b)(i) of this Chapter, the design load on the fittings is to be at least 1.25 times the intended mooring load.

(vi) The design load applied to supporting hull structures for mooring winches is to be 1.25 times the intended maximum brake holding load.

(vii) The design load applied to supporting hull structures for capstans is to be 1.25 times the intended maximum hauling-in force.

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Fig. XV 25-1 has been renumbered as follows:

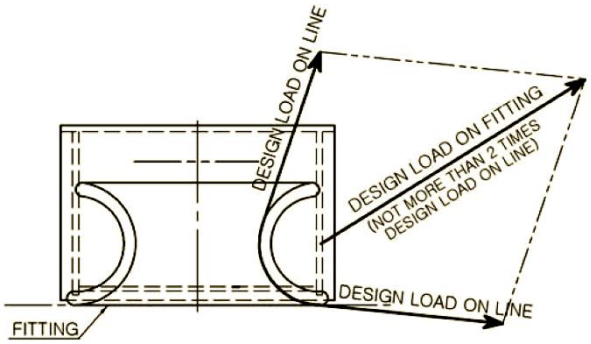

Fig. XV 25-~~1~~4
Design load

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