RUSSIAN MARITIME REGISTER OF SHIPPING

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ANNEXES

TO THE RULES

FOR THE CLASSIFICATION SURVEYS OF SHIPS IN SERVICE

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St. Petersburg

ANNEXES TO THE RULES FOR THE CLASSIFICATION SURVEYS OF SHIPS IN SERVICE

The present version of Annexes to the Rules for the Classification Surveys of Ships in Service has been approved in accordance with the established approval procedure and comes into force on 1 January 2024.

The present version is based on the version dated 15 September 2023 and Rule Change Notice No. 23-243764 taking into account the amendments and additions developed immediately before publication (refer to the Revision History).

REVISION HISTORY[1]

For this version, there are no amendments to be included in the Revision History.

[1] With the exception of amendments and additions introduced by Rule Change Notices (RCN), as well as of misprints and omissions.

ANNEX 1

TECHNICAL DOCUMENTATION ON ITEMS OF THE RS TECHNICAL SUPERVISION

The lists of ship's technical documentation given in Annexes 1.1 and 1.2 of this Annex, contain documents, as a rule, required for the ship, MODU or FOP in service in accordance with Section 6, Part I "General Provisions" of these Rules (including significant repair, conversion, modification or replacement of items of technical supervision).

To ensure safety of the ship and offshore installation in service, as well as for efficient execution of survey, assessment of technical condition, maintenance and repair on board the ship/offshore installation it is required to provide completeness of documentation as per Annexes 1.1 or 1.2 (as applicable) sufficient for the RS surveyor to confirm compliance with the applicable requirements of the RS rules.

As regards the ship's operational documentation, the minimum list of ship's operational documentation listed in Appendix 1 to Part II "Technical Documentation" of RTSCS (as applicable) shall be met.

ANNEX 1.1

LIST OF SHIP'S TECHNICAL DOCUMENTATION

1 SHIP'S GENERAL DOCUMENTATION:

1.1 ship specification (may be submitted in separate parts);

1.2 stability and subdivision calculations with verification of the compliance with the requirements of the Rules for the Classification and Construction of Sea-Going Ships (if requested by the surveyor);

1.3 freeboard calculation (if requested by the surveyor);

1.4 general arrangement plan;

1.5 lines drawing (if requested by the surveyor);

1.6 list of machinery and equipment installed on board with brief indication of their characteristics;

1.7 load line and draught mark drawing.

2 DOCUMENTATION ON SHIP HULL:

2.1 hull specification (may be submitted within the general ship specification, refer to 1.1 of this Annex);

2.2 determination of hull scantlings, longitudinal and local strength and allowable deck load calculations (if requested by the surveyor);

2.3 hull drawings:

2.3.1 midship section plan;

2.3.2 structural drawings (ship profile, decks and platforms, double bottom, superstructures and deckhouses);

2.3.3 shell expansion drawing (for reinforced plastic ships, only in case when shell plating has variable thickness);

2.3.4 transverse and longitudinal bulkhead drawings;

2.3.5 drawings of stems, propeller brackets and bossing;

2.3.6 drawings of main engine seatings and boiler bearings with bottom structure underneath;

2.3.7 structural drawing of foil arrangement and air cushion skirt;

2.3.8 drawings of ship ends.

For ships constructed in accordance with the IACS Common Structural Rules for Bulk Carriers and Oil Tankers (hereinafter referred to as "the **CSR** ships"), plans showing for each structural element both as-built and renewal thicknesses, and any thickness for "voluntary addition".

3 DOCUMENTATION ON SHIP EQUIPMENT AND OUTFIT:

3.1 specification on ship equipment and outfit (may be submitted within the general ship specification, refer to 1.1 of this Annex);

3.2 documentation on arrangement and closing appliances of openings in shell plating, decks, superstructures, deckhouses and bulkheads:

3.2.1 arrangement plan of openings in shell plating, decks, superstructures, deckhouses and bulkheads with indication of coaming heights and design of closing appliances, remote drives for closing appliances and drive control panels;

3.2.2 structural drawings of machinery casings, companionways, side ports, cargo hatches and watertight doors in bulkheads (may be submitted within the hull drawings, refer to 2.3 of this Annex);

3.2.3 strength calculation of closing appliances (if requested by the surveyor);

3.3 steering gear documentation:

3.3.1 steering gear arrangement plan;

3.3.2 drawings of rudder and its parts;

3.3.3 strength calculations of essential components of the rudder and gear (if requested by the surveyor);

3.4 documentation on anchor arrangement:

general arrangement plan of anchor arrangement;

3.5 documentation on mooring arrangement:

general arrangement plan of mooring arrangement;

3.6 documentation on towing arrangement:

general arrangement plan of towing arrangement;

3.7 documentation on masts and rigging:

mast drawings with specification of ropes and loose gear;

3.8 documentation on equipment of holds for bulk cargo separation:

structural drawing of shifting boards and feeders and their attachment to the ship structures;

3.9 documentation on crew and passenger protection:

general arrangement plans of gangways and under deck passages; hand rails on weather decks, platforms and gangways, grab rails and guard rails on deck timber cargo;

3.10 documentation on ship spaces (refer also to 3.12.2 of this Annex):

general arrangement plans of ship spaces and exits there from (may be shown on ship general arrangement plan, refer to Section 1 of this Annex;

3.11 documentation on securing devices for containers:

3.11.1 drawing of containers stowing and securing;

3.11.2 certificates issued by the Register or certificates issued by ACS — IACS member on loose securing devices for containers;

3.12 documentation on emergency outfit:

3.12.1 list of emergency outfit (may be included in the specification, refer to 3.1 of this Annex);

3.12.2 outfit arrangement plan with indication of emergency stations;

3.13 documentation on fire protection:

3.13.1 description of ship fire protection with indication of the materials used in ship spaces and information on their combustibility, closing appliances for openings in fire-resisting and fire-retarding divisions, closures of doors, casings, ventilation ducts, ring spaces of funnels, skylights and other openings in cargo, machinery and pump rooms as well as description of fire-fighting, fire alarm and detection systems (description may be included in the specification, refer to 3.1 of this Annex);

3.13.2 general arrangement plan of ship spaces with indication of fire-resisting and fire-retarding divisions, closures therein, fire control rooms and stations, escape routes and emergency exits; for passenger ships and ships assimilated to passenger ships main vertical zone subdivision drawings;

3.13.3 basic diagrams of fire-fighting systems;

3.13.4 basic diagrams of fire alarm and detection systems;

3.13.5 list of fire-fighting outfit and arrangement plan;

3.13.6 plans exhibited in the main fire control station, wheelhouse and in conspicuous places, refer to 1.4, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships.

4 DOCUMENTATION ON MACHINERY INSTALLATION:

4.1 machinery installation specification (may be submitted within the general ship specification, refer to 1.1 of this Annex);

4.2 general arrangement plans for machinery, boilers, heat exchangers and pressure vessels in machinery spaces and boiler rooms;

4.3 documentation on main and auxiliary machinery, gears and couplings:

descriptions of main and auxiliary machinery, gears and couplings with necessary manufacturer's structural drawings. Where the descriptions do not contain sufficient information, the following is required:

4.3.1 general view with sections;

4.3.2 drawings of crankshafts and cargo shafts, pinions and gears, reduction gears as well as driven and driving gears;

4.3.3 assembly drawings of turbine rotors, hydraulic drives, air chargers, pumps, etc.;

4.3.4 circuit diagrams of control, governing, monitoring, alarm and protection systems;

4.3.5 drawings of welded parts (engine frame, bed plates, housings and other parts) containing welding information;

4.3.6 strength calculations for essential parts (if requested by the surveyor);

4.3.7 torsional vibration calculations in the engine – power receiver system as well as results of torsional vibration metering in the engine – shafting – propeller system and conclusion on the results;

4.3.8 operational of documentation of main and auxiliary machinery (files, schedules of technical maintenance and repair) compiled on the basis of the manufacturers' recommendations, operation experience and the RS normative documents;

4.4 documentation on shafting and propeller:

4.4.1 shafting general arrangement plan;

4.4.2 drawings of sterntube, propeller, intermediate and thrust shafts;

4.4.3 propeller drawing;

4.4.4 CPP pitch control gear drawing;

4.4.5 CPP system diagrams;

4.5 documentation on steam boilers, heat exchangers and pressure vessels: structural drawings with sections;

4.6 documentation on systems and piping:

4.6.1 diagrams of piping systems;

4.6.2 bottom and side valves arrangement plan.

5 DOCUMENTATION ON REFRIGERATING PLANT:

5.1 specification for ship refrigerating plant (may be submitted within the general ship specification, refer to 1.1 of this Annex);

5.2 general arrangement plans of a refrigerating plant;

5.3 arrangement plans of equipment in the refrigerating machinery rooms with indication of escape routes;

5.4 arrangement plans of equipment in the refrigerated spaces and their insulation;

5.5 circuit diagrams of refrigerant, cooling medium, cooling water systems;

5.6 air cooling basic diagram;

5.7 basic diagram of telethermometer station and thermometer pipe arrangement;

5.8 general arrangement plan of cooling and freezing apparatus and their insulation;

5.8.1 for unclassed refrigerating plant documentation shall be submitted in the scope indicated in 5.2, 5.3 and 5.5 of this Annex;

5.8.2 documentation on compressors, pumps, fans and their prime movers, heat exchangers and other apparatus, pressure vessels, fittings, piping systems and electrical equipment shall be submitted in the scope indicated in Sections 4 and 6 of this Annex.

6 DOCUMENTATION ON ELECTRICAL EQUIPMENT:

6.1 specification on ship electrical equipment (may be submitted within the general ship specification, refer to 1.1 of this Annex);

6.2 general arrangement plans of essential electrical equipment and electric propulsion plant;

6.3 diagrams of power distribution from the main and emergency sources of electrical power: ship's mains, lighting (up to suction switch boards) and navigation lights;

6.4 diagrams of main and emergency switch boards and control desks;

6.5 detailed diagrams of the main current, excitation, pilot, signalling, protection and interlocking of the electric propulsion plant;

6.6 circuit diagrams of outer connections of ship control, telephone communication, general alarm system, fire detection and fire alarm system;

6.7 diagrams of essential electric drives;

6.8 diagrams of lubrication and cooling systems for main electric machines;

6.9 protective earthing diagrams, lightning conductor calculations for oil tankers, gas carriers, MODU and non-metal ships;

6.10 calculation of necessary output of ship's electric power plant providing the operating conditions of the ship (if requested by the surveyor).

7 DOCUMENTATION ON AUTOMATION SYSTEMS:

7.1 line and block diagrams of automation systems of equipment and machinery (control, signalling, automation and protection);

7.2 general arrangement plans of automation units, boards, monitoring and control panels, etc, as well as their location plans on board a ship;

7.3 mounting and structural drawings of automation systems and devices, sensors, alarm devices, instruments, as well as switchboards and desks of control and monitoring.

ANNEX 1.2

LIST OF TECHNICAL DOCUMENTATION OF MODU/FOP

1 GENERAL DOCUMENTATION OF MODU:

.1 general MODU specification (may be submitted in separate parts);

.2 calculations of stability, resistance to flooding and freeboard with verification of compliance with the requirements of the MODU/FOP Rules (at special request of the RS surveyor);

.3 general MODU arrangement plan;

.4 lines drawing;

.5 list of machinery and equipment installed on MODU with indication of their characteristics;

.6 load line and draught mark drawing;

.7 conclusion of competent bodies on MODU fire and explosion safety, related to the operation of drilling equipment.

2 MODU HULL:

2.1 MODU hull specification (may be submitted within the general MODU specification, refer to 1.1);

2.2 determination of hull members scantlings;

2.3 hull drawings:

.1 midship section;

.2 structural drawings (longitudinal profile, decks and platforms, double bottom, lower hulls (pontoons), stability columns, superstructures, deckhouses);

.3 shell expansion;

.4 transverse and longitudinal bulkheads;

.5 stems, propeller brackets and bossings;

.6 legs;

.7 jack houses;

.8 drilling derrick substructure with elements when stowed for transit;

.9 main machinery seatings and main diesel-generators.

3 MODU/FOP ARRANGEMENTS, EQUIPMENT AND OUTFIT:

3.1 specification on MODU/FOP arrangements, equipment and outfit (may be submitted within the general MODU/FOP specification, refer to 1.1);

3.2 plans of closing appliances of openings in MODU/FOP hull, superstructures and deckhouses:

.1 arrangement plan of openings in shell plating, superstructures and deckhouses of MODU/FOP, as well as in watertight bulkheads with indication of coaming height, drives for closing appliances and drive control stations;

.2 drawings of doors in watertight bulkheads;

.3 strength calculations of closing appliances (at special request of the RS surveyor);

3.3 drawings of rudder and steering gear;

.1 general rudder and steering gear arrangement;

.2 drawings of rudder plate ant its parts;

.3 strength calculations of essential components of the rudder and steering gear (at special request of the RS surveyor);

3.4 general arrangement of anchor arrangement;

3.5 systems used to maintain MODU/FOP at drilling/positioning site:

.1 general arrangement of positioning system;

.2 plans of anchor line and "chain-rope" connection design;

.3 strength calculations of anchor lines (at special request of the RS surveyor);

3.6 mooring and boarding arrangements of MODU:

.1 general arrangement of mooring and boarding arrangements;

.2 description of arrangements;

.3 plans of mooring platforms and embarkation ladders;

.4 strength calculations of mooring arrangements (at special request of the RS surveyor);

3.7 general arrangement of MODU mooring arrangement;

3.8 general arrangement of MODU towing arrangement;

3.9 jacking system for the hull of self-elevating MODU:

.1 general arrangement of the system;

.2 drawings of units and essential parts of the system;

.3 strength calculations of essential parts of the system;

3.10 arrangement for lifting and lowering columns of submersible sea water pumps:

.1 general arrangement of system;

.2 drawings of essential parts of the arrangement, specification of ropes;

.3 strength calculations of essential parts of the arrangement (at special request of the RS surveyor);

3.11 drawings of signal masts with specification of ropes and loose gear;

3.12 cargo handling gear;

.1 general arrangement of the gear;

.2 specification of cranes, hoists, winches and ropes;

3.13 crew protection:

.1 general arrangements of gangways, drilling floorings, guard rails on open decks, floors and bridges;

.2 drawings of rails;

3.14 MODU/FOP spaces:

.1 general arrangement of escape routes from spaces (may be shown on general MODU/FOP arrangement plans, refer to 1.7);

3.15 emergency outfit:

.1 list of emergency outfit items;

.2 emergency outfit arrangement plan with indication of emergency stations;

3.16 life-saving appliances:

.1 general arrangement of life-saving appliances;

.2 drawings of launching appliances with their rigging;

.3 strength calculations of launching appliances (at special request of the RS surveyor);

3.17 signal means:

.1 general arrangement of signal means with indication of their principal location.

4 MACHINERY INSTALLATION:

4.1 specification on machinery installation (may be submitted within the general MODU specification, refer to 1.1);

4.2 general arrangement of machinery, boilers, heat exchangers and pressure vessels in machinery spaces and boiler rooms;

4.3 general arrangement machinery and equipment in spaces for mud and cementing pumps, mud cleaning system and compressor station;

4.4 main and auxiliary machinery, gearing and couplings:

.1 general view with sections;

.2 drawings of crank and propeller shafts, pinions and gear wheels, reduction gears, as well as driving and driven elements of couplings;

.3 assembly drawings of hydraulic drives, air-charges, pumps, etc.;

.4 circuit diagrams of control, regulation, monitoring, alarm and protection systems;

.5 drawings of main control stations for remote control of jacking system of self-elevating MODU, principal diagrams of control units accompanied by description of working principles, interlocking, protection and alarm systems;

.6 drawings of welded parts (engine frame, bed plates, housings and other parts), containing welding data;

.7 strength calculations of essential parts (at special request of the RS surveyor);

.8 torsional vibration calculation in the "engine-power receiver" system, as well as torsiographing results of the "engine-shafting-propeller" system;

4.5 shafting and propeller:

.1 general shafting arrangement;

.2 drawings of sterntube arrangement, propeller, intermediate and thrust shafts;

.3 propeller drawing;

.4 CPP pitch control gear drawing;

.5 CPP systems diagrams;

4.6 steam boilers, heat exchangers and pressure vessels:

.1 structural drawings with sections;

.2 strength calculations;

4.7 systems and piping:

.1 diagrams of systems and piping subject to the Register technical supervision;

.2 bottom and side fittings arrangement plan.

5 REFRIGERATING PLANT:

5.1 general arrangement plan of MODU refrigerating plant;

5.2 arrangement plan of equipment in refrigerating machinery spaces with indication of escape routes;

5.3 basic diagrams of refrigerant, liquid cooling medium and cooling water systems.

6 ELECTRICAL EQUIPMENT:

6.1 specification on MODU electrical equipment (may be submitted within the general MODU specification, refer to 1.1);

6.2 general arrangement plans of electrical equipment for essential electrical equipment and electric propulsion plant;

6.3 circuit diagrams of electrical power distribution from main and emergency sources of power circuits, lighting circuits (from section switchboards) and navigation lights circuits;

6.4 circuit diagrams of main and emergency switchboards and control stations;

6.5 circuit diagrams of main current, excitation, control, monitoring, alarm, protection and interlocking of the electric propulsion plant;

6.6 circuit diagrams of control, interlocking, protection and alarm systems of electrical drives of jacking system of self-elevating MODU, machinery for lifting and lowering submersible sea water pumps, as well as electrical drives of submersible sea water pumps;

6.7 description of principle of operation and main technical characteristics of electrical drives of jacking system of self-elevating MODU, control, interlocking, alarm and protection systems;

6.8 circuit diagrams of outer connection of MODU control, telephone communication, general alarm and fire alarm devices; alarm to indicate malfunction of jacking system of self-elevating MODU, positions of remotely controlled valves in MODU flooding and draining system, monitoring system of liquid level in tanks, bilges, etc., malfunction of ventilation system for hazardous spaces, monitoring system of air pressure in blown-through electrical equipment;

6.9 circuit diagrams of electrical drive of rudder and steering gear, electrical systems for remote control of electric steering gear, protection and alarm;

6.10 diagrams of lubrication and cooling systems of main electrical machines;

6.11 remote control diagram of valves of MODU flooding and draining system;

6.12 circuit connection diagram of emergency selective de-energizing of consumers;

6.13 circuit connection diagram of gas detection and alarm system devices;

6.14 power supply diagram of electrical systems of drilling equipment;

6.15 arrangement plans of all electrical equipment and cabling in hazardous spaces and areas;

6.16 required power calculations to provide all MODU operating conditions, including emergency source of electrical power (at special request of the RS surveyor).

7 RADIO EQUIPMENT:

7.1 specification on MODU radio equipment (may be submitted within the general MODU specification, refer to 1.1);

7.2 connection diagram of radio equipment and commutation of aerials (with indication of types and cross-sectional areas of cables as well as protective means from radio interference);

7.3 drawings and diagrams of radio equipment for lifeboats (capsules);

7.4 arrangement plans of aerials (plan and side view) in spaces containing radio equipment (with indication of heating appliances, ventilation, communication, alarm and lighting facilities);

7.5 arrangement plans of aerials (plan and side view) indicating spaces containing radio equipment and accommodation spaces of radio officer and radio operators;

7.6 calculation of range of main and reserve transmitters (at special request of the RS surveyor);

7.7 calculation of accumulator battery capacity of reserve radio communication facilities (at special request of the RS surveyor);

7.8 descriptions, circuit diagrams, photos and test records of radio equipment having no approval by the Register.

8 AUTOMATION:

8.1 line and block diagrams of automation equipment and machinery (control, alarm, automation and protection systems);

8.2 general arrangement plans of automation devices (units), boards, monitoring and control panels, etc.;

8.3 structural drawings of units of automation systems and devices, sensors, alarms, indicators as well as monitoring and control boards and panels.

ANNEX 2

INSTRUCTIONS FOR DETERMINATION OF THE TECHNICAL CONDITION AND REPAIR OF THE HULLS OF SEA-GOING SHIPS

1 PURPOSE

1.1 APPLICATION

1.1.1 The Instructions for Determination of the Technical Condition and Repair of the Hulls of Sea-Going Ships[1] contain regulations for determining the technical condition and recommendations for repairing the hulls of displacement ships in service that are subject to the technical supervision of the Register. For ships built under the IACS Common Structural Rules, permissible wear limits shall be only in accordance with the IACS Common Structural Rules (depending on which IACS Common Structural Rules are applied based on the date of build of the ship).

The requirements of the Instructions apply to the hulls, superstructures and deckhouses of steel ships and made of aluminium alloys.

The Instructions apply to ships whose purpose, dimensions and design are covered by the Rules for Construction. For ships for which the reduced as-built scantlings have been approved by the Register in accordance with the Rules for Construction, the permissible residual scantlings shall be calculated based on the scantlings determined in accordance with the Rules for Construction for a 25-year ship service life. The provisions of these Instructions shall not apply to small vessels.

For polar class ships, permissible wear limits for hull structures in the regions of ice-strengthening including plated elements, girder webs and face plates shall be in compliance with the requirements of Section 1, Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships" of the Rules for the Classification and Construction of Sea-Going Ships, for example, refer to 1.2.11.

1.1.2 The provisions of the Instructions are based on the condition of ensuring safe hull operation during 5 years between special surveys.

1.1.3 The Instructions have supplemented these Rules and the Guidelines on Technical Supervision of Ships in Service.

1.1.4 The application of the Instructions is mandatory when determining the technical condition of the ship's hull.

1.1.5 The application of the Instructions is recommended when carrying out the hull repair.

1.1.6 The provisions of the Instructions cover the following hull structural defects:

wear;

residual deformations;

cracks.

1.1.6.1 The Instructions contain the definitions of the following types of wear:

total wear;

local wear;

pitting.

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[1] Hereinafter referred to as "the Instructions".

The Instructions contain the definitions of the following types of local wear:
spot wear;
linear wear;
groove wear.

1.1.6.2 The Instructions contain the definitions of the following types of residual deformations:
deflections;
ribs;
indentations;
bulges.

1.1.6.3 The provisions of the Instructions apply to fatigue cracks and fractures.

1.1.7 In some cases, when substantiations approved by the Register are available, departures from the provisions of the Instructions are permissible.

1.2 DEFINITIONS

1.2.1 Definitions not included in this Chapter are given in Chapter 2.1 of Part I "General Provisions" of the Rules for the Classification Surveys of Ships in Service[1]. For the purpose of the Instructions, the following definitions have been adopted.

Framing member is a member of primary or deep framing.

Deflection is a residual deformation of plating portion between adjacent non-deformed framing (girders) (refer to Fig. 1.2.1-1).

Indentation (set-in, set-down, set-up, set-back) is a residual deformation of plating portion together with framing (girders) (refer to Fig. 1.2.1-1).

Bulge is a residual deformation of framing (girder) web or portion of the strengthening plate element in way of indentation (refer to Fig. 1.2.1-1).

Rib is a residual deformation of two and more adjacent plating portions between framing (girders) (refer to Fig. 1.2.1-1).

Group of structural members is a set of hull members designed to perform the same functions and used under equal conditions as other group members (e.g., deck plates, bottom plates with bilge, side shell plating, longitudinal bulkheads, deck longitudinals of the same profile, etc.), framing members may be grouped irrespective of plate elements or included into the relevant group together with plate members.

Defect is a member thickness variation (wear), an initial shape deformation (residual deformation), loss of integrity (crack, fracture and rupture) of the hull structure due to wear, damage or procedural violations during shipbuilding and ship repair works relating to the hull.

Flaw detection is a process of identifying and quantitative evaluation (sizing) of defects in the hull or hull members, which shall be determined instrumentally and the defect parameters shall be recorded.

Residual deformation is a change in the initial form of the hull or hull member that remains after removal of loads causing the deformation.

Wear is a diminution of hull member thickness due to corrosion, erosion and/or abrasion.

Groove wear is a groove-shaped reduction of plate or hull member thickness (refer to Fig. 1.2.1-2). An example of grooving corrosion is shown in Fig.1.2.1-4.

Linear wear is a plate thickness reduction on the narrow length of welds, by which hull members are attached (refer to Fig. 1.2.1-2).

Local wear is a local reduction in the thickness of hull members (plate sections) in the form of groove, linear and spot wear.

Total wear is an approximately equal diminution of hull member thickness over their entire surface, determined by a sum of measurements at various points of the hull member, except for sections with pitting (refer to Fig. 1.2.1-2).

Spot wear is a local thickness diminution of part of the plate (refer to Fig. 1.2.1-2) or portion of framing (girder) web as separate spots.

Pitting is a local hull member thickness reduction in the form of separate recesses, rustings, pits, cavities, etc. (refer to Fig. 1.2.1-2). Pitting intensity is defined as shown in Fig.1.2.1-3.

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[1] Hereinafter referred to as "these Rules".

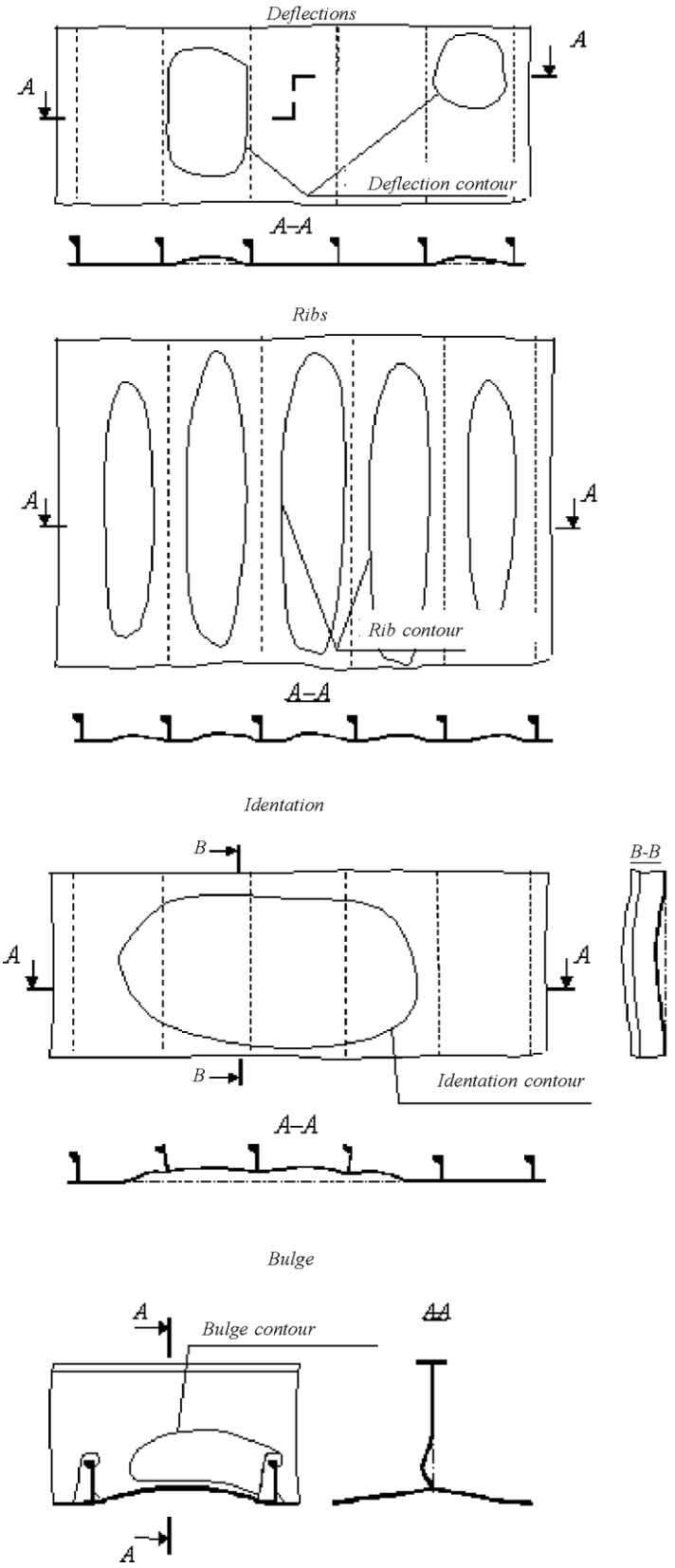


Fig. 1.2.1-1
Types of residual deformations

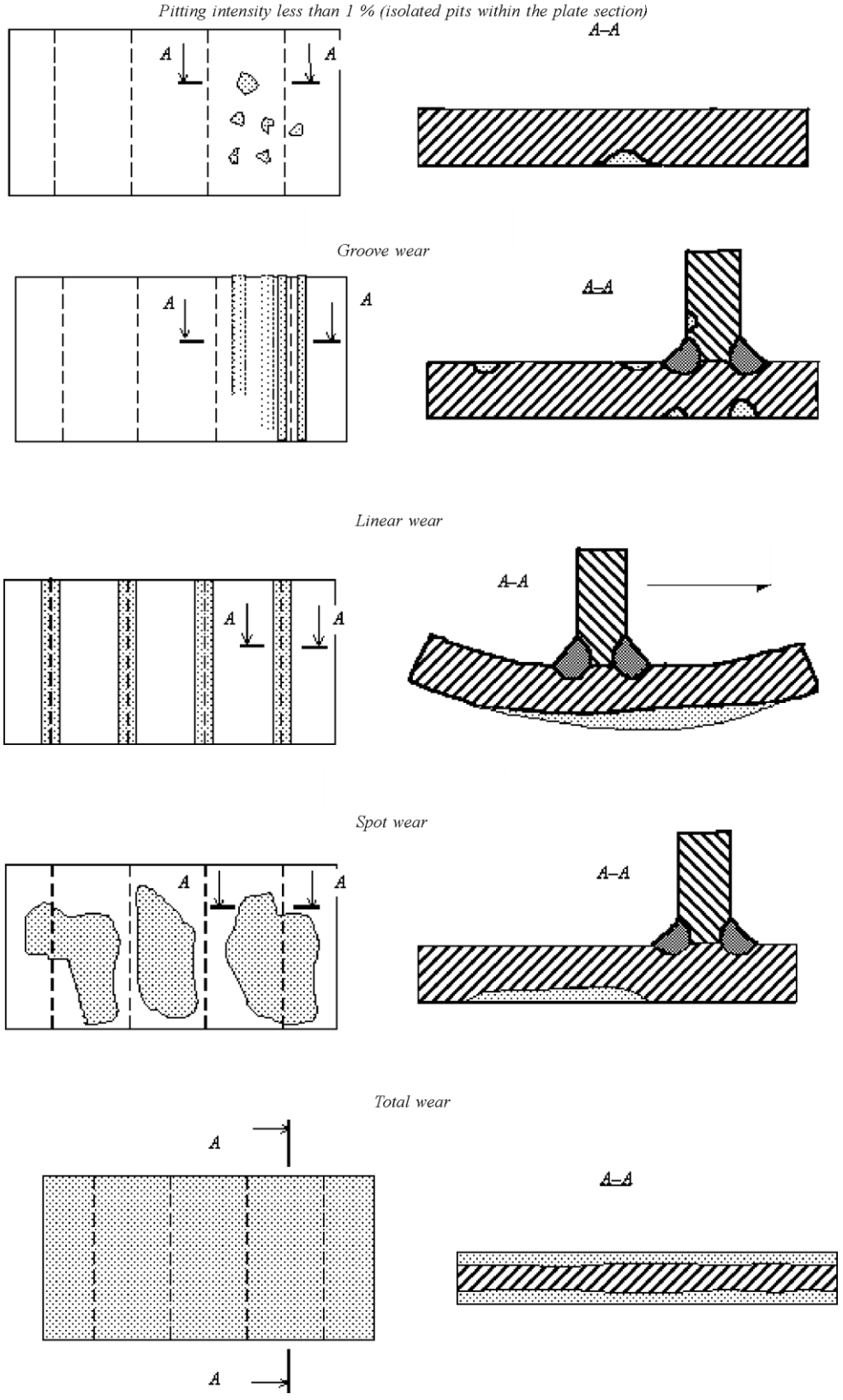


Fig. 1.2.1-2
Types of wear

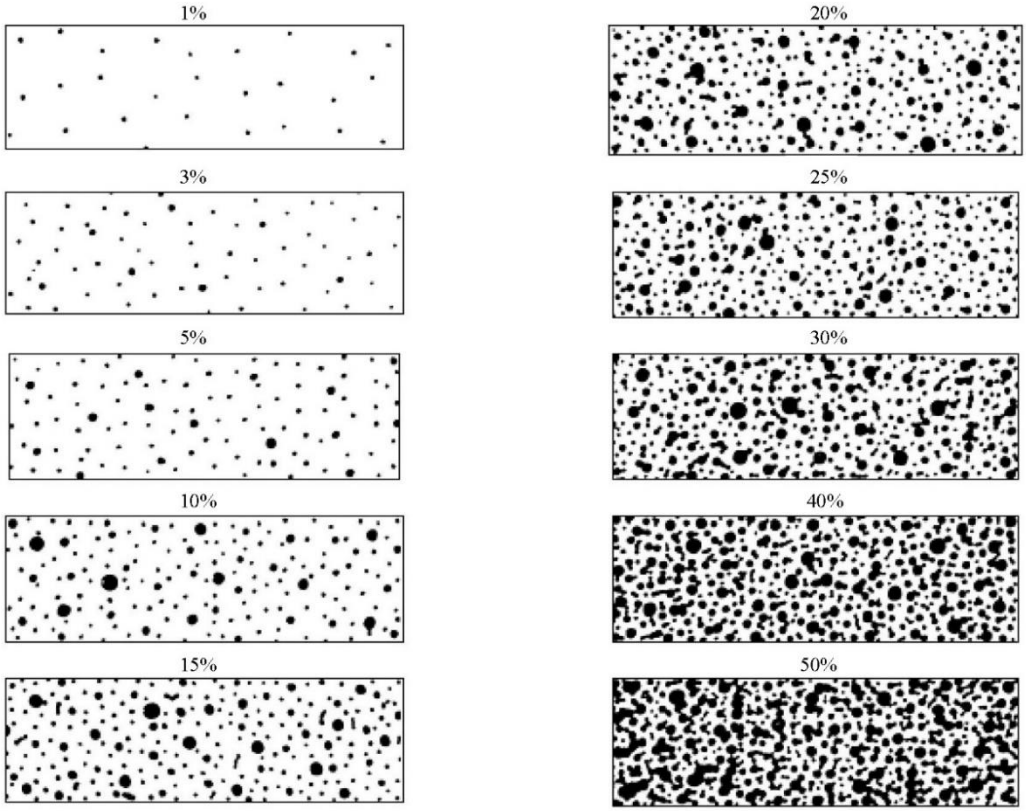


Fig. 1.2.1-3
Pitting intensity (area) of the plate (from 1 % to 50 %)

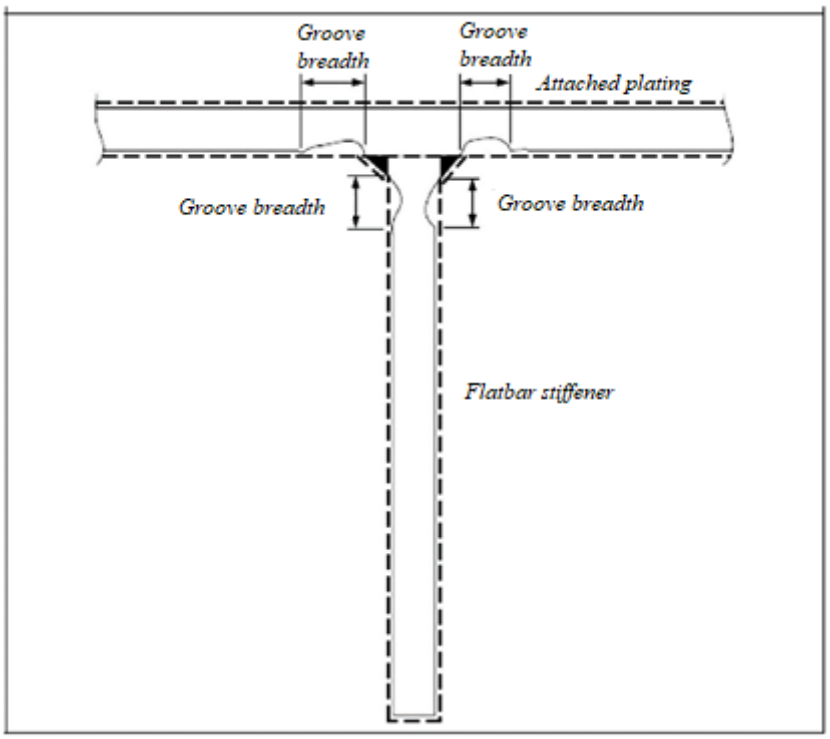


Fig. 1.2.1-4
Grooving corrosion

Intensive wear is an extent of corrosion consisting of hard and/or loose scale (corrosion products), including pitting, over 70 % of the area under consideration, accompanied by evidence of thickness diminution.

Edge corrosion is defined as local corrosion at the free edges of plates, stiffeners, primary support members and around openings. An example of edge corrosion is shown in Fig. 1.2.1-5.

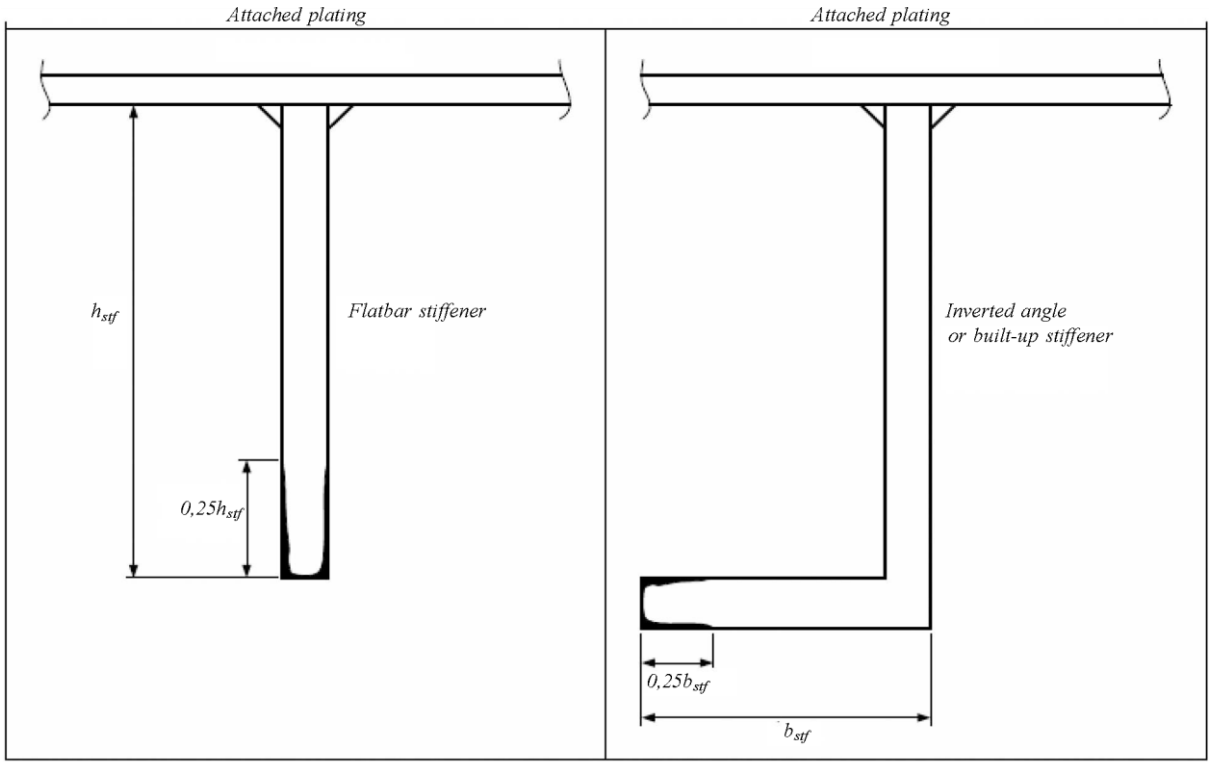


Fig. 1.2.1-5
Edge corrosion

Plate is a plating element limited by the welds.

Uniform plates are the plates of plating related to one of the following groups:

deck plating between the side and the line of large openings;

inner bottom plating;

bottom plating including the bilge;

side shell plating;

inner side plating;

plating of longitudinal bulkheads;

continuous side coamings amidships, etc.

Ship's ends are portions of the ship's length beyond the midship region.

Damage is a defect, which parameters are not in agreement with standards.

Local strengthening is a stiffener, knee or bracket ensuring the strength, rigidity and stability of a plate section or web frame/girder web, as well as a stanchion of double bottom, double side, tank, etc.

Rupture is a fracture type discontinuity of a hull member as a result of external actions and due to depletion of the material plasticity.

Strengthening area is a hull area, for which additional strengthening of structures is stipulated by the Rules for Construction, e.g. ice strengthening.

Midship region is the part of the ship's length equal to 0,4*L* (0,2*L* forward and aft of amidships), unless expressly provided otherwise.

Measuring device is a facility for measuring the parameters of defects, which has standardized metrological properties.

Higher strength steel is the steel with yield strength exceeding 235 MPa.

Camber (deflection) is the distance between the point on the surface of the deformed member and the same point on the surface of the same figuratively non-deformed member.

Average (mean) residual thickness is a thickness defined as a mean thickness from a series of measurements of the actual residual thickness of the member.

As-built thickness is a thickness stated in the hull report (as-built) drawings.

Required thickness is a thickness required by the Rules for Construction.

Crack is a fracture type discontinuity of a hull member caused by material fatigue or brittle fracture.

Excessive wear is an extent of corrosion that exceeds the allowable limit.

Hull member is a plate, framing (girder), web and face plate of framing (girder), weld, riveted connection, connecting element, local strengthening (reinforcement).

Connecting element is a knee, bracket, liming, plate, etc., which ensure the connection of hull members.

Plate section is a portion of the plate surface limited by adjacent framing (girders) or hull structures walls.

1.3 ABBRIVIATIONS

TM software — a software "OCEAN" developed by RS and intended for recording thickness measurements as well as collection, storage and assessment of defects parameters of ship's hull structures, ship's arrangements and pipelines (i.e. wear, deformations, cracks etc.).

CSR ships — ships built under the IACS Common Structural Rules.

Abbreviations not listed in this Chapter are specified in the Rules for Construction, these Rules.

1.4 SYMBOLS

X, Y are locations of measurements in figures.

2 INSTRUCTIONS ON ASSESSMENT OF THE HULL TECHNICAL CONDITION

2.1 GENERAL

2.1.1 This Section provides guidance for assessing the technical condition of the hull and its members based on the defects found during the ship survey.

2.1.2 The hull technical condition is the complex of parameters, on which the strength, rigidity and integrity of the hull depend and which vary because of defects originating and developing during the ship service.

2.1.3 Assessment of the hull technical condition shall be carried out based on the results of comparison between actual parameters of the defects found and their permissible values. Parameters of defects shall be determined in compliance with the requirements of Section 3 of this Annex. Standards for hull members with defects shall be determined in compliance with the requirements of Section 4 of this Annex considering the requirements of Section 5, Part I "General Provisions" of these Rules.

Technical conditions of the hull are established as follows:

.1 "complying with the RS requirements" (hereinafter referred to as "complying") denotes the ship hull, the numeric parameters of which members are, in complex, in compliance with the standards applicable to the ship current class;

.2 "not complying with the RS requirements" (hereinafter referred to as "not complying") denotes the ship hull, the numeric parameters of which members are not in compliance with the standards established for its current class.

Hull members that are not in compliance with standards shall be repaired. When carrying out the repair, the provisions of Section 5 shall be met.

2.1.4 Assessment of the hull technical condition is carried out periodically within periods and in the scope set down by these Rules.

2.1.5 Assessment of technical condition of hull members with defects and verification of the hull cross-sectional characteristics in compliance with the requirements of 2.2 — 2.4.

The conditions of 2.2 — 2.4 were formulated for the "complying" technical condition based on the standards established according to Section 4.

2.1.6 The results of the ship's hull technical condition assessment shall be drawn up by the shipowner or authorized shipowner's representative in the form of set of records listed below:

report(s) on gauging of the hull defects parameters drawn up in accordance with Section 6 of this Annex (total, local wear and pitting of hull structures and other hull members, wear of welds and riveted joints, connecting elements and local strengthening, residual deformations, hull cracks, etc.);

verification of the hull cross-sectional (transvers sectional) characteristics and/or evaluation of the loss in cross-sectional (transvers sectional) area of the strength deck outside the line of hatch openings and/or bottom shell plating including the bilge, if required according to 2.2.1. If necessary, hull structural drawings and lines plan or their copies shall be enclosed;

verification of the hull cross-sectional (transvers sectional) characteristics after renewal (replacement) or strengthening (reinforcement) of structural members if required as a result of initial verification.

2.1.7 Verification of the hull girder section modulus/ultimate section modulus shall be carried out by using the thickness measured, renewed or reinforced, as appropriate. The welds between longitudinal internal members and hull envelopes (shell plating) shall be in sound condition so as to keep integrity of longitudinal internal members and hull envelopes.

2.1.8 Conclusion on the hull technical condition shall be recorded by the RS surveyor performing the ship survey in the Survey checklist (form 6.1.01) or, where applicable, in the reports (form 6.3.7 or 6.3.12, or 6.3.10/K). Based on the results of gauging of defect parameters, completion of repairs to the extent required shall be confirmed in the RS reports issued upon the survey results. The RS surveyor shall list in the reports all the hull structures repaired with their designation and location, repair method (complete or partial replacement, strengthening, etc.), including the steel grade and dimensions of the replaced hull members, relevant sketches/photos, repair extent, results of non-destructive testing (NDT) and tests performed.

Information on available doublers, doubling straps, where fitted, shall be recorded in the List of Survey's Status indicating their location and dimensions with reference to the RS reporting document by which this installation was agreed upon. The information on defects (residual deformations of hull members) not exceeding the permissible limits shall be recorded in the List of Survey's Status indicating their location and dimensions, or the reference may be made to the Report on Technical Condition Assessment of the Ship's Hull/RS report.

2.1.9 When ship′s hull structures failures is found RS surveyor is to draw up the document "Report on Hull Failure Incidents and Repair" (form 6.3.64) and send it to RHO in accordance with the IACS Early Warning Scheme.

2.1.10 The set of records on the hull technical condition, as required by the Instructions and the rules for surveys, shall be kept on board, by the shipowner and at the RS Branch Office where the ship is registered.

2.2 STRUCTURES WITH WEAR

2.2.1 Hull cross-sectional characteristics.

2.2.1.1 For ships:

of unrestricted areas of navigation and restricted areas of navigation **R1** and **R2**, of 65 m in length and above; and

restricted area of navigation **R2**, **R2-RSN(4,5)**, **R3-RSN** and **R3**, of 60 m in length and above;

verification of the hull cross-sectional (transverse sectional) characteristics is carried out in accordance with Table 2.2.1.1.

Table 2.2.1.1

	Evaluation of the loss in cross-sectional (transvers sectional) area* of the strength deck outside the line of hatch openings with continuous side coaming and/or bottom shell plating including the bilge with longitudinal framing or without it	Verification of the hull cross-sectional (transvers sectional) area* amidships (midship region) and outside of amidships where the design was modified or steel grades other than those specified were used, in accordance with 2.2.1.2	Verification of the hull girder ultimate strength*, in accordance with 2.2.1.3
Ships built according to the Rules for Construction	Required**	Required if the residual cross-sectional area (column 2) is less than 90 % of the as-built area	—
Ships built according to the rules of Russian River Register/Russian Classification Society (RCS)	—	Required at any wear degree	Required at any wear degree
Ships transferred into the RS class from ACS — IACS member	According to the losing society standards***	According to the losing society standards***	According to the losing society standards***
Ships transferred into the RS class from ACS — non-IACS member or accepted into the RS class as non-classed ships	—	Required at any wear degree	—

* Verification of the hull cross-sectional (transverse sectional) characteristics is carried out at each special survey starting from the second one, by using the thickness measured, renewed or reinforced, as appropriate. The verification of the hull cross-sectional characteristics may be required, as deemed necessary by the RS surveyor, at annual/intermediate/occasional survey of ships over 10 years of age, if suspect areas, residual deformations have been found on the deck and/or bottom shell plating including the bilge, that may affect the hull cross-sectional characteristics.

** For ships built according to the Rules for Construction, the allowable diminution of the transverse sectional (cross-sectional) areas of deck and bottom with bilge shall be established equal to and less than 10 % of the as-built area.

*** Evaluation of longitudinal strength of the hull shall be carried out according to the losing society standards when a decision on their application has been made by the Register and the relevant standards are stated in the ship's file. If permissible residual scantlings of hull members are applied to the ship based on the calculation agreed with the Register and performed in accordance with the Rules for Construction, the allowable diminution of transverse sectional (cross-sectional) areas of deck and bottom with bilge and hull girder section modulus shall be established equal to and less than 10 % of the as-built area/modulus. With regard to verification of such hull section modulus, its necessity shall be defined based on additional instructions related to this verification available in the rules of the losing society, or if the permissible residual scantlings of hull members are applied to the ship, which are determined in accordance with the Rules for Construction, and if the ship has been built to the Russian River Register/Russian Classification Society (RCS) class.

2.2.1.2 The hull cross-sectional area amidships, and outside of amidships where the design was modified or materials other than those specified were used, shall meet the following condition:

$$W'_{d(b)} \geq [W_{d(b)}] \qquad (2.2.1.2)$$

where $W'_{d(b)}$ = residual hull section modulus determined in accordance with 3.2.2.1 — 3.2.2.2;

$[W_{d(b)}]$ = permissible residual hull section modulus determined in accordance with 4.2.1.1.

2.2.1.3 For ships specified in 2.2.1.1 of this Annex, built in compliance with the rules of Russian River Register/RCS, additionally, the verification of the hull section ultimate bending moment or ultimate section modulus shall be performed in accordance with the conditions (2.2.1.3-1) or (2.2.1.3-2) accordingly:

$$M''_{sag(hog)} \geq M_{ult} \qquad (2.2.1.3\text{-}1)$$

where $M''_{sag(hog)}$ = ultimate hull section bending moment (disregarding the sign) in case of sagging, hogging determined in accordance with 3.2.2.3 and 3.3.2.2;
M_{ult} = required ultimate hull section bending moment determined in accordance with 4.2.1.2.

$$W''_{d(b)} \geq [W^d_{d(b)}] \qquad (2.2.1.3\text{-}2)$$

where $W''_{d(b)}$ = residual ultimate hull section modulus determined in accordance with 3.2.2.3 and 3.3.2.2;
$[W^d_{d(b)}]$ = permissible ultimate residual hull section modulus determined in accordance with 4.2.1.2.

Such verification of the hull cross-sectional characteristics shall be performed at each special survey starting from the second one.

2.2.1.4 For single-sided bulk carriers with side doors and shell doors, the following condition shall be met additionally:

$$S'_{s(b)} \geq [S_{s(b)}] \qquad (2.2.1.4)$$

where $S'_{s(b)}$ = residual thickness of side shell plating, inner side, longitudinal bulkheads of section in question, as determined in accordance with 3.2.2.4;
$[S_{s(b)}]$ = permissible residual thickness of side shell plating, inner side, longitudinal bulkheads, as determined in accordance with 4.2.1.3.

2.2.2 Plates.

2.2.2.1 In case of total wear, a plate shall meet the condition

$$S'_1 \geq [S_1] \qquad (2.2.2.1)$$

where S'_1 = average residual plate thickness in accordance with 3.2.3.1.
$[S_1]$ = permissible residual plate thickness in accordance with 4.2.2.1.

2.2.2.2 In case of local wear, a plate area shall meet the condition

$$S'_3 \geq [S_3] \qquad (2.2.2.2)$$

where S'_3 = average residual plate area thickness in accordance with 3.2.3.2;
$[S_3]$ = permissible residual plate area thickness in accordance with 4.2.2.2.

2.2.2.3 In case of pitting, a plate shall meet the condition

$$S'_4 \geq [S_4] \qquad (2.2.2.3)$$

where S'_4 = residual plate thickness in the pit in accordance with 3.2.3.3;
$[S_4]$ = permissible residual plate thickness in the pit in accordance with 4.2.2.3.

2.2.3 Girders.

2.2.3.1 In case of total wear, a girder cross section shall meet the conditions:

$$W_1' \geq [W_1];$$

$$F_1' \geq [F_1]; \qquad (2.2.3.1)$$

$$S_1' \geq [S_1]$$

where W_1', F_1', S_1' = residual cross-section modulus with effective flange, residual web cross-sectional area and residual average girder web thickness in accordance with 3.2.4.1 of this Annex;

$[W_1], [F_1], [S_1]$ = permissible residual section modulus, permissible residual web cross-sectional area and permissible residual girder web thickness in accordance with 4.2.3.1 — 4.2.3.3 of this Annex.

Only those characteristics of hull girder cross-section shall be verified according to Formula (2.2.3.1), that are covered by the requirements of the Rules for Construction.

During evaluation of allowable wear, the permissible residual thickness of a girder member $[S_1]$ shall be determined. The permissible residual thickness of a girder member shall not be less than the thickness at which the conditions for permissible residual girder section modulus $[W_1]$ and/or permissible residual web cross-sectional area $[F_1]$ (depending on what is regulated by the Rules for Construction) are met, and the permissible residual face plate thickness shall not be less than the thickness at which the condition for permissible residual girder section modulus $[W_1]$ is met.

2.2.3.2 In case of local wear, a girder member area shall meet the condition

$$S_3' \geq [S_3] \qquad (2.2.3.2)$$

where S_3' = average residual girder member area thickness in accordance with 3.2.4.2;

$[S_3]$ = permissible residual girder member area thickness in accordance with 4.2.3.4.

2.2.3.3 In case of pitting, a girder member shall meet the condition

$$S_4' \geq [S_4] \qquad (2.2.3.3)$$

where S_4' = residual girder member thickness in the pit in accordance with 3.2.4.3;

$[S_4]$ = permissible residual girder member thickness in the pit in accordance with 4.2.3.5.

The present provision applies only to those girders, which ensure structural integrity, for instance, the integrity of floors, stringers, beams, which are the upper supports of corrugated transverse tight bulkheads, etc.

2.2.4 Welded and riveted joints.

2.2.4.1 When worn on lengths exceeding 0,3 m, welds, which condition shall be assessed on the basis of 3.2.5.1, shall comply with the provisions of 4.2.4.1.

2.2.4.2 When worn on lengths between 0,1 m and 0,3 m, welds shall comply with the condition

$$S_3' \geq [S_3] \qquad (2.2.4.2)$$

where S_3' = average residual weld thickness in accordance with 3.2.5.2;

$[S_3]$ = permissible residual weld thickness in accordance with 4.2.4.2.

2.2.4.3 When worn on lengths below 0,1 m, welds shall comply with the condition

$$S_4' \geq [S_4] \qquad (2.2.4.3)$$

where S_4' = residual weld thickness in accordance with 3.2.5.3;
$[S_4]$ = permissible residual weld thickness in accordance with 4.2.4.3.

2.2.4.4 Worn riveted joints, which condition shall be assessed on the basis of 3.2.5.4, shall comply with the provisions of 4.2.4.4. The joints shall be tight in structures, where it is necessary.

2.2.5 Connecting elements and local strengthening.

2.2.5.1 In case of total wear, the connecting elements, which condition shall be assessed on the basis of 3.2.6, shall comply with the relevant provisions of the Instructions for girders strengthened by them.

The local wear and pitting of connecting elements are not regulated.

2.2.5.2 In case of total wear, the local strengthening shall comply with the condition

$$S_1' \geq [S_1] \qquad (2.2.5.2)$$

where S_1' = average residual thickness of local strengthening in accordance with 3.2.6;
$[S_1]$ = permissible residual thickness of local strengthening in accordance with 4.2.5.

The local wear and pitting of local strengthening are not regulated.

2.2.6 Particular hull structures.

In bulk carriers of 150 m in length and above, which carry bulk cargoes having a density of 1,78 t/m^3 and above, the members of the transverse watertight vertically corrugated bulkhead fitted between cargo holds Nos. 1 and 2, and the double bottom members in cargo hold No. 1 shall comply with the requirements of 5.9 and 5.10, Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules. Surveys of bulk carriers for compliance with the above requirements shall be carried out simultaneously with the survey of their damage stability for compliance with the requirements of 5.11.2 of the above Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" within the terms stipulated in 5.11.1 of the same Part. Compliance with the above requirements ensures simultaneous compliance with the requirements of regulations XII/4 and XII/6 of SOLAS 74/78.

2.2.7 For ships of aluminium alloys hull structure scantlings shall be determined based on the calculation of overall and local strength taking into consideration the requirements of 2.2, 3.2 and 4.2 of these Instructions, where applicable, as well as Sections 2 and 5 of Part II "Hull Structure and Strength" of the Rules for the Classification and Construction of High-Speed Craft.

2.3 STRUCTURES WITH DEFORMATIONS

2.3.1 Hull cross-sectional characteristics.

2.3.1.1 In ships of 65 m in length and above, the strength deck and bottom with residual deformations of hull cross section amidships, as well as outside of amidships where the design was modified or materials other than those specified were used, shall meet the condition

$$\sum_{i=1}^{n} l_{i_{b(d)}} \leq \left[\sum_{i=1}^{n} l_{i_{b(d)}}\right] \qquad (2.3.1.1)$$

where $l_{i_{b(d)}}$ = length of i-the deflection, rib, indentation within the deck and bottom cross section;

$\sum_{i=1}^{n} l_{i_{b(d)}}$ = total length of deflections, ribs and indentations within the deck and bottom cross section in accordance with 3.3.2.1;

$\left[\sum_{i=1}^{n} l_{i_{b(d)}}\right]$ = permissible total length of deflections, ribs and indentations within the deck and bottom cross-section in accordance with 4.3.1.

2.3.1.2 Deformations of the continuous side coaming are not permitted, amidships, the ships with a length of 65 m and above.

2.3.1.3 For ships specified in 2.2.1.1 of this Chapter built in compliance with rules of Russian River Register, as well as for ships, which bottom or strength deck is transversely framed, the condition stipulated in 2.2.1.3 of this Chapter shall be additionally met, if there are deflections, ribs or indentations in the deck cross section outside the line of hatch openings or bottom amidships.

2.3.2 Deflections and ribs.

2.3.2.1 Structures containing deflections or ribs with the maximum camber of 25 mm and less, or 1/20 of spacing, whichever is less, need no further measurement, assessment or repair.

On agreement with the Register, particular deflections and ribs with the maximum camber, exceeding 25 mm may be left unattended until the next intermediate or special survey.

2.3.2.2 When examined on both sides, structures containing deflections, except for deck stringer, sheer strake and bottom shell plating amidships, may not be measured or repaired in the absence of cracks or ruptures.

2.3.2.3 When examined on one side, structures containing deflections, as well as the strength deck outside the line of hatch openings, sheer strake and bottom shell plating containing deflections amidships shall meet the condition

$$f'/b' \leq [f/b] \qquad (2.3.2.3)$$

where f' = maximum deflection camber in accordance with 3.3.3.1;

b' = minimum projected size of deflection in accordance with 3.3.3.2;

$[f/b]$ = permissible relative camber in accordance with 4.3.2.1.

2.3.2.4 Ribbed structures shall meet the condition

$$f'/a \leq [f/a] \qquad (2.3.2.4)$$

where f' = maximum rib camber in accordance with 3.3.3.3;

a = girder spacing in accordance with 3.3.3.4;

$[f/a]$ = permissible relative camber in accordance with 4.3.2.2.

2.3.3 Indentations and bulges.

2.3.3.1 Structures with indentations having the maximum girder camber of 25 mm and less need no further measurement, assessment or repair.

On agreement with the Register, particular indentations with the maximum girder camber exceeding 25 mm may be left unattended until the next intermediate or special survey.

2.3.3.2 In the bottom and strength deck amidships, as well as in the sheer strake, single smooth indentations are permissible, which maximum projected size would not exceed five spacing and for which the maximum residual girder camber to the minimum size ratio would not exceed 1/20.

2.3.3.3 In the absence of a bulge, the girders shall simultaneously meet the following conditions:

$$f'/l' \le [f/l];$$

$$d'/h \le [d/h]; \qquad (2.3.3.3\text{-}1)$$

$$f'/c' \le [f/c]$$

where f' = maximum girder camber in accordance with 3.3.4.2;
l' = length of deformed girder area in accordance with 3.3.4.2;
d' = girder web deviation from the initial position in accordance with 3.3.4.3;
h = girder depth in accordance with 3.3.4.4;
c' = distance between the girder camber with maximum section and its nearest undeformed support in accordance with 3.3.4.5;
$[f/l]$ = permissible relative girder camber in accordance with 4.3.3.1;
$[d/h]$ = permissible relative girder web deviation in accordance with 4.3.3.1;
$[f/c]$ = permissible relative position of girder camber maximum in accordance with 4.3.3.1.

Compliance with the last condition mentioned in Formula (2.3.3.3-1) may not be verified in the following cases: girder is deformed together with the support; indented area of structure does not reach as for as the support; less than five successive girders are deformed in way of indentations.

Girders, which do not comply with the first of conditions of Formula (2.3.3.3-1), and which relative camber lies within

$$[f/l] < f'/l' < 1{,}5[f/l] \qquad (2.3.3.3\text{-}2)$$

shall comply additionally with the condition

$$f'_{300} \le [f_{300}] \qquad (2.3.3.3\text{-}3)$$

where f'_{300} = 300 mm based girder camber in accordance with 3.3.4.6;
$[f_{300}]$ = permissible 300 mm based girder camber in accordance with 4.3.3.1.

2.3.3.4 Where a bulge is present, girders and plate elements shall comply with the condition

$$f'/l' \le [f/l] \qquad (2.3.3.4)$$

where f' = maximum camber of a deformed girder web area or plate element in accordance with 3.3.4.7;
l' = length of a deformed girder web area or plate element in accordance with 3.3.4.7;
$[f/l]$ = permissible relative camber of a girder web area or plate element in accordance with 4.3.3.2.

2.3.3.5 No cracks or ruptures are permissible in girders and plate elements where bulges are present.

2.3.4 Welded, riveted joints, connecting elements and local strengthening.

2.3.4.1 In structures with residual deformations, the welds and riveted joints shall comply with the applicable provisions of the Instructions. Where necessary, the riveted joints of structures shall be tight.

2.3.4.2 In connecting elements (knees) and in local strengthening, the residual deformations shall be determined based on technical survey experience.

2.3.5 Requirements of 2.3 of these Instructions in connection with hull structure deformation apply to ships made of aluminium alloys, where reasonable and applicable, taking into account the requirements of 3.3, 4.3 and Section 5 of these Instructions.

2.4 STRUCTURES WITH CRACKS AND RUPTURES

2.4.1 No cracks or ruptures are permitted in the hull members.

2.4.2 Any cracks, fractures and ruptures shall be eliminated (repaired). Instructions on repair of structures with cracks, fractures or ruptures are given in Section 5.

3 PROCEDURE OF INSPECTION (FLAW DETECTION) OF THE SHIP'S HULL

3.1 GENERAL

3.1.1 This Section describes the hull flaw detection for the purpose of assessment of the hull technical condition in accordance with the provisions of Section 2.

3.1.2 The provisions of this Section set down the procedure for measuring the parameters of hull members with the defects found during examinations or surveys.

3.1.3 The dates and scope of the hull flaw detection are established by these Rules.

The dates and scope of the hull flaw detection may be specified by the Register based on the ship technical condition.

3.1.4 The hull shall be prepared for flaw detection by the shipowner: insulation and lining shall be opened and removed, corrosion products, sludge deposits, residual fluids shall be removed from surfaces to be measured, scaffolding and other means of access to structures to be measured shall be prepared, tanks shall be degassed, etc. (refer also to 4.11 of Part I "General Provisions" and 1.3.2 — 1.3.6 of Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules).

3.1.5 Parameters of deformations, cracks and other defects (except thickness measurements) shall be measured either by the Register at the shipowner's written request, or by the shipowner in the presence of the RS surveyor.

Thickness measurements of hull members, piping, arrangements and other ship structures shall be carried out by the Register at the shipowner's written request, or by the TM service suppliers recognized by the Register, in the presence of the RS surveyor to the extent necessary for the process control (this requirement also applies to thickness measurements taken during voyages). The attendance of the RS surveyor shall be recorded in column "Confirmation of RS" of the Attachment to the Minutes of Meeting prior to Commencement of the Thickness Measurements, and certified by signature and stamp.

The possibility of obtaining permission for service suppliers recognized by other classification societies is set forth in Section 7 of Part I "General Provisions" of these Rules. The RS surveyor shall check the information on cancellation of the TM service suppliers recognition by other classification societies on the RS internal website in Section "Information Systems/Industry/List of TM Service Suppliers Recognized by Other Classification Societies, whose Certificates are Cancelled". A list of TM service suppliers recognized by other classification societies is posted on the website www.iacs.org.uk in Section "Ship/Company data/Thickness Measurement Firms". In cases where the RS surveyor reveals that the recognition of any TM service supplier has been cancelled by ACS or other classification societies, he/she, if necessary, may contact RHO for further instructions on this occasion.

Requirements or the TM service supplier recognition are specified in Section 9 of Part I "General Regulations for Technical Supervision" of RTSCS. Category I TM service suppliers recognized by the Register are allowed to carry out thickness measurements on all ships regardless of their gross tonnage.

On ESP ships and ships covered by the requirements of Section 7 of Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules, the thickness measurements shall be carried out by the Register at the shipowner's written request, or by the category I TM service suppliers recognized by the Register. Category II TM service supplier recognized by the Register are allowed to carry out thickness measurements only on fishing vessels regardless of their gross tonnage, and on non-ESP ships less than 500 gross tonnage.

If thickness measurements, measurements of para meters of deformations, cracks and other defects of hull structures are carried out by surveyors/specialists of the Register, the procedure established for specialists of the TM service suppliers is valid for them. The RS Branch Offices, having thickness measurement specialists in their staff, shall be guided by the scheme specified in Annex 2-8 to this Annex. These RS Branch Offices shall maintain, as a minimum, lists and documents of certified thickness measurement specialists, schedules of training/confirmation of qualification of specialists, documentation on the equipment used, schedules of its technical maintenance, calibration, logs of performed works.

3.1.6 Planning.

3.1.6.1 Prior to commencement of the thickness measurements (recommended also during annual surveys, when essential corrosion areas, etc. are available), as required by these Rules at intermediate and special surveys of ships and floating facilities, including MODU (hereinafter referred to as "the ship"), a meeting shall be held between the RS attending surveyor(s), the master of the ship or an appropriately qualified representative appointed by the master or company, the owner's representative(s) in attendance and the representative(s) of the TM service supplier so as to ensure the safe and efficient execution of the surveys and thickness measurements to be carried out onboard. During the meeting the authorization of the TM service supplier which directed this particular operator/supervisor on board the ship to perform thickness measurements shall be submitted to the RS surveyor. The authorization shall have original signature and stamp of the TM service supplier. The copy of it shall be attached to the TM Report. Based upon results of the meeting, the Minutes of Meeting prior to Commencement of the Thickness Measurements with one of the Attachments (depending on the type and age of the ship and type of the survey) shall be drawn up and signed by all parties. Forms of the Minutes of Meeting prior to Commencement of the Thickness Measurements and Attachments thereto (form 6.6.1) in the MS Word format can be downloaded from the RS internal website, and are generated with the help of TM software. When the Minutes of Meeting with Attachments thereto are drawn up with the help of TM software, it is not necessary to duplicate the Minutes with Attachments as per the forms available at the RS internal website.

3.1.6.2 It is recommended that thickness measurements shall be carried out in a single operation, by one TM service supplier. If, however, thickness measurements are carried out in several operations within the period prescribed for the survey and/or by different TM service suppliers, separate meetings shall be held at each time with drawing up a separate Minutes of Meeting prior to Commencement of the Thickness Measurements with an appropriate Attachment thereto.

3.1.6.3 Communication with surveyor(s), TM operator(s) and owner's representative(s) shall be agreed at the meeting with respect to at least the following:

.1 reporting of thickness measurements to the RS surveyor on regular basis in accordance with the thickness measurement schedule (e.g. at the end of each working day when the measurements were taken);

.2 prompt notification of the RS surveyor in case of finding: excessive (in excess of allowable limits) and/or extensive corrosion or pitting/grooving of any significance; structural defects like buckling, fractures, camber, bulges and other deformed structures; detached and/or holed structure; corrosion of welds.

3.1.6.4 Items that shall be addressed and agreed in this meeting and recorded in the Minutes of Meeting are among others:

schedule for thickness measurements;

provisions for thickness measurements and examination of hull structures (i.e. personal safety, means of access, cleaning and de-scaling as appropriate, illumination, ventilation, communication, etc.);

planned scope of survey and thickness measurements (mandatory extent of thickness measurements according to these Rules, and areas subject to close-up surveys and thickness measurements including areas previously identified with substantial corrosion, if applicable);

availability on board of drawings with as-built (original) scantlings of hull structures;

allowable thickness diminution;

procedure for additional thickness measurements in the areas with substantial corrosion;

communication between RS surveyor(s), TM operator(s) and shipowner;

the RS surveyor carrying out the survey of the ship together with the TM operator shall decide final extent and location of thickness measurements after overall survey of the ship hull and hull structures/spaces onboard.

3.1.6.5 Upon completion of intermediate and special surveys at which thickness measurements have been done, the Minutes of Meeting prior to Commencement of the Thickness Measurements together with appropriate Attachments thereto drawn up properly and containing all necessary signatures and stamps/seals shall be submitted by the RS surveyor to be kept in the ship file in accordance with the common procedure established by the Register as regards the RS reporting documents control (except for the cases when the Minutes of Meeting together with the Attachments are drawn up with the help of TM software).

3.1.6.6 During thickness measurements the TM operator shall, as a minimum:

familiarize himself/herself with the RS normative documents relating to assessment of the ship technical condition, the RS reporting documents on ship, as-built documentation on ship or technical supervision item (e.g. drawings with as-built (original) scantlings of hull structures); with the results of the previous thickness measurements; with the applicable permissible residual scantlings of the hull members and of other ship's elements which are subject to measurements;

prepare (together with the shipowner or the shipowner's representative) in advance, i.e. during survey planning, the set of schemes of structures, which shall be measured;

select location of thickness measurements under the direction of the RS surveyor;

carry out thickness measurements in compliance with the requirements of these Rules in the scope established by the Minutes of Meeting prior to Commencement of the Thickness Measurements considering additional requirements of the RS attending surveyor supervising the thickness measurements on board, and record the measurements results (for instance, on the sketches, standard forms, in textual descriptions, etc.);

regularly submit to the RS surveyor (e.g. at the end of each working day when measurement was done or more frequently) the results of measurements and their assessment (as a preliminary TM Report — a draft) signed by the TM operator , including information on total wear, detection of local wear/pitting, substantial corrosion, intensive/excessive wear, corrosion holes and other defects (cracks, ruptures, detached structures, residual deformations, doubler plates (doublers), cement boxes, corrosion holes, corrosion of welds and etc.);

upon completion of all the required measurements submit to the RS surveyor the final TM Report drawn up in compliance with the requirements of these Rules.

3.1.6.7 All works shall be executed in accordance with the requirements of the RS normative documents and observance of safety engineering regulations.

3.1.6.8 Thickness measurements and examination of ship hull structures of oil tankers, bulk carriers, combination carriers, ore carriers and chemical tankers (ESP ships) shall be carried out in accordance with the provisions of the Enhanced Survey Programme (ESP) approved or developed by the Register.

3.1.7 Monitoring of thickness measurement process onboard.

3.1.7.1 Notwithstanding the planned extent of thickness measurements agreed at the meeting prior to commencement of thickness measurements and included in the Minutes of Meeting, the RS surveyor shall decide final extent and location of thickness measurements based on results of the ship survey. Based on survey results, the RS surveyor may require that additional thickness measurements shall be taken. The decision to extent the scope of measurements shall be reported in the Attachment to the Minutes of Meeting with background for the decision. Particular attention shall be given to structures specified in 2.2.2.3.1, Part II "Carrying Out Classification Surveys of Ship" of the Guidelines as well as to structures adjacent to heated tanks, hatch covers and coamings, longitudinal bulkheads (in particular, defects such as cracks/fractures/ruptures may be observed in way of discontinuities/openings, particularly at the upper and lower zones of the bulkheads; examples of discontinuities include fire-screen door openings, cable and pipe penetrations, elevator access arrangements and ventilation duct openings, etc.); downflooding ducts fitted to improve stability in the damaged condition; ventilation ducts and air pipes (in particular, presence of wear); grey and black water tanks (sanitary/domestic waste water and sewage holding tanks), including biological treatment system tanks (in particular, presence of wear); stabilizer housings (in particular, presence of wear); structures adjacent to refrigerated rooms (in particular, presence of water); permanent ballast or fixed ballast (solid (non-liquid), liquid, corrosive or non-corrosive type), etc.

3.1.7.2 The RS surveyor shall direct the gauging operation by selecting locations such that readings taken represent, on average, the condition of the structure for that area.

3.1.7.3 Thickness measurements mainly to evaluate the extent of corrosion which may affect the hull girder strength shall be carried out in a systematic manner for all longitudinal structural members, instructions for which are given in the relevant Parts of these Rules, under supervision of the RS attending surveyor.

3.1.7.4 Where thickness measurements indicate substantial corrosion or excessive diminution the surveyor shall direct locations for additional thickness measurements in order to delineate areas of substantial/excessive corrosion and to identify structural members for repairs/renewals.

3.1.7.5 Thickness measurements of hull structures in areas where close-up surveys are required shall be carried out simultaneously with the close-up surveys.

3.1.7.6 In the cases provided for in these Rules, the RS attending surveyor may specially consider the extent (number) of thickness measurements of structures within spaces where the protective coating is found to be in GOOD condition. The decision is taken by the RS surveyor on account of fulfillment of sufficient scope of close-up survey and thickness measurements in order to confirm actual overall condition of structures under protective coating. At that, the RS surveyor shall take photos of all items whose extent of thickness measurements has been reduced and confirmation (control/representative) thickness measurements shall be carried out to substantiate the RS surveyor's decision on possible reduction of measurement extent. In addition, for special surveys starting from the second special survey, the RS surveyor's decision to reduce the extent of thickness measurement shall be verified by the Head or appointed specialist of the RS Branch Office, and for the RS Branch Office with one specialist — by the RS Branch Office responsible for verification of documents of such Branch Office (in this case, the RS surveyor shall submit his/her proposals on reduction of measurement extent indicating specific structures, their location as well as photos and results of coating condition assessment and confirmation (control) measurements). Where such a possibility exists in the RS Branch Office, confirmation (control) measurements are recommended to be performed by the RS surveyor himself/herself.

3.1.7.7 Whether thickness measurements of hull structures within substantial corrosion, found during previous surveys, are carried out during subsequent annual, intermediate or special survey, and on the basis of the result of measurements and assessment it is found that measured structures do not belong anymore to the substantial corrosion zones, the RS surveyor, carrying out survey of the ship, shall certify:

readability of a measuring equipment (ultrasonic thickness meter) using reference specimens (verification shall be done in the presence of the RS surveyor). If the readability of the thickness meter is not correct, the RS surveyor shall require recurring residual thickness measurements of all hull structures, which were measured before the prescribed moment using gaged and calibrated thickness meter;

correctness of the scheme used by the TM operator, and number of measurements of hull structures and its compliance with the requirements of these Rules. If measurements have not been done in compliance with these Rules, the RS surveyor shall require recurring thickness measurements in full compliance with the requirements of these Rules;

correctness of assessment of the measurement results (it is necessary to check correctness of the assigned upper level of the substantial corrosion zone, correctness of conditional formatting in the TM Report forms in the MS Excel format, etc.). In case of finding of any deficiencies, the RS surveyor shall require recurring assessment of the measurement results. If necessary, additional RHO instructions on further actions of the RS surveyor may be requested by the RS Branch Office, which performed the survey.

Decision on exclusion of any structures from the summary table of substantial corrosion zones shall be grounded by the RS surveyor and indicated in the RS reporting documents (for example, form 6.1.03), as well as in the List of Survey's Status taking into account the fulfillment of all verifications specified above.

3.1.7.8 Before beginning of thickness measurements the RS surveyor shall do the following:

check type of the equipment (it is necessary to ensure that the thickness measurement operator an instrument will be using instruments using pulsed echo technique (either with oscilloscope or digital instruments using multiple echo). Single echo instruments may be used on uncoated surfaces, which have been properly cleaned;

verify that the equipment is calibrated according to recognized national/ international standards and properly labeled;

to ascertain that the equipment has been calibrated in accordance with the recognized national/ international standards and provided with adequate marking; to be present during the calibration which shall be performed as per dimension and material type; to ensure that the operator possesses adequate skills and qualifications;

check operator qualification documents be satisfied with operator's skills and competence;

get familiarized with the results of the previous thickness measurements; repair history of ship's hull structures, records in the List of Survey's Status and RS reporting documents upon the results of previous surveys of the hull.

3.1.7.9 The RS surveyor responsible for monitoring of thickness measurements shall at least:

check that the safe and efficient execution of survey of structures (in particular, removing scales, dirt, rust, etc. from structures) is ensured;

be on board to the extent necessary for process monitoring; check the quality of measurements;

where necessary, the RS surveyor may require the TM operator to carry out corrective actions (re-measurements, additional thickness measurements, etc.);

agree the number of measurements and identify locations where the thickness measurements shall be carried out (the RS surveyor directs the gauging operations, selects the locations such that readings taken represent, on average, the condition of the structure for that area);

take photos of the items;

verify preliminary TM reports regularly submitted by the TM operator and certified by his/her signature and stamp;

impose requirements for increasing the extent of measurements, repairs, where necessary based on measurement/survey results;

coordinate actions of the TM operator;

verify correct preparation of preliminary/final TM Report;

verify final TM Report and countersign the cover page of the final TM Report on condition of satisfactory results of consideration.

When the RS surveyor determines the scope of thickness measurement process monitoring, the following shall be taken into account:

thickness measurements of hull structures in areas where close-up surveys are required shall be carried out simultaneously with the close-up surveys;

the RS surveyor directs the gauging operations, selects the locations such that readings taken represent, on average, the condition of the structure for that area).

The RS surveyor shall carry out survey the gauged item; for items whose measurements were not under the RS surveyor continuous supervision, during their survey carried out by the RS surveyor, the confirmation (control/representative) thickness measurements shall be witnessed by the RS surveyor. It is recommended that such control thickness measurements be performed by the RS attending surveyor himself/herself (if duly calibrated ultrasonic thickness meter is available in the RS Branch Office). The Record Book of Technical Supervision During Survey of Ship Under Repair (form 6.3.48) or the Report on Survey of the Ship (form 6.3.10) shall contain a record on attendance of the RS surveyor for thickness measurements supervision, as well as a record on control measurements taken. If there is no record book as per form 6.3.48 (e.g. during measurements of areas with substantial corrosion at annual survey of the ship), the report as per form 6.3.10 shall be drawn up and contain the results of supervision during the thickness measurement process (which confirm the attendance of the RS surveyor) or the appropriate information shall be included in the Survey checklist (form 6.1.01).

If the RS attending surveyor findings differ from those submitted by the TM operator upon completion of technical condition assessment (this primarily applies to control measurement results, pitting and corrosion holes, edge corrosion, cracks, cement boxes, doubler plates (doublers), detached framing members, etc. found by the RS attending surveyor and their absence in the reports of the TM operator submitted to the RS surveyor on a regular basis throughout the period of measurements), the extent of supervision during the thickness measurement process on board by the RS surveyor shall be of continuous manner rather than periodical/random nature.

The extent of supervision during thickness measurements process on board shall also be increased if the RS surveyor finds that the TM operator fails to comply with the measurement extent and procedures established by these Rules. All comments found based on results of thickness measurement process monitoring shall be recorded in the above RS reporting.

Regardless of comments on the TM operator work based on results of supervision during thickness measurements process, the Register is responsible for the quality of survey performed including the assessment of technical condition. In case information on repair of the ship's hull structures to be repaired upon the flaw detection results is entered by the TM operator, this information cannot be considered by the Register as the official repair information and the RS surveyor cannot draw a conclusion that hull structure repair has been made based on the TM Report provided.

The RS surveyor carrying out the ship survey shall examine the extent of repairs made in order to ensure that all the structures to be repaired according to the technical condition assessment results, specified in the flaw detection records, RS reports, have been adequately repaired in accordance with the RS requirements and the repair results have been recorded in the RS documents in the prescribed manner.

In case information on repair of the ship′s hull structures to be repaired upon the flaw detection results is entered by the TM operator, this information cannot be considered by the Register as the official repair information and the RS surveyor cannot draw a conclusion that hull structure repair has been made based on the TM Report provided. The RS surveyor carrying out the ship survey shall examine the extent of repairs made in order to ensure that all the structures to be repaired according to the technical condition assessment results, specified in the flaw detection records, RS reports, have been adequately repaired in accordance with the RS requirements and the repair results have been recorded in the RS documents in the prescribed manner.

3.1.7.10 The extent of control (representative) thickness measurements if required by these Rules (e.g. in case of transfer of a ship into the RS class) and/or the RHO instructions, shall be determined by the RS surveyor based on results of current survey for transfer of a ship into the RS class, review of the TM Report performed under supervision of the losing society, presence/absence of suspect areas, pitting and edge corrosion, corrosion holes, residual deformations, cracks, raptures/fractures, doubler plates (doublers), cement boxes and other defects/damages with further mandatorily recording of the information in the Minutes of Meeting prior to Commencement of the Thickness Measurements and the TM Report per relevant form.

Control residual thickness measurements performed shall reflect real condition of structures.

Whether information on the results of control thickness measurements and previous results substantially differs, it is necessary to check the following:

readability of a measuring equipment (ultrasonic thickness meter) using reference specimens (verification shall be done in the presence of the RS surveyor). If the readability of the thickness meter is not correct, the RS surveyor shall require recurring residual thickness measurements of all hull structures, which were measured before the described moment using gaged and calibrated thickness meter;

correctness of the scheme used by the thickness measurement operator, and number of measurements of hull structures and its compliance with the requirements of these Rules. If measurements have not been done in compliance with these Rules, the RS surveyor shall require recurring thickness measurements in full compliance with these Rules;

correctness of assessment of the results of measurement results (correctness of wear norms, etc.).

If no faults were found upon the results of verification, the RS surveyor shall require increasing of the scope of measurements as minimum, up to required by these Rules. Requirements to the minimum extent of thickness measurements and close-up survey depending on type, age of the ship and type of survey are given in the relevant Parts of these Rules.

If based on results of control measurements of main hull structures, the RS surveyor confirms that the actual measurement results comply with those included in the TM Report and no structural deterioration is found based on the ship survey results, the further extent of control measurements may be reduced by the RS surveyor in accordance with the procedure specified in 3.1.7.6. All results of control measurements and the RS surveyor's decisions shall be recorded in the appropriate RS documents (record book as per form 6.3.48 or report as per form 6.3.10, or survey checklist as per form 6.1.01, as applicable).

3.1.8 Review and verification.

3.1.8.1 Upon completion of the thickness measurements, the surveyor shall make sure that the thickness measurements were taken to the full extent and confirm that no further gaugings are needed (refer to 6.4.2), or specify additional gaugings. In any case, additional gaugings required by the RS surveyor shall be taken before completion of the survey.

3.1.8.2 Bearing in mind 3.1.7.6, if the extent of thickness measurements has been reduced, the RS surveyor shall reflect this fact in the reporting documents, in the TM Report or Minutes of Meeting with reasoning the correctness of the decision made.

3.1.8.3 In case thickness measurements are partly carried out, taking into account provisions of 3.1.6, the extent of remaining thickness measurements shall be reported for the use of the next surveyor

3.1.8.4 The results of the thickness measurements shall be drawn up as final TM Report consisting of the hull structural drawings and relevant tables in the scope required in Section 6.

3.1.9 Selection of areas for close-up survey and thickness measurements.

3.1.9.1 Based on risk assessment of corrosion initiation and experience in ship design, areas for close-up survey and hull transverse sections for thickness measurements can be identified. Transverse sections of the ship hull for thickness measurements are generally assigned within tanks, holds and spaces where risk of corrosion initiation is considered to be the highest. Holds, tanks and spaces for the close-up survey shall be selected on the risk level of corrosion formation and shall include ballast tanks. Such selection of the spaces shall be based on the principle that a risk level is increasing with the age of the ship and that incomplete or uncertain information is also an important factor to carry out survey. The minimum requirements for the extent of close-up survey and residual thickness measurements are given in the relevant Parts of these Rules and 3.2 of this Annex.

3.1.9.2 In any type of survey, i.e. special, intermediate, annual or other surveys having the scope of the foregoing ones, thickness measurements of structures in areas where close-up surveys are required, shall be carried out simultaneously with close-up surveys.

3.1.9.3 In selection of locations for thickness measurements it is necessary to take into consideration that intensity of corrosion is affected by:

type of the cargo carried in holds and compartments (coal, mineral fertilizers, ore, different oil products, salt, chemicals, acid, fish in barrels, etc.);

type and location of a ship space (spaces within double bottom under boilers or oil/ballast tanks, pump rooms of oil tankers, nearest location of heating piping, bilges, spaces with cement and other equivalent coating, drain wells, segregated and clean ballast tanks of oil tankers);

possible water stagnation (for example, areas on the deck plating under deck machinery in the forward part of the ship, in way of scuppers, coamings of ventilation ducts).

The following structures are subject to more intensive corrosion: structures for which thinner as-built thickness was allowed (in particular, in fore and aft parts of wind and water strakes, welded branches for side and bottom fittings), intersections of longitudinal and transverse framing members, mainly on the bottom where local spot wear is likely to appear, plating of lower parts of transverse bulkheads in the area of connection with tween decks, inner bottom plating and in areas of pitting and linear wear (ice belt plates, forward portions of the bottom plating, wind and water strake, mainly in transition areas from the forward end to the parallel middle body).

Areas where groove wear is likely to occur are listed below:

near butts and seams of hull shell plating in the underwater part of the ship;

longitudinal and transverse bulkhead plating of oil tankers;

within the weld adjacent zone near the area where framing members are welded to the underwater shell plating as well as to the plating of bulkheads in cargo/ballast tanks, tank bulkheads;

on the bottom plating in the area of openings on webs for overflow of liquids, cut in the framing members of tanks in oil tankers.

3.1.10 Use, storage and calibration of instruments.

3.1.10.1 Provisions for thickness measurement instruments are given in 3.2.1.

3.1.10.2 Thickness measurement instruments shall be used in accordance with manufacturer's documentation.

3.1.10.3 All the equipment used shall have serial numbers; inventory numbers shall be assigned thereto

3.1.10.4 Individual logs shall be provided for recording of the calibrations made and indication of the dates of the future calibrations in the RS Branch Office performing thickness measurements, the TM service supplier.

3.1.10.5 A person responsible for storage and calibration of equipment shall be assigned in the RS Branch Office performing thickness measurements, the TM service supplier

3.1.10.6 Calibrations of the equipment by competent bodies with specified intervals shall be documented. The calibration documents shall be submitted to the RS surveyor prior to the commencement of thickness measurement operations by the TM service supplier.

3.2 STRUCTURES WITH WEAR[1]

3.2.1 Examination of structures.

3.2.1.1 Condition of hull structures with wear shall be characterized by residual thicknesses to be determined by measurements.

The hull technical condition in terms of hull wear is determined based on the results of comparing actual thickness measurements with requirement criteria stated in these Rules.

In order to record the nature of deterioration of ship's hull condition it is accepted to consider wear on the following areas along the length of the ship:

amidships — on the length 0,2*L* fore and aft from the midship;

fore part — on the length 0,30*L* aft of the forward perpendicular;

aft part — on the length 0,30*L* forward of the aft perpendicular.

It is advisable that such structures as transverse and longitudinal bulkheads, lower deck plating, framing inside holds and tanks and other items where nature of corrosion depends on the type of cargo carried shall be considered within the cargo spaces.

Wear of the structures in the ship ends, located outside the forward and aft perpendiculars, shall also be considered separately.

Residual thickness of hull members shall be generally determined, using non-destructive testing methods. The depth of pits is measured with the aid of a depth meter or indicating gage. The accuracy of hull member thickness measurements shall not be less than 0,1 mm.

Thickness measurements shall be done taking into account requirements of GOST R 16908-2015 or ISO 16809-2012 whatever is applicable.

3.2.1.2 The type of wear of a hull member shall be determined visually during the ship survey and based on the random measurements of residual thickness.

3.2.1.3 On painted surfaces the echo-sounding equipment shall be used (either an oscilloscope or digital devices applying multiple echo or single-chip method). Devices with a single echo can be used on unpainted surfaces exposed to cleaning and polishing.

The precision of hull member thickness measurements shall not be less than 0,1 mm.

The depth of pits is measured using depth meter, indicating gage or other similar instruments to ensure the precision not less than 0,1 mm.

3.2.1.4 Extent of thickness measurements is assigned in compliance with the applicable requirements of Part II "Survey Schedule and Scope" and Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules depending on the type and age of the ship as well as on the type of survey. During examination of the hull members, the service conditions of the structures, experience in technical supervision and information about critical structural areas of similar ships and ships of the series, if any, shall be also considered.

3.2.2 Hull cross-sectional characteristics.

3.2.2.1 To determine the residual hull section modulus of deck and bottom $W'_{d(b)}$, the most structurally weakened and the most worn sections shall be taken considering repairs made. The residual hull section modulus $W'_{d(b)}$ shall be determined for the average residual member thicknesses S'_1 within the chosen circular hull section limited by the length of a plate arranged longitudinally.

When the residual hull section modulus is determined, the residual thickness of members, which annual average wear u_{aS} , in mm/year, exceeds the relevant value u, in mm/year, to be found in the Rules for Construction and which percentage is in accordance with the conditions stipulated under 4.1.5.2 of this Annex shall be reduced by the value of ΔS_a, in mm, to be determined from the formulae:

$$\Delta S_a = \tau(u_{aS} - u); \qquad (3.2.2.1\text{-}1)$$

[1] When determining the number of measurement points in bulk carriers, oil/bulk carriers, oil tankers and chemical tankers, one shall be guided by the requirements of Part III "Additional Survey of Ships Depending on their Purpose and Hull Material" of these Rules shall be met.

$$u_{aS} = (S_0' - S_1')/T \qquad (3.2.2.1\text{-}2)$$

where S_1' = average residual thickness, in mm, of a hull member to be determined in accordance with 3.2 of this Section during the survey in question;
S_0' = as-built hull member thickness, in mm;
$\tau \leq 5$ time, in years, before the next specified survey/examination of the hull member;
T = service life, in years, of the hull member from the date of its fitting on board.

3.2.2.2 The residual hull section modulus $W'_{d(b)}$ shall be calculated in accordance with the effective Rules for Construction with due regard to the bending moments stipulated for the ship hogging and sagging. The possibility of using previous editions of the Rules for Construction shall be agreed with RHO. In any case, the reduction of compressed members shall be considered. The compressed longitudinal girders shall be checked for stability. Critical stresses shall be determined based on the Rules for Construction for residual member thicknesses.

3.2.2.3 The hull section ultimate bending moment $M''_{sag(hog)}$ and/or residual ultimate hull section modulus $W''_{d(b)}$ shall be calculated in accordance with the requirements of the Strength Norms for Sea-Going Ships developed by the Register or by means of incremental-iterative method (Smith method)[1]. Actual member scantlings shall be considered when calculating geometrical characteristics.

3.2.2.4 The average residual shell plating thickness $S'_{s(b)}$ of the outer side, inner side and longitudinal bulkhead for the most structurally weakened and worn section in regions stipulated by the Rules for Construction shall be determined from the formula

$$S'_{s(b)} = \sum_{i=1}^{n} S'_{1i} b_i \,/\, \sum_{i=1}^{n} b_i \qquad (3.2.2.4)$$

where S'_{1i} = average residual thickness of the *i*-th shell plate of the outer side, inner side or longitudinal bulkhead. The average residual thickness of the *i*-th plate, which annual average wear u_{aS}, in mm/year, exceeds the relevant value u, in mm/year, to be found in the Rules and which percentage is in accordance with the condition stipulated under 4.1.5.2 of this Annex, shall be reduced by the value of ΔS_a, in mm, to be determined from Formula (3.2.2.1-1) of this Chapter;
b_i = *i*-th plate breadth, in mm;
n = number of plates.

3.2.2.5 The location of the transverse sections along the ship length shall be selected by the RS surveyor and generally determined after taking the required thickness measurements of deck and bottom plating. Minimum number of transverse sections to be measured shall be in compliance with the applicable requirements of these Rules. One of the transverse sections shall be selected amidships. Other transverse sections shall be selected at areas where the largest thickness reductions of the deck and bottom plating within 0,4*L* amidships are revealed. For dry cargo ships and bulk carriers transverse sections shall be selected at the area of cargo hold hatch openings; for oil tankers — refer to 3.2.2.7.

The length of the section is determined depending on a plate length (deck plating, shell plating, etc.), related to the section and selected on condition of its technical condition on the basis of the measurement results (i.e. the most weakened structurally and the most worn-out plates).

[1] Refer to the Rules for the Classification and Construction of Sea-Going Ships, Part XVIII "Additional Requirements for Structures of Container Ships and Ships, Dedicated Primarily to Carry their Load in Containers".

The results of thickness measurements of ship's hull members in transverse sections are used for assessment of an overall longitudinal strength of the ship's hull and at substantial diminution of the cross-sectional area of a deck and/or bottom with bilge (refer to 2.2.1.1) it is required to verify cross-sectional modulus of the ship's hull. The assessment of the cross-sectional areas of a deck and/or bottom with bilge shall be carried out at special surveys. This assessment may also be required by the RS surveyor at annual, intermediate, occasional surveys if suspect areas, substantial corrosion areas and residual deformations have been found, and which may affect cross-section characteristics of the ship's hull. If it is found, that one or more transverse sections does not comply with requirements to the longitudinal strength, the number of transverse sections for thickness measurements shall be increased.

3.2.2.6 For all types of ships, except for oil tankers of 130 m in length and over (refer to Figs. 3.2.2-1 — 3.2.2-4): the pattern of measurements in transverse section of dry cargo ships and bulk carriers is shown in Figs. 3.2.2-1 — 3.2.2-4 and may be partly applied to other types of ships, except for oil tankers 130 m in length and over. The minimum density of measurements in transverse sections (the transverse section shall be limited by the length of a plate arranged longitudinally):

every longitudinal of the deck, bottom, sides and other structures — in accordance with 3.2.4.1;

every longitudinal girder of the deck, bottom, sides, etc. — in accordance with 3.2.4.1;

every plate of the deck, bottom, side plating as also of other plate structures, included into transverse section, at least 3 measurements per plate;

on transversely framed ships — adjacent transverse framing to be measured in accordance with 3.2.4 and 3.2.7.

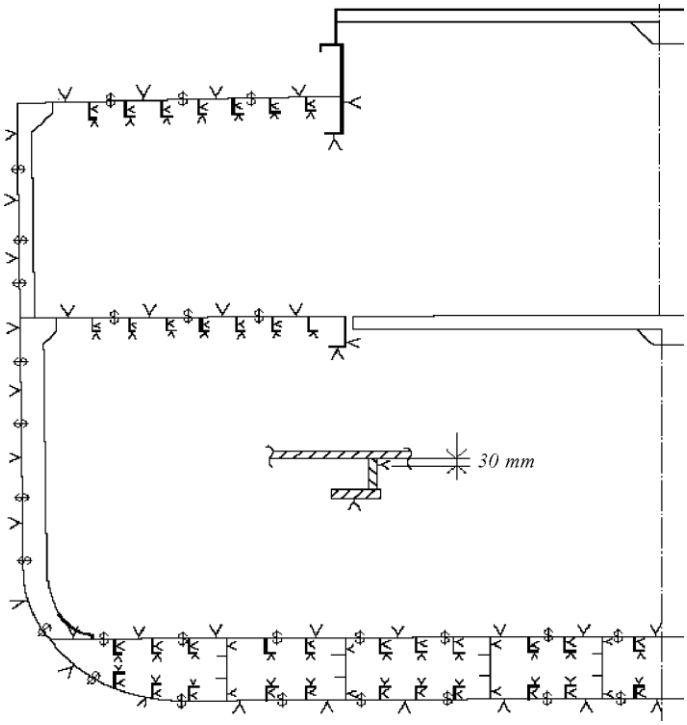


Fig. 3.2.2-1
Pattern of measurement of hull members in transverse section of general dry cargo ship
(may be used for all other types of ships, except for bulk carriers and oil tankers)

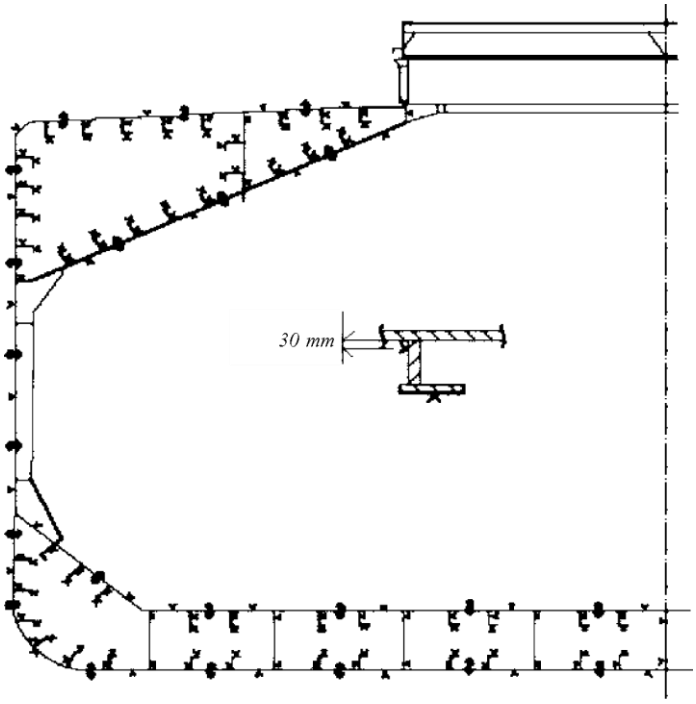


Fig. 3.2.2-2
Pattern of measurements of hull members in transverse section of single sided bulk carrier

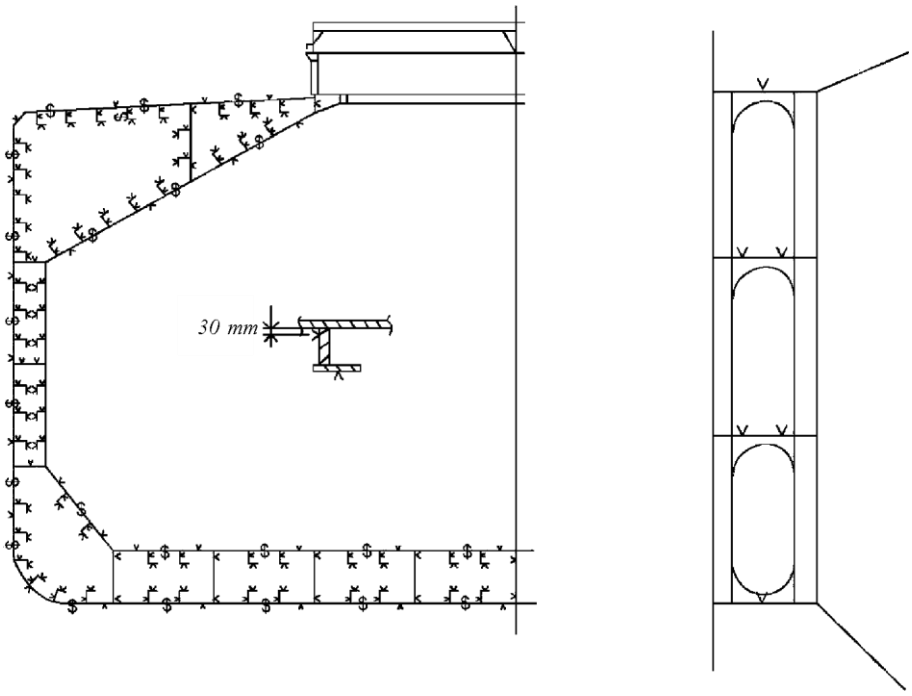


Fig. 3.2.2-3
Pattern of measurements of hull members in transverse section of double sided bulk carrier
(thickness measurements shall be done within selected transverse section both sides)

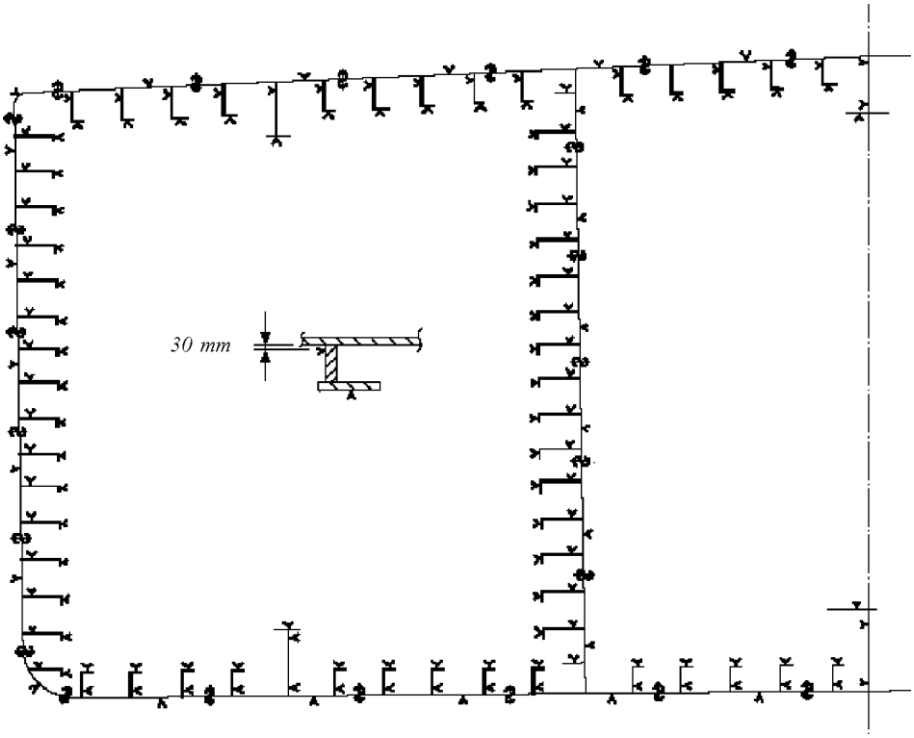


Fig. 3.2.2-4
Pattern of measurements of hull members in transverse section of oil tanker
(gauging shall be done port or starboard of transverse section selected)

3.2.2.7 In case of oil tankers of 130 m in length and upwards (refer to Fig. 3.2.2-5 — 3.2.2-7): covered by Sections 2 and/or 3, Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules, provisions of the ESP Code, the following procedure for verification of the hull cross-sectional (transverse sectional) characteristics is applied:

.1 General.

Longitudinal strength shall be evaluated within 0,4*L* amidships for the extent of the hull girder length that contains tanks therein and within 0,5*L* amidships for adjacent tanks which may extend beyond 0,4*L* amidships.

N o t e . The above-mentioned tanks mean ballast tanks and cargo tanks;

.2 Thickness measurement pattern.

The minimum number of transverse sections to be sampled shall be in accordance with Table 2.2.4.1 and/or 3.2.4.1, Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules, as applicable.

The transverse sections shall be chosen where the largest thickness reductions are suspected to occur or are revealed from deck plating measurements. In cases where two or three sections shall to be measured, at least one shall include a ballast tank within 0,5*L* amidships. Transverse sections shall be chosen such that thickness measurements can be taken for as many different tanks in corrosive environments as possible (e.g. ballast tanks sharing a common plane boundary with cargo tanks fitted with heating coils, other ballast tanks, cargo tanks permitted to be filled with sea water and other cargo tanks). Ballast tanks sharing a common plane boundary with cargo tanks fitted with heating coils and cargo tanks permitted to be filled with sea water shall be selected where present.

The transverse sections shall be chosen where the largest thickness reductions are suspected to occur or are revealed from deck and bottom plating measurements prescribed below and shall be clear of areas which have been locally renewed or reinforced: at least three points shall be measured on each deck plate and/or bottom shell plate required to be measured within the cargo area in accordance with the requirements of Table 2.2.4.1 or 3.2.4.1 of Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules.

Within 0,1*D* (where *D* is the ship's moulded depth, in m) of the deck and bottom at each transverse section to be measured in accordance with the requirements of these Rules, every longitudinal and girder shall be measured on the web and face plate according to 5.3, and every plate shall be measured at one point between longitudinals.

Every longitudinal between the deck and bottom shall be measured according to 3.2.4, and at least three points shall be measured on each plate.

The thickness of each component shall be determined by averaging all of the measurements taken in way of the transverse section on each component.

Where one or more of transverse sections are found to be deficient in respect of the longitudinal strength requirements, the number of transverse sections for thickness measurement shall be increased such that each tank within the 0,5*L* amidships region has been sampled. Tank spaces that are partially within, but extend beyond, the 0,5*L* region, shall be sampled.

Additional thickness measurements shall also be performed on one transverse section forward and one aft of each repaired area to the extent necessary to ensure that the areas bordering the repaired section also comply with applicable requirements of these Rules;

.3 Effective repair methods.

The extent of renewal or reinforcement carried out to provide hull longitudinal strength shall be defined in accordance with applicable requirements with regard to the following:

the minimum continuous length of a renewed or reinforced structural member shall be not less than twice the spacing of the primary members in way. In addition, the thickness diminution in way of the butt joint of each joining member forward and aft of the replaced member (plates, stiffeners, girder webs and flanges, etc.) shall not be within the substantial corrosion range (75 % of the allowable diminution associated with each particular member). Where differences in thickness at the butt joint exceed 15 % of the lower thickness, a smooth transition taper shall be provided;

alternative repair methods involving the fitting of doubling straps or structural member modification is subject to special consideration by the Register in each case.

In considering the fitting of doubling straps, it shall be limited to the following conditions:

to restore and/or increase longitudinal strength;

the thickness diminution of the deck or bottom plating to be reinforced shall not be within the substantial corrosion range (75 % of the allowable diminution);

the alignment and arrangement, including termination of doubling straps, shall meet the Register requirements;

the doubling straps are continuous over the entire 0,5*L* amidships length;

continuous fillet welding and full penetration welds are used at butt welding and, depending on the width of the doubling strap, slot welds. The welding procedures applied shall be approved by the Register.

The existing structure adjacent to replacement areas and in conjunction with the fitted doubling straps, shall be capable of withstanding the applied loads, taking into account the buckling resistance and the condition of welds between the longitudinal members and hull envelope plating.

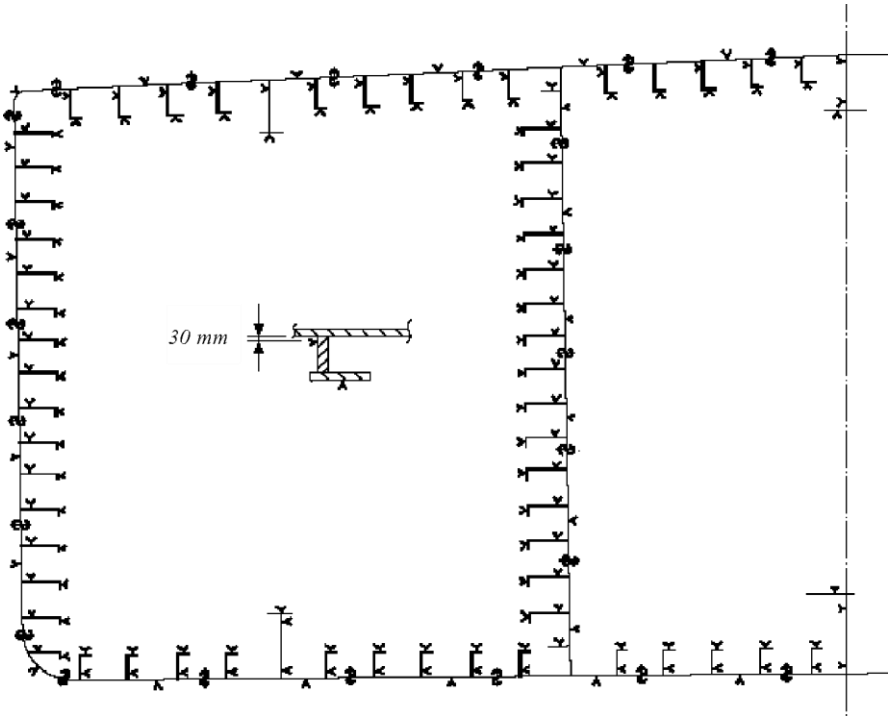


Fig. 3.2.2-5
Pattern of measurements of hull members in transverse section of single hull oil tanker

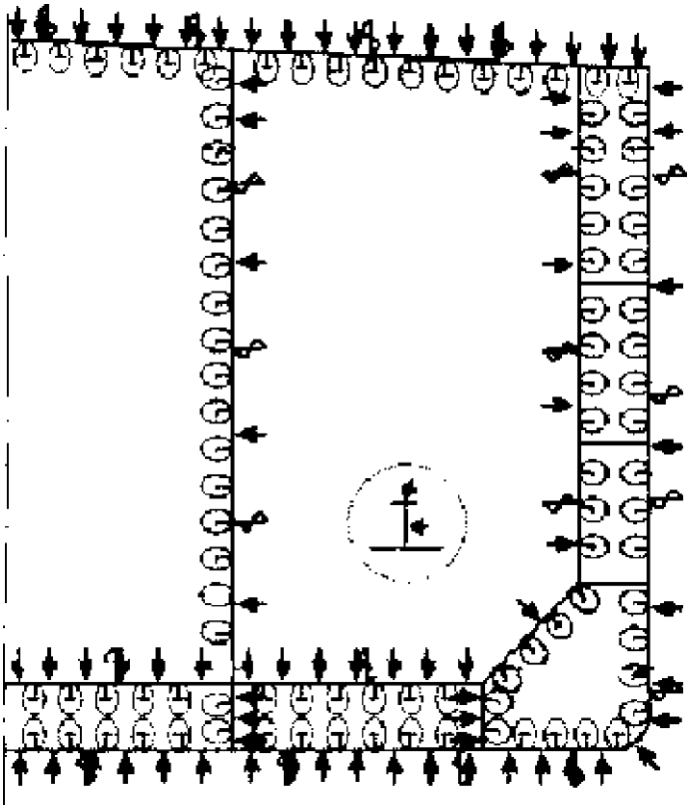


Fig. 3.2.2-6
Pattern of measurements of hull members in transverse section of double hull oil tanker of 10 years of age and over

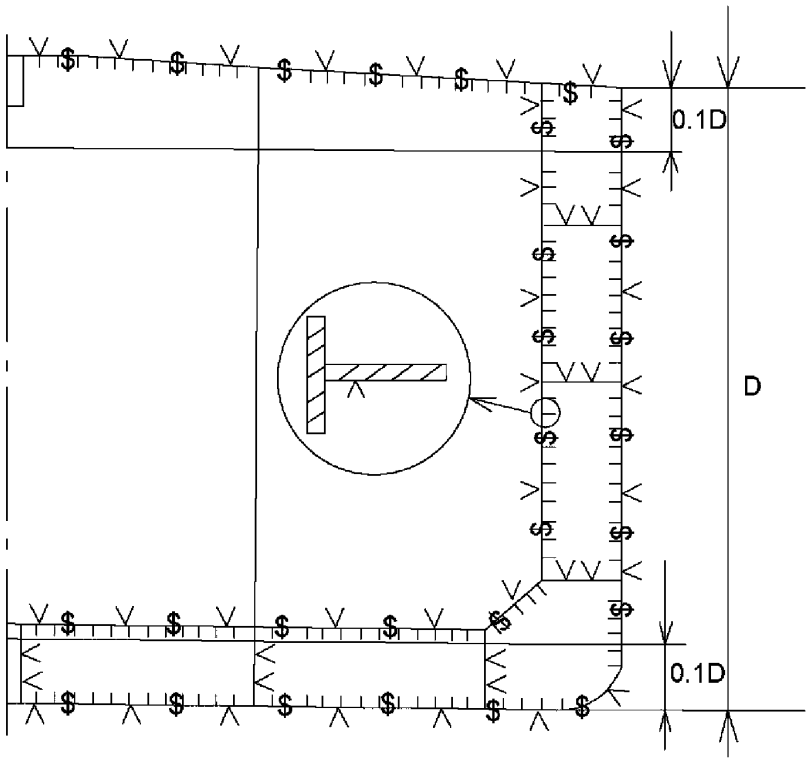


Fig. 3.2.2-7
Pattern of thickness measurements of hull members in transverse section
of double hull oil tanker of less than 10 years of age

3.2.3 Plates.

3.2.3.1 In case of total wear, the average residual plate thickness S_1', in mm, is determined as an arithmetic mean of residual thicknesses measured at points uniformly distributed over the plate surface. In this case, the residual thicknesses measured at points in areas of linear and groove wear, as well as in deep pits, shall be disregarded.

Measurements shall be taken in forward, middle and after parts of the plate, at least in three (3) points per plate (plating and side plating) or at 1 point per 5 m^2 of the plate surface, whichever is the greater.

Where a plate refers to both ballast and fuel tank, measurement may be taken separately for the two items. In case the plate was partially renewed earlier, attention shall be paid to the measurements taken both on the renewed part and on the old part of the plate.

The number of thickness measurement points shown in Fig. 3.2.3-1 is only an example and may be applied in cases where the difference between measured residual thicknesses of one component is equal to or less than 1,5 mm. Where the difference between measured residual thicknesses is more than 1,5 mm but equal to or less than 3 mm, the number of measurements shall be increased up to seven and over (refer to Fig. 3.2.3-2). The number of thickness measurement points shall be selected depending on the spread of residual thickness values on the area. If the maximum difference of the thicknesses measured at points on the plate having as-built thickness equal to or less than 16 mm, exceeds 2 mm, and for as-built thickness above 16 mm, exceeds 3 mm, the number of measurement points on the plate area with the minimum residual thickness shall be increased according to pattern of measurements used for spot wear, i.e. 3 points on the a plate section.

The following shall be taken into consideration:

in determination of S_1' values measurements in places of local spot wear shall be also included in the number of measurements. In such case, the mean residual thickness in case of spot wear shall be used as the residual thickness in one measurement point for determination of thickness S_1';

where local wear at the particular plate covers more than 40 % of plate sections, the number of measurements for determination of S_1' shall be doubled against that shown in Fig. 3.2.3-2;

mean values of measured residual thicknesses may be registered in the TM Report.

For additional thickness measurement instructions applicable to the hull plate members refer to 3.2.7.

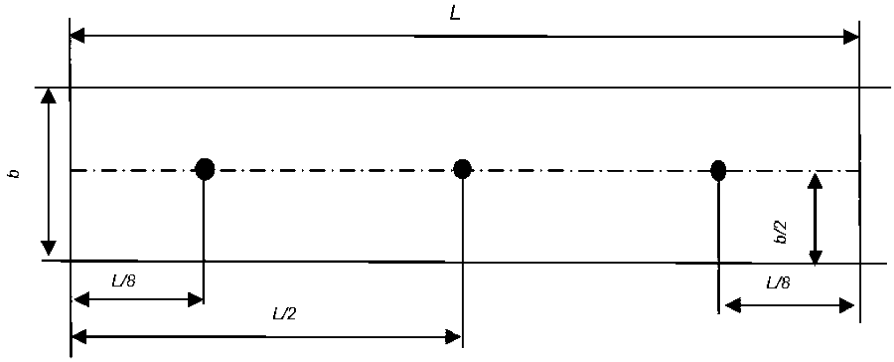


Fig. 3.2.3-1
Pattern of residual thickness measurements in three points

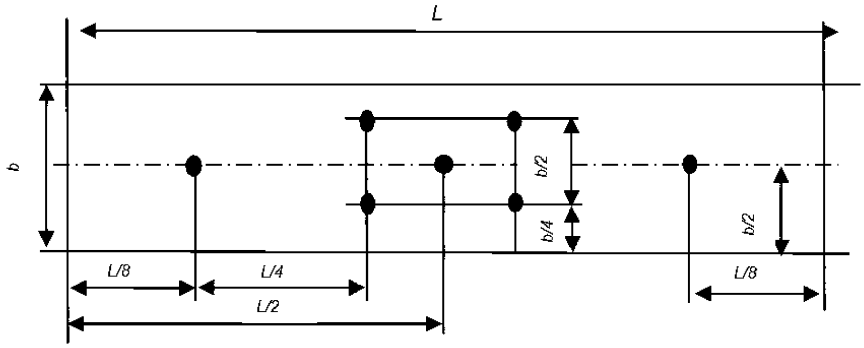


Fig. 3.2.3-2
Pattern of residual thickness measurements in seven points

3.2.3.2 In case of local wear, the average residual thickness S_3', in mm, of a plate area is determined on the basis of measurements at points lying within the worn plate area, as follows:

as an arithmetic mean of values measured at points with residual thicknesses for the case of spot wear and linear, wear of plate areas;

from the following formula for the case of groove wear:

$$S_3' = S_1' - (h_1 + h_2) \qquad (3.2.3.2)$$

where S_1' = average residual plate thickness, in mm, in accordance with 3.2.3.1;

h_1 and h_2 = groove depth, in mm, on the face and the reverse side of the plate respectively.

Measurement points shall be uniformly distributed on the worn plate area. The number of points for residual thickness shall not be less than:

three arranged uniformly within a plate section, for the case of spot wear;

three within a zone not nearer 10 mm to and not farther than 20 mm from the stiffening girder in the direction of the greatest wear, for the case of linear wear. Where the transverse framing system is applied, the most worn side would normally be the one lying forward of the stiffening girder;

one per 0,3 m of groove length, for the case of groove wear.

3.2.3.3 In case of pitting, the residual plate thickness S_4', in mm, is determined based on the wear measured in the pits within the plate section, as given by the formula

$$S_4' = S_1' - h_4 \qquad (3.2.3.3)$$

where S_1' = average residual plate thickness, in mm, in accordance with 3.2.3.1;
h_4 = maximum measured pit wear, in mm, with regard to the plate area surface.

The number of pits to be measured is in each case determined based on their visual examination. If the pits are difficult to separate, the maximum pit wear shall be determined with regard to a bar 300 — 400 mm long, which is freely, placed on the plate surface, cleaned from corrosion products.

The minimum permissible thickness of the hull member in an isolated pit is determined according to 4.2.

For the plate having a pitting intensity of 100 % (i.e. as a total wear), average measured depth in pits shall not exceed permissible thickness diminution, determined to the gauged hull member for condition of total wear (refer to 4.2). For the intermediate values of pitting intensity (from isolated pits — refer to Fig. 1.2.1-2 and to 100 % — refer to Fig. 1.2.1-3) permissible residual thickness in pits shall be determined using linear interpolation method.

Where pitting corrosion is found, the results of the plate thickness measurements in pits shall be recorded in accordance with the provisions of Section 6. In case when areas with deep and/or intensive pitting corrosion are found (e.g. deep corrosion area is 20 % or more and the hull members having the mean measured pit from 1/3 and above of the actual thickness of the member, but within the permissible limits) — such areas shall be recorded using a particular form provided in the TM software or using form RTM8 (refer to Section 6). The RS surveyor shall be notified of such areas on board. The surveyor shall take a decision whether the renewal of the plate or a plate area is required.

3.2.4 Girders.

3.2.4.1 In case of total wear, the residual section modulus W_1', in cm^3, of a girder with a flange determined on the basis of the Rules for Construction, the cross-sectional area F_1' in cm^2, of a girder web and the average residual thickness S_1', in mm, of a girder member are determined based on the residual thickness measurements taken on one section of the most worn girder at points on their webs and flanges.

The number of measurements of framing may be then specified more exactly, having regard to supervision experience, specific features of the structure, ship size and technical condition of the hull.

Residual girder member thicknesses are measured on the most worn sections at supports and midspan.

The number of residual thickness measurement points of girder webs and face plate shall be at least (refer also to 3.2.7 as regards the additional instructions on girders/framing members thickness measurements):

for girder webs — at least two measurements along the face plate depth and two along the web depth. The results of the measurements shall be averaged for the face plate and web separately. The number of transverse webs in ballast tanks shall be selected in accordance with the scope prescribed in these Rules depending on the type and age of the ship:

floors: at least one measurement between center girder and bottom girder, between every bottom girder, bottom girder and inclined margin plate or if there are no bottom girders — at 3 to 5 points on the width of the tank and minimum 2 measurements on the floor web depth. It is advisable that measurements shall be taken near the openings in the floors. It is also necessary to take measurements of adjacent longitudinal framing at 1 point on the web and face plate (based on minimum 3 or 4 longitudinals on the width of the tank, the number of longitudinals shall depend on their condition) and adjacent plating in accordance with the requirements for measurements of plate members;

center girder, bottom girders, inclined margin plate, longitudinal girders of hopper and topside tanks, deck girders, side stringers — 1 measurement between transverse webs, but not less than 1 measurement per 5 m^2;

web frames — 3 measurements on the web depth of the upper, middle and lower part of the frame and 2 measurements on the web depth;

side shell and intermediate frames, except frames of bulk carriers complying with IACS UR S31 — 2 — 3 measurements on the frame span and 2 measurements on the web depth. Thickness measurements of side frames in bulk carries complying with IACS UR S31 shall be carried out in accordance with Appendix 5.12 of Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules;

web beams — 3 — 4 measurements on the web along the breadth of the ship or compartment, but not less than 1 measurement per 5 m;

for a girder made of rolled angle sections, one on the effective flange and one on the web;

for a girder made of rolled bulb sections, one on the web.

The residual thicknesses of girder members shall be measured at the following points:

on the web, if measured at toe in way of the weld, by which the girder is connected with the plate being strengthened, and, where necessary, at 2/3 of web depth from the toe;

on the effective flange, if measured at edge(s).

3.2.4.2 In case of local wear, the average residual thickness S_3', in mm, of a girder member area is determined on the basis of residual thickness measurements to be taken on its most worn section at points on its web or flange.

The length of worn area and the weakest section of the girder on its span are determined either visually or by random measurements of residual thicknesses of its members.

The average residual thickness of a girder member area, as well as the number and arrangement of residual thickness measurement points on the effective flange or web of a girder shall be determined:

in case of spot wear, in accordance with 3.2.4.1;

in case of groove wear, in accordance with 3.2.3.2.

3.2.4.3 In case of pitting, the residual thickness S_4', in mm, of a girder member and the number of measurement points shall be determined in accordance with 3.2.3.3.

3.2.5 Welded and riveted joints.

3.2.5.1 On a length of more than 0,3 m, the degree and uniformity of butt weld wear is determined by comparing the welds with the surface of the plates being joined, and the fillet weld wear is determined by measuring the weld leg.

The number of points for measuring the weld wear is determined based on the experience in technical supervision.

3.2.5.2 If a weld is worn on a length between 0,1 m and 0,3 m, its average residual thickness S_3', in mm, shall be determined as a difference between the residual plate thickness in way of the worn weld and the groove depth.

3.2.5.3 If a weld is worn on a length not exceeding 0,1 m its residual thickness S_4', in mm, is determined in accordance with 3.2.3.3 as in the case of a pitted hull element.

3.2.5.4 The wear of riveted joints is determined based on examination, tapping, random measurement of rivets and plate edges, testing the integrity of structures, for which this is required.

3.2.6 Connecting elements and local strengthening.

In case of wear of connecting elements and local strengthening, the average residual thickness S_1', in mm, is determined as an arithmetic mean of residual thicknesses measured at points uniformly distributed over the member or strengthening surface.

The number of points for measuring residual thickness over a member or strengthening shall be determined proceeding from the experience of technical supervision but it shall not be less than 2 points over the width and 2 points over the depth of the member.

If the wear in some area of a member or strengthening is much greater than in the others, the number of points for residual thickness measurement shall be increased in this area of extensive wear based on the experience in technical supervision.

3.2.7 Additional instructions on hull members measurements (bulkheads, frame rings, floors and other ship's elements).

3.2.7.1 Different patterns of measurements for bulkheads, frame rings and side shell frames, floors, beams, etc. are shown in Figs. 3.2.7-1 — 3.2.7-17. The patterns are applicable in addition to 3.2.4 and shall be applied in those cases where the measurements are part of the systematic requirements of these Rules or part of the close-up survey.

3.2.7.2 For the cargo hold hatch covers, the pattern shown in Fig. 3.2.7-16 shall be applied as minimum:

.1 three sections *L*/4, *L*/2, 3*L*/4 of hatch cover length, including: one measurement of each hatch cover plate and skirt plate; measurements of adjacent beams and stiffeners; one measurement of coaming plates and coaming flange, each side one measurement of every plate of the hatch cover plating and at the end plates of the cover;

.2 measurements of both ends of hatch cover skirt plate, coaming plate and coaming flange;

.3 one measurement (two points for web plate and one point for face plate) of one out of three hatch coaming brackets and bars, on both sides and both ends.

3.2.7.3 In respect of bulkheads, transverse sections, deep members, etc. that cannot be related to any of the above patterns, one shall be guided by the characteristics of the specific design.

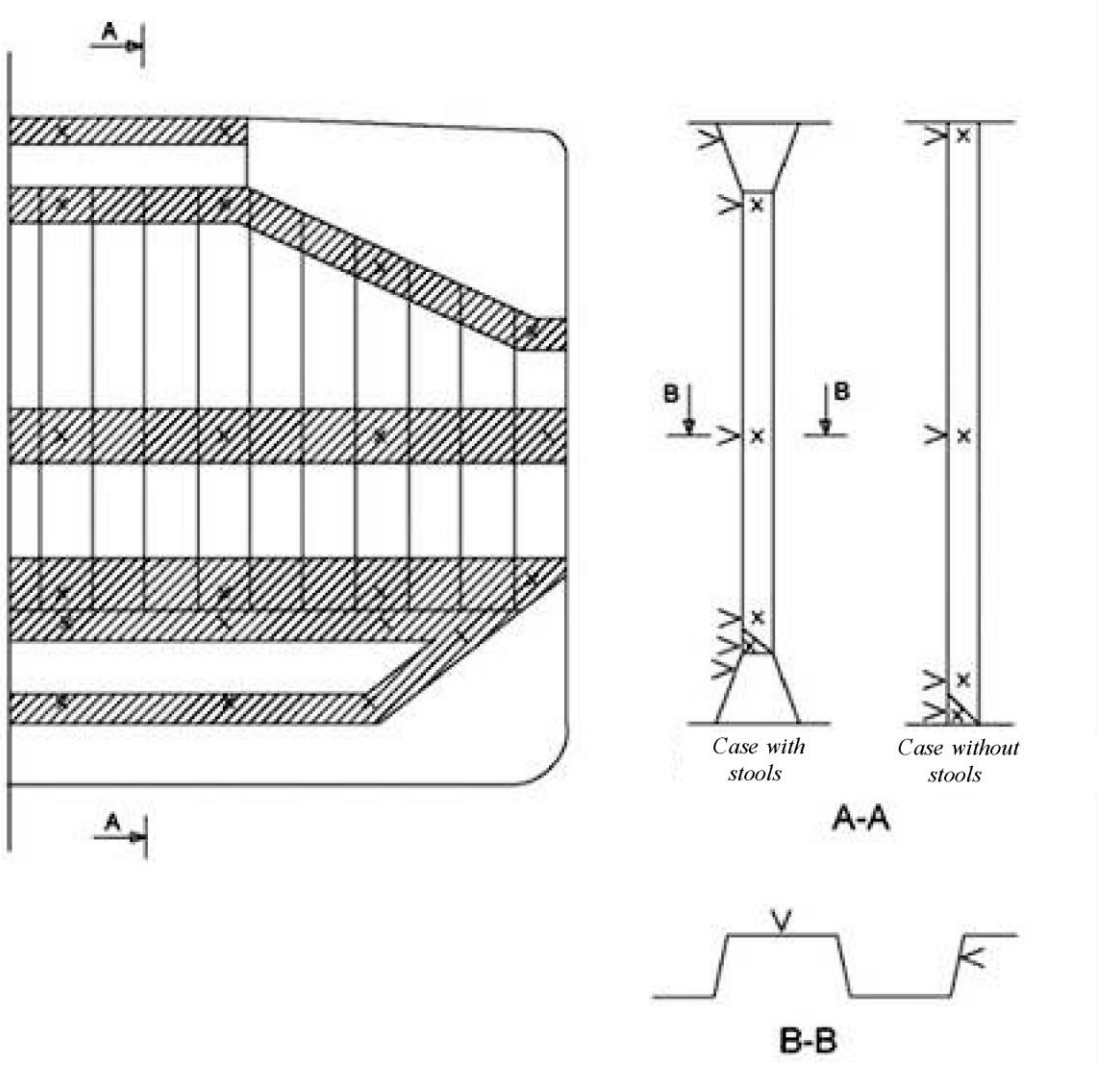


Fig. 3.2.7-1
Pattern of measurements of corrugated transverse bulkhead plating in cargo hold of bulk carrier (with upper and lower stools)

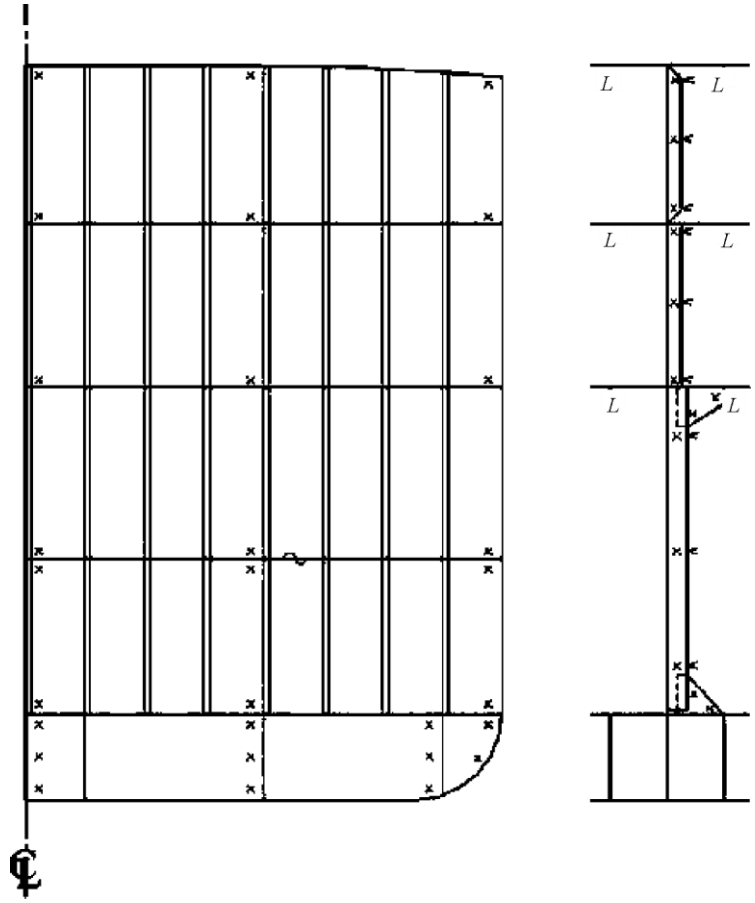


Fig. 3.2.7-2
Pattern of thickness measurements of plane transverse bulkhead plating with vertical stiffeners

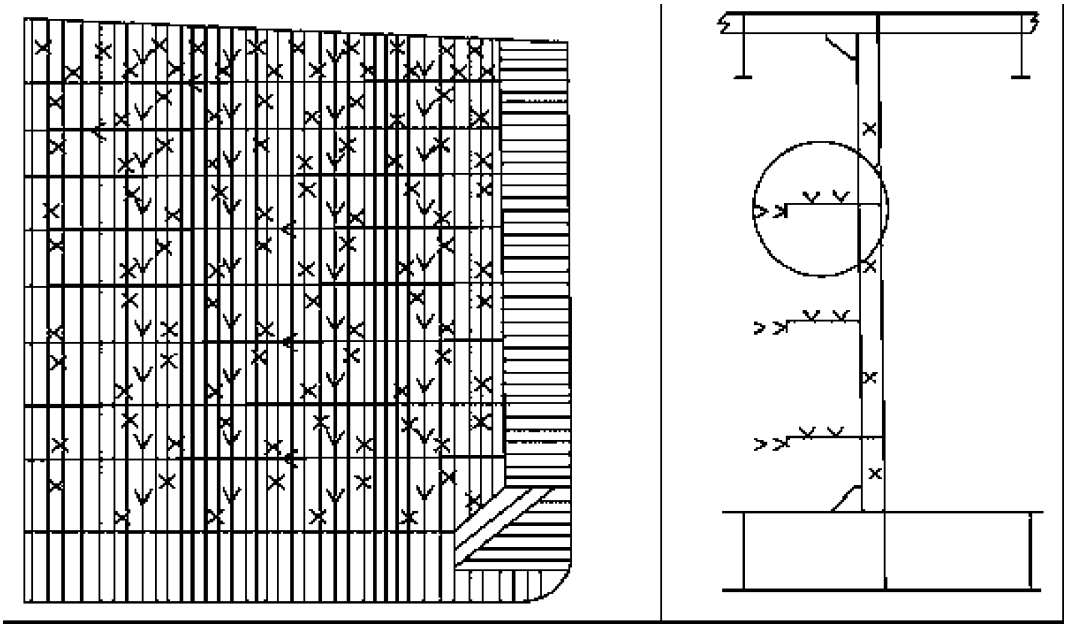


Fig. 3.2.7-3
Thickness measurements pattern of transverse bulkhead of cargo tanks of oil tanker with double sides and double bottom

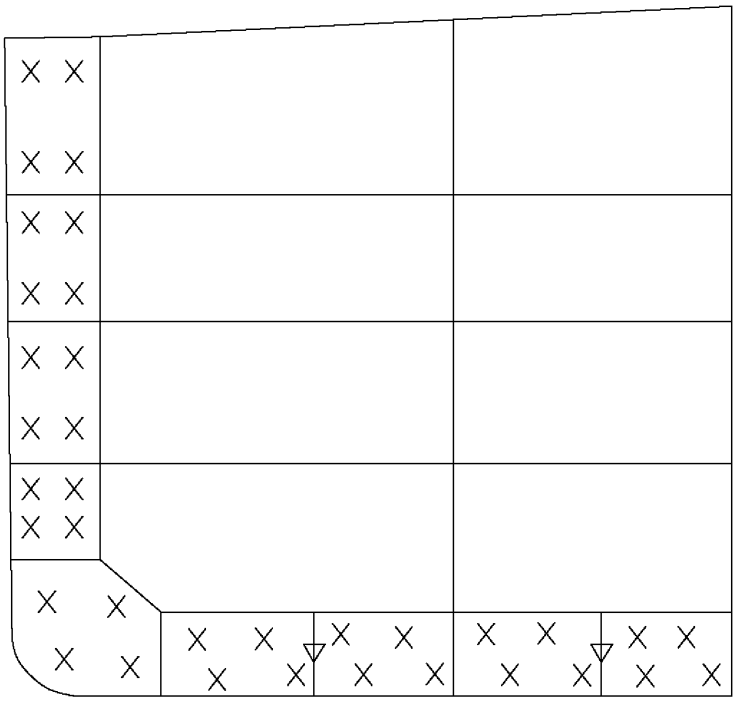


Fig. 3.2.7-4
Thickness measurements pattern of ballast tanks transverse bulkheads of oil tankers with double sides and double bottom

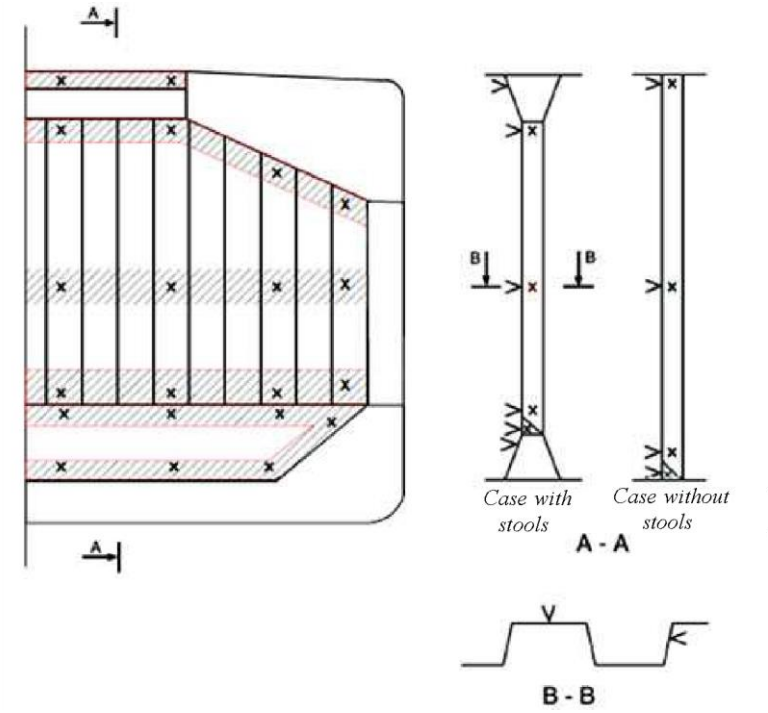


Fig. 3.2.7-5
Thickness measurements pattern of cargo hold transverse bulkheads of bulk carriers with double sides and double bottom (additional thickness measurements of internal structures of upper and lower stool shall be done, i.e. two gaugings for upper and lower stool — refer to section A-A)

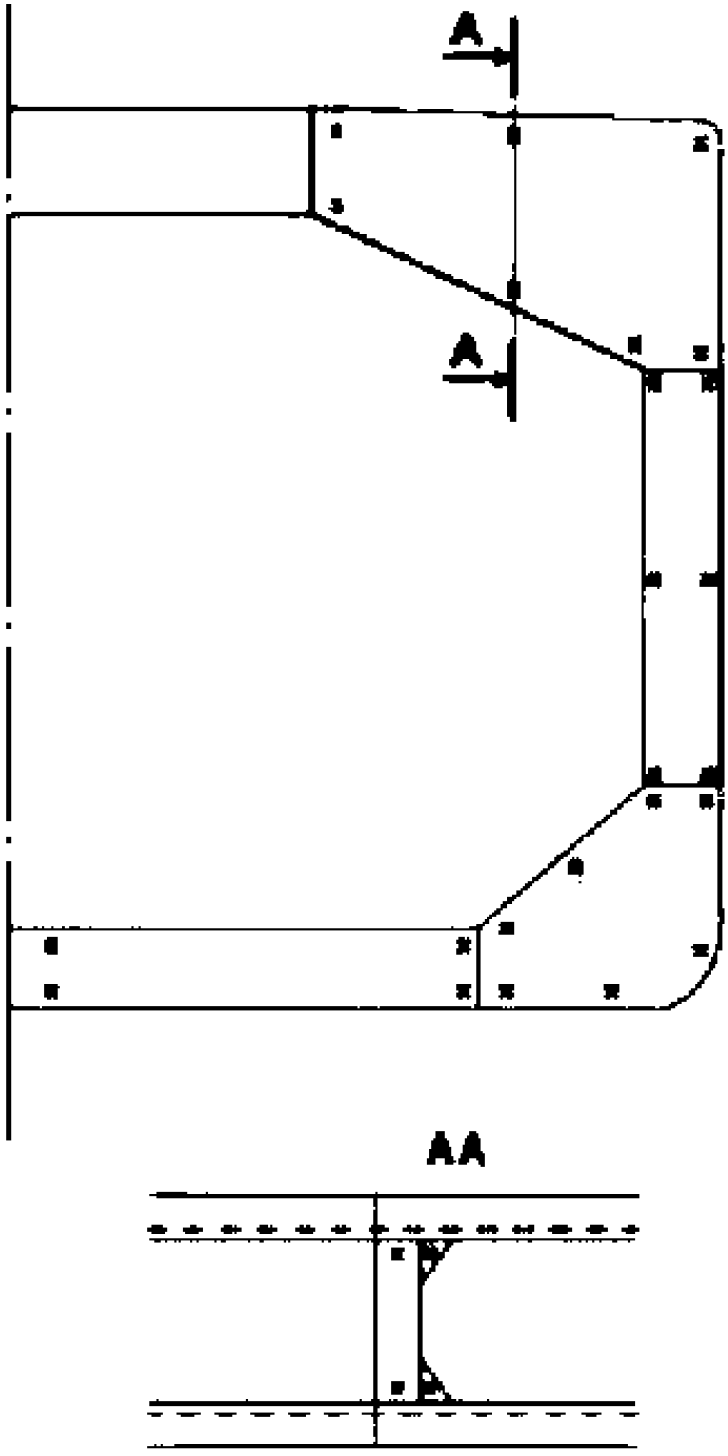
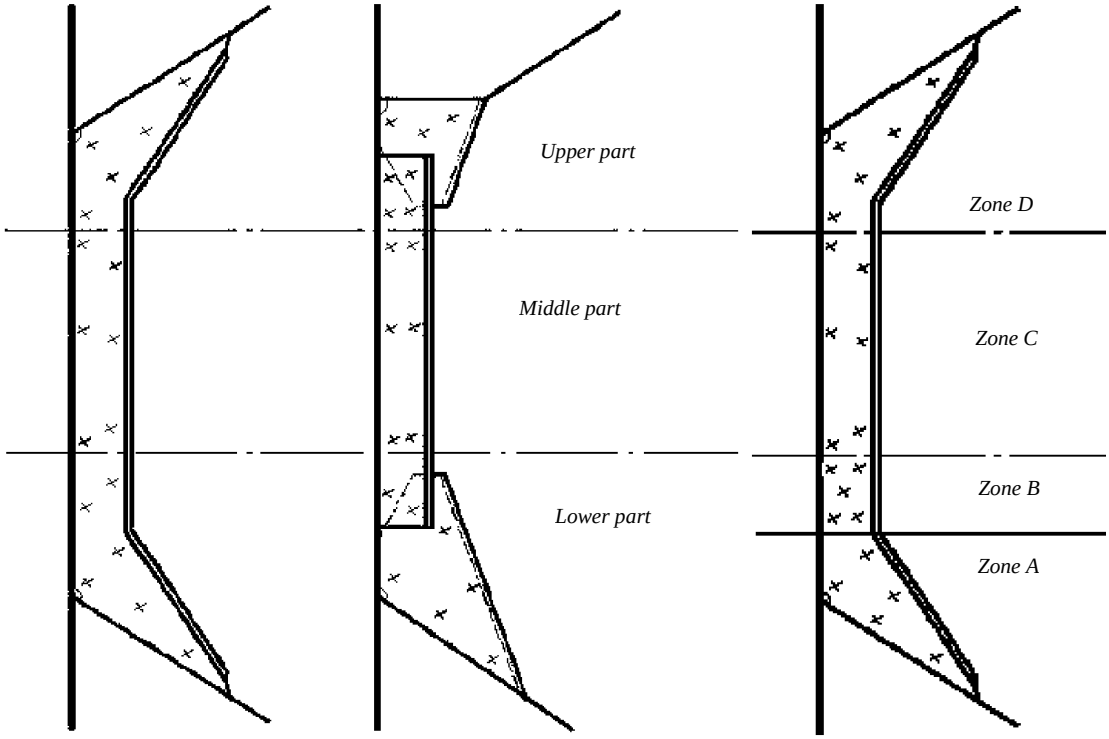


Fig. 3.2.7-6
Thickness measurements pattern for ballast tanks transverse bulkheads of bulk carriers with double sides and double bottom



Figs. 3.2.7-7 and 3.2.7-8
Pattern of measurements of side shell frames in bulk carriers according to IACS UR S31 and frames of other ships, respectively

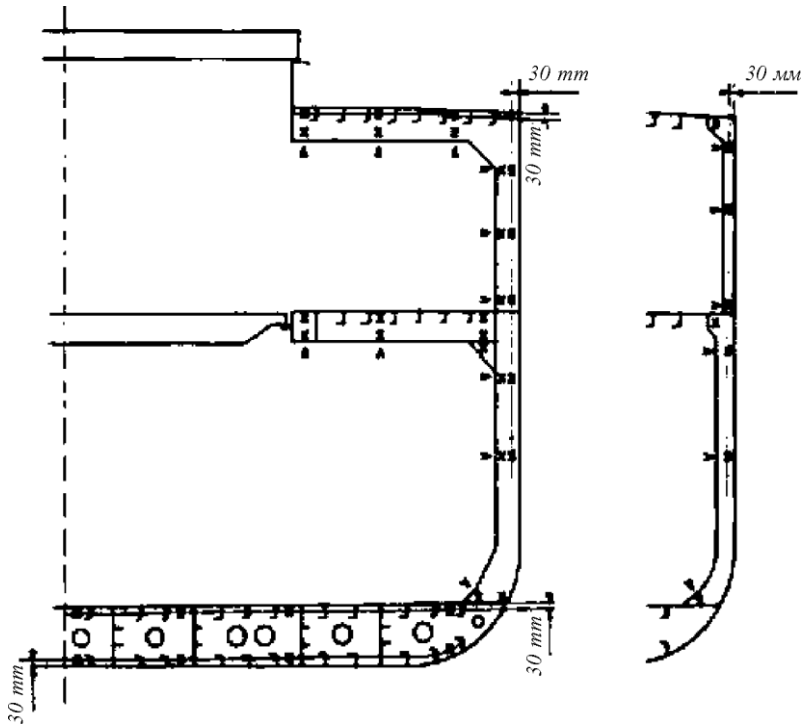


Fig. 3.2.7-9
Pattern of transverse framing measurements in ships of all types, except for bulk carriers and oil tankers (random measurements of adjacent framing and plating shall be also taken)

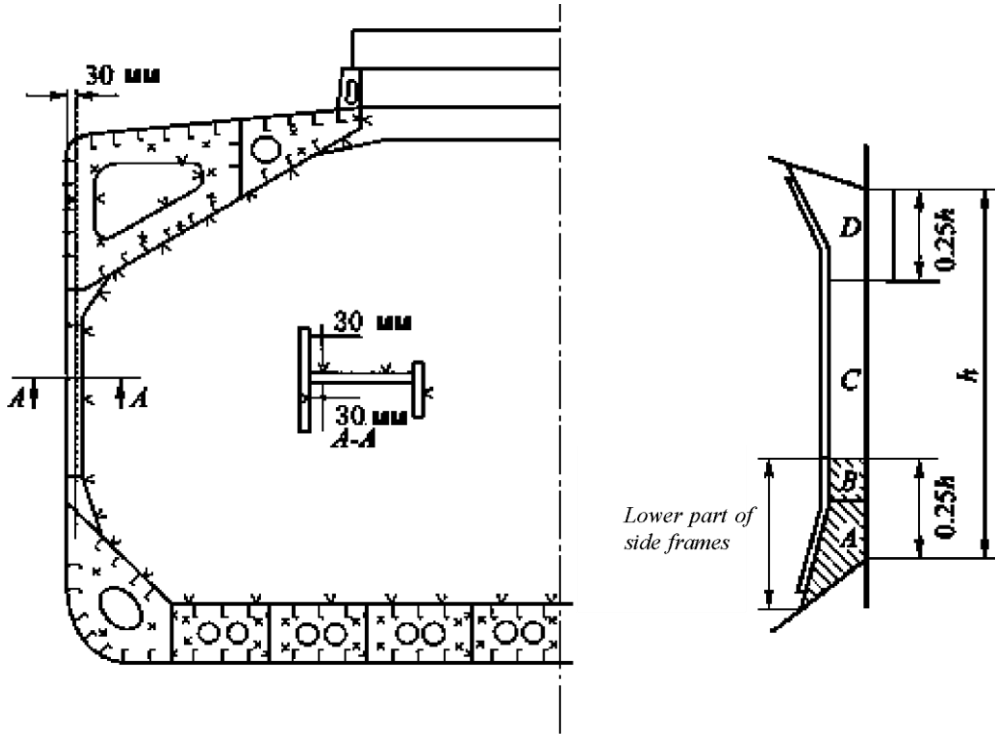


Fig. 3.2.7-10
Pattern of transverse framing measurements in single skin bulk carriers

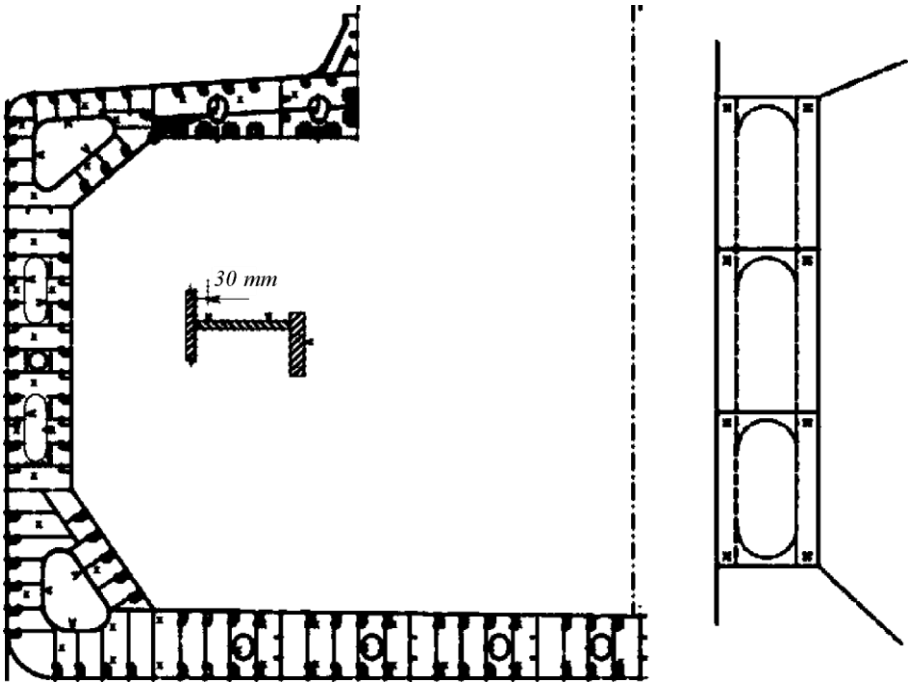


Fig. 3.2.7-11
Thickness measurement pattern for ballast tank transverse framing on bulk carriers with double sides and double bottom

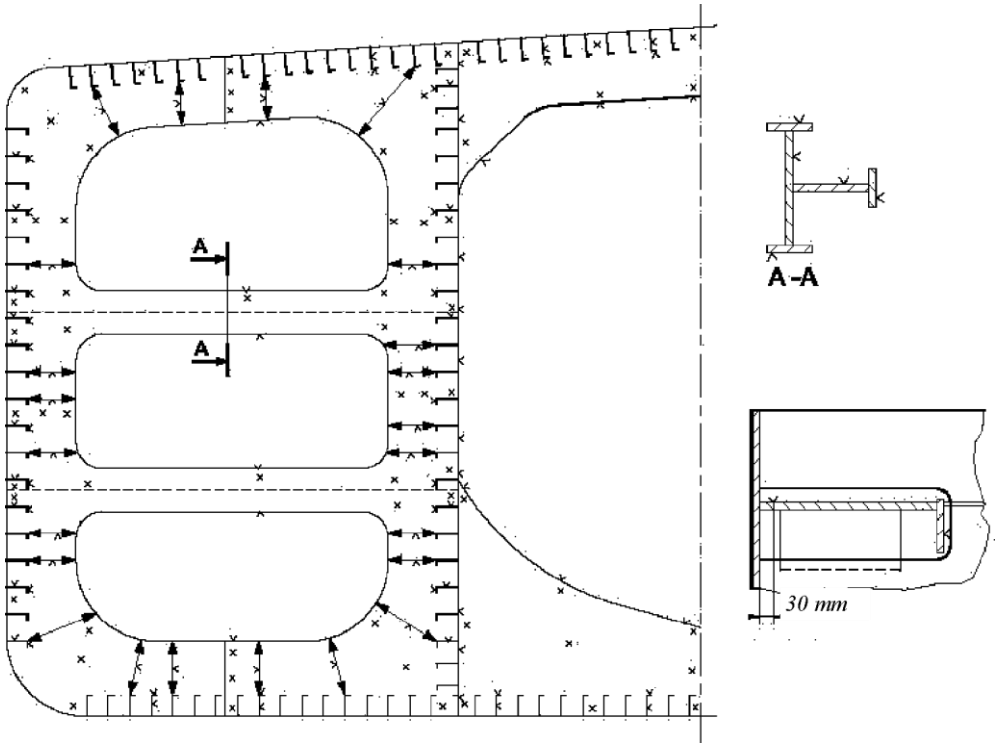


Fig. 3.2.7-12
Pattern of transverse frame measurements in single hull oil tankers

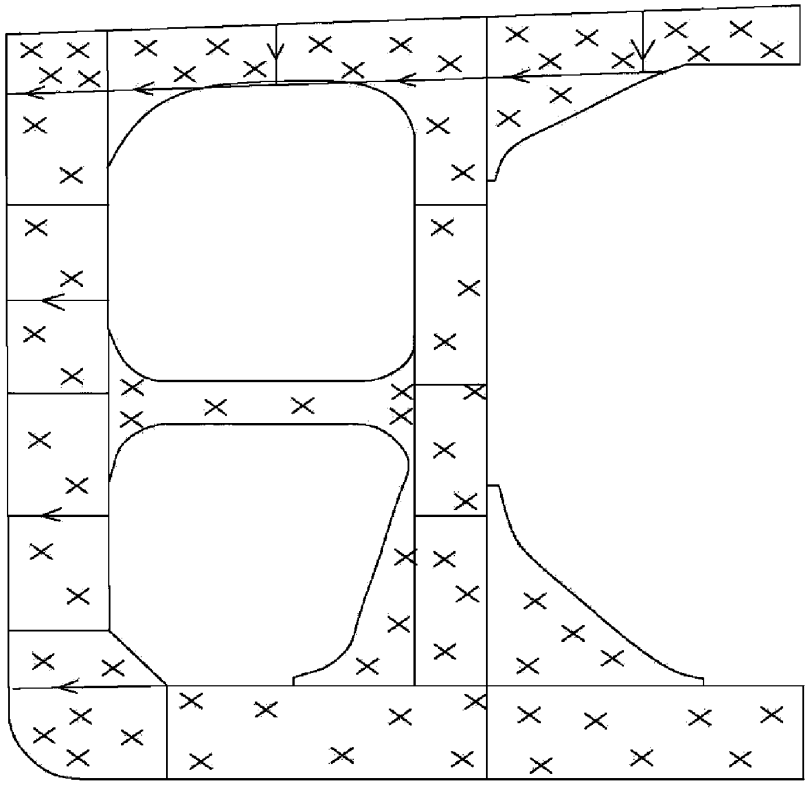


Fig. 3.2.7-13
Thickness measurement pattern for web frame rings of oil tankers with double sides and double bottom

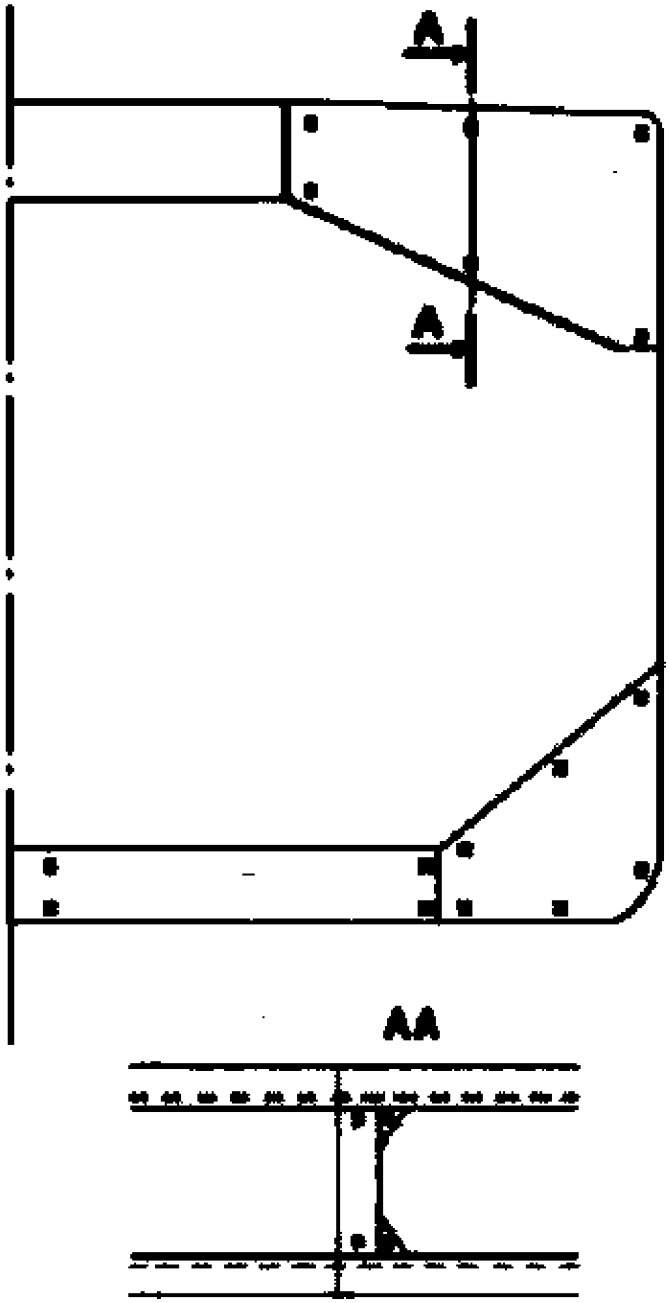


Fig. 3.2.7-14
Pattern of transverse bulkhead measurements in topside and hopper side tanks, and tight floors of bulk carriers

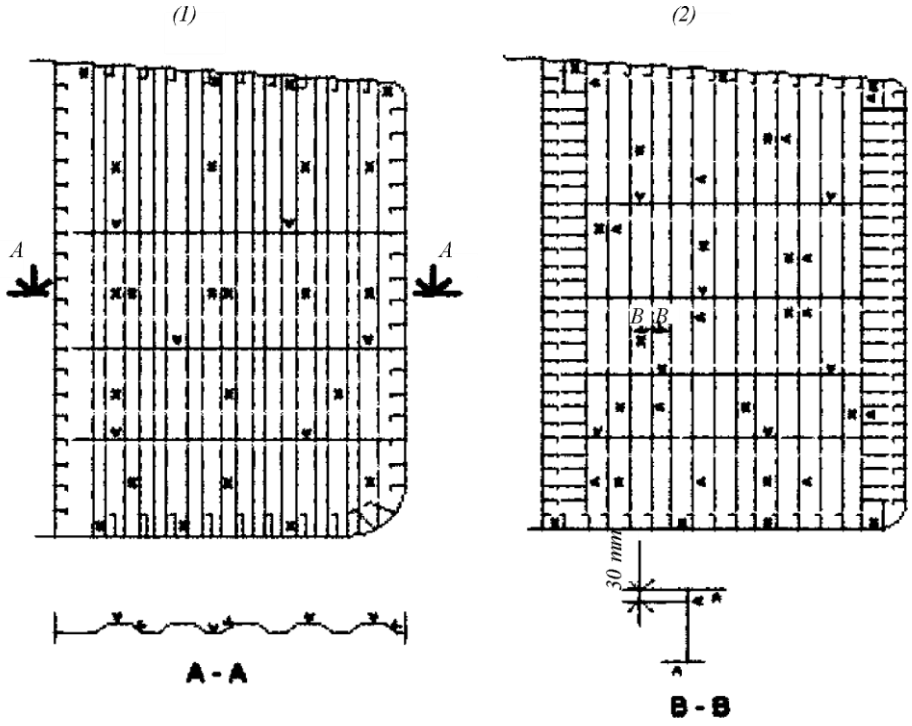


Fig. 3.2.7-15
Thickness measurements of transverse bulkheads in oil tankers
(1) — corrugated bulkhead
(2) — plain transverse bulkhead

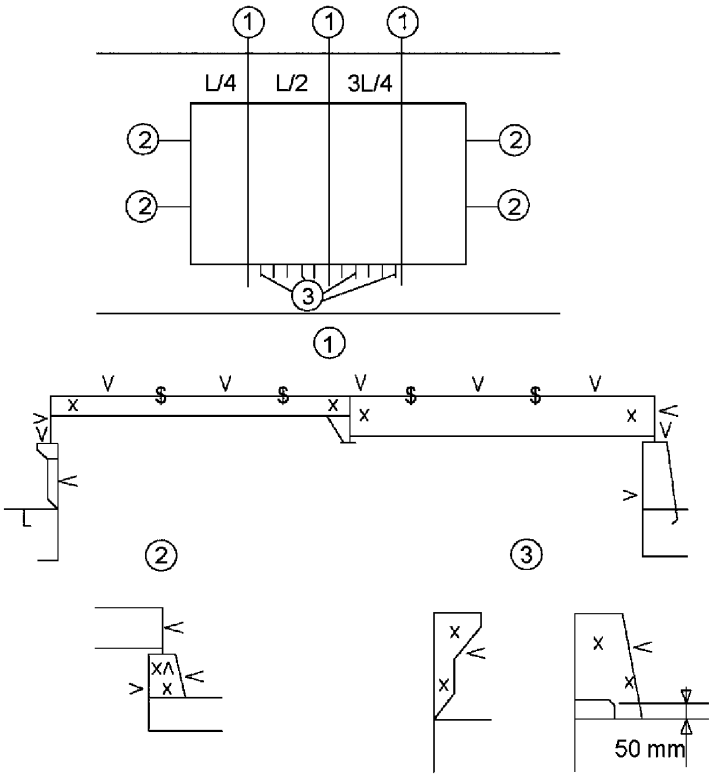


Fig. 3.2.7-16
Pattern of plating thickness measurements of hatch covers and hatch coamings of cargo holds

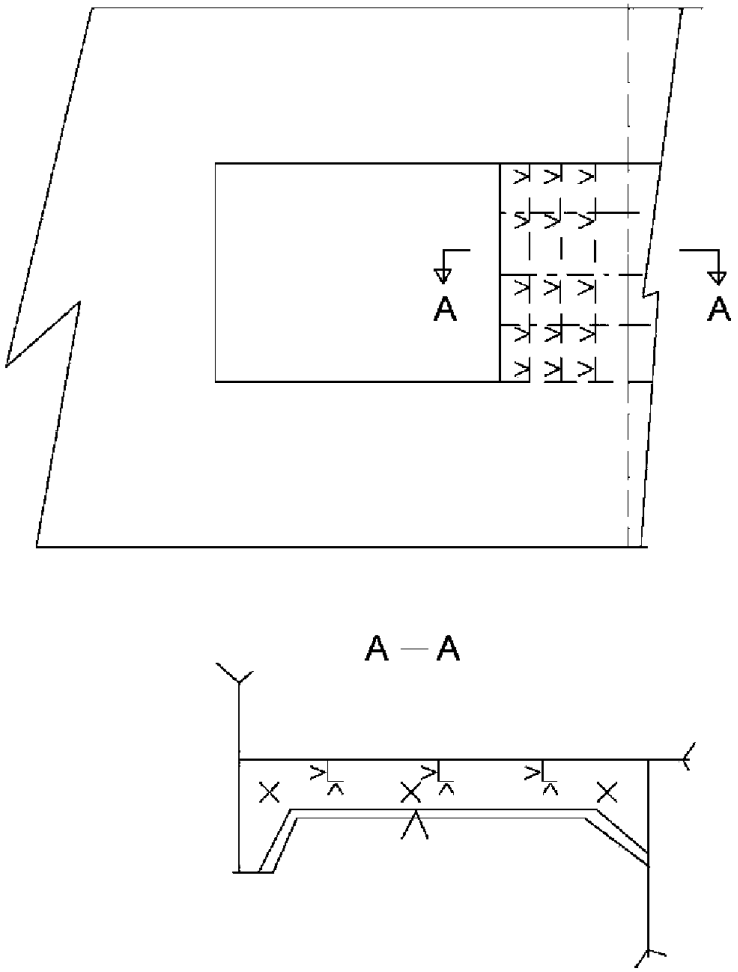


Fig. 3.2.7-17
Thickness measurement pattern of deck framing

3.2.8 Requirements for measurements and calculation of permissible wear limits for ship's arrangements, masts and other ship's elements for assessment of their technical condition.

3.2.8.1 For the assessment of the technical condition of the hull watertight closing appliances, ship's arrangements, masts, branches of the bottom and side valves, pipelines and other ship's elements it necessary to fulfill relevant requirements of these Rules and the Guidelines. Summary information on the requirements for measurements and their frequency as well as for calculation of the permissible wear limits is given in Annex 2-6 to this Annex.

3.3 STRUCTURES WITH DEFORMATIONS

3.3.1 Examination of structures.

3.3.1.1 Condition of hull structures with deformations is characterized by camber and the dimensions of deformed areas of structures in projection.

3.3.1.2 The type of hull member deformation shall be determined visually during the ship survey based on the experience in technical supervision. In the same cases, additional measurement of camber in stiffeners may be required to determine the deformation type.

3.3.1.3 The deformation parameters shall be measured with regard to the initial non-deformed surface using standard measuring devices, such as a ruler, a caliper with a depth meter, an indicating gage, etc.

When deformed sections of structures are measured in profile, the precision shall be 100 mm at least, for maximum camber, this shall not be less than 1 mm, and for 300 mm based camber, not less than 0,1 mm.

3.3.1.4 The results of measurements shall be drawn up in accordance with Section 6. The deformation type, results of camber measurements and other standardized parameters of the hull member deformations shall be indicated in the appropriate drawings of the gauged structures (shell expansion drawings, deck, double bottom and bulkhead plans, etc.).

3.3.1.5 Deformed hull members shall be examined with due regard to the service conditions for the structures and based on the experience in technical supervision.

3.3.2 Hull cross-sectional characteristics.

3.3.2.1 For determining the total deflection, corrugation and bulge length $\sum_{i=1}^{n} l_{i_{b(d)}}$, in m, the weakest hull cross-section is chosen amidships having a length not greater than 5 spacings in an area where deformations in the strength deck or bottom are the most numerous.

The dimensions of deformations $l_{i_{b(d)}}$, in m, shall be summed up, separately for the deck outside the line of hatch openings and bottom including the bilge, in the chosen hull cross-section irrespective of the relative camber values.

If deformed hull members are strengthened in accordance with 5.3.2, the deformations may not be included in the total length of deflections, ribs and indentations.

3.3.2.2 The hull section ultimate bending moment $M''_{sag(hog)}$ and/or residual ultimate hull section modulus $W''_{d(b)}$ shall be determined in case of ship hogging and sagging in accordance with the procedures approved by the Register. In any case, the reduction of compressed hull members and of those deformed hull members, which are compressed and strained, shall be considered. The calculation of $M''_{sag(hog)}$ and/or $W''_{d(b)}$ shall be reviewed and agreed upon by the Register.

3.3.3 Deflections and ribs.

3.3.3.1 The maximum camber f', in mm, of a deflection or a rib shall be measured with regard to girders. The pattern of measuring f' is illustrated in Fig. 3.3.3.1.

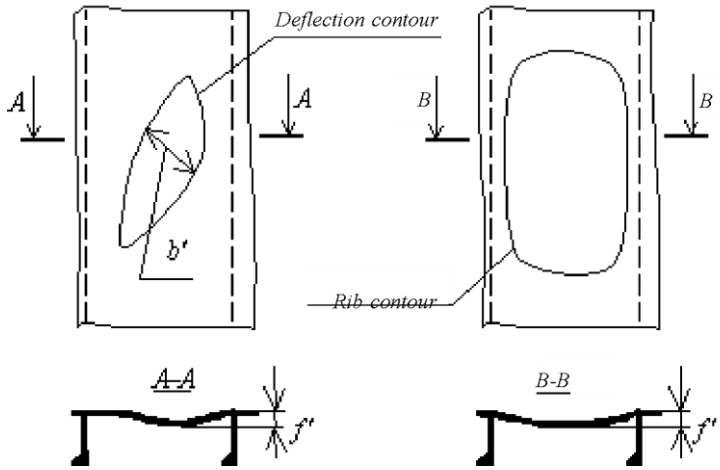


Fig. 3.3.3.1
Measurement of deflection and rib parameters

3.3.3.2 The minimum size of deflection in profile b', in mm, is measured in the area of the maximum hogging. The pattern of measuring b' is illustrated in Fig. 3.3.3.1.

3.3.3.3 The maximum rib camber f', in mm, is determined as the maximum value measured for each rib.

3.3.3.4 The spacing *a*, in mm, of primary members is either determined by the structural plan or is measured on the structure.

3.3.4 Indentations.

3.3.4.1 In case of the structure with an indentation where 10 successive primary members are deformed, measurements shall be taken on each girder, where 10 — 15 girders are deformed, every other girder may be measured, and where 15 or more girders are deformed every third girder may be measured including the one having the maximum camber f'.

If all conditions of Formula (2.3.3.3-1) are met for in case of a girder with a maximum camber, the other girders found in the area of the indentation may not be measured.

3.3.4.2 The maximum camber f', in mm, and length l', in mm, of the deformed girder section shall be measured in the same plane, in which the girder lies. The patterns of measuring f' and l' are shown in Fig. 3.3.4.2, *a*.

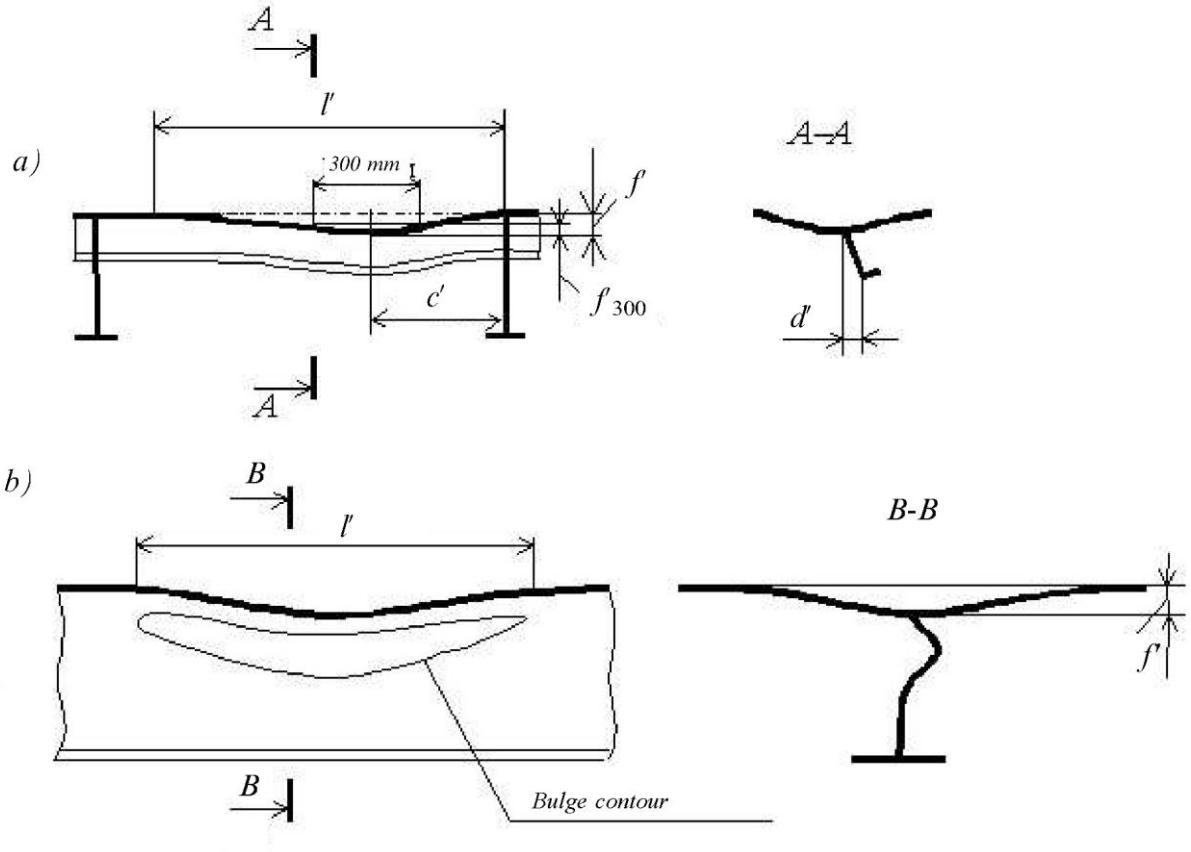


Fig. 3.3.4.2
Measurement of indentation parameters:
a) for primary members; *b*) for web framing girders and plate elements

3.3.4.3 The deviation d', in mm, of a girder web from its initial position is measured on the faceplate level where the deviation is the greatest. The pattern of measuring d' is shown in Fig. 3.3.4.2, *a*.

3.3.4.4 The girder depth *h*, in mm, is determined from the structural plan or is measured on the structure.

3.3.4.5 The distance between the girder section c', in mm, at which the camber is the greatest and its nearest non-deformed support shall be measured in the same plane, in which the girder lies. When measuring the value of c', web frames/girders fitted perpendicularly, as well as decks, platforms, bulkheads, etc. serve as supports for a primary member. The pattern of measuring c' is shown in Fig. 3.3.4.2, *a*.

3.3.4.6 The 300 mm-based camber f'_{300}, in mm, of a girder is measured in way of the maximum camber f'. Recommendations for measuring the f_{300}' parameter are given in Annex 2-2. The pattern for measuring f'_{300} is shown in Fig. 3.3.4.2, *a*.

3.3.4.7 The maximum camber f', in mm, and the deformed area length l', in mm, of a girder or plate elements are measured in the same plane, in which they lie. The patterns of measuring f' and l' are shown in Fig. 3.3.4.2, *b*.

3.3.5 Connecting elements and local strengthening.

The necessity for examining the connecting elements and local strengthening, as well as the necessity and procedure for measuring the deformation parameters therein shall be determined based on the experience in technical supervision.

3.4 STRUCTURES WITH CRACKS AND RUPTURES

3.4.1 Examination of structures.

3.4.1.1 Condition of the hull structures with cracks and ruptures is characterized by their type, location within the structure, length, area, orientation and opening displacement, which are determined by measurements.

3.4.1.2 The type of crack or rupture is determined visually during the hull survey and based on the experience in technical supervision.

3.4.1.3 The cracks and ruptures in hull members may be revealed as a result of examination, tests and by using the following testing methods:

radiographic testing;

ultrasonic testing;

magnetic particle testing;

dye penetrant testing;

using aqueous dispersions, kerosene with chalk, etc.

3.4.1.4 The crack or rupture parameters are measured on the surface of the damaged hull member by means of a caliper, ruler or other measuring devices, which ensures an accuracy of not less than 5 mm.

3.4.1.5 The results of measurements shall be drawn up in accordance with Section 6. Cracks with indication of their length, opening displacement and orientation shall be indicated in the appropriate drawings of the cracked structure.

3.4.1.6 The examination of hull members with cracks and ruptures shall be carried out with due regard to the service conditions of the structures and based on the experience in technical supervision.

3.4.2 Measurement of crack parameters.

The crack length λ', in mm, in a hull member is measured on the shortest distance between its ends. The location of the crack end shall be determined visually with an addition of 10 mm.

The opening displacement t', in mm, of a crack is determined by the maximum distance between its edges. The crack orientation in a member is determined by the angle α, in deg., formed by the line connecting the beginning and end of the crack, and the centre plane or base plane of the ship.

4 STANDARDS FOR HULL WITH DEFECTS

4.1 GENERAL

4.1.1 The present Section contains the standards for defective hull members for determining the technical condition of the hull in accordance with the provisions of Section 2.

4.1.2 The standards contained in the present Section regulate the technical condition of hull members corresponding to the "complying" hull condition as per Section 2.

4.1.3 The standards for the "complying" hull condition shall be determined based on the current RS class and 5-year periodicity of special surveys.

4.1.4 In order the hull technical condition could be assessed as "complying" in case some standard is not complied with, the possibility of relevant changing of class notation and ship purpose may be reviewed by RHO at the shipowner's request. In this case the shipowner shall submit technical background to service conditions limitations and/or reduction of intervals between surveys to ensure the required level of ship safety for the current technical condition of the hull or to reduce the repair extent (refer also to 5.1.6).

4.1.4.1 Limitations of service conditions specified for a ship shall be assigned based on the current hull technical condition and the shipowner's intentions concerning the future service of the ship. The introduction of service limitations will involve a modification of the relevant requirements of the Rules for Construction for the dimensions and characteristics of hull members.

The limitations of specified service conditions for a ship may refer to the following:

area of navigation;

weather conditions and navigation season (sea condition, wind force);

speed and power of main propulsion plant;

type of cargo carried;

distribution and rate of ship loading (specific distribution of carried cargo and ballast, increase of freeboard and minimal forward draught);

method and procedure of cargo handling operations;

conditions of ice navigation;

conditions of mooring at sea (weather and hull regions, by which mooring is permitted).

The above limitations may be applied in combination and other limitations may be applied on agreement with the Register.

4.1.4.2 Reducing the intervals to less than 5 years between surveys preceding the repair or scrapping of the ship makes it possible to low the standards for hull members. This provision does not apply to ships aged 30 years and above.

4.1.5 For all ships, the standards may be determined based on 4.2.1 — 4.2.5, 4.3 and 4.4.

4.1.5.1 On agreement with the Register, the standards may be specified based on the experience in ship operation and calculation estimates.

4.1.5.2 For a ship, in which the parameters of defects exceed 75 % of permitted values[1], the standards for similar members or the date of next survey may be specified in accordance with 4.4 and, at the RS surveyor's discretion, submitted by the shipowner or shipowner's representative to the Register for agreement in the following cases:

the annual average wear of more than 25 % on similar members exceeds the values stipulated in the Rules for Construction;

deformation parameters in hull members progress (increase) during routine ship service.

4.1.5.3 The provisions of 4.2.1 — 4.2.3 of this Section make it possible to develop standards for hull members with wear, bearing in mind the hull structural features and the service conditions of the ship.

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[1] By the permitted wear of hull members, the difference between their as-built and permissible residual thickness is meant.

The standards are established based on the hull member dimensions required by the newly published Rules for Construction for a new hull disregarding the reduced design service life of the ship and corrosion protection being provided. Where the dimensions of particular members do not comply with the requirements of the Rules for Construction or where the latter do not contain the requirements for the members, the standards shall in each case be reviewed by the Register.

4.1.5.4 The application of the Rules for Construction published in the previous years, as well as determining the standards for particular hull members based on the as-built dimensions, is subject to agreement with RHO.

4.1.6 For ships, which class has not been changed since construction, the standards for hull members with wear may be determined during the hull flaw detection according to 4.2.6 of this Section, based on the as-built dimensions of the members, unless special norms or standards determined using the Rules for Construction, and based on 4.2.1 — 4.2.3 of this Section are available.

4.1.7 For hull members with wear in ships built in non-compliance with the Rules for Construction, classed with or transferred to RS class from ACS — non-IACS member, the relevant standards shall be determined based on 4.2.1 — 4.2.3 with due regard to 4.1.5.3 of this Section. Standard determination based on 4.2.6 of this Section is not permitted.

4.1.8 For ships, which are being transferred from the class of ACS — IACS member and after that, the standards for hull members with wear may be determined based on the rules of the loosing society.

4.1.9 For ships, which subsequent service shall not exceed 5 years, the standards for hull members with wear may be determined with due regard to 4.2.8.

4.1.10 A simultaneous application of standards for hull members with wear, which were determined based on 4.2.1 — 4.2.3 and 4.2.6, as well as standards of ACS — IACS member and 4.2.6 is not permitted.

4.1.11 Permissible residual dimensions in the calculation shall be specified for all hull members, hull section modulus for which the residual thickness measurements are required during their service life. At the customer’s discretion, the calculation may be made in either Russian or English, or both Russian and English languages. The cover page and summarized table in the calculation of permissible residual scantlings shall be only in English, or in both Russian and English. The exceptions are ships flying the RF flag and not engaged on international voyages, for which the calculation may be made only in Russian.

The standards for defective hull members shall be drawn up as a calculation of permissible residual scantlings of hull members made according to the Rules for Construction and agreed with the Register, shall contain at least the following sections, chapters and appendices:

Section 1. Introduction.

This Section shall contain the following text: "This calculation has been made according to the Rules … (please indicate the title of the Rules) and do not apply to the ship (please indicate the name of the ship), RS No. (identification number) …, IMO No. …" (it is advised to leave a blank space below the text to indicate, if necessary, the name(s) of similar ship(s) as well as her/their RS No. and/or IMO No.);

Section 2. Initial data.

In this Section the hull structural drawings shall be listed with indication of their numbers as well as the approved Loading Manual and/or Stability Booklet. According to this documentation as well as List of Survey's Status, this Section shall specify ship's main particulars, including minimum forward draught for a ship in ballast condition, frame spacing, distance between longitudinals, amidships position, disposition of watertight bulkheads, steel grade, permissible still water bending moments and shear forces, permissible loads for cargo decks and double bottom.

Section 3. Calculation of permissible scantlings of hull members.

Chapter 3.1. Calculation of permissible hull section modulus in accordance with 2.2.1.2.

Chapter 3.2. Additional calculation of permissible ultimate hull section modulus in accordance with 2.2.1.3, if applicable.

Chapter 3.3. Calculation of permissible side shell thickness for bulk carriers with single sides and ships with side doors or/and shell doors in accordance with 2.2.1.4.

Chapter 3.4. Calculation of permissible hull member thickness and geometric parameters (section modulus and web cross-sectional area of a girder) in accordance with 2.2.2 — 2.2.5 of this Annex.

The permissible thickness of strength deck plating shall be determined taking into account the requirements of 2.6.4.1.1, Part II "Hull" of the Rules for the Classification and Construction of Sea-Going Ships.

In case the corrosion rate is increased as compared with the mean annual values as per the Rules of Construction, the information shall be specified on the revised wear standards or service life in accordance with 4.4.

Chapter 3.5. Calculation of permissible residual deformations in accordance with 2.3.

In case the residual deformations are increased, the information shall be specified on the revised/adjusted residual deformations or the service life in accordance with 4.4.

Section 4. Conclusion.

This Section shall specify the values of permissible residual scantlings of hull members in terms of total, local wear and pitting as well as the upper limit of substantial corrosion area. The permissible scantlings are given in a tabular form. For model tabular form refer to Annex 2-4 of this Annex.

The Section shall also contain a list of hull members for which at least one of permissible scantlings is greater than the as-built value. A full description of strengthenings (location and dimensions including weld sizes and steel grade) shall be made for each hull member stated in the list, or there shall be a reference to the attached schemes of strengthenings — refer to Appendix 4 stated below. In this case, there shall be stated that the hull technical condition without any strengthenings does not comply with the RS requirements.

Appendix 1. Verification of the hull members for compliance with the requirements of the Rules for Construction (in a tabular form).

Appendix 2. Calculation of required thickness of strength deck plating in accordance with 2.6.4.1.1, Part II "Hull" of the Rules for the Classification and Construction of Sea-Going Ships.

Appendix 3. Direct strength calculations (in case they are required by the Rules for Construction).

Appendix 4. Schemes of hull members strengthening — refer to Section 4 "Conclusion" stated above.

4.2 STRUCTURES WITH WEAR

4.2.1 Hull cross-sectional characteristics.

4.2.1.1 The permissible residual hull section modulus $[W_{d(b)}]$, in cm^3, for a deck or bottom is determined from the formula

$$[W_{d(b)}] = kW_{d(b)} \qquad (4.2.1.1\text{-}1)$$

where $W_{d(b)}$ = hull section modulus, in cm^3, for a deck or bottom, as required by the Rules for Construction for a new ship;

k = a factor equal to the following:
for ships operating in unrestricted areas of navigation and ships having distinguishing marks for restricted areas of navigation **R1, R2** in their class notations;

$$k = 0{,}65 + 0{,}0012l \qquad (4.2.1.1\text{-}2)$$

L = design ship length, in m;

for ships, having the distinguishing marks for restricted areas of navigation **R2-RSN**, **R2-RSN(4,5)**, **R3-RSN**, **R3** in their class notations:

$$k = 0{,}70 + 0{,}0012l \text{ but not less than } 0{,}8. \qquad (4.2.1.1\text{-}3)$$

In any case, the factor *k* shall not be adopted more than 0,90.

For ships, which deck and continuous longitudinals on the outer side of the deck, including the box and continuous side coamings, are made of materials having different yield strength, the permissible residual hull section modulus $[W_d]$, in cm^3, for a deck shall be increased by multiplying it by the factor k_1 to be determined from the formula

$$k_1 = \frac{\eta_d}{\eta_c} \cdot \frac{z_d}{z_c} \text{ but not less than } 1 \qquad (4.2.1.1\text{-}4)$$

where η_d = steel mechanical properties utilization factor for deck, to be determined from the Rules for Construction;

η_c = steel mechanical properties utilization factor for continuous longitudinals on the outer side of the deck, to be determined from the Rules for Construction;

z_d = distance, in m, between the strength deck and the neutral axis of the hull cross-section;

z_c = distance, in m, between the upper flanges of continuous longitudinals on the outer side of the deck and the neutral axis of the hull cross-section.

For ships of 90 m in length and above of unrestricted area of navigation, as well as for all ships of 200 m in length and above regardless of their area of navigation, the permissible residual hull girder section modulus at deck or bottom $[W_{d(b)}]$, in cm^3, shall additionally comply with the condition

$$[W_{d(b)}] \geq 0{,}9W_{min} \qquad (4.2.1.1\text{-}5)$$

where W_{min} = minimum hull girder section modulus within the midship region (for deck and bottom), in cm^3, required by the Rules for Construction.

4.2.1.2 The required ultimate hull section bending moment in case of sagging, hogging M_{ult}, in kNm, is determined from the formula

$$M_{ult} = 1{,}1 \cdot |0{,}92M_w + M_{sw}| \qquad (4.2.1.2\text{-}1)$$

where M_w, M_{sw} = bending moments in case of sagging, hogging, in kNm, to be determined from the Rules for Construction.

The permissible residual ultimate hull section modulus $\left[W^u_{d(b)}\right]$, in cm^3, for a deck or bottom is determined from the formula

$$\left[W^u_{d(b)}\right] = \frac{M_{ult}}{\sigma_n} \cdot 10^3 \qquad (4.2.1.2\text{-}2)$$

where σ_n = standard yield stress of deck (bottom) material, in MPa, in accordance with the Rules for Construction.

4.2.1.3 Permissible residual thickness of side shell plating, inner side, continuous longitudinal bulkhead $\left[S_{s(b)}\right]$, in mm, to be determined from the formula

$$\left[S_{s(b)}\right] = kS_{s(b)} \qquad (4.2.1.3)$$

where k = factor given in 4.2.1.1;
$S_{s(b)}$ = thickness, in mm, of side shell plating, inner side or longitudinal bulkhead, as required by the Rules for Construction.

4.2.2 Plates.

4.2.2.1 In case of total wear, the permissible residual plate thickness $[S_1]$, in mm, is determined from the formula

$$[S_1] = m_1(S - \Delta S) \qquad (4.2.2.1\text{-}1)$$

where m_1 = factor to be adopted from Table 4.2.2.1-1;
S = plate thickness, in mm, required by the Rules for Construction without taking into consideration the requirements for minimal thickness;
ΔS = wear allowance, in mm, to be determined from the Rules for Construction.

The permissible residual plate thickness $[S_1]$, in mm, shall additionally comply with the following: in the general case

$$[S_1] \geq m_2 S_{min}; \qquad (4.2.2.1\text{-}2)$$

for ships built to the RS Rules whose keel was laid before 1 October 1990 (may also be applied to series of ships built to the RS Rules irrespective the keel laying date, provided that the keel of the prototype ship was laid before 1 October 1990)

$$[S_1] \geq 0{,}5S_0; \qquad (4.2.2.1\text{-}3)$$

for ships built to the RS Rules whose keel was laid on or after 1 October 1990 as well as to the Rules of other classification societies or without technical supervision of any classification society

$$[S_1] \geq 0{,}7S_0 \qquad (4.2.2.1\text{-}4)$$

where m_2 = factor to be adopted from Table 4.2.2.1-1 of this Chapter;
S_{min} = minimal plate thickness, in mm, required by the Rules for Construction;
S_0 = as-built plate thickness.

The factors m_1 and m_2 indicated in Table 4.2.2.1-1 are used for ships of 90 m in length and above; for ships of 65 m in length and below, the factors m_1 and m_2 shall be the some along the ship length and assumed equal to the values at the ship's ends; for ships' intermediate lengths, the values of m_1 and m_2 shall be determined by linear interpolation.

The difference $[S_1]$ of permissible residual thicknesses of two adjacent plates shall not exceed 3 mm.

In any case, the permissible residual thickness for total wear shall not be less than the permissible residual thickness determined from Formula (4.2.2.3).

Table 4.2.2.1-1

Factors m_1, m_2 and m_0 for plates

Nos.	Structural member	Region of ship length	Ships of group I[1]		Ships of group II[1]		Ships of groups I and II[1]
			m_1	m_2	m_1	m_2	m_0
1	**Decks and platforms[2]**						
1.1	Upper strength deck[3], continuous hatch side coaming	midship	0,85	0,75	0,80	0,70	0,80
		region ends	0,75	0,65	0,75	0,65	0,70
1.2	Second continuous deck lying higher than 0,75*D* above the base plane[3], trunk deck; another continuous deck adjacent to the hatch coaming top of the cargo hold, with the adjacent side plating	midship	0,80	0,65	—	—	0,80
		region ends	0,75	0,60			0,70
1.3	Other decks and platforms	—	0,75	0,65	—	—	0,70
2	**Sides[2]**						
2.1	Sheerstrake	midship	0,85	0,75	0,80	0,70	0,80
		region ends	0,75	0,65	0,75	0,65	0,70
2.2	Outer side:						
	in the region of alternating waterlines	full length	0,75	0,65	0,75	0,65	0,70
	outside the region of alternating waterlines	midship	0,80	0,70	0,80	0,70	0,70
		region ends	0,75	0,60	0,75	0,60	0,70
2.3	Inner side						
	upper strake	midship	0,80	0,70	0,80	0,70	0,80
		region ends	0,75	0,60	0,75	0,60	0,70
	middle strake	full length	0,75	0,65	0,75	0,65	0,70
	lower strake	midship	0,80	0,65	0,80	0,65	0,80
		region ends	0,75	0,60	0,75	0,60	0,70
3	**Bottom[2]**						
3.1	Plate keel	midship	0,85	0,75	0,85	0,75	0,80
		region ends	0,75	0,65	0,75	0,65	0,70
3.2	Bottom with bilge	midship	0,85	0,75	0,80	0,70	0,80
		region ends	0,75	0,65	0,75	0,60	0,70
4	**Inner bottom[2]**						
4.1	Inner bottom	full length	0,80	0,65	0,80	0,65	0,80
5	**Bulkheads[2]**						
5.1	Fore peak bulkhead	—	0,80	0,65	0,80	0,65	0,80
5.2	Transverse bulkheads, cofferdam bulkheads						
	upper strake		0,75	0,60	0,85	0,60	0,70
	middle strake	—	0,75	0,60	0,75	0,60	0,70
	lower strake		0,80	0,65	0,80	0,65	0,70
5.3	Longitudinal bulkheads						
	upper strake	midship			0,85	0,70	0,80
		region ends			0,75	0,60	0,70

Nos.	Structural member	Region of ship length	Ships of group I[1]		Ships of group II[1]		Ships of groups I and II[1]
			m_1	m_2	m_1	m_2	m_0
	middle strake	full length	—	—	0,75	0,65	0,70
	lower strake	midship			0,80	0,65	0,80
		region ends			0,75	0,60	0,70
5.4	Wash bulkheads	—	—	—	0,75	0,65	0,70
6	**Tanks[2]**						
6.1	Tanks and cofferdams of double bottom and double side	—	0,85	0,75	0,85	0,75	0,70
6.2	Topside and hopper tanks	midship	—	—	0,85	0,70	0,80
		region ends	—	—	0,80	0,70	0,70
6.3	Other tanks	—	0,80	0,60	0,80	0,60	0,70
7	**Superstructures and deckhouses[4]**						
7.1	Superstructure side	—	0,80	0,60	0,80	0,60	0,70
7.2	End bulkheads of superstructures and deckhouses, and side walls of deckhouses	—	0,80	0,70	0,80	0,70	0,70
7.3	Superstructure and deckhouse deck	—	0,80	0,60	0,80	0,60	0,70
8	**Regions of strengthening**						
8.1	Ice strengthening	region *A*	1,0		1,00		0,80
		region *B*	0,90	—	0,90	—	0,80
		region *C*	0,90		0,90		0,80
8.2	Strengthening of ships mooring at sea	—	0,85	—	0,85	—	0,80
8.3	Strengthening in regions, to which extreme hydrodynamic pressures are applied	—	0,75	—	0,75	—	0,80
9	**Other hull members**						
9.1	Other hull members	—	0,70	0,55	0,70	0,55	0,70

[1] Ship groups (ship types are determined in the appropriate Rules for Construction):
I — dry cargo ships (except for bulk carriers, ore carriers, combination carriers), dry cargo barges (barge carriers (lighter carriers)), tugs, icebreakers, drilling ships, MODU, FOP, crane ships, passenger ships, high-speed craft, fishing vessels, refrigerated ships (refrigerating transport ships), fish transport vessel (including whale and fish factory ships), ro-ro ships, cable-laying ships, salvage ships, industrial ships, supply vessels, special purpose ships, dredgers, hopper barges, floating cranes, lightships, pontoons for transportation services, berth-connected ships (except for floating docks, ships used as floating oil storage units (FSO and FPSO), floating storage and offloading units (FSO)), nuclear ships and nuclear floating facilities, nuclear support vessels, and ships having similar structural characteristics;
II — tankers, bulk carriers, combination carriers, ore carriers, oil tankers, gas carriers, tank barge, floating offshore oil-and-gas product units (FPU), ships used as floating oil storage units (FSO and FPSO), floating storage and offloading units (FSO)), and ships having similar structural characteristics.

[2] To determine the permissible scantlings of structural hull members made of aluminium alloys, as well as of plating of superstructure and deckhouse made of aluminium alloys, the factor $m_0 = m_1 = m_2 = 0,8$ of the as-built thickness shall apply.

[3] For ships with large deck openings, the requirements applicable to the midship region refer to deck areas between the side and the line of large openings, for deck areas between large openings the requirements for the specified deck at the ship's ends shall apply.
For the upper deck in the midship region of ships of restricted area of navigation **R3-RSN**, $m_2 = 0,65$.

4.2.2.2 In case of local wear, the permissible residual thickness $[S_3]$, in mm, of a plate area shall be determined from the formula

$$[S_3] = 0,85[S_1] \qquad (4.2.2.2)$$

where $[S_1]$ — refer to 4.2.2.1.

In case of a plate area with groove, wear having a length of 100 mm and less, $[S_3]$ shall be adopted as in the case of pitting in accordance with 4.2.2.3.

4.2.2.3 In case of pitting, the permissible residual plate thickness $[S_4]$, in mm, shall be determined from the formula

$$[S_4] = 0,30S_0 \text{ but not less than 3 mm} \qquad (4.2.2.3)$$

where S_0 — refer to 4.2.2.1.

4.2.3 Girders.

4.2.3.1 The permissible residual section modulus $[W_1]$, in cm^3, of a girder shall be determined from the formula

$$[W_1] = nW \qquad (4.2.3.1)$$

where W = girder section modulus, in cm^3, as required by the Rules for Construction;
n = factor to be adopted equal to:
0,80 for primary members and web framing (girders) in way of strengthening;
0,75 for longitudinals of strength deck, sheerstrake, upper and lower strake of inner side (inter skin) and longitudinal bulkheads, topside and hopper tanks, inner bottom and bottom amidships, as well as for all web framing (girders);
0,70 for other girders;
0,65 for trapezoidal corrugations.

4.2.3.2 The permissible residual area $[F_1]$, in cm^2, of a girder web cross-section shall be determined from the formula

$$[F_1] = nF \qquad (4.2.3.2)$$

where F = cross-sectional area, in cm^2, of a girder web, as required by the Rules for Construction;
n = factor to be adopted from 4.2.3.1 of this Chapter.

4.2.3.3 In case of total wear, the permissible residual thickness $[S_1]$, in mm, of a girder element shall be determined from the formula

$$[S_1] = nS \qquad (4.2.3.3\text{-}1)$$

where n = factor to be adopted in accordance with 4.2.3.1 of this Chapter;
S = thickness, in mm, of a girder member, as required by the Rules for Construction.

The permissible residual thickness of a girder member shall not be less than the thickness at which the conditions for permissible residual section modulus $[W_1]$ of a girder and/or permissible residual area $[F_1]$ of a girder web cross-section according to Formula (4.2.3.2) (depending on what is regulated by the Rules for Construction) are met, and the permissible residual face plate thickness shall not be less than the thickness at which the condition for permissible residual section modulus $[W_1]$ of a girder according to Formula (4.2.3.1) is met.

The permissible residual thickness $[S_1]$, in mm, of a girder element shall additionally comply with the following:

in the general case

$$[S_1] \geq 0{,}65S_{\min}; \qquad (4.2.3.3\text{-}2)$$

for ships built to the RS Rules whose keel was laid before 1 October 1990 (may also be applied to series of ships built to the RS Rules irrespective the keel laying date, provided that the keel of the prototype ship was laid before 1 October 1990)

$$[S_1] \geq 0{,}5S_0; \qquad (4.2.3.3\text{-}3)$$

for ships built to the RS Rules whose keel was laid on or after 1 October 1990 as well as to the rules of other classification societies or without technical supervision of any classification society

$$[S_1] \geq 0{,}7S_0 \qquad (4.2.3.3\text{-}4)$$

where $S_{\min}$ = minimal girder element thickness, in mm, required by the Rules for Construction;
S_0 = as-built girder element thickness, in mm.

For a trapezoidal corrugation, the following condition shall be additionally met:

$$[S_1] \geq 12{,}5b/\sqrt{\eta} \qquad (4.2.3.3\text{-}5)$$

where b = trapezoidal corrugation thickness, in m, in the plane parallel to the bulkhead plane;
η = mechanical properties utilization factor for the steel of trapezoidal corrugations, to be adopted from the Rules for Construction.

In any case, the permissible residual thickness for total wear shall not be less than the permissible residual thickness determined from Formula (4.2.2.3).

4.2.3.4 In case of local wear, the permissible residual thickness $[S_3]$, in mm, of a girder member area is determined from the formula

$$[S_3] = 0{,}85[S_1] \qquad (4.2.3.4)$$

where $[S_1]$ — refer to 4.2.3.3.

4.2.3.5 In case of pitting, the permissible residual thickness $[S_4]$, in mm, of a girder member is determined from Formula (4.2.2.3).

4.2.4 Welded and riveted joints.

4.2.4.1 In case of weld wear on a length exceeding 0,3 m, the permissible wear shall be established as follows:

for butt welds — not deeper than the surface of the hull member with the smaller thickness in the joint;

for fillet welds — pass reduction by 1 mm or 20 %, whichever is less.

4.2.4.2 In of weld wear on a length between 0,1 m and 0,3 m, the permissible residual thickness $[S_3]$, in mm, of the weld shall be determined from Formula (4.2.2.2).

4.2.4.3 In case of weld wear on a length below 0,1 m, the permissible residual thickness $[S_4]$, in mm, of the weld is determined from Formula (4.2.2.3).

4.2.4.4 The permissible wear of riveted joints shall be established as follows:

for flat and cup heads — not greater than 0,2 of the rivet body diameter;

for countersunk and raised countersunk heads — not deeper than 0,1 of the rivet body diameter; if shallow spot facing or rivet defects are revealed by random drilling of rivets, the permissible wear depth for countersunk heads shall be reduced to 0,05 of the rivet diameter;

the distance from the centre of the marginal row of rivets to the worn plate edge shall not be less than 1,3 of the rivet body diameter;

for riveted joints in structures made of aluminum alloys and steel, the separation of connected plates shall not exceed 2 mm. Where an aluminum alloy plate or its section is connected to a steel plate, a drop of the former exceeding 20 % of its as-built thickness is not permitted.

4.2.5 Local strengthening.

In case of total wear, the permissible residual thickness $[S_1]$, in mm, of local strengthening is determined from the formulae:

for ships built to the RS Rules whose keel was laid before 1 October 1990 (may also be applied to series of ships built to the RS Rules irrespective the keel laying date, provided that the keel of the prototype ship was laid before 1 October 1990)

$$[S_1] \geq 0{,}5S_0; \qquad (4.2.5\text{-}1)$$

for ships built to the RS Rules whose keel was laid on or after 1 October 1990 as well as to the Rules of other classification societies or without technical supervision of any classification society

$$[S_1] \geq 0{,}7S_0 \qquad (4.2.5\text{-}2)$$

where S_0 = as-built thickness, in mm, of local strengthening.

4.2.6 Standards to be applied directly during hull survey.

4.2.6.1 The standards stated below apply only to those ships, which Register class has not been modified since their construction, as well as to ships built to the RS class and which have not undergone major repair or modification upon completion of construction.

4.2.6.2 The permissible residual hull section modulus $[W_{d(b)}]$, in cm^3, for a deck or bottom is determined from Formula (4.2.1.1-1) where k=0,9 and $W_{d(b)}$ is determined for as-built member scantlings.

4.2.6.3 In case of total wear, the permissible residual plate thickness $[S_1]$, in mm, is determined from the formula

$$[S_1] = m_0 S_0 \qquad (4.2.6.3)$$

where m_0 = factor to be adopted from Table 4.2.2.1-1; for ships with restricted areas of navigation **R2-RSN, R2-RSN(4,5)**, **R3-RSN** and **R3**, m_0 shall be adopted not less than 0,75;

S_0 = as-built plate thickness, in mm.

The factor m_0 indicated in Table 4.2.2.1-1 is used for ships of 90 m in length and above; for ships of 65 m in length and below, the factor m_0 shall be the same along the ship length and assumed equal to the values at the ship's ends; for ship's intermediate lengths, the value m_0 shall be determined by linear interpolation.

In any case, the permissible residual thickness for total wear shall not be less than the permissible residual thickness determined from Formula (4.2.2.3).

4.2.6.4 In case of local wear, the permissible residual plate thickness $[S_3]$, in mm, is determined from the formula

$$[S_3] = 0{,}85[S_1] \qquad (4.2.6.4)$$

where $[S_1]$ — refer to 4.2.6.3.

4.2.6.5 In of pitting, the permissible residual plate thickness $[S_4]$, in mm, shall be determined in accordance with 4.2.2.3.

4.2.6.6 In case of total wear, the permissible residual thickness $[S_1]$, in mm, of a girder member is determined from the formula

$$[S_1] = nS_0 \qquad (4.2.6.6)$$

where n = factor to be adopted from 4.2.3.1;
S_0 = as-built thickness, in mm, of a girder member.

4.2.6.7 In case of local wear, the permissible residual thickness $[S_3]$, in mm, of a girder member is determined from the formula

$$[S_3] = 0{,}5S_0 \qquad (4.2.6.7)$$

where S_0 = refer to 4.2.6.6.

4.2.6.8 In case of pitting, the permissible residual thickness $[S_4]$, in mm, of a girder member is determined from Formula (4.2.2.3).

4.2.6.9 The permissible wear in welded and riveted joints shall be determined in accordance with 4.2.4, and that of local strengthening, in accordance with 4.2.5.

4.2.7 Requirements for determination of permissible residual plate thickness of cargo hold hatch covers.

4.2.7.1 For ships contracted for construction on or after 1 July 2012, except for bulk carriers, ore carries, combination carriers and **CSR** ships, the requirements of Section 7 of IACS UR S21A (refer to 7.10.6.53, Part III "Equipment, Arrangements and Outfit" of the Rules for the Classification and Construction of Sea-Going Ships) shall be met when determining the permissible residual plate thickness.

4.2.7.2 For ships contracted for construction during the period from 1 January 2005 till 1 July 2012, except for bulk carriers, combination carriers and ore carries contracted for construction on or after 1 January 2004, the determination of permissible residual plate thickness shall be made considering the requirements of 4.2.2 of this Chapter and Regulation 16 of the International Convention on Load Lines, 1966, as amended by the 1988 Protocol relating thereto (revised in 2003).

4.2.7.3 For ships contracted for construction prior to 1 January 2005, except for bulk carriers, combination carriers and ore carries contracted for construction on or after 1 January 2004, the determination of permissible residual plate thickness shall be made considering the requirements of 4.2.2 of this Chapter and Regulation 15(7) of the International Convention on Load Lines, 1966.

4.2.7.4 Criteria for assessment of the condition of hatch covers and hatch coamings of cargo holds of bulk carriers, ore carriers and combination carriers contracted for construction on or after 1 January 2004, except for CSR ships, are given in Appendix 5.2-1, Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules.

4.2.7.5 Criteria for assessment of the condition of hatch covers and hatch coamings of cargo holds of CSR ships are given in the IACS Common Structural Rules.

4.2.8 Ships, which subsequent service shall last for less than 5 years.

4.2.8.1 The standards stated below apply only to ships, which subsequent service shall last for less than 5 years, i.e. to ships to be written off from active fleet or scrapped.

4.2.8.2 Reduction of the permissible residual hull section modulus $[W_{d(b)}]$, in cm^3, for a deck or bottom, as determined in accordance with 4.2.1, shall be in each case reviewed by the Register.

4.2.8.3 In case of total wear, the permissible residual plate and girder thickness $[S_1]$, in mm, determined from 4.2.2 and 4.2.3 of this Chapter may be reduced by the value of ΔS^*, in mm, determined from the formula

$$\Delta S^* = (5 - \tau)u_a \qquad (4.2.8.3)$$

where τ = time, in years, before the nearest survey, repair or scrappage; $\tau < 5$;

u_a = average annual wear, in mm/year, of hull members to be determined on the basis of Formula (4.4.3-2) of this Section but not more than the average annual u, in mm/year, in accordance with the Rules for Construction.

For welds worn on lengths exceeding 0,3 m, provided they are surveyed and measured at random once in 2,5 years at least, the permissible wear may be as follows:

for butt welds — up to $0{,}95S_1'$, but not deeper than 1 mm from the plate surface;

for fillet welds — pass reduction by 1,5 mm or by 30 %, whichever is less, where S_1' shall be adopted from 4.2.4 of this Chapter.

The permissible wear for riveted joints shall be established based on 4.2.4 of this Chapter.

In case of total wear, the permissible residual thickness of local strengthening shall be established based on 4.2.5 of this Chapter.

4.2.8.4 In case of local wear, the permissible residual thickness $[S_3]$, in mm, of hull members is determined from the formula

$$[S_3] = 0{,}85[S_1] \qquad (4.2.8.4)$$

where $[S_1]$ — refer to 4.2.8.3.

4.2.8.5 In case of pitting, the permissible residual thickness $[S_4]$, in mm, of hull members is determined from the formulae:

$[S_4] = 0{,}30S_0$, for $2{,}5 < \tau < 5$ but not less than 3 mm; (4.2.8.5-1)

$[S_4] = 0{,}25S_0$, for $1 < \tau \leq 2{,}5$ but not less than 2,5 mm; (4.2.8.5-2)

$[S_4] = 0{,}20S_0$, for $\tau \leq 1$ but not less than 2 mm; (4.2.8.5-3)

where S_0 — refer to 4.2.2.1;

τ — refer to 4.2.8.3.

4.3 STRUCTURES WITH DEFORMATIONS

4.3.1 Hull cross-sectional characteristics.

The permissible total length $\left[\sum_{i=1}^{n} l_{i_{b(d)}}\right]$, in m, of deflections, ribs and indentations in way of strength deck or bottom amidships is determined as follows:

$$\left[\sum_{i=1}^{n} l_{i_{b(d)}}\right] = 0{,}4B_1 \qquad (4.3.1)$$

where B_1 = deck breadth, in m, between the line of hatch openings and side, or bottom breadth including the bilge.

The standard $\left[\sum_{i=1}^{n} l_{i_{b(d)}}\right]$ may be specified by using special procedures agreed with the Register.

4.3.2 Deflections and ribs.

4.3.2.1 For deflections in the strength deck outside of the line of hatch openings, in the sheerstrake and bottom shell plating amidships, the permissible relative camber $[f/b]$ shall be established as follows:

$$\left.\begin{array}{l}[f/b] = 0{,}05 \; for \; L \geq 90 \; m \\ [f/b] = 0{,}10 \; for \; L \leq 65 \; m\end{array}\right\} \qquad (4.3.2.1)$$

where L = design ship length, in m.

For 65< L<90 m, the rate $[f/b]$ shall be determined by linear interpolation.

For the same hull members at ends up to 0,1 L of relevant perpendiculars and for other hull members through the ship length, the rate $[f/b]$ shall be determined from Table 4.3.2.1. For the regions lying between the midship region and 0,1 L of relevant perpendiculars, the rate $[f/b]$ shall be determined by linear interpolation.

Table 4.3.2.1

Permissible relative camber $[f/b]$ in deflections

b′/a	0,65 and less	0,70	0,75	0,80	0,85	0,90	0,95	1,00
[*f*/*b*]	0,060	0,066	0,071	0,077	0,083	0,089	0,094	0,1
N o t e . *b′* = minimum deflection size, in mm (refer to 3.3.3.2); *a* = girder spacing, in mm (refer to 3.3.3.4).								

4.3.2.2 For ribs in strength deck plating, sheerstrake and bottom shell plating amidships, the permissible relative camber $[f/a]$ shall be established as follows:

$$\left.\begin{array}{l}[f/a] = 0{,}05 \; for \; L \geq 90 \; m \\ [f/a] = 0{,}09 \; for \; L \leq 65 \; m\end{array}\right\} \qquad (4.3.2.2\text{-}1)$$

where L — refer to 4.3.2.

For 65< L<90 m, the rate $[f/a]$ shall be determined by linear interpolation.

For the same hull members at ends up to 0,1 L of relevant perpendiculars and for other hull members through the ship length, the rate $[f/a]$ shall be established as follows:

$$[f/a] = 0{,}09. \qquad (4.3.2.2\text{-}2)$$

For the regions lying between the midship region and 0,1 L of relevant perpendiculars, the rate $[f/a]$ shall be determined by linear interpolation.

4.3.2.3 For hull members with deflections and ribs, which are made of aluminum alloys having the yield strength $R_{p0,2}$ = (120 – 150) MPa, the rates mentioned under 4.3.2.1 and 4.3.2.2 shall be used.

4.3.3 Indentations.

4.3.3.1 For girders made of steel having the yield strength R_{eH} = 235 MPa, in which there are no bulges, the permissible relative camber $[f/l]$, relative framing (girder) deviation $[d/h]$, relative position of camber maximum $[f/c]$ and of 300 mm based camber $[f_{300}]$ shall be established as follows:

$[f/l]$ to be adopted from Table 4.3.3.1; (4.3.3.1-1)

$$[d/h] = 0{,}15; \quad (4.3.3.1\text{-}2)$$

$$[f/c] = 0{,}1; \quad (4.3.3.1\text{-}3)$$

$$[f_{300}] = 840/h. \quad (4.3.3.1\text{-}4)$$

Where deformed girders cannot be examined, the standards shall be amended as follows:

$[f/l]$ to be multiplied by a factor of 0,5;

$[d/h]$ to be substituted by the rate

$$[(f_a - f_b)/a] = 0{,}15 \quad (4.3.3.1\text{-}5)$$

where f_a and f_b = maximum cambers, in mm, of two adjacent girders; $(f_a \geq f_b)$, in accordance with 3.3.4.2;

a = girder spacing, in mm;

the rate $[f/c]$ to be multiplied by a factor of 0,8;

the rate $[f_{300}]$ to be multiplied by a factor of 0,5.

Table 4.3.3.1

Permissible relative camber $[f/b]$ for girders in an indentation

l'/h	$[f/l]$	l'/h	$[f/l]$
10 and less	0,050	20	0,080
12	0,055	24	0,088
16	0,070	30 and more	0,097
Note. l' = length, in mm, of deformed area of a girder in accordance with 3.3.4.2.			

4.3.3.2 For girders and plate elements made of steel having the yield strength R_{eH} = 235 MPa, in which a bulge is present, the permissible relative camber $[f/l]$ shall be established as follows:

with holes in the girder web or plate element

$$[f/l] = 0{,}05; \quad (4.3.3.2\text{-}1)$$

in the absence of holes in the girder web or plate element

$$[f/l] = 0{,}07. \quad (4.3.3.2\text{-}2)$$

4.3.3.3 For girder and plate elements made of steel having the yield strength R_{eH} = 290 MPa, the rates $[f/l]$ complying with Formula (4.3.3.1-1), $[f/c]$ complying with Formula (4.3.3.1-3) and $[f_{300}]$ complying with Formula (4.3.3.1-4) shall be multiplied by a factor of 0,85.

For girders and plate elements made of steel having the yield strength 235<R_{eH}<390 MPa, the standards shall be determined by linear interpolation.

The rates $[d/h]$ complying with Formula (4.3.3.1-2), $[f/l]$ complying with Formulae (4.3.3.2-1) and (4.3.3.2-2) do not depend on the yield strength of steel.

4.3.3.4 For girders and plate elements made of aluminum alloys having the yield strength $R_{p0,2}$ = 120 – 150 MPa, the rates as per 4.3.3.1, 4.3.3.2 shall be used.

4.4 STRUCTURES WITH INTENSIVE WEAR AND PROGRESSING DEFORMATIONS

4.4.1 The provisions of this Chapter apply to hull members covered by 4.1.4.2.

4.4.2 The permissible residual hull section modulus $[W_{d(b)}]$, in cm^3, for a deck or bottom is determined from Formula (4.2.1.1-1).

4.4.3 For hull members with the average annual wear u_{aS}, in mm/year, exceeding the annual average wear u, in mm/year, as stipulated in the Rules for Construction, the permissible residual thickness $[s_1]$, in mm, as determined in accordance with 4.2 of this Section, shall be increased by the value of ΔS_a, in mm, to be determined from the formula

$$\Delta S_a = 5(u_{aS} - u) \qquad (4.4.3\text{-}1)$$

where $u_{aS} = (S_0 - S_1')/T$ (4.4.3-2)

or the permissible time $[T]$, in years, of their subsequent service shall be determined from the formula

$$[T] = \frac{S_1' + 5u - [S_1]}{S_0 - S_1'} T \qquad (4.4.3\text{-}3)$$

where S_1' = average residual hull member thickness, in mm, determined during the present hull flaw detection in accordance with 3.2;
S_0 = as-built hull member thickness, in mm;
T = time of previous service life, in years, of the hull member before its being installed on board.

4.4.4 For hull members with residual deformation parameters progressing (increasing) at the rate of u_{af}, in mm/year, the permissible camber $[f]$, in mm, for any type of deformation, as determined in accordance with 4.3, shall be reduced by the value of Δf, in mm, to be determined from the formula

$$\Delta f = 5u_{af} \qquad (4.4.4\text{-}1)$$

where $u_{af} = \frac{f_1 - f_2}{T}$ (4.4.4-2)

or their permissible subsequent service life $[T]$, in years, shall be determined from the formula

$$[T] = \frac{[f]^2 - (f_1')^2}{(f_1')^2 - (f_2')^2} \qquad (4.4.4\text{-}3)$$

where f_1' and f_2' = hull member camber, in mm, determined during the present and the previous hull flaw detection in accordance with 3.3 and based on deformation type;
T = period of time, in years, between the present and the previous hull flaw detection. It is permitted to establish $T = 5$ years as the interval between the special surveys of the ship.

4.5 STRUCTURES WITH SUBSTANTIAL CORROSION

4.5.1 The definition of substantial corrosion is given in 2.1 of Part I "General Provisions" of these Rules.

4.5.2 Upper ultimate thickness of the hull member with substantial corrosion shall be determined from the following formula:

$$S_{[75\%]} = [S_i] + 0{,}25(S^* - [S_i]) \qquad (4.5.2)$$

where $S_{[75\%]}$ = upper ultimate thickness of the hull member with substantial corrosion, in mm;

S^* = hull member thickness, being decisive value in calculating permissible residual thickness (as-built or calculated according to the Rules for Construction — required or minimum), in mm;

$[S_i]$ = permissible residual thickness for total, local wear and pitting ($[S_1]$, $[S_3]$, $[S_4]$), in mm.

4.5.3 Formula (4.5.2) shall not apply to hull structures, which scantlings are determined using net scantling approach (for example, according to IACS Common Structural Rules, IACS UR S21, S21A, etc.).

5 INSTRUCTIONS AND GUIDELINES FOR THE HULL REPAIRS

5.1 GENERAL

5.1.1 This Section contains provisions for the repair of damaged hulls, which technical condition has been assessed as "not complying" under the provisions of Section 2.

5.1.2 In repaired hull structures, their strength, rigidity and toughness shall be restored to a level not lower than specified by the Instructions for the technical condition "complying" under the provisions of Section 2.

5.1.3 As repair methods for the structures, replacement, strengthening, straightening, welding-up and closing by fusion are recommended[1]. Unless expressly provided otherwise, only the damaged section of the structure may be repaired.

5.1.4 In accordance with the provisions of Section 5, Part I "General Provisions" of these Rules and Annex 17 to the Guidelines the temporary repair may be permitted by the Register.

As temporary repair, provisional strengthening, cement boxes, doubler plates (doublers), etc. are permitted.

As temporary repair of superstructure/deckhouse structures, application of mastic or reinforced cement coating (on areas having pitting corrosion), fitting of metal plates (on local isolated areas to eliminate water leakage) may be permitted in compliance with the internal normative documents on repair for the use of RS surveyors, provided the total wear of plates of the considered structures does not exceed allowable values (for more details refer to 5.2.1.5).

Subject to compliance with the requirements of 5.2.1.6, three-layer panels (so called sandwich panels) may be used for repair of hull structures upon the shipowner’s request and by agreement with RHO. The method consists of reinforcement of scantlings by forming three-layer structures with self-curing filling compound neutral to metal. Deteriorated or damaged plating, doubler plate and filling compound are the three-layer panel components. Depending on the properties of the applicable filling compound, application of three-layer panels for repair of flame-resistant or fire-proof members shall be agreed with the Register in each particular case. Application of the method under consideration is practicable in the areas where replacement of plating is difficult due to significant amount of the associated work.

5.1.5 The repair method shall be determined on the basis of the following:

type of damage and its numerical parameters;

grade of the structure material;

area of damaged structure and its location in the hull;

possible reasons of damage;

ship's age and period of its subsequent service;

workmanship of ship repair to be carried out.

5.1.5.1 The type of damage and its numerical parameters shall be determined in accordance with Section 3.

5.1.5.2 The importance of the damaged area for the structure shall be assessed in accordance with the purpose and classification of member groups as stipulated in the Rules for Construction and considering the requirements for tightness.

5.1.5.3 As possible

reasons of damage, the following reasons may be mentioned:

design faults;

internal defects of material;

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[1] The Instructions do not consider repair methods involving substantial modification or modernization of the hull.

technological errors and low quality of structure fabrication;
errors and unforeseen circumstances in service.

5.1.5.4 The period of subsequent ship service shall be determined based on the ship's age, technical condition of the hull, devices, engine, machinery, electrical equipment and instruments, as well as on the shipowner's intentions in respect of the repair extent.

The period of ship's service is established in years if it less than 5 years, and as a multiple of 5 years, if it is equal to or longer than 5 years.

5.1.5.5 It shall be considered that, given a low quality of repair, the structures may prove less reliable than initially when damaged. The workmanship at the yard, where the ship will be repaired, shall be assessed in respect of the workmanship during the ship construction.

5.1.5.6 The repair method shall be in each case determined by the shipowner and shall be agreed with the Register in advance.

5.1.6 Technical documentation of hull repair project, such as structural drawings, calculation-explanatory notes, tool write-up cards, sheets, etc. shall be agreed with the Register. The required thickness (scantling) of a restored structure of the ships' hull shall be generally determined from the as-built drawings (taking into account the performed agreed conversions, if applicable). In so doing, for ships which as-built scantlings according to the RS-approved calculations are less than those determined according to the Rules for Construction, the required thickness (scantling) of a restored structure shall comply with the thickness (scantling) calculated according to the Rules for Construction as for a new hull and specified in the RS-approved calculation.

It is permitted not to restore a structure to its as-built condition (not applicable to **CSR** ships, as well as to structures which scantlings are determined using net scantling approach, for example, according to IACS UR S21, S21A and etc.). When determining structural scantlings, the conditions and period of subsequent ship service shall be considered.

The required thickness of a restored hull member shall not be less than determined from the formula

$$S = [S_1] + (T - 5)u \qquad (5.1.6)$$

where S = required thickness, in mm, of restored hull member;
$[S_1]$ = permissible residual thickness, in mm, of a restored hull member in case of total wear, as determined in accordance with 4.2.2 — 4.2.6 with due regard to 4.2.1, taking into account the specified operational limits as well;
T = expected period, in years, of further service of the ship;
u = average annual wear, in mm/year, as per the Rules for Construction.

The difference in thickness between the restored member and the existing adjacent hull member shall not exceed 3 mm.

Calculations of new scantling of hull members shall be agreed with the Register. The RS surveyor who has performed supervision during repair with application of new thickness of the renewed hull member, shall make entries in the classification section "Memoranda for Shipowners and Surveyors" of the List of Survey's Status on new thickness [indicate the value in mm] that has been applied for the particular hull member, as well as permissible residual thickness for this member and limitations, if any.

5.1.7 The material used for repair of hull structures shall be verified by the Register in accordance with Annex 2-5.

For repair purposes, the replacing or strengthening hull members may be installed, which are made of material with a grade not lower than that required by the Rules for

Construction, which refers to both higher strength steels and lower strength steels as compared to the initial ones, provided a calculation substantiation and the Register agreement are available.

The replacing or strengthening hull members contributing to longitudinal strength shall be made of steel with a grade not lower than that used during construction, and of the same or higher strength.

5.1.8 The hull repair procedure shall be agreed with the Register.

5.1.9 All hull repair operations shall be carried out under the RS technical supervision.

5.1.10 Repaired structures shall be submitted to the Register so that tests stipulated in these Rules may be carried out where necessary. The provisions of the Rules for Construction pertinent to ship stability shall be also taken into consideration.

5.1.11 The possibility of the ship class renewal/retainment depends on good workmanship of structural repair and satisfactory test results.

5.1.12 When choosing the repair methods and design, the documents stated in Annex 3 to these Rules shall be applied.

5.1.13 Thorough repair of superstructure/deckhouse walls and decks (above the first tier) using doublers may be allowed by the RS surveyor carrying out the survey, provided the following conditions are met:

identified defects/damages relate to local wear or pitting, no excessive wear of the adjacent frames is available;

no lifeboats, masts and deck machinery are installed on the deck;

repair procedure shall be agreed with the Register and the doublers are fitted according to the agreed procedure;

as well as the following actions are taken:

upon repair completion the repair history shall be recorded in the List of Survey's Status with indication of the structure which has been repaired and the exact location thereof with reference to the RS reporting document which describes the repair made; the required annual and special surveys of doublers and their locations to be carried by the Register shall also be recorded;

annual survey of doublers and their connections to the main structure shall be carried out and the survey results shall be recorded in the RS reporting document (refer to 3.4, Part II "Carrying Out Classification Surveys of Ships" of the Guidelines);

thorough examination of doublers and their connections to the main structure, thickness measurements of doublers (allowable wear shall not exceed 10 %), tightness tests of places of doubler location shall be carried out at each special survey and the survey results shall be recorded in the RS reporting document (refer to 3.4, Part II "Carrying Out Classification Surveys of Ships" of the Guidelines);

required repair shall be carried out if the technical condition of doublers and/or their connections to the main structure is assessed as not complying with the RS requirements.

5.1.14 During technical supervision of repair of structures using welding at least the relevant provisions of Part XIV "Welding" of the Rules for the Classification and Construction of Sea-Going Ships shall be met.

5.2 STRUCTURES WITH WEAR

5.2.1 Repair methods.

5.2.1.1 For hull members with wear, the following repair methods are recommended:
replacement of hull member or its section;
strengthening of hull member or its section;
sealing of a hull member section by fusion.

The detailed information in connection with repair of structures made of aluminium alloys is given in Table 5.2.1.1.

Table 5.2.1.1

Wear of hull structures of aluminium alloys, methods of their repair and control

Nos.	Types of wear	Possible repair	Control norms and methods
1	Pitting and through holes as separate pits of shell plating or framing in inaccessible and hard-to-reach places, on internal surfaces of branch pipes and rudder trunk	**1.** *a)* Preparation and building up welding of pitting. Refer also to 5.2.3.3 of Annex 2 to these Rules *b)* Corrosion protection of damaged area shall be provided by application of protective coating or sacrificial anodes, where applicable. **2.** Replacement of damaged area/product in case of fusing or pitting of large area	**1.** Annex 2 to these Rules, 4.2.2.3, 4.2.6.5 and 4.2.6.8, where applicable, taking into account Table 4.2.2.1-1 **2.** Annex 2 to these Rules, 4.2.2.3, 4.2.3.5, 4.2.6.8 and 5.2.5.2, taking into account Table 4.2.2.1-1
2	Local spot wear as loosening over the surface: in the points of contact with heterogenic materials, at deck areas under WC bowls and different coatings	**1.** Application of epoxy coating to damaged areas of structures not included into overall strength **2.** Replacement of damaged area of the essential structures, as well as in case of significant wear of the sizeable area of structures specified in item 1 above. N o t e . Building up welding of sections in case of local wear is not recommended	**1.** Internal normative documents on repair intended for the use of the RS surveyors **2.** Annex 2 to these Rules, 4.2.6.4, 4.2.6.7 and 5.2.5.2 taking into account Table 4.2.2.1-1
3	Total wear (if present)	Repair in compliance with 5.2 of Annex 2 to these Rules, where applicable	Annex 2 to these Rules, 4.2.6.3, 4.2.6.6, 5.2.3.1 and 5.2.4.1

5.2.1.2 The replacing hull members or their sections shall have thicknesses not less than those determined from Formula (5.1.6).

When girders are replaced, their intersections with other frames shall be so executed that the structural continuity of primary members is ensured.

5.2.1.3 A hull member or its section may be strengthened by means of the following:
doubling straps increasing the section modulus of hull and girders;

doublers for local strengthening of structures and ensuring watertightness (as a temporary repair with a due date established in compliance with the requirements of Section 5, Part I "General Provisions" of these Rules), and for the ships with subsequent service of less than 5 years;

girders and stiffeners for increasing the section modulus of hull as well as local strengthening of structures, doublers to ensure local strength and tightness, fitted as defined in IACS recommendation No. 47 (Rev.10 Sep 2021)[1], adopted as prompt and thorough repair on agreement with the Register according to the established procedure.

A doubling strap may have a thickness exceeding by not more than 50 % the residual plate thickness of the structure being strengthened, but not greater than 30 mm, and a breadth not exceeding 50 times its own breadth, but not greater than 700 mm. The application of doubling straps with parameters exceeding the above limits shall in each case be reviewed by the Register.

Before fitting, the surfaces of doubling straps and hull structure to be joined shall be carefully cleaned and adjusted. The clearances between the surfaces of plates being joined shall not exceed 2 mm.

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[1] Document is available on the IACS website www.iacs.org.uk.

When doubling straps are fitted, measures shall be taken to maximally reduce the longitudinal bending moment of the hull.

A doubling strap shall be fitted using fillet welds. Plug and intermittent welds are not permitted. The quality of 100 % of butt welds in doubling straps shall be controlled. In the case of doubling straps fitted below the waterline, the quality of fillet welds shall be tested by air pressurization with application of a foam compound.

The structural adjustment of doubling strap butts shall be carried out in accordance with Fig. 5.2.1.3-1, and of their ends, in accordance with Fig. 5.2.1.3-2.

Doublers used for temporary repair shall comply with the provisions of the documents agreed with the Register as regards their dimensions, material, manufacturing procedure and fitting on the hull member being repaired. No doublers are permitted in areas of intensive vibration and in those areas, to which ice loads are applied.

The scantlings of strengthening girders and stiffeners shall be determined analytically bearing in mind the expected service period.

The strengthening girders may be intercostal. Their ends shall be attached to deep framing members following the design applied elsewhere in the hull. If another method of attaching the girder ends is preferred, this shall be considered when determining the scantlings of stiffening girders.

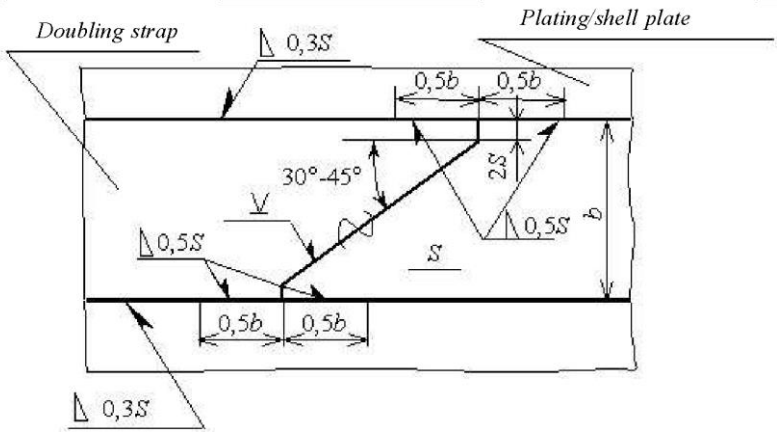


Fig. 5.2.1.3-1
Adjustment of doubling strap butts

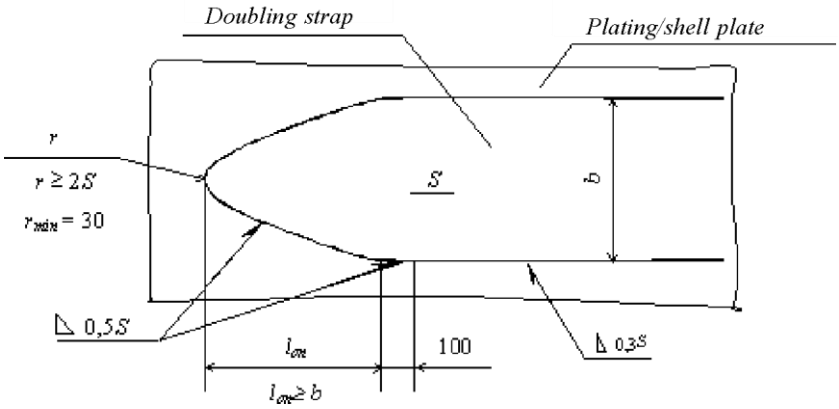


Fig. 5.2.1.3-2
Adjustment of doubling strap ends

5.2.1.4 The sealing of a hull member section by fusion shall be carried out using electrodes corresponding to the grade of material, of which the repaired section is made.

Before welding, the hull member section shall be carefully cleaned of corrosion products and prepared for welding operations.

Efficient welding procedures providing for the necessary heat input, heat concentration, sequence of making welds or pad welds shall be applied.

When welding operations are completed, the weld or pad weld shall be after treated and tested for the presence of cracks.

5.2.1.5 If according to 5.1.4 the temporary repair of superstructure/deckhouse structures is permitted by applying of epoxy mastic or reinforced cement coating, fitting of metal plates such repair shall be performed by the firm recognized by the Register to carry out such works and in accordance with the internal normative documents on repair for the use of RS surveyors.

In case of applying the reinforced cement coating on the upper-tier superstructure deck platings, the compliance with 1.5 of Part IV "Stability" of the Rules for the Classification and Construction of Sea-Going Ships shall be verified. The results of verification shall be submitted to the Register for approval.

5.2.1.6 When, according to 5.1.4, a RHO agreement in principle is available for performing temporary repair of ship structures using three-layer panels, one shall be guided by the following requirements given below.

5.2.1.6.1 Repair using the suggested procedure may be accepted for the following structures:

decks and platforms having ordinary and primary framing;

decks and walls of superstructures/wheelhouses;

funnel coamings;

double bottom plating.

5.2.1.6.2 According to the process control documentation for repair agreed by the Register together with all necessary calculations and diagrams/plans, the repair shall be carried out by a firm recognized by the Register or ACS — IACS member, and under the RS supervision.

5.2.1.6.3 Application of this procedure during the repair is not permitted for the following ship types: gas carriers; ships having **ESP** descriptive notation in the class notation; ships intended for the carriage of solid bulk cargoes possessing chemical hazards and/or materials hazardous only in bulk (MHB); CSR ships.

5.2.1.6.4 Repair procedure using three-layer panels is not permitted:

during the repair of shell plating and bottom structures, as well as any corrugated structures;

during the repair of platings with through corrosion. When through corrosion is present, the relevant plate areas shall be repaired in compliance with the requirements of these Rules.

5.2.1.6.5 All materials, applied during such repair, shall meet the requirements of Part XIII "Materials" of the Rules for the Classification and Construction of Sea-Going Ships and have the appropriate RS Type Approval Certificates. When Part XIII "Materials" of the above-mentioned Rules does not contain the requirements concerning particular materials, the application of which is conditioned by the need of repair based on this procedure, such materials may be applied based on the manufacturer's certificates. When three-layer panels are used as fire structures, they shall meet the requirements of Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships.

5.2.1.6.6 Three-layer panels shall be installed in such a way that the existing framing shall be a support for a new structure. Technical condition of the existing framing in way of three-layer panel application shall comply with the requirements of these Rules.

5.2.1.6.7 When the application of three-layer panels is necessary for the entire main deck area from the fore to aft and from side to side or between the engine room and peak bulkhead and from side to side, it is necessary to make additional calculations in compliance with the International Convention on Load Lines, 1966, as amended by the Protocol of 1988 relating thereto (2003 revision), Load Line Rules for Sea-Going Ships, Part IV "Stability" of the Rules for the Classification and Construction of Sea-Going Ships, as applicable.

5.2.1.6.8 Upon completion of repair, the structures repaired using three-layer panels shall be documented in the RS reporting documents in compliance with the requirements of Section 3, Part II "Carrying Out Classification Surveys of Ships" of the Guidelines. In addition, the following shall be specified in the List of Survey's Status: structure name, frame number, repair method, Number of RS Conclusive Letter concerning the approval of the repair procedure using three-layer panels, introducing test approval mode for the period of at least the next intermediate or special survey, whichever comes first, as well as notification that the structures are subject to annual monitoring by RS and shipowner and, in case of unforeseen situation related to such repair and that may affect the safety of the ship, passengers on board, etc., the ship shall be promptly repaired in compliance with the RS rules, i.e. using the traditional thorough repair practice.

5.2.2 Characteristics of the hull cross-section.

5.2.2.1 If the diminution of cross-sectional (transvers sectional) areas of deck and/or bottom including the bilge exceeds the specified standard (refer to 2.2.1.1), one of the following measures shall be taken:

to renew (replace) or reinforce (strengthen) the deck or bottom structures so that the actual cross-sectional area shall not be less than that calculated in accordance with the relevant standard; or

to verify the hull girder section modulus by using the thickness measured, renewed or reinforced, as appropriate, in compliance with the requirements of the Rules for Construction.

5.2.2.2 To restore the necessary characteristics of the hull cross-section, repair is permitted in the form of replacing or strengthening a coaming, upper deck, sheerstrake, bottom, inner bottom, side, inner side, longitudinal bulkheads with adjacent longitudinals.

5.2.2.3 The hull length to be repaired shall be determined based on the hull flaw detection ring sections. Where the length of repaired section is less than the midship region length, the member scantlings of hull sections adjacent to the repaired ones shall be checked for compliance with the provisions of 2.2.1.

5.2.2.4 The scantlings of each repaired member shall be checked for compliance with the buckling strength requirements of the Rules for Construction.

5.2.2.5 The hull strengthening may be effected by fitting doubling straps and/or additional longitudinals.

The application of doubling straps for increasing the hull section modulus by more than 20 % shall in each case be reviewed by the Register.

The recommended arrangement of doubling straps is shown in Fig. 5.2.2.5-1.

Additional girders may be fitted between existing ones and also, ship's service conditions permitting, on the reverse sides of plates, for instance, on the external surface of deck plating of an oil tanker (Fig. 5.2.2.5-2).

The length of strengthening shall be sufficient, as compared to the ship length, to ensure the required values of $[W_{d(b)}]$ in the controlled hull sections, and in any case to lap over the midship region.

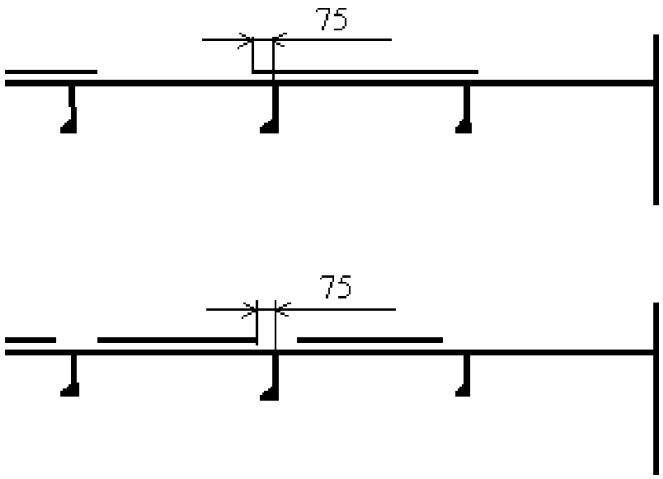


Fig. 5.2.2.5-1
Doubling strap arrangement

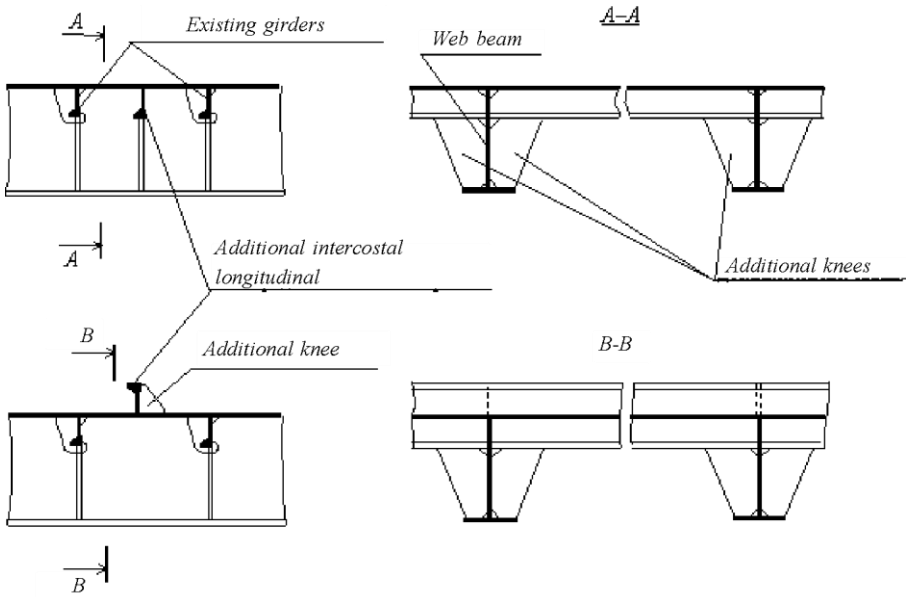


Fig. 5.2.2.5-2
Fitting of additional girders

5.2.3 Plates.

5.2.3.1 In case of total wear, the thickness of the plate to be replaced shall not be less than that determined from Formula (5.1.6). For shell plates, bulkhead plating and deck plating in areas of intensive vibrations, the replaced plates shall have thicknesses required by the Rules for Construction for newbuildings.

5.2.3.2 In case of local wear, the total area of non-adjacent sections being replaced shall not exceed 40 % of the plate area.

The temporary repair of a worn plate section with local wear may be carried out by means of doublers. Plates with linear wear in way of the ice strake and hull areas strengthened for mooring may not be repaired by fitting doubling straps.

Where a worn plate section is repaired by strengthening with intercostal girders or stiffeners, the efficiency of this structural design shall be substantiated analytically. In this case, the permissible residual plate thickness [S_3] may be reduced bearing the strengthening in mind.

Plates with groove wear may be repaired by welding up. The total welded-up area shall not exceed 5 % of the plate section area.

5.2.3.3 For plates with pitting, the pits may be sealed by fusion, observing the same procedures as in the case of plates with groove wear. Pits removed from a riveted seam by less than 50 mm may not be sealed by fusion.

If a plate is repaired by replacing its pitted section, the repair shall be carried out in accordance with the provisions of 5.1.6.

Temporary repair of a pitted plate section may be carried out by means of doublers.

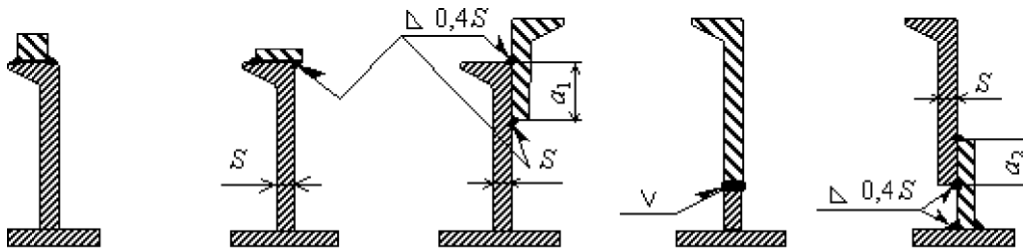
5.2.4 Girders.

5.2.4.1 In case of total wear, the girder shall be replaced completely, if the cross-sectional area of its member lost, due to wear, more than 60 % of the initial value or if the girder is located in the midship region and is a longitudinal framing member of a deck or bottom.

If a girder is repaired by strengthening in the form of reinforcement of its members, reinforcement throughout the relevant span shall be ensured. For girder strengthening, doubling straps fitted on webs and flanges may be used, as well as rolled section beams. The recommended designs of worn girder strengthening are shown in Fig. 5.2.4.1-1. The section modulus of a strengthened girder may not be increased above the as-built value.

This repair procedure is not permitted for deck and bottom longitudinals amidships.

If a girder is repaired by strengthening in the form of additional girders or supports (web girders) in a grillage (refer to Fig. 5.2.4.1-2), the efficiency of designs adopted shall be substantiated analytically. In this case, the permissible residual thicknesses [S_1] of girder elements may be reduced in view of the strengthening effected.



$a_1 \geqslant 2S + 25\ mm;\ a_2 \geqslant 2S + 50\ mm$

Fig. 5.2.4.1-1
Girder strengthening:
— existing girders; — additional strengthening

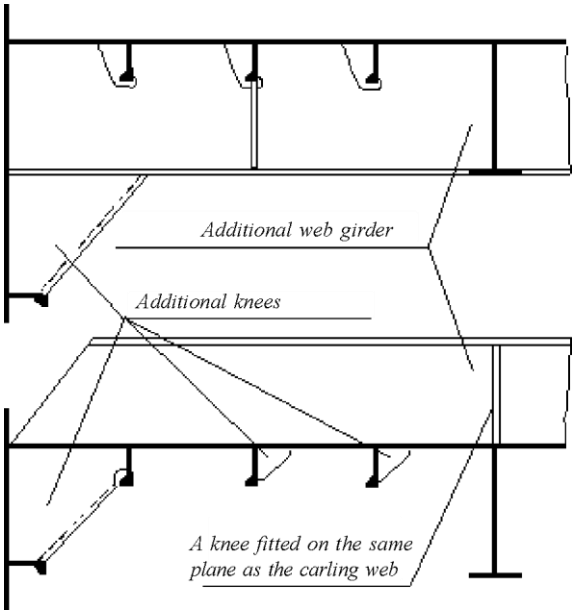


Fig. 5.2.4.1-2
Strengthening of primary members with web girders

5.2.4.2 In the case of local pitting or groove wear, a girder member may be replaced on a limited span length in way of wear. The dimensions of the replaced section shall not be less than the as-built dimensions of the girder.

If a girder is repaired by strengthening in the form of reinforcement of its members, the strengthening shall be effected throughout the worn section. If is also permitted for the worn deep girder web areas to be strengthened with stiffeners. The recommended plans of strengthening the girder areas are shown in Fig. 5.2.4.2.

Repair by strengthening is not permitted for the elements of deck and bottom longitudinals amidships.

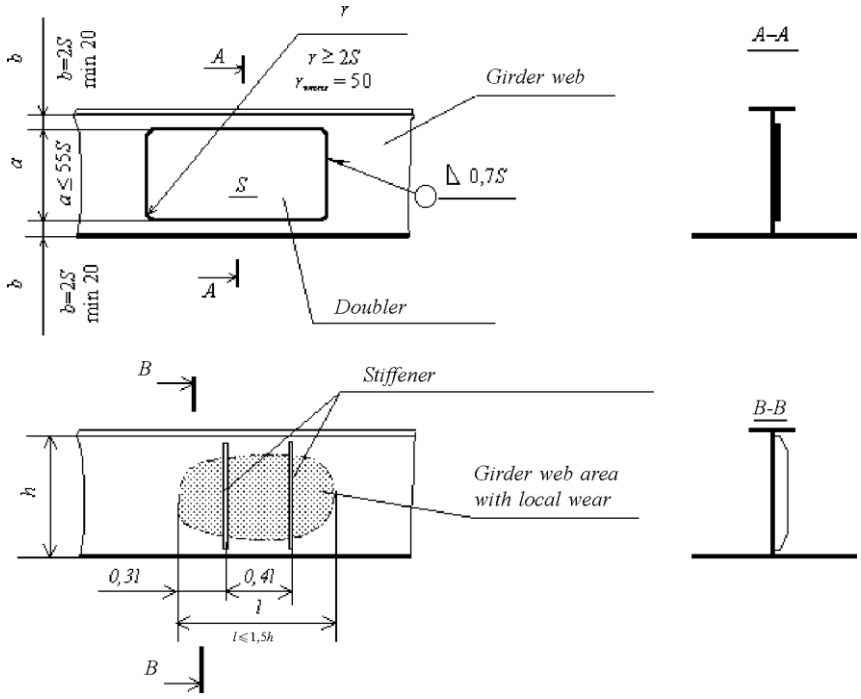


Fig. 5.2.4.2
Strengthening of a girder area

5.2.4.3 In case of pitting, a girder element may, where necessary, be repaired using methods described under 5.2.3.3.

5.2.5 Welded and riveted joints.

5.2.5.1 Worn welds may be repaired by welding-up. If necessary, particular weld lengths may be cut out and welded anew.

5.2.5.2 Weak, non-waterproof or worn joints shall be re-riveted. When replacing blind rivets, the chamfering depth shall not be greater than 0,9 and less than 0,7 of the residual thickness of the chamfered member.

If an aluminum alloy plate is worn in way of its connection to a steel one, the worn plate area shall be removed, and the riveted joint shall be re-riveted.

In some cases, boxing of non-weakened and waterproof rivets, individual non-waterproof rivets, or electric riveting may be permitted on agreement with the Register.

5.2.6 Connecting elements and local strengthening.

5.2.6.1 In case of total wear, a connecting element shall be replaced, if the girder, which it strengthens, is replaced.

If the girder is repaired by other methods, the worn connecting element may be strengthened, for instance, a stiffener may be fitted on the web plate of a knee connecting web members. In such a case, the efficiency of adopted design shall be substantiated analytically or in another way.

5.2.6.2 In case of local wear, the connecting element may be partially replaced in the area of intensive wear, for instance, at bracket ends, large knees. The thickness of replaced section shall not be less than that of the element remainder.

In some cases, strengthening in the form of doubling straps or stiffeners may be applied for repairing a connecting element section on agreement with the Register.

5.2.6.3 Worn local strengthening shall normally be replaced completely. Where necessary, a partial replacement of the most worn section is permitted.

5.3 STRUCTURES WITH DEFORMATIONS

5.3.1 Repair methods.

5.3.1.1 For hull members with residual deformation, the following repair methods are recommended:

replacement of the hull member or its section;

strengthening of the hull member or its section where residual deformation is present;

flattening.

In addition, peculiarities of repair of ships made of aluminium alloys are specified in the internal normative documents on repair intended for the use of the RS surveyors.

5.3.1.2 A hull member or its section shall be replaced in accordance with the provisions of 5.2.1.2.

5.3.1.3 A hull member or its section may be strengthened by means of the following:

strings (doubling straps);

girders or stiffeners.

The strings, girders and stiffeners shall be manufactured and fitted bearing in mind the relevant provisions of 5.2.1.3.

5.3.1.4 Deformation shall be repaired by flattening in accordance with the procedure approved by the Register. The total deformed area of a member shall be intensively heated.

For hull members made of higher strength steels, which were heat-treated, residual deformation repair by flattening is not permitted.

5.3.2 Characteristics of hull cross-section.

For deformed hull members located amidships in the strength deck or bottom may be repaired by means of replacement or strengthening. The acceptability of indentation strengthening shall be analytically substantiated.

The longitudinals of the strength deck and bottom amidships may not be repaired by fitting strings.

5.3.3 Deflections and ribs.

5.3.3.1 Where a hull member containing indentations and ribs is replaced, the thickness of replaced section shall not be less than determined from Formula (5.1.6).

A hull member containing ribs shall be repaired by replacement, if $f'/a \geq 1{,}5[f/a]$ where f', f, a, $[f/a]$ shall be adopted from 3.3.3 and 4.3.2.

5.3.3.2 Deflections and ribs shall be strengthened with girders or stiffeners, which height is not less than 75 % of that of existing girders. A recommended method of deflection and rib strengthening is shown in Fig. 5.3.3.2.

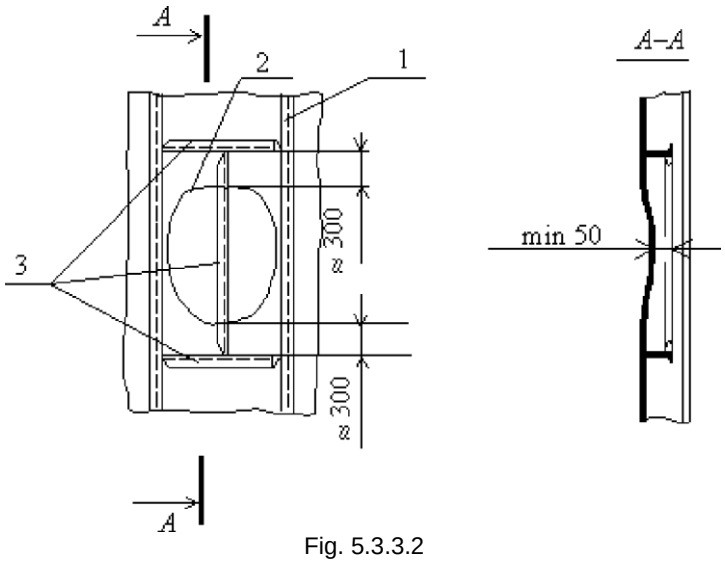


Fig. 5.3.3.2
Strengthening of deflections and ribs with stiffeners:
1 — primary member; 2 — a deflection or rib contour; 3 — stiffeners

5.3.3.3 When hull members with deflections and ribs are repaired, one and the same deformed section may be repaired by flattening not more than during two repairs, which shall be accompanied by mandatory intensive heating of shell/plating in the following cases:

for deflections, in which the deformed shell/plating area (section) does not go as far as the girders, the whole of the area, in which the deflection is formed, shall be covered;

for ribs and deflections, in which the deformed shell/plating area (section) goes as far as the girders, lengthwise with regard to framing members and in way of the maximum camber.

5.3.4 Indentations and bulges.

5.3.4.1 A hull member with a rupture (ruptures) and containing an indentation or a bulge shall be repaired by replacement, if it is not possible to eliminate the rupture by welding-up in accordance with 5.4.1.4.

Where a member containing indentations or bulges is replaced, the thickness of the replaced section shall not be less than that determined from Formula (5.1.6).

Primary members in way of an indentation shall be repaired by replacement, if $f'/l' > 2[f/l]$ and $f'_{300} > 2[f_{300}]$ where f', l', f'_{300}, $[f/l]$, $[f_{300}]$ shall be adopted from 3.3.4 and 4.3.3.

A hull member containing a bulge shall be repaired by replacement where $f'/l' > 2[f/l]$.

5.3.4.2 It is permitted for the structure in way of an indentation to be strengthened by fitting additional girders or stiffeners, for instance, intermediate frames, and stringers. The efficiency of strengthening shall be analytically substantiated with due regard to the parameters of the particular indentations.

If the conditions of 2.3.3.3 are not met by only the girder webs deviating from their initial plane, it is recommended that they be strengthened with strings welded to the upper surface of face plates perpendicularly to their direction (refer to Fig. 5.3.4.2-1).

When strings are fitted, they shall exceed the damaged area by two spacings to each side at least. The cross-sectional area of a string shall be chosen close to that of the girder face plate.

Where the conditions of 2.3.3.3 are not met, bulges may be strengthened with stiffeners provided $f'/l' \leq 2[f/l]$. The recommended methods of bulged girder web strengthening are shown in Fig. 5.3.4.2-2. The thickness S of strengthening stiffener shall be adopted equal to the strengthened girder web thickness, and the minimum stiffener web depth shall be determined from the condition $h_{min} \geq 5s$.

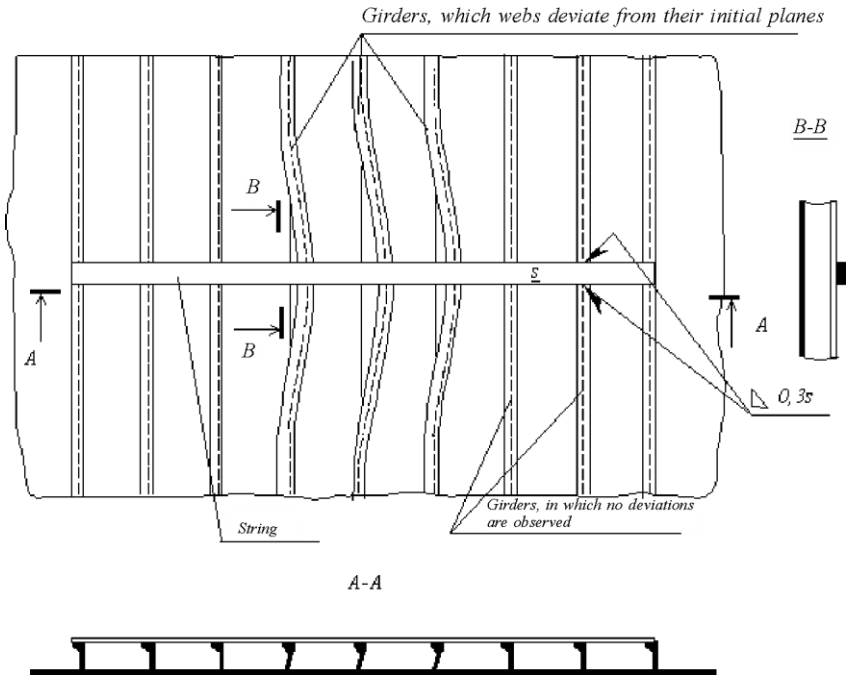


Fig. 5.3.4.2-1
Girders strengthening with a string

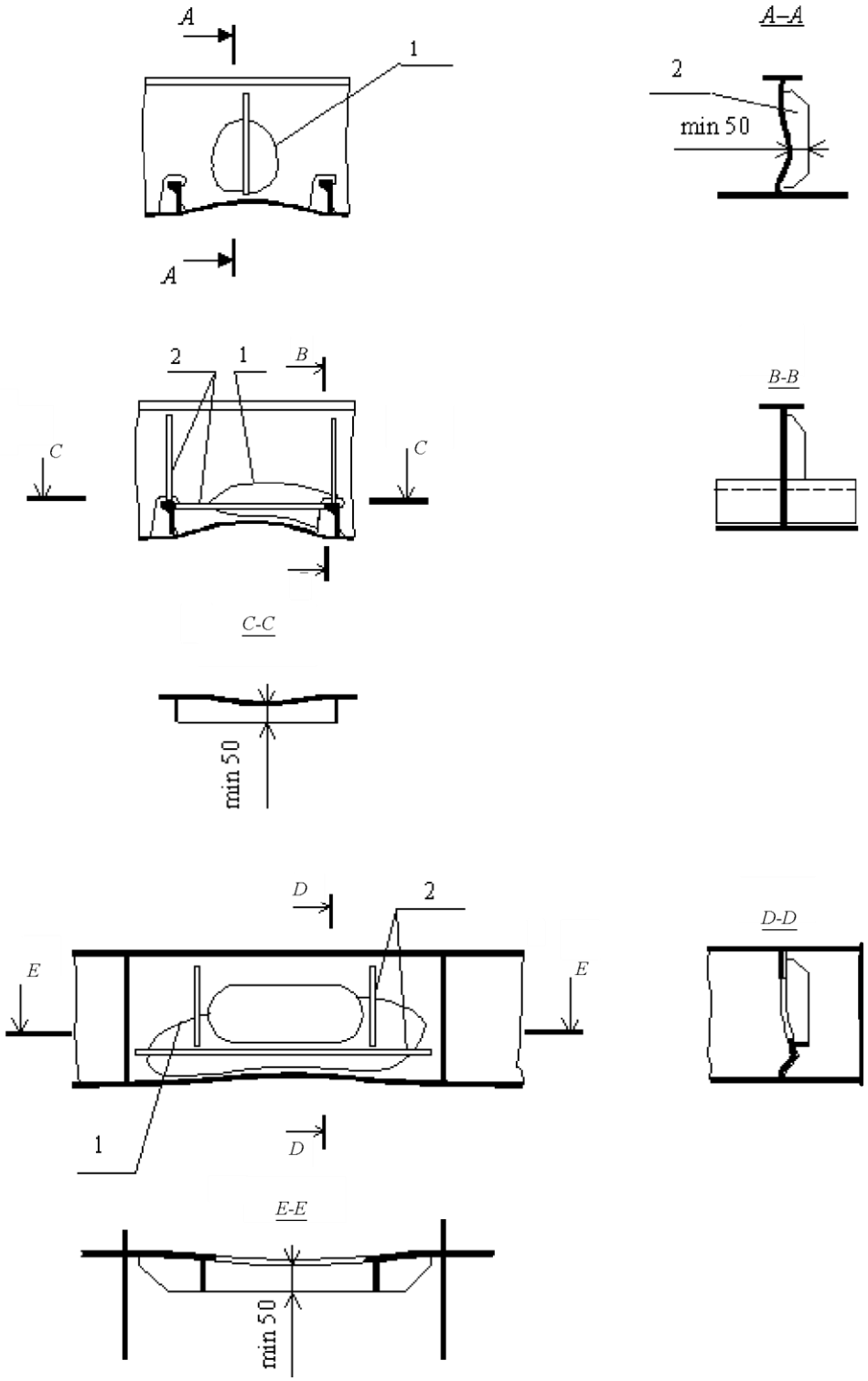


Fig. 5.3.4.2-2
Bulge strengthening:
1 — bulge contour; 2 — stiffener

5.3.4.3 When indentations are repaired, only those sections may be flattened, which were not subjected to flattening during previous repairs, with a simultaneous intensive heating of the girder in way of maximum camber and shell/plating with adjacent girder web on the indentation contour. When indentations with bulges are flattened, the provisions of 5.3.3.3 for deflections shall also be met.

5.3.5 Connecting elements and local strengthening.

5.3.5.1 Knees with deformed face plates shall be repaired by replacement.

5.3.5.2 Deformed knees without a face plate/flange, as well as knees with non-deformed face plate/flange may be strengthened with stiffeners.

5.3.5.3 Deformed local strengthening shall be repaired by replacement.

5.4 STRUCTURES WITH CRACKS AND RUPTURES

5.4.1 Repair methods.

5.4.1.1 For hull members with fractures and ruptures, the following repair methods are recommended:

replacement of the hull member section, in which a fracture or rupture is contained, without further reinforcement/modification;

replacement of the hull member section containing a fracture or rupture with further reinforcement/modification of the structure;

welding-up.

5.4.1.2 Replacement of the hull member section with a fracture without further reinforcement/ modification is recommended when the fractures are caused by:

.1 internal defects or low quality of material;

.2 low quality of welding or poor manufacturing quality of the structure;

.3 overheating or burning of material (due to fire, flattening and welding);

.4 lean-on, grab or cargo impact, etc.;

.5 metal lamination.

Detailed information is given in the internal normative documents on repair intended for the use of the RS surveyors.

The dimensions of member section to be replaced shall be determined as the greater of the following:

the section and the fracture shall completely overlap in length with an addition of at least 30 mm along the direction of the crack propagation from its peak (refer to additional the internal normative documents on repair intended for the use of the RS surveyors);

the border of the section shall lie outside the hull member area with stress concentration due to its shape;

the dimensions of the section shall render technological operations possible on the level of workmanship required for the repair.

Hull members with ruptures shall be repaired by replacement. Hull members not subjected to forces due to the longitudinal bending of hull with ruptures may be repaired with doublers as temporary strengthening until the next scheduled repair provided the rupture is welded up taking into account 5.4.1.4. In this case, a doubler shall go beyond the edge of a rupture for at least $2S + 25$ mm, where S is the smaller thickness, in mm, of the plates joined.

5.4.1.3 Replacement of the hull member section with a fracture together with reinforcement/ modification is recommended in the following cases:

.1 when rigid points, stress concentration and other structural failures are present;

.2 in case of hull or machinery vibration;

.3 in case of branched progressing fractures where possible reasons of cracking are the failures stated in 5.4.1.3.1 and 5.4.1.3.2.

Replacement of the hull member section with a fracture together with structural modification/reinforcement may also be recommended based on the experience of technical supervision of ships of the series or similar ships.

Structural modification/reinforcement consists in improving the structure for the purpose of cracking elimination in future.

The efficiency of structural design suggested shall be substantiated, and the design shall be agreed with the Register.

5.4.1.4 Welding-up of a crack is recommended in the following cases:

possible reasons of cracking are slag inclusions, cavities and other internal defects of material, technological errors, poor assembly and manufacturing quality of the structure, as well as operating errors and abnormal service conditions (foul, impact, collision, grounding, etc.).

For hull members with ruptures and containing deflections and indentations, welding-up of ruptures is permitted where the separation distance does not exceed the allowances for edge preparation before welding.

Welding repairs of cracks and ruptures shall be carried out in accordance with the procedure approved by the Register (refer to IACS recommendation No. 47 (Rev.10 Sep 2021))[1]. The crack and rupture edges shall be prepared for welding, and the crack end shall be drilled. The opening diameter shall not be less than the plate thickness.

5.4.1.5 In all cases when the hull members with cracks and ruptures are repaired, the choice of welding consumables, material of section to be replaced and repair procedure shall be in accordance with 5.1.7 and 5.1.8.

5.4.2 Hull members.

5.4.2.1 The cracks and ruptures in hull members contributing to the longitudinal (overall) strength may be welded up in cases specified in 5.4.1.4 when their length does not exceed the standards established in Table 5.4.2.1. In other cases, the provisions of 5.4.1.2 and 5.4.1.3 shall be met.

Table 5.4.2.1

Permissible crack length [λ], in mm

Hull member	Material	
	steel, for which R_{eH} = 235 MPa, and aluminum alloy	higher strength steel
Plates	200	150
Girders	0,1*h* but not greater than 100 mm	0,075*h* but not greater than 75 mm
Connecting elements and local strengthening	0,1*c* but not greater than 100 mm	0,075*c* but not greater than 75 mm
Note: *h* = girder depth, in mm; *c* = knee side, length, in mm, of the side of local strengthening, along which the crack propagates. The permissible crack length [λ], in mm, may be specified by using special procedures agreed with the Register.		

5.4.2.2 Plates and girders with cracks and ruptures shall be repaired in accordance with the provisions of 5.4.1.2 — 5.4.1.5.

5.4.2.3 Weld lengths with cracks shall be cut out to sound metal and then shall be welded up on lengths not less than determined in 4.2.4.

Weld lengths with ruptures may be welded up after residual deformation elimination whenever possible.

Repair work shall be carried out following the provisions of 5.2.1.4.

5.4.2.4 Lengths of riveted joints with cracks and ruptures taking up loads arising from hull buckling shall be replaced and re-riveted.

Cracks and ruptures in riveted joints, by which tightness is ensured, may be welded up in cases stipulated in 5.4.1.4. In other cases, the provisions of 5.4.1.2 and 5.4.1.3 shall be met.

5.4.2.5 A connecting element section containing a crack and a rupture shall be repaired in accordance with the provisions of 5.4.1.2 — 5.4.1.5. Where the crack length is commensurate with the connecting element dimensions, the element as a whole shall be replaced or modernized.

5.4.2.6 The necessity of and repair method for local strengthening containing cracks and ruptures shall be determined based on the experience in technical supervision. Welding-up of a cracked strengthening section is permitted without drilling the crack end and edge preparation.

[1] Document is available on the IACS website www.iacs.org.uk.

5.5 GENERAL REQUIREMENTS FOR TECHNICAL SUPERVISION DURING REPAIR OF HULL STRUCTURES

5.5.1 Prior to commencement of hull repairs, a meeting shall be held between the shipowner's representatives, other interested parties and the RS surveyor to discuss and confirm the following:

.1 it is the shipowner's responsibility to ensure continued effectiveness of hull structures, including longitudinal strength, watertight/weathertight integrity and protection against corrosion;

.2 availability of the following documentation approved by the Register or ACS — IACS member:

documents related to type and specific repair processes;

welding procedure specifications;

other necessary documentation on repair;

.3 extent of intended repairs under the RS technical supervision is identified;

.4 review of necessary ship's technical documentation to be submitted to the RS surveyor;

.5 verification of hull structures subject to replacement with their appropriate certificates to be submitted to the RS surveyor before insertion thereof;

.6 availability of copies of valid welder approval test certificates that remain on board for the entire period of repair and may be provided to the RS surveyor upon his request.

N o t e . The RS surveyor shall verify qualification of welders by checking welder approval test certificates as well as compliance of range of approval established in the welder approval certificate with the works performed. Welders employed at the RF ship repair yards (organizations) shall have the RS certificates; outside the Russian Federation, it is allowed to accept welding works done by the welders certified by ACS — IACS member;

.7 verification of the qualification of the ship repair yard (organization) NDT specialists, such specialists shall have valid certificates confirming the method of non-destructive testing and qualification level of the specialist.

N o t e . NDT specialists mentioned above, shall be employed by the testing laboratory having the RS recognition certificates (or certificates issued either by the ACS — IACS member or by the international or national accreditation body);

.8 review of intended repair; the repair extent may be changed during repair works subject to agreement with the RS surveyor;

.9 review of intended technical supervision and quality control; during repair, the extent of works on cleaning, hull member planishing may be increased, as well as the extent of the RS technical supervision, including the extent of welding inspection, for example, by non-destructive testing methods due to improper quality of completed repairs. Such additional repairs shall be agreed upon by the RS surveyor;

.10 review of the application of repair coating; the extent of restoring of protective coating during repairs shall be agreed;

.11 review of intended working conditions; the shipowner shall be notified about his responsibility to provide necessary means of access, adequate lighting, ventilation, etc. during repairs;

.12 review of intended technical supervision and quality control; the shipowner is notified that the entire extent of completed repairs together with intermediate stages of the RS technical supervision (e.g. preparation of hull structures for welding), quality control of welded joints, etc. shall be submitted to and accepted by the Register;

.13 after repair completion, the hull structures shall be examined and tested by methods and to the extent as required by the RS normative documents.

The results of the meeting shall be documented in the appropriate report.

5.5.2 The use of certain materials for repair of hull structures is specified in Annex 2-5 to this Annex.

5.5.3 When planning significant replacements of hull structures affecting the longitudinal strength, the appropriate strength calculations and, if necessary, recommendations on the sequence of dismantling and assembly works shall be developed. Additionally, documentation on hull structures reinforcement during repair, procedures for reducing of stress and control methods of the hull geometric parameters shall be developed, if necessary. All necessary documentation shall be reviewed and approved by the Register.

5.5.4 Completed repairs, quality control, testing and results of the RS technical supervision during repair shall be recorded in the RS reports in accordance with the provisions of 3.4 of Part II "Carrying Out Classification Surveys of Ships" of the Guidelines.

6 THE PROCEDURE FOR RECORDING THICKNESS MEASUREMENTS AND OTHER DEFECT PAFRAMETERS

6.1 GENERAL

6.1.1 The results of defect parameter measurements shall be drawn up using TM software (refer to 6.3). In case the final report cannot be drawn up by the survey completion time, provisions of 6.4 shall be met. In substantiated cases when TM software cannot be used, inter alia, during the final report preparation period allowed by 6.4 (e.g. due to unstable Internet operation in the relevant region, website blocking in specific states, national prohibition of the use of specific software, as well as when the thickness measurements are carried out by a TM service supplier having no RS recognition (refer to 3.1.5)), the Head of the RS Branch Office carrying out the ship's survey shall make a final decision on possible drawing-up of the TM report in accordance with 6.2 based on the information provided by the RS surveyor carrying out survey, and TM service supplier. The decision shall be documented and verified/endorsed by the Head of the RS Branch Office. The decision copy shall be attached to the TM Report.). A similar procedure for drawing up the TM report without using TM software may be applied to the ships with small as-built thicknesses (3 mm or less).

Forms of tables for drawing up TM Reports in accordance with 6.2 can be downloaded from the RS official website, section "Additional information on surveys of ships in service". For CSR ships, MODU, FOP, steel floating docks, ships of inland navigation (for European inland waterways) and small ships, reports shall be drawn up in accordance with 6.2.

6.1.2 For CSR, the TM reports shall be filled-in using forms recommended by relevant IACS UR ZZ10s (Annex II (CSR)).

6.1.3 For structures of cargo hold hatch covers, ship's hull structures and other ship's elements, which are not subject to the provisions of 6.1.2 and which scantlings are determined using net thickness approach, the TM report forms recommended by Annex II of IACS UR Z7 shall be used.

6.1.4 The data of deformations and cracks in hull members and/or other defects, where available, shall be drawn up using TM software. Assessment of hull members with deformations/cracks shall be performed in compliance with 3.2-3.4 and 4.3. In cases specified in 6.1.1, it is permitted to draw up the report on residual deformations and cracks in the format of the TM Report tables that can be downloaded from the RS official website (www.rs-class.org), section "Additional information on survey of ships in service", together with the appropriate instructions for their filling-in.

Where the measurements of thickness and deformation/crack parameters are performed by one TM service supplier, it is recommended that the tables with records of deformation and crack parameter measurements together with the diagrams to be attached to the TM Report. In this case the cover page shall include the information on the actual content of the document (e.g. the title shall be corrected as follows: "Report on thickness, residual deformation and cracks measurements").

6.1.5 While drawing up the TM Reports, the provisions of 6.4 shall be additionally complied.

6.2 PROCEDURE FOR DRAWING UP THE TM REPORT IN MS EXCEL FORMAT

6.2.1 Instructions on filling-in the forms of tables for recording thickness measurements are given in electronic file with tables on thickness measurements (refer to 6.1.1). For ships engaged on international voyages tables for TM report shall contain translation into English language or the TM report shall be drawn up in English only.

6.2.2 For recording of thickness measurements of hull members in transverse sections, form RTM2 shall be used. Average values of measured thicknesses shall be recorded in relevant column of form RTM2.

In applicable cases for certain ships (refer to Sections 2 and 3, Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules, 2.2.1 and 5.2 of this Annex) the assessment of area reduction of deck and bottom zone transverse section shall be done. The following structures shall be included into the deck zone: strength deck plating, deck longitudinals, continuous cargo hold hatch coaming (plating and framing). The following structures shall be included into the bottom zone: bottom plating, bilge strake plating, bottom longitudinals.

For this assessment, the form RTM1 shall be used. For information, Annex 2-7 contains method of the assessment of the reduction of cross-section area of the deck and bottom with bilge. The assessment of cross-section area reduction is made automatically in form RTM1 by comparison of the results with 10 % from as-built scantling — permissible reduction according to these Rules. In cases, when it is allowed by these Rules to use allowable wear values of ACS — IACS member, assessment of the deck and bottom area reduction shall be performed in compliance with the rules of that ACS. For recording of thickness measurements of hull members in transverse sections, Transverse section diagram of the ship's hull shall be attached to the form RTM1 containing indications of a transverse section position along the hull length (beyond of transverse section along the ships length — frame numbers) and dimensions of its components. The hull transverse section components shall be numbered on the diagram.

6.2.3 For recording thickness measurements of all shell plates, deck plating, inner side, longitudinal and transverse bulkheads, longitudinal and transverse framing and other hull members, not included in forms RTM1 and RTM2, use shall be made of form RTM3. Diagrams or drawings of shell expansion, plans of decks, inner bottom, bulkheads, etc. shall be attached to the table.

6.2.4 The shell strakes and plates shall be numbered as follows:

bottom plating — from the plate keel to the side up to the bilge, inclusive;

shell plating — from sheerstrake to the upper edge of the bilge;

plating of decks, platforms and inner bottom — from the side to the centre line, including the strake in the centre line, if any;

plating of transverse and longitudinal bulkheads, and inner side — from the upper deck down to inner bottom plating (bottom);

plating of sloped part of the topside tank — from longitudinal coaming to the side;

plating of sloped part of the hopper tank — from the side to inner bottom plating.

N o t e . In case the calculation of permissible residual scantlings of ship's hull structures is available onboard, numbering of the hull members it is necessary to accept according to the table of permissible residual scantling of the calculation in order to exclude mistakes in assigning of the permissible residual thickness for each particular hull structure.

6.2.5 Framing members shall be numbered as follows:

the number of the primary and deep members of the transverse framing other than those of transverse bulkheads shall coincide with the number of the appropriate frame;

primary and deep members of the longitudinal framing as well as transverse bulkhead members shall be numbered successively in accordance with 6.2.4 for plate strakes.

N o t e . In case the calculation of permissible residual scantling is available onboard, numbering of the hull members it is necessary to accept according to the table of permissible residual scantling of the calculation in order to exclude mistakes in assigning of the permissible residual thickness for each particular item.

6.2.6 For recording the thickness measurements of various hull structural members, connecting items, items of ship arrangements, foundations, pipeline, sea chest plating, form RTM4 shall be used.

6.2.7 For recording the thickness measurements of hull members with local wear and pitting, and welds, and results of examination of riveted joints use can be made of form RTM5. The form shall include information containing the designation of the structure and its location in the hull (numbers of frames, plating strake, etc.), residual thickness in connection with local wear or pitting, weld length and grooves, allowable scantlings, etc. Appropriate table columns shall be filled out depending on type of defect. The results of thickness measurements shall be also shown on the appropriate diagrams. The results of rivet joint examination shall contain information on designation of the structure with a rivet joint and location of the structure in the hull with indication of frame numbers, strake, etc.; steel grade (yield strength) of the rivet joint; results of examination and hammer test of the joint; the results of random measurements of the rivets with indication of the number of measurements taken, measurement results of rivet centre distances from the edges of the plates connected; results of tightness tests of the structures, where required.

6.2.8 For recording the thickness measurements of welded branches for bottom and side valves form RTM6.1 shall be used. For recording the thickness measurements of ships pipeline the form RTM6.2 may be used.

6.2.9 For recording the thickness measurements of frames in cargo holds use shall be made of form RTM7, and for bulk carries additionally form RTM7 (S31).

6.2.10 In case structures with substantial corrosion and/or deep or intensive pitting were found in the course of the thickness measurements, an executive summary report on such areas shall be compiled, using form RTM8.

6.2.11 If any measurements required by these Rules are missing or not carried out to the full extent, the reason shall be recorded and grounded by the RS surveyor in the relevant RS reporting documents.

6.2.12 In case of application of the forms recommended by IACS UR Z7, Z10s, ESP Code for those type of ships for which they are applicable, it is necessary to fulfill completion guidelines of used forms according to the mentioned URs and/or ESP Code.

6.3 DRAWING UP THE TM REPORT USING TM SOFTWARE

6.3.1 TM Reports shall be drawn up using TM software in accordance with the improved forms, as compared to 6.2, considering the forms required by IACS UR Z7 and IACS UR Z10s. TM software enables to draw up the results of assessment of technical condition of ship's elements for wear and other defects. Application of TM software makes it possible to enter the information on completed repairs/replacements of hull structures and other ship's elements, condition of hard protective coating in the ship spaces for using at further surveys and in preparation for scheduled repairs.

6.3.2 Drawing up the TM Report using TM software shall be carried out in accordance with the User Manual available at the RS official website https://lk.rs-class.org/public/ocean.

6.4 ADDITIONAL REQUIREMENTS OF DRAWING UP THE REPORTS WITH FLAW DETECTION RESULTS

6.4.1 The TM Report shall also contain plans of transverse sections, structural drawings of shell expansion, web frames, plans of decks, inner bottom, bulkheads, hatch covers, etc. with identification of measured items, actual measurements. Final TM Report shall be drawn up taking into account 2.1.6 (i.e. it shall contain information on total wear, local wear/pitting; the areas of substantial corrosion, if any, and areas subject to repair shall also be indicated, etc.). Information on measurements of hull structural members identified for repairs/renewals shall not be changed in the report. The TM Report shall be made in English and may, at the shipowner's discretion, include translation into Russian. In case the ship is operated under the State flag of the Russian Federation, if the ship is not and will not be engaged in international voyages, the report is allowed to be made only in Russian. The copy of the authorization of the TM service supplier, which directed the operator on board to perform thickness measurements, shall be attached to the TM Report. The general arrangement plan shall also be attached to the TM Report.

The TM Report tables shall mandatorily contain a column with permissible diminution values to carry out assessments of the gauging results. Technical condition assessment is part of the whole complex and consists in determination of acceptability of hull structure wastage and wastage of other ship's items. Assessment of condition of the gauged structures (comparison of the actual results of measurements with permissible values) shall be carried out by TM operators qualified to level II according to standard ISO 9712. In all cases prior to signing of the TM Report, the RS surveyor shall check quality of the assessment with respect to validity of the permissible values, existence of non-recorded structures not complying with the RS requirements, substantial corrosion areas, etc. The TM report shall be signed by the TM operator (signatures of the TM operator shall be at least specified on the cover page, page containing the main data, the Minutes of Meeting prior to Commencement of the Thickness Measurements and in the conclusion to the TM Report). In addition, the cover page and the page containing the main data shall be stamped or sealed by the TM supplier on behalf of which the services are rendered by the TM operator.

6.4.2 Upon completion of the thickness measurements onboard, the RS surveyor shall verify, sign and stamp the preliminary TM Report. Preliminary report is a draft (for example: copies of schemes of gauged structures), consisting of information of measured structures, number of measurements, about substantial corrosion areas, hull members with excessive corrosion etc., which are filled out and signed by the thickness measurement operator and then transferred to the attending surveyor during whole period of thickness measurements onboard the ship (for convenience the drafts can be scanned and submitted in electronic format to the RS surveyor). Final TM Report shall be submitted to the RS surveyor before completion of survey. Failure to submit the final report to the RS surveyor may delay the completion of the survey.

6.4.3 If the operator has no possibility to submit final TM Report before completion of survey, the RS surveyor is allowed to accept the preliminary TM Report. At that the RS surveyor shall ensure that this report contains the results of assessment, conclusion on compliance of the ship technical condition with the RS requirements and that all structures subject to repair have been repaired and/or replaced before completion of survey. In such cases, when only preliminary report is submitted before completion of survey, the RS surveyor shall impose the requirement to the shipowner in the RS reporting documents and List of Survey's Status concerning necessity to submit final report, filled-out by the TM service supplier, to the RS Branch Office performing survey of the ship and supervision on thickness measurements, not later than 3 (three) month from the date of survey completion. Prior to survey completion, the RS surveyor shall confirm ship compliance with the RS requirements on the basis of the assessment of technical condition of the ship's hull done in the preliminary report.

6.4.4 The final TM Report shall be verified by the RS surveyor, who supervised thickness measurements onboard the ship (if thickness measurements are performed by the RS surveyor, who simultaneously performed thickness measurements and ship's survey, the report shall be verified by the personnel, duly authorized for verification of reporting documents upon the results of survey, of the RS Branch Office, where the RS surveyor — executor of thickness measurements is employed). During verification of the report the RS surveyor shall ensure that information provided in the final TM Report is consistent with the data of preliminary report taking into account requirements for final TM Report (refer to 6.4.1). During verification it is necessary to confirm that all structures, required to be repaired, are repaired and relevant confirmatory documents are available. Otherwise, the RS surveyor, carrying out the survey of the ship, shall impose requirement in the RS reporting documents to perform necessary repair of such structures before completion of the survey. During verification of the TM report special attention shall be paid to availability of substantial corrosion zones and thicknesses in excess of as-built values.

When repair or re-assessment (full or partial) of substantial corrosion zones, specified in the TM report submitted, have been performed during the survey, the RS surveyor shall arrange the updating of the information on these zones and reflect the updated information in the RS reporting documentation, including the List of Survey's Status.

Where the actual thickness values are in excess of the as-built ones, the RS surveyor shall verify that the dimensions given in the TM Report are true (e.g., based on the verification of the repair history, replacements, etc.). When no evidence is available, the repeated measurements shall be requested and the measurement results shall be corrected, where necessary.

During verification it is necessary to check correctness of terms applied (name of structures), that information on location of transverse bulkheads, web frames etc. is in line with drawings, the RS reporting documents and other ship's documentation. Any non-conformity found during verification shall be eliminated before the final report is signed and stamped by the RS surveyor. After completion of verification, the RS surveyor shall sign and stamp title page of the final report. Copy of the TM Report signed and stamped by the RS surveyor shall be forwarded to the RS Branch Office for in-service supervision. Control verification of the report may be done by the RS Branch Office, responsible for survey of the ship and/or at the RS Branch Office for in-service supervision. Originally signed and stamped copies of the TM Report shall be kept onboard and by the shipowner. When the TM Report is drawn up without the use of TM software, it shall be verified in compliance with the Check List on Verification of Thickness Measurements Report (form 6.1.04). In this case, the information relating to elimination of nonconformities identified shall be recorded by the RS surveyor in the Check list (form 6.1.04). The Check list duly signed and verified shall be submitted to be kept in the ship file together with the TM Report.

6.4.5 The RS Branch Office which carried out the survey shall send final reports to the RS Branch Office for in-service supervision within 10 working days after survey completion in electronic format (scanned). Scanned documents shall be saved in PDF format only. As a recommendation, simultaneously with a scanned copy of the report, the thickness measurement results may be submitted to the Register additionally in any electronic format (e.g. XML, HTML, MS Excel, etc.).

In addition, the TM Reports drawn up using TM software, shall be sent to the RHO server in compliance with the User Manual for software.

6.4.6 For the cases, when final TM Report was not submitted before completion of survey (refer to 6.4.2), the copy of the preliminary TM Report shall be send to the RS Branch Office for in-service supervision within 10 working days after completion of the survey in electronic (scanned) format taking into account 6.4.5. A copy of the Minutes of Meeting prior to Commencement of the Thickness Measurements (form 6.6.1) together with appropriate Attachments thereto duly filled in and containing all necessary signatures and stamps/seals

shall be attached to the copy of preliminary TM Report. The accompanying letter to the RS Branch Office for in-service supervision shall include an entry that preliminary TM Report was submitted with reference to the number of the RS Report with condition of class concerning necessity to submit final TM Report in assigned terms. The preliminary TM Report shall be kept at the RS Branch Office which performed the survey of the ship, and by the RS surveyor who was engaged in survey of the ship and supervision of thickness measurements at least until endorsement of the final TM Report after receipt thereof. The preliminary TM Report shall be kept at the RS Branch Office for in-service supervision until that moment when the duly endorsed final TM Report will be received and appropriate condition of class will be deleted from the List of Survey's Status by the RS Branch Office which endorsed the TM Report.

6.4.7 The requirements of 6.4.2 — 6.4.6 cover also the Reports with the measurements of deformation and crack parameters, as applicable.

ANNEX 2-1

PROCEDURE FOR CHECKING AVAILABLE/UPDATING INFORMATION ON PERMISSIBLE SCANTLINGS OF HULL STRUCTURES

1 The requirements for application of wear standards are given in Section 5 of Part I "General Provisions" to these Rules and Section 4 of Annex 2 to these Rules. Wear standards that are inapplicable or not updated (where updating is required) shall not be used. The Register shall be responsible for correct standards applied. At that, in case the calculation of permissible residual scantlings of ship's hull structures is agreed for a ship, the RS Branch Office, which has agreed this calculation, shall be responsible for correct and complete information on permissible scantlings of hull structures.

2 Information on permissible scantlings is uploaded in the ship's file/ TM software server in electronic format using the format required by the RS rules and RS internal procedures. The procedure for uploading and updating the information on permissible scantlings of metal hull structures of ships shall comply with the RS rules (refer to Table 1) and the applicable RS internal procedures. The main file with permissible scantlings of hull structures stored in the ship's file shall have the following format: "reg. No._t.pdf". The file generated by TM software shall comply with the requirements of TM software.

Depending on the standards applied in accordance with 5.12.3 of Part I "General Provisions", the following requirements shall be met when generating/uploading information on permissible scantlings of hull structures.

2.1 The standards according to 4.2.6 of this Annex 2 (refer to 5.12.3.1 of Part I "General Provisions"): the file shall at least contain the information on permissible scantlings of hull structures specified in Annex 2-3 (only in English). When entering standards into TM software, the option for determining scantlings according to "m_0" shall be selected.

2.2 The standards according to ACS — IACS member rules (if allowed by 5.12.3.2, Part I "General Provisions"): the file shall contain standards received from the losing society when accepting the ship into the RS class, including information on permissible hull section modulus/ultimate section modulus (if applicable). Reference information on standards according to ACS — IACS member rules is posted on the RS internal website for the RS surveyors. When entering the standards into TM software, the option of standards entry according to the ACS — IACS member rules shall be selected.

2.3 The standards according to 4.2.1 — 4.2.5 of Annex 2: the file shall at least contain information in accordance with Annex 2-4 to Annex 2 and a copy of the cover page with a stamp confirming the agreement with the Register. If the use of standards determined by calculations agreed prior to 1 January 2015 is allowed on the ship, the file shall at least contain a copy of the cover page with a stamp confirming the agreement with the Register, as well as information on permissible scantlings of hull structures subject to thickness measurements, determined by calculation. Decision on possible application to the ship of the calculations of permissible scantlings of hull structures agreed prior to 1 January 2015 shall be based on compliance with the applicable provisions of 4.2.1 — 4.2.5 of Annex 2. At that, in case the applicable requirements are not met, the calculation shall be updated and the RS Branch Office that revealed the non conformity shall inform the shipowner and the RS Branch Office for in-service supervision (if revealed by another RS Branch Office). In this case, the RS Branch Office for in-service supervision shall make an entry in the List of Survey's Status on the necessity to update permissible scantlings of hull structures prior to commencement of the relevant survey, during which thickness measurements are required.

When standards are entered into TM software, the option for scantlings determination according to "m_1, m_2" shall be selected.

2.4 For ships, to which the standards according to 5.12.3.4, Part I "General Provisions" apply (i.e. when the appropriate IACS URs S18, S19, S21, S21A, S22, S31, etc. are applicable), an additional file shall be included in the ship's file, containing information on permissible scantlings of hull structures, which shall be supplemented by the information specifying the structure, standards, appropriate values and calculations for technical condition assessment and repairs, as well as the technical condition assessment procedure determined in accordance with the applicable IACS UR. The file shall have the following format: "reg. No._S[IACS UR No.].pdf". The appropriate option shall be selected additionally in the TM software for entering such standards.

2.5 For ships built in accordance with the IACS Common Structural Rules, information on permissible scantlings of hull structures is shown in structural drawings. Assessment of the technical condition of hull structures of such ships shall be carried out according to the IACS Common Structural Rules. The procedure for determination of permissible scantlings of hull structural members in terms of hull wear described in Annex 2 to these Rules shall not apply to these ships, except for ship's elements, for which such information is not shown in the drawings. For such ships, the file with information on permissible scantlings to be included in the ship file shall at least contain the following entry: "Information on permissible scantlings of ship's hull structures is shown in the relevant structural drawings. For other ship's elements (in case of lack of information in ship's drawings) the relevant provisions of Annex 2 to the Rules for the Classification Surveys of Ships in Service shall be applied.". When entering the wear standards by the use of TM software, the appropriate option for entering such standards according to the IACS Common Structural Rules shall be selected.

2.6 For ships built using materials other than steel and aluminum, the file with information on permissible scantlings of hull structures shall contain requirements from the relevant sections of Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material" of these Rules (e.g. provisions of Section 15 for glass-reinforced plastic ships, etc.).

2.7 For steel floating docks, the file shall contain information on permissible residual thicknesses determined in accordance with the Instructions for Determination of Technical Condition and Repair of Steel Floating Dock Hulls, as amended.

2.8 For MODU and FOP, the file shall contain information on permissible scantlings of hull structures determined in accordance with Section 19, Part III "Additional Surveys of Ships Depending on their Purpose and Hull Material".

Table 1

Procedure of RS work with information on permissible scantlings of hull structures (permissible residual thicknesses)

Check/updating schedule. Description of actions	Responsible RS Branch Office		
	RS Branch Office/RHO Location, which has performed or agreed calculation of permissible residual thicknesses	RS Branch Office for in service supervision (where a ship is registered)	RS Branch Office performing survey of a ship requiring thickness measurements
	A	B	C
1. In case of survey of a ship in service not related to acceptance of ship into the RS class	In cases stipulated by the Rules, a responsible person shall send the file prepared in accordance with provisions of para 2, Annex 2-1 to the RS Branch Office for in service supervision and the RS Branch Office performing the survey, not later than in 2 working days from the date of registration and sending of the letter of conclusion	Where necessary (refer to A and C), enter the information received from the RS Branch Offices into the ship's file in accordance with the RS internal procedures not later than in 2 working days from the date of information receipt, update information in the List of Survey's Status in accordance with the RS internal procedures	1) Check the available information on permissible residual thicknesses in the ship's file; 2) Check the available warning entries on permissible residual thicknesses in the List of Survey's Status. 3) Check updated information on permissible residual thicknesses in accordance with paras 1 and 2, Annex 2-1. Where necessary, provide updating of information on permissible residual thicknesses, involving the RS Branch Office for in-service supervision and a shipowner (where required), prior to completion of survey. Provide technical condition assessment using updated standards and, where necessary, repair of structures prior to completion of survey. 4) Check the available, correct (when correct permissible residual thickness category in doubt) and complete information on permissible residual thicknesses entered by the use of TM software. 5) Add/Correct information on permissible residual thicknesses by the use of TM software. Export the supplemented/ corrected file to the RHO server prior to completion of survey. Where necessary, re-issue the TM Report prior to completion of survey, taking into account the updated standards. 6) Where necessary, introduce missing/updated information on permissible residual thicknesses together with the set of documents on survey results to the ship's file in the prescribed manner
	Notes: 1. During surveys, involving the minimum thickness measurements (e.g. annual surveys or, where thickness measurements are carried out in the areas with substantial corrosion, intermediate surveys covered only by IACS UR Z7 or UR Z7.2), entering complete information on wear standards in the TM software may be omitted. 2. During special surveys (irrespective of the ship's age and type), as well as intermediate surveys covered by provisions of IACS URs Z7.1 and Z10s), information on ship's elements wear standards shall be entered in the maximum possible scope. 3. At the discretion of the RS surveyor, information on wear standards may be entered in the TM software by operators of the TM suppliers recognized by RS, provided that 100 % monitoring by the RS surveyor is provided (the RS surveyor shall be fully responsible for correct information entered). 4. When there are several documents/files containing different permissible residual thickness values on the ship or in the ship's file and there is any doubt in the correct choice, possibility of using certain standards shall be agreed upon with the RS Branch Office for in-service supervision prior to application of the standards on the ship. In case of disputes, RHO shall be contacted.		

Check/updating schedule. Description of actions	Responsible RS Branch Office		
	RS Branch Office/RHO Location, which has performed or agreed calculation of permissible residual thicknesses	RS Branch Office for in service supervision (where a ship is registered)	RS Branch Office performing survey of a ship requiring thickness measurements
	A	B	C
	5. Standards shall be updated involving the shipowner or duly authorized representative of the shipowner. When new calculation is performed, it shall be submitted to the Register for review. The calculation approved by RS shall be submitted to the RS surveyor on board the ship prior to completion of survey.		
2. Initial survey after the ship construction	Refer to para 1, Annex 2-1, if the set of documents approved by the RS includes calculation of permissible scantlings of hull structures	Introduce the applicable information on permissible residual thicknesses in the ship's file not later than in 10 working days after receipt of the set of records upon the survey results from the RS Branch Office performing the initial survey	—
	N o t e . In case "m_0" standards are used, it is recommended to enter information in the TM software during the initial survey. In this case, the file with information on permissible residual thicknesses shall be exported by the RS surveyor to the RHO server in the prescribed manner.		
3. Acceptance of ship into the RS class	In cases stipulated by the Rules, a responsible person shall send the file prepared in accordance with provisions of para 2, Annex 2-1 to the Branch Office for in-service supervision and the RS Branch Office authorized to perform the survey to accept the ship into the RS class not later than in 2 working days from the date of registration and sending of the letter of conclusion	Enter the information received in the ship's file in accordance with the RS internal procedures not later than in 2 working days from the date of information receipt	In cases when survey involving thickness measurements is prescribed upon the RHO authorization: 1) provide application of standards in accordance with para 1, Annex 2-1, as well as Section 5, Part II "Carrying Out Classification Surveys of Ships" of the Guidelines; 2) check the availability of correct information on permissible residual thicknesses in the Enhanced Survey Programme (for ships having **ESP** distinguishing mark in the class notations. Where necessary, provide entering of any necessary corrections (refer to 1.3, Part III "Additional Surveys of Ships Depending on Their Purpose and Hull Material" of these Rules); 3) enter the standards by the use of TM software. Export the file to the RHO server by the use of TM software (refer to the Notes to item 1 of the Table); 4) send the file containing permissible residual thickness, prepared in accordance with para 2, Annex 2-1 to RHO together with the set of records upon the survey results. RHO, after checking that the conditions of assignment of class to the ship are met regarding the permissible scantlings, shall send the information on permissible residual thicknesses received to the RS Branch Office for in service supervision to be introduce into the ship's file

Check/updating schedule. Description of actions	Responsible RS Branch Office		
	RS Branch Office/RHO Location, which has performed or agreed calculation of permissible residual thicknesses	RS Branch Office for in service supervision (where a ship is registered)	RS Branch Office performing survey of a ship requiring thickness measurements
	A	B	C
4. Annually in the ship's file	—	1) Check the available information in the ship's file and on the internal site in the TM software. 2) Check updated information on permissible residual thicknesses, as well as available translation into English (where applicable, refer to 4.1.11, Annex 2). 3) Provide introduction of missing/ updated information into the ship's file. In case the ship survey is performed simultaneously with the ship's file check, the RS Branch Office performing survey shall be informed on the permissible residual thickness changes made	—
	Notes: 1. The up-to-date status of information shall be checked in accordance with provisions of paras 1 and 2, Annex 2-1. 2. Where necessary, standards shall be updated involving the shipowner or duly authorized representative of the shipowner. In case new calculation shall be performed, it shall be submitted to the Register for review. Information on permissible scantlings from the approved calculation shall be introduced into the ship's file by the RS Branch Office, which has reviewed and agreed the calculation. The file shall be introduced in the ship's file in the prescribed manner. 3. In case the standards cannot be timely updated due to objective reasons, an entry warning may be made in the permissible residual thickness file of the ship's file and in the List of Survey's Status that the standards have not been updated and shall be updated not later than in 1 month prior to commencement of survey. 4. When translation of permissible residual thickness information into English is not available, information on permissible residual thickness shall be translated and the information translated shall be subsequently introduced in the ship's file in the prescribed manner. Translation shall be performed by RS. 5. In case the information on permissible residual thicknesses is not available on the RS internal website in the TM software, provide adding of the information (if it is found according to the ship's file that the TM Report was issued by the use of TM software) involving the RS Branch Office performing supervision of thickness measurements on the ship or the RS Branch Office performing thickness measurements by itself (whichever is applicable). 6. In case the information on permissible residual thicknesses is not available on the RHO server and the reports of thickness measurements on the ship were not drawn up by the use of TM software, provide entering of the standards into TM software by the RS Branch Office for in-service supervision itself. Information may be entered into TM software by the RS Branch Office for in-service supervision based on information in the ship's file, without attending the ship. At that, information entry shall be suspended if the information is insufficient (necessary drawings, calculations are not available) or in case of doubts regarding information reliability.	
5. Transfer of ship from the RS class to ACS class	—	To ensure that requirements of para A.2.3bis, IACS PR1A (regarding the losing society forwarding information on permissible scantlings of hull structures to the gaining society) are met when receiving from RHO the request on the ship transfer into the ACS class, the following procedure shall be complied with: forward information on permissible residual thicknesses to the gaining society immediately (in 5 working days for main hull structures wear standards, in 12 working days for results of assessment according to IACS URs S19, S31, etc., if applicable). The information shall be submitted in English.	—

Check/updating schedule. Description of actions	Responsible RS Branch Office		
	RS Branch Office/RHO Location, which has performed or agreed calculation of permissible residual thicknesses	RS Branch Office for in service supervision (where a ship is registered)	RS Branch Office performing survey of a ship requiring thickness measurements
	A	B	C
		In case information on permissible residual thicknesses is not translated into English, translation shall be performed by the RHO Location responsible for translation not later than the specified due dates mentioned above minus one working day necessary for forwarding the information to ACS by the responsible RHO Location). At that, information on permissible residual thicknesses entered by the use of TM software may be taken into account (where applicable)	

ANNEX 2-2

RECOMMENDATIONS ON MEASUREMENT OF f'_{300} PARAMETER AT INDENTATION MEASURING

When measuring the f'_{300} parameter on the framing having indentations, it is proposed to use a deflection gage. It consists of a steel batten with stationary legs at the ends; and in the middle of this batten a device for deflection measuring is fitted. A watch-type indicator ИЧ-10 providing the accuracy of measurement of 0,01 mm or a trammel with a slide (slide-depth indicator) with the accuracy of measurement at least 0,1 mm, may be used as such a device.

When manufacturing the deflection meter, the safety attachment of the indicator (slide-depth indicator) to the batten shall be ensured in order to prevent its offset while gauging.

Prior to taking measurements by means of the deflection gage the initial indication of the device shall be recorded — the reading b_0 of the deflection gage mounted on the surface, preferably on the reference plate, shall be taken. While doing so, the deflection gage shall be fixed to the plate by the stationary legs.

When taking the measurement on the curved surface in way of indentation, the final indication shall be recorded in the same way, i.e. the readings b_{dg} of the deflection gage shall be taken. The camber f'_{300} shall be calculated according to the formula

$$f'_{300} = |b_{dg} - b_0|.$$

For gauging of the b_{dg} value the deflection gage shall be oriented along the framing detected, the movable leg of the deflection gage (indicator or slide-depth indicator) shall be aligned with the maximum camber point of this framing f'.

In all the cases, the final result shall be taken three times: b^{I}_{dg}, b^{II}_{dg}, b^{III}_{dg}, each time shifting the deflection gage from the maximum camber point f' along the strained framing; the value b_{dg} shall be determined as the mean arithmetic of three measurements:

$$b_{dg} = \frac{1}{3}\left(b^{\mathrm{I}}_{dg} + b^{\mathrm{II}}_{dg} + b^{\mathrm{III}}_{dg}\right)$$

If the result, being significantly differ of two other values, is obtained during one of the measurements, this results shall be rejected and the measurement shall be taken again.

When the measurements are taken on the heavily corroded shell plating and the plate surface has large local unevenness, it may be recommended to carry out gauging using a thin backing.

The backing shall be overlapped with the plating in the measuring point and fluently turns it in such a way that the curved surface pattern remains and the unevenness becomes smooth. The deflection gage shall be put on the backing. Steel millimeter-scale ruler may be used as a backing.

If the measurements are conducted on the curved part of the side, the initial indication of the deflection gage shall be taken not on the plane but on the outer plating without deformations where the plating has the same bending as in the damaged area. In this event, the measurements at the initial indication shall be taken three times with observance of all the instructions regarding the final indication.

It shall be noted that while the outer hull flaw defection the concave surface is measured, as a rule, and inside the hull — the convex surface. For this the deflection gage shall be adjusted accordingly. When measuring the convex surface the initial indication b_0 shall be maximum, and when measuring the concave surface it shall be minimum.

It may be recommended to adjust the deflection gage to obtain $b_0 = 5{,}4 \div 5{,}7$ mm. Then the gage may be used for measuring both the concave and convex surfaces without readjustment. If the value b_{dg} is outside the gage limits, it always mean that f'_{300} is greater than the allowable $[f_{300}]$ value.

ANNEX 2-3

Wear standards according to 4.2.6 of Annex 2 (i.e. using factor m_0).

PERMISSIBLE SCANTLINGS OF HULL STRUCTURES

1. The permissible residual hull girder section modulus for deck and bottom is equal to 90 % of as-built value.

2. The permissible residual thickness of plates and framing members is stated in table.

Nos		Permissible thickness		
		Total corrosion	Local corrosion (grooving etc.)	Pitting corrosion
1. Plating				
1.1	Midship region (0,4*L**) — Upper strength deck — Continuous hatch coaming — Second continuous deck located above 0,75*D*** from the base plane; trunk deck; another continuous deck adjacent to the hatch coaming top of the cargo hold, with the adjacent side plating — Sheerstrake — Upper and lower strakes of inner side — Upper and lower strakes of longitudinal bulkhead — Plate keel — Bottom with bilge — Top-side and hopper tanks — Inner bottom throughout the length	0,80*t* ***	0,70*t*	0,30*t*, but not less than 3,0 mm
1.2	— Hull elements, as listed under 1.1, outside the midship region as well as any elements anywhere along the hull length:			
	— For ships operating in unrestricted areas of navigation and ships having the distinguishing marks for restricted areas of navigation **R1**, **R2** in their class notations	0,70*t*	0,60*t*	
	— For ships, having the distinguishing marks for restricted areas of navigation **R2-RSN**, **R3-RSN**, **R3**, **R2-RSN(4,5)** in their class notations	0,75*t*	0,65*t*	
1.3	Structural members in the areas as follows: — ice strengthening — strengthening of ships mooring at sea — strengthening in regions to which extreme hydrodynamic pressures are applied	0,80*t*	0,70*t*	
2. Framing				
2.1	The main and web framing in way of strengthening mentioned in 1.3	0,80*t*	0,50*t*	0,30*t*, but not less than 3,0 mm
2.2	Longitudinals of upper strength deck, sheerstrake, upper and lower strakes of inner side and longitudinal bulkheads, top-side and hopper tanks, inner bottom and bottom amidships, as well as all web framing	0,75*t*		
2.3	Longitudinals, as listed under 2.2, outside the midship region as well as any others girders anywhere along the hull length	0,70*t*		
2.4	Transverse corrugated bulkhead	0,65*t*		

**L* = design ship's length in accordance with the RS Rules.
***D* = depth in midship region.
****t* = as-built thickness of hull structural members.

Structural Diminution Allowances to be used during Ship Survey in Accordance with RS Rules. The norms apply to ships whose RS class has not been changed since their construction.

Application of the present norms is to be affirmed by RS Head Office (Hull Department) in case of:

— major modernization/conversion of hull structure,
— new tonnage;
— new mark of navigation area; new ice category mark etc.

ANNEX 2-4

PERMISSIBLE RESIDUAL THICKNESS OF SHIP'S HULL STRUCTURES

Table 2-4.1

Permissible residual thickness of ship's hull structures[1]

Nos.	Item	As-built thickness S_0	Thickness, as required by the Rules for Construction S	Permissible residual thickness			Upper level of the substantial corrosion zone [$S_{75\%}$]
				total wear [S_1]	local wear [S_3]	pitting [S_4]	
		mm	mm	mm	mm	mm	mm
1	2	3	4	5	6	7	8
1	**Strength deck:**						
1.1	Strength deck plating						
1.2	Deck stringer						
1.3	Upper deck plating between cargo hold hatches						
1.4	Deck girders (web/flange)						
1.5	Deck longitudinals						
1.6	Web beams (web/flange)						
1.7	Beams						
2	**Cargo hold hatches**						
2.1	Cargo hatch coamings						
2.2	Cargo hatch coaming stiffeners						
2.3	Hatch cover plating						
2.4	Hatch cover framing						
3	**Other decks and platforms**						
3.1	Plating						
3.2	Beams						
3.3	Web beams (web/flange)						
3.4	Deck longitudinals						
3.5	Deck girders (web/flange)						
4	**Side:**						
4.1	Sheerstrake						
4.2	Side shell plating in way of water and wind strakes						
4.3	Side shell plating outside line of water and wind strakes						
4.4	Side shell longitudinals						
4.5	Web frames (web/flange)						
4.6	Ordinary frames						
4.7	Intermediate frames						
4.8	Side stringer (web/flange)						
5	**Bottom and double bottom:**						
5.1	Keel plate						
5.2	Bottom plating						
5.3	Bilge shell plating						
5.4	Bottom center girder (web/flange[2])						
5.5	Bottom side girder (web/flange[2])						
5.6	Bottom longitudinals						
5.7	Floors (web/flange[2])						
5.8	Double bottom plating						
5.9	Double bottom longitudinals						
6	**Bulkheads:**						
6.1	Forepeak bulkhead						
6.1.1	Plating						
6.1.2	Web framing (web/flange)						
6.1.3	Vertical and horizontal stiffeners						
6.2	Transverse bulkheads						
6.2.1	Upper strake plating						
6.2.2	Middle strake plating						

Nos.	Item	As-built thickness S_0	Thickness, as required by the Rules for Construction S	Permissible residual thickness			Upper level of the substantial corrosion zone [$S_{75\%}$]
				total wear [S_1]	local wear [S_3]	pitting [S_4]	
		mm	mm	mm	mm	mm	mm
1	2	3	4	5	6	7	8
6.2.3	Lower strake plating						
6.2.4	Transverse bulkhead stiffeners						
6.2.5	Vertical webs (web/flange)						
6.2.6	Horizontal girder (web/flange)						
6.2.7	Horizontal stiffeners						
6.2.8	Horizontal plate of upper stool						
6.2.9	Slope (vertical) plate of upper stool						
6.2.10	Upper stool brackets						
6.2.11	Horizontal plate of lower stool						
6.2.12	Slope (vertical) plate of lower stool						
6.2.13	Lower stool brackets						
6.2.14	Shedder plate						
6.2.15	Gusset plate						
6.3	Longitudinal bulkhead, inner side						
6.3.1	Plating, upper strake						
6.3.2	Plating, middle strake						
6.3.3	Plating, lower strake						
6.3.4	Slope plate						
6.3.5	Longitudinals						
6.3.6	Vertical webs						
6.3.7	Vertical stiffeners						
6.3.8	Horizontal stiffeners						
6.3.9	Horizontal girder						
7	**Superstructures and deckhouses:**						
7.1	Superstructure side plating						
7.2	End bulkhead superstructures/ deckhouses						
7.3	Side walls of deckhouses						
7.4	Forecastle deck plating						
7.5	Poop deck plating						
7.6	Superstructure/deckhouse decks plating						
7.7	Underdeck framing						
7.8	Side framing						
8	**Hopper side tank**						
8.1	Plating						
8.2	Framing						
9	**Topside tank**						
9.1	Plating						
9.2	Framing						
10	**Region of strengthening**[3]						
10.1	Ice zone plating						
10.1.1	Region A						
10.1.2	Region B						
10.1.3	Region C						
10.2	Slamming region						
10.2.1	Side plating						
10.2.2	Bottom plating						
11	**Other hull members**[4]						

[1] This table includes the information on permissible thicknesses of the ship's main hull structures. Thicknesses specified therein shall also satisfy the requirements of the present Rules for the allowable cross-sectional area of a girder web.

[2] Flange — for case of absence of double bottom plating.

[3] Permissible thickness of framing for regions of strengthening shall be calculated as the maximum (based on all the requirements) and is specified in columns 4 and 5.

[4] The additional structures shall be included in Section 11 "Other hull members" depending on the type of the ship and her structural features.

N o t e s : 1. Additional information may be provided in Table 2-4.1 if required by the conditions of the structural calculation etc.

2. Information on permissible scantlings of the hull members shall be provided considering subdivision of the ship on forward, aft and middle parts. It is necessary to provide information on the scantlings for each part of the ship. A more detailed zoning may be used.

Table 2-4.2

Permissible hull section modulus for a ship in service

Number of transverse sections or area	Location of hull transverse section or area along the ship's length, frame No.		Section modulus, in cm^3		
			as-built[1] W_0	as required by the Rules for Construction[2] W	permissible[3] [W]
		Upper deck Bottom Upper deck Bottom Upper deck Bottom			

[1] Section modulus for a new hull of the ship.
[2] Section modulus determined from the Rules for Construction for a new hull of the ship.
[3] Section modulus determined from the Rules for Construction for a hull of the ship in service.

ANNEX 2-5

VERIFICATION OF THE PROPER USE OF MATERIALS

1. The proper use of materials listed in technical documentation on repair of the ship's hull structures shall be verified by the Register.

2. Materials with properties complying with the ship's as-built drawings shall be applied for repair of hull structures. The materials used for repair of hull structures shall be manufactured under the RS technical supervision and meet the requirements of Part II "Hull" and Part XIII "Materials" of the Rules for the Classification and Construction of Sea-Going Ships. It is allowed to apply materials certified by ACS — IACS member. More detailed instructions on selecting the material for repair of hull structures are given in the internal normative documents on repair for the use of RS surveyors.

3. Provision shall be made for an accurate system for verification of material supplied to the shipyard, for parts marking including cases when the material used lacks the per sheet marking in manufacturing. The shipyard's procedure for recording, storage and use of materials shall provide an opportunity to submit to the RS surveyor a certificate on metal used for manufacture or repair of hull members at any stage of repair. Code systems or other techniques may be used with automatic mechanical marking.

ANNEX 2-6

PERMISSIBLE WEAR LIMITS FOR HULL WATERTIGHT CLOSING APPLIANCES, ARRANGEMENTS, MASTS AND OTHER SHIP ELEMENTS

1 Hull watertight closing appliances.

In order to assess the technical condition of the hull watertight closing appliances (such as doors, hatch covers, companionways, skylights and vent covers, etc.) in the absence of as-built data or standards, one shall be guided in determination of allowable residual thickness by the provisions of Part III "Equipment, Arrangements and Outfit" of the Rules for the Classification and Construction of Sea-Going Ships, having regard to the appropriate factors given in Table 4.2.2.1-1 of Annex 2 to these Rules, depending on the structure, in which the closing appliance is fitted.

For ships originally classed with RS, the following total wear standards shall be applied in assessing technical condition of steel hatch covers of cargo holds in ships other than bulk carriers contracted for construction on or after 1 January 2004):

for plating — not more than 30 %;

for framing — not more than 25 % of as-built scantlings.

In order to assess technical condition of small hatch covers, doors that generally have small thickness and manufactured by press forming — not more than 20 % of as-built thickness based on total wear.

In any case, hatch covers shall comply with applicable requirements of the International Convention on Load Lines or the Load Line Rules for Sea-Going Ships.

Where local and/or pitting wear is found, one shall be guided by the provisions of the relevant sections of these Instructions for assessing the level of wear.

2 Steering gear.

In assessing technical condition of the steering gear in the course of survey, one shall be guided by the following:

mean wear of the rudder blade plating, nozzle rudders and fixed nozzles shall not exceed 25 % of the as-built thickness;

strength members (including chains and steering chain rods) having mean wear 10 % and more of the as-built thickness or diameter, or having fractures or permanent set may not be used in operation;

a steel wire rope in the steering gear system shall be replaced, provided the number of wire breaks in any place over its length equal to eight diameters is 10 % or more of the total number of wires or in case of excessive deformation of the wire rope;

the diameter of the rudder stock, pintles and rudder shaft may not be reduced below the values specified in the Rules for the Classification and Construction of Sea-Going Ships;

allowable gaps in mounting assemblies of the rudder shall be specified in each particular case, having regard to their as-built size and matching design;

the rudder stock if twisted for 5*8* and more may be allowed for use, provided a quadrant or steering tiller is stress relieved and fitted on a new key. The rudder stock shall be replaced in case it is twisted for an angle 15° or more and if cracks are found;

foundations of steering gear drives shall be replaced if their elements are worn 20 % of the as-built thickness and more.

3 Anchor arrangement.

For assessment of technical condition of anchor arrangement it is necessary to follow the instructions of Annex 50 "Guidance on Technical Supervision of Anchoring Equipment in Service (with due Account for the Provisions of IACS Recommendation No. 79)" to the Guidelines.

4 Signal masts.

In assessing technical condition of masts and their rigging, one shall be guiding by the following:

the mean wear of steel mast plates shall not exceed 20 % of the as-built thickness;

wooden masts shall be replaced, provided they are rotten for 10 % or more of the cross-sectional area;

stressed items having mean wear 10 % or more of the as-built thickness or diameter may not be used;

a steel wire rope shall be replaced, provided the number of wire breaks in any place over its length equal to eight diameters is 10 % or more of the total number of wires or in case of excessive deformation of the wire rope.

5 Fixed equipment for separating bulk cargo.

In assessing technical condition of fixed equipment, rates of wear and damages relating to ship structure shall be applied in accordance with Annex 2 of these Rules.

6 Towing arrangement.

In assessing technical condition of towing arrangement, one shall be guided by the following provisions:

a steel wire rope shall be replaced, provided the number of wire breaks in any place over its length equal to eight diameters is 10 % or more of the total number of wires or in case of excessive deformation of the wire rope;

for a chain used in the towing arrangement for emergency towing of ships, one shall be guided by rates of wear and defects for anchor chain cables;

a fiber rope shall be replaced in case rope yarns are broken, or it is rotten, substantially worn-out or deformed;

hooks, bollards, bitts and hawse pipes shall not have excessive wear, burrs or other damages;

foundations of towing arrangement drives shall be replaced if their elements are worn 20 % of the as-built thickness and more.

7 Mooring arrangement.

In assessing technical condition of mooring arrangement, one shall be guided by the following:

a steel wire rope shall be replaced in case the number of wire breaks in any place over its length equal to eight diameters is 10 % or more of the total number of wires, or in case surface wear or corrosion results in reduction of the wire diameter by 40 % or more as compared to the original value as well as in case of excessive deformation of the wire rope;

fiber and synthetic ropes shall be replaced in case rope yarns are broken, they are rotten, substantially worn-out or deformed;

fairlead rollers, guide rollers, bollards, hawse pipes and mooring drums shall not have excessive wear, burrs or other damages.

8 Ship piping, welded branches of bottom and side valves.

Annex 26 to the Guidelines contains the requirements for assessing technical condition of metal and alloyed piping of ship's and machinery installation systems subject to technical supervision of the Register, including welded branches of bottom and side valves, the sea chest pipelines and their filters.

In assessing technical condition of air pipes and ventilator pipes in accordance with 2.4.2.7 and 2.4.2.8, Part II "Survey Schedule and Scope" of these Rules, the standards for structures with wear according to 4.2.2 (refer to item 9.1, Table 4.2.2.1-1) of Annex 2 to these Rules shall apply, and when suspect areas are found — 4.5 of Annex 2.

9 Items of survival craft launching appliances.

During assessment of technical condition of survival craft, one shall be guided by the following:

lifeboats, rigid liferafts and buoyant apparatus having damages, such as cracks, holes or dents, and wooden boats rotten or leaking shall not be permitted for use/operation;

mean wear of metal structures shall not exceed 20 % of the as-built thickness;

strength items with mean wear equal to 10 % or more of the as-built thickness or diameter shall be replaced;

a steel wire rope shall be replaced in case the number of wire breaks in any place over its length equal to eight diameters is 10 % or more of the total number of wires as well as in case of excessive deformation of the wire rope;

a fiber rope shall be replaced even if one rope yarn is broken, rotten, or it is substantially worn out or deformed.

At each special survey of ships over 10 years of age and at the second or third annual survey of ships over 20 years of age, the residual thickness measurements of metal structures of survival craft and rescue boats shall be carried out. In other cases, such measurements shall be taken at the discretion of the RS surveyor.

10 Items of cargo-handling gear.

Residual thickness of metal structures shall be measured at least once every five year. In case defects affecting safe operation of the cargo-handling gear, as well as wear that exceed permissible values are found at a periodical survey, worn-out or damaged items shall be replaced or repaired, and deficiencies eliminated.

These rates are approximate and may be changed depending on nature of item operation and type of wear. In order to identify how wear affects strength and reliability of the item, computational methods may be used.

The rates refer to the locations of the maximum wear.

Items worn by 10 % or more in terms of thickness or diameter, as well as items having cracks, breaks or permanent deformation are not allowed to be used.

Metal masts and derricks, winch foundations as well as metal structures of cranes and loose gear, if residual wall thickness is 80 % or less of their as-built thickness may not be used.

Wear of the lift items and assembly units shall not exceed the rates specified by manufacturers or given in 10.6.6 of the Rules for the Cargo-Handling Gear of Sea-Going Ships.

11 Heat exchangers and pressure vessels. Freon tanks.

During technical condition assessment of pressure vessels it is necessary to note the following:

if the average wear of walls of hulls, tubes and other responsible elements determined upon several residual thickness measurements exceeds 10 % of the initial thickness or local wear in the form of pitting wear exceeds 20 % of the initial thickness, the worn element shall be replaced or repaired; at that, excessive thicknesses in relation to those required by these Rules may be considered.

For the assessment of the results of freon tanks structures it is necessary to note the following:

if a wear of tank walls averaged over a few measurements exceeds 10 % of the initial thickness, the tank shall be replaced or repaired.

ANNEX 2-7

METHOD OF ASSESSMENT OF REDUCTION OF SHIP'S DECK AND BOTTOM CROSS-SECTIONAL AREAS

Assessment of reduction of deck and bottom cross-sectional areas shall be carried for the purpose of determination of the necessity to check the cross sections' modulus of the ship's hull.

For this assessment, required by 2.2.1 of Annex 2 to these Rules on class surveys of ships in service, it is necessary to guide by the following: when doing such verification the whole breadth of the ship shall be taken into account (for the deck — from side to side, for the bottom — from bilge to bilge). For illustration, only half of the deck's breadth is shown in Fig. 1. The calculation shown in example is done for the half of the ship's breadth.

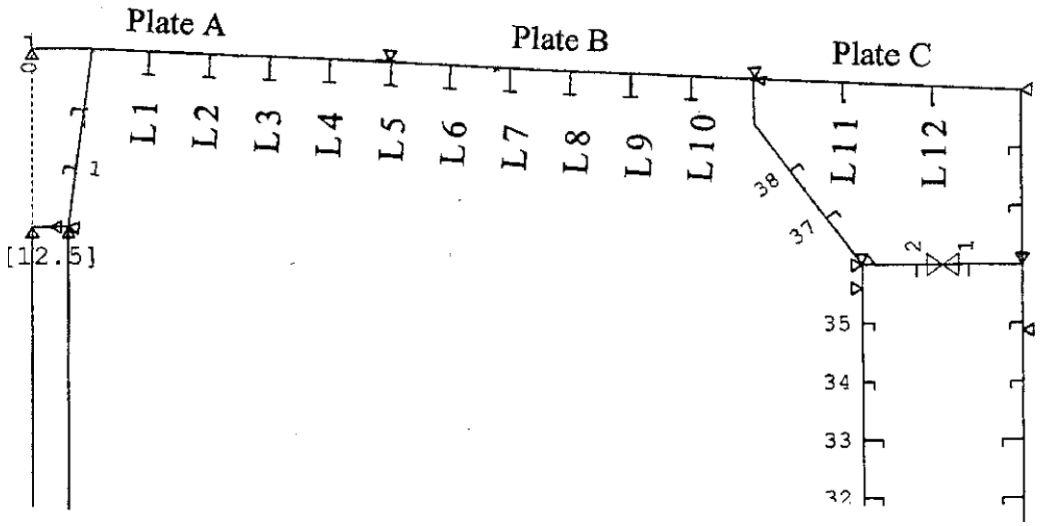


Fig. 1
Scheme of the half of the deck breadth section

1) Calculation of area of the selected section of the deck, plates (Fig. 1):

Plates	Plate A	Plate B	Plate C
Length, in m	4	4	3
As-built thickness, in mm	16	15	14
Measured thickness, in mm	15	14,5	13

Total original area of the deck:
4000 mm × 16 mm + 4000 mm × 15 mm + 3000 mm × 14 mm = 166 000 mm^2.
Total measured area of the deck:
4000 mm × 15 mm + 4000 mm × 14,5 mm + 3000 mm × 13 mm = 157 000 mm^2.

2) Calculation of the underdeck framing section area:

Member number	As-built scantlings, in mm	Measured thicknesses for the web, in mm	Measured thicknesses for the flange, in mm
*L*1	300 × 14 + 150 × 20	12,8	19
*L*2	300 × 14 + 150 × 20	12,5	18,8

Member number	As-built scantlings, in mm	Measured thicknesses for the web, in mm	Measured thicknesses for the flange, in mm
*L*3	300 × 14 + 150 × 20	11,5	19,2
*L*4	300 × 14 + 150 × 20	12,0	19,2
*L*5	300 × 14 + 150 × 20	13,5	20,2
*L*6	300 × 14 + 150 × 20	14,0	20,0
*L*7	300 × 14 + 150 × 20	14,0	20,0
*L*8	300 × 14 + 150 × 20	14,0	18,8
*L*9	300 × 14 + 150 × 20	14,5	19,5
*L*10	300 × 14 + 150 × 20	13,0	19,0
*L*11	250 × 16 (НП)	15,2	NA
*L*12	250 × 16 (НП)	14,9	NA

Total as-built area:
(300 × 14 + 150 × 20)×10 + 2×(250 × 16 approx.) = 80000 mm^2.
Total measured area:
300 × (12,8 + 12,5 + 13 + 11,5 + 12 + 13,5 + 14 + 14 + 14,5 + 13) + 150 ×
× (19 + 18,8 + 18,9 + 19,2 + 17 + 20,2 + 20 + 18,8 + 19,5 + 19) + 250 × 15,2 + 250 ×
× 14,9 = 72 325 mm^2.

3) Total sum of area for deck plates and framing:
at as-built scantlings:
166000 mm^2 + 80000 mm^2 = 246000 mm^2;
at measured sizes:
157000 mm^2 + 75325 mm^2 = 232325 mm^2.
Total area reduction is:

$$\frac{24600 - 232325}{246000} \times 100\% = 5{,}6\%$$

If area reduction does not exceed allowable reduction — 10 %, thus, it is not necessary to check the hull on cross section modulus (refer to 2.2.1 of Annex 2 to these Rules).

In case when allowable area reduction shall not exceed 5 % (for example, in accordance with DNV GL standards), thus the calculation of cross section modulus shall be performed.

Assessment of bottom area reduction shall be done the same way.

For the assessment of reduction of deck/bottom transverse section area it is recommended to use form RTM1, in which the assessment is carried out by the following formula:

$$\Delta F = E \times (0{,}1S_0 - \Delta S), \text{ mm}^2$$

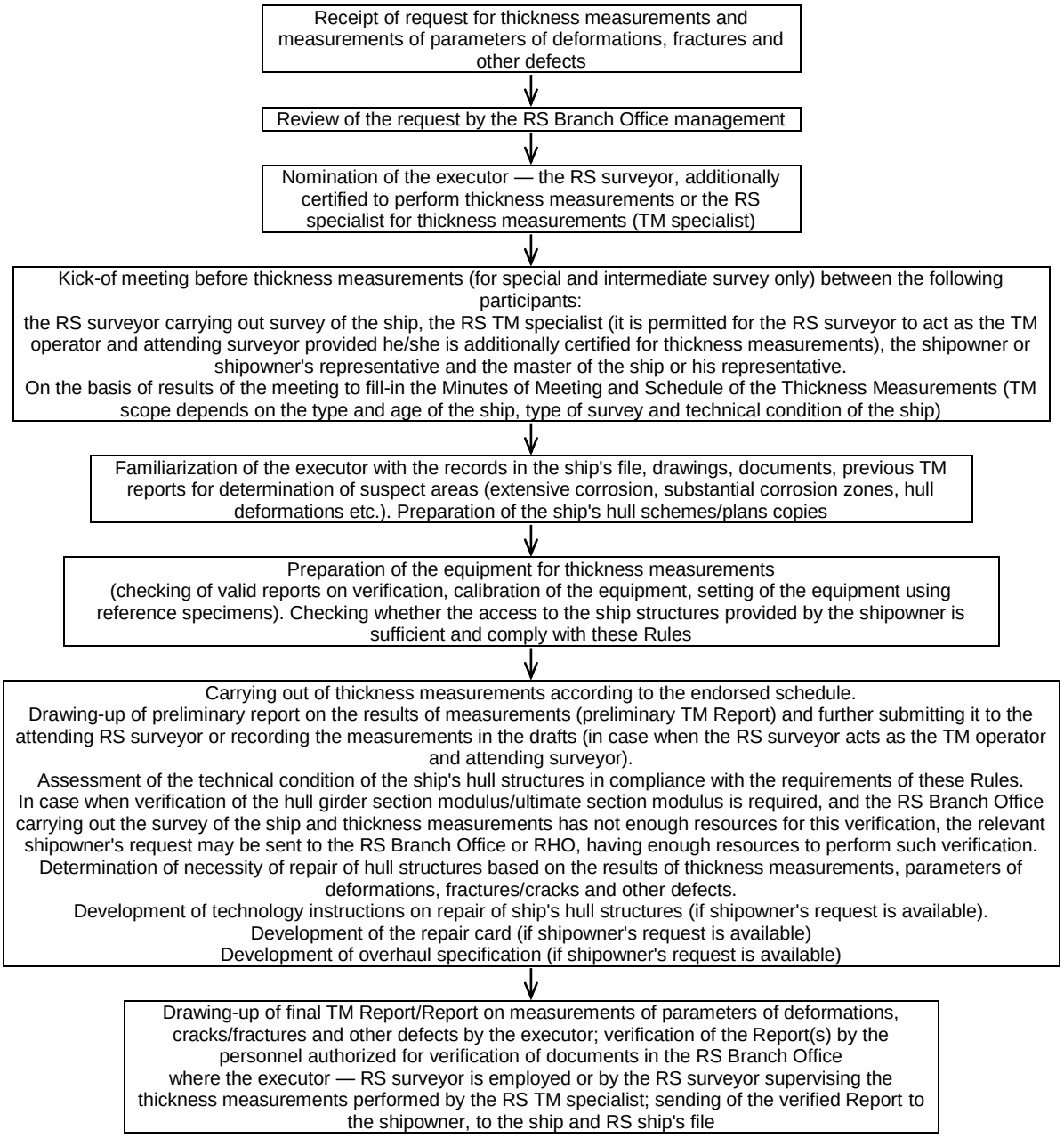
where E = plate breadth, in mm;
S_0 = as-built thickness of the hull member, in mm;
ΔS = absolute thickness diminution (wastage) of hull member in relation to as-built thickness, in mm.

At that it is necessary to take into account that during filling out of the form RTM1 the separate total sum ($\Sigma\Delta F$) for all deck items in transverse section and separate total sum of bottom with bilge shall be calculated in summary. If any of those sums will be negative (below 0), cross section modulus of the hull shall be verified.

Longitudinal and girders are accounted in calculation as follows: depending on profile of the longitudinal/girder, the column "Plate breadth" of form RTM1 to be filled out appropriately, for example: for the angle profile — two separate lines of the table to be filled out for recording the measured thicknesses of angle legs and the length of angle legs shall be indicated in graph "Plate breadth"; for t-beam profile — sizes of web and flange in transverse section on two separate lines; for bulbs — web height only on one line.

ANNEX 2-8

FLOW-CHART OF THE PROCESS ON FULFILLMENT OF THE REQUEST FOR FAULT DETECTION OF THE SHIP'S HULL BY RS



ANNEX 3

LIST OF DOCUMENTS RECOMMENDED FOR USE DURING REPAIR OF THE SHIP'S HULL AND ARRANGMENTS

1. IACS documents[1]:

.1 IACS Recommendation No. 47 "Shipbuilding and Repair Quality Standard" (Rev.10 Sep 2021);

.2 IACS Recommendation No. 54 "Guidelines for Acceptance, Application and Survey of Semihard Coatings in Ballast Tanks" (Rev.1 Oct 2006);

.3 IACS Recommendation No. 55 "General Cargo Ships — Guidelines for Surveys, Assessment and Repair of Hull Structure" (Rev.1 June 2016);

.4 IACS Recommendation No. 72 "Confined Space Safe Practice" (Rev.3 Dec 2018);

.5 IACS Recommendation No. 76 "IACS Guidelines for Surveys, Assessment and Repair of Hull Structure — Bulk Carriers" (Rev.2 Corr.1 Sept 2007);

.6 IACS Recommendation No. 82 "Surveyor's Glossary — Hull Terms and Hull Survey Terms" (Rev.1 Oct 2018);

.7 IACS Recommendation No. 84 "Container Ships. Guidelines for Surveys. Assessment and Repair of Hull Structures" (Rev.1 Nov 2017);

.8 IACS Recommendation No. 87 "Guidelines for Coating Maintenance and Repairs for Ballast Tanks and Combined Cargo/Ballast tanks on Oil Tankers" (Rev.2 May 2015);

.9 IACS Recommendation No. 96 "Double Hull Oil Tankers — Guidelines for Surveys, Assessment and Repair of Hull Structures" (Rev.2 May 2023).

[1] Documents are available on the IACS website www.iacs.org.uk.

Russian Maritime Register of Shipping

Annexes to the Rules for the Classification Surveys of Ships in Service

FAI "Russian Maritime Register of Shipping"
8, Dvortsovaya Naberezhnaya,
191186, St. Petersburg,
Russian Federation
www.rs-class.org/en/