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PART TWO METALLIC MATERIALS

CHAPTER 1 ROLLED STEEL

1.1 Application

1.1.1 This Chapter applies to the works approval and products inspection of the rolled steel, i.e. normal strength hull structural steel, high strength hull structural steel and high strength quenched and tempered steel for welded structure (including plates, strips and sections) and its materials (including billet, slab and ingot), which are manufactured according to the requirements of CCS Rules for Classification of Sea-going Steel Ships and CCS Rules for Materials and Welding.

1.1.2 Where steels are intended for use in boilers and pressure vessels, reference may be made to in this Chapter. Additional property tests may be necessary for works approval and products inspection subject to agreement by CCS.

1.1.3 For a rolled steel plating works, where the unreeling and crosscutting need subcontracted, the quality management and quality control of the subcontractor on dimension, appearance, straightness and marks transfer are to be included in the works approval by CCS.

1.1.4 The rolled steel (steel tape) unreeling works is to be subject to works approval by CCS and to type test as appropriate. The unreeled steel plates are to be subject to inspection and a quality certificate endorsed by CCS Surveyor after satisfactory inspection.

1.1.5 For a rolled steel plating works, where the billet steel need to be purchased, the billet material is to be ordered from the billet works as approved by CCS.

1.2 Basis for approval and inspection

The basis for approval and inspection of rolled steel works to which this Chapter apply are as follows:

(1) CCS Rules for Classification of Sea-going Steel Ships;

(2) CCS Rules for Materials and Welding;

(3) IACS UR W11 Normal and Higher Strength Hull Structural Steels;

(4) IACS UR W16 High Strength Quenched and Tempered Steel for Welded Structures;

(5) relevant national and international standards.

1.3 Plans and documents

1.3.1 A manufacturer intending for approval by CCS is to submit an application to CCS for works approval.

1.3.2 The applicant is to submit the following documents in triplicate to CCS for information.

1.3.2.1 Particulars of the manufacturer:

the name, address and history of the manufacture; the type and specification of the manufactured products; the type, specification and delivery condition of the products for approval; the chemical composition and mechanical properties of the steel grades or similar steel type, specification, delivery condition of the products for approval (to prove the high quality and stability); other recognized qualification certificates.

1.3.2.2 Management documents, including quality system documents:

(1) organizational structure, quality control points, responsibilities of management departments / managers, quality management system documents, identification and documentary trail or related descriptions;

(2) for a rolled steel plating works, where the billet steel need to be purchased, the provisions for control of such purchase and acceptance are to be established.

1.3.2.3 Main production, inspection/test equipment:

(1) information on main production equipment: parameters of blast furnace and steel-making furnace, casting equipment, types/relevant parameters of heating furnace, parameters of the rolling mill (the power of main motor, maximum rolling force, size of roll, main control means of the rolling mill such as hydraulic AGC), parameters of on-line accelerating cooling system, types/parameters of heat treatment furnace, shearing equipment, straightening equipment, cooling bed;

(2) main inspection/test equipment: equipment for chemical composition analysis, mechanical property test and NDT. The manufacturer itself is to be equipped with the above inspection/test equipment.

1.3.2.4 Process documents

Flow chart of manufacturing process, component design of approved steel type, control criteria of the manufacturer, technological specifications (operation guidance) in which the following are to be included:

(1) hot metal pretreatment and steelmaking:
- pre-desulphurization method of hot metal;
- deoxidation method, grain refining elements;
- information on materials and quality control;
- refining means (LF, RH, VD);

(2) casting:
- casting method;
- size and mass of ingots, size of continuous cast billets;
- quality control measures (electromagnetic stirring, soft reduction, etc.);

(3) rolling:
- heating system;
- descaling, water pressure;
- measurement of temperature and thickness;
- initial and finishing rolling temperatures (and total reduction for supply in the controlled rolled condition or TMCP);
- on-line cooling method, cooling parameters;

(4) heat treatment:
- heat treatment system;

(5) for hot rolled steel plate, the following are to additionally be submitted:
- specification and mass of the maximum and minimum coils;
- reeling temperature;
- information on unreeling, straightening, crosscutting, sampling and marking.

1.3.2.5 Qualification certificate of the test and inspection personnel.

1.3.3 The type test program is to be submitted to CCS for approval.

1.3.4 Other documents where deemed necessary by CCS.

1.4 Type test

1.4.1 Determination of the type test program

Prior to works approval, CCS and the applicant are to determine the type test program through negotiation. The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

(1) the type, specification and delivery condition of the products for approval (the clear relationship between deoxidation method, grain refining elements and delivery condition for different grades);

(2) the steel grade, specification, number and delivery condition of the typical samples for test approval;

(3) the test items and the standard or rules adopted;

(4) sampling position, schemes and sampling instructions;

(5) place of test and qualification of the laboratory (if applicable, the qualification of the subcontractor and the agreement);

(6) name of the test organization.

1.4.2 Selection of typical samples for type test

The requirements are as follows:

(1) The typical samples are to be taken for type test from the largest products for each type and each delivery condition. CCS may require additional approval test for the smallest or medium products as the case may be.

(2) For materials with similar composition design and the same manufacturing method and delivery condition, subject to consent of CCS, higher roughness grade may replace lower roughness grade for the same strength (such as B for A), or higher strength grade may replace lower strength grade for the same roughness (such as AH36 for AH32).

(3) The test plates are to be rolled at the positions corresponding to the top and bottom of billets (top of ingots), and the test specimens are to be taken at the top or bottom of the plates. CCS may randomly designate casting blank to rolled steel plate for type test as deemed necessary.

(4) For coils, test specimens are to be taken from the top, middle and bottom respectively, see for the test items in 1.4.3. In approval of an unreeling works, the test specimens are to be taken from the top, middle and bottom for tensile, impact and ageing impact testing.

(5) In application for materials approval, the materials are to be rolled into finished products for mechanical property test.

1.4.3 Type test items and requirements

Type test items and requirements are given in Table 1.4.3 with details as follows.

1.4.3.1 Chemical composition analysis

The requirements are given in Table 1.4.3. Elements Sb and B are to additionally be determined where electric arc furnace is applied.

1.4.3.2 Tensile test

(1) Tensile specimens are to be of full thickness. For plates over 40 mm thick, round test specimens may be used with sampling location at 1/4 and 1/2 of the thickness of the product.

(2) Tensile specimens are to be taken longitudinally and transversely respectively. For strips and sections of less than 600 mm in width, the specimens may be taken only longitudinally.

(3) For materials showing no yield phenomenon, the proof strength $R_{p0.2}$ is to be determined.

(4) Where the steel is supplied in TMCP condition, the tensile test of stress relief is to be conducted with heating temperature of 600℃ and heating time of 2 min/mm, but not less than one hour.

1.4.3.3 Bend test

The bend test specimens are to be 30 mm in width and bent to an angle of 180° with former diameter three times the plate thickness.

1.4.3.4 Charpy V-notch impact test

(1) Charpy V-notch impact test is to determine the energy, the percentage of crystalline fracture and side expansion value, and a curve is to be drawn to determine the brittle transition temperature (corresponding to 50% crystalline fracture). The photo of the fracture is to be provided.

Test items for type approval **Table 1.4.3**

Test items	Applicable grades	Sampling requirements	Test requirements				Remarks
Chemical composition	A, B, D	ladle samples and finished products	C, Si, Mn, P, S, Cr, Ni, Mo, V, Cu, Al and other added elements				
	E, AH32/36/40, DH32/36/40, EH32/36/40, FH32/36/40		C, Si, Mn, P, S, Nb, V, Ti, Cr, Ni, Mo, Cu, Al, B, As, Sn, Pb, [N], [H], [O] and other added elements				
	A420~690, D420~690, E420~690, F420~690,						
Tensile test	all grades	top and bottom longitudinal and transverse	ReH, Rm, A				
Bend test	all grades	top and bottom longitudinal and transverse					
			temperature ℃				
Impact test	A, B, AH32/36/40, A420~690	top and bottom longitudinal and transverse	+20	0	-20	-40	
	D, DH32/36/40, D420~690		0	-20	-40	-60	
	E, EH32/36/40, E420~690		0	-20	-40	-60	
	FH32/36/40, F420~690		-20	-40	-60	-80	
Ageing impact test	A, B, AH32/36/40, A420~690	top and bottom longitudinal	+20	0	-20		5% plastic deformation, ageing for one hour at 250℃, not lower than the required value of assessment temperature
	D, DH32/36/40, D420~690		0	-20	-40		
	E, EH32/36/40, E420~690		-20	-40	-60		
	FH32/36/40, F420~690		-40	-60	-80		
Sulphur prints	the same as sampling requirements	materials and finished products					
Macrostructure	the same as sampling requirements	one end					
Microstructure	the same as sampling requirements	one end					
Drop weight	grades other than A, B, AH32/36	transverse	Test temperature is selected according to GB/T 6803				
Welding property	E, higher strength steels and quenched and tempered steels		the maximum thickness and the highest grade				
CTOD test	E, EH32/36/40, FH32/36/40, E420~690, F420~690	See Rules for Materials and Welding	Specimen of full thickness, see Rules for Materials and Welding				The feature value is based on 0.25 and the result is for reference

(2) The temperature requirements for impact test are given in Table 1.4.3.

(3) For materials of thickness less than or equal to 40 mm, the impact specimens are to be taken close to the surface; for materials of thickness more than 40mm, the specimens are to be taken at 1/4 and 1/2 of the thickness respectively.

(4) Plates of less than 6 mm in thickness may be free from impact test.

(5) Sections of less than 600 mm in width may be tested only in longitudinal direction.

(6) For steel bars of less than 60 mm in diameter, the specimens are to be taken at 1/3 of the radius from the outer surface. Where the diameter is more than or equal to 60 mm, the specimens are also to be taken at the core.

1.4.3.5 Ageing impact test

The temperature requirements for ageing impact test are given in Table 1.4.3.

1.4.3.6 Sulphur print test

(1) The test is to be carried out on the materials having the maximum thickness. For plates, the sulphur prints are to be taken for half cross section from the center to the side of the plate. For slabs, the sulphur prints are to be taken for full cross section.

(2) The sulphur prints for plates are to be taken from the middle of the plate with length greater than 600 mm.

1.4.3.7 Macrostructure examination

The macrostructure examination is to be carried out on materials and finished products. The requirements for sampling position and length are the same as those for sulphur prints.

1.4.3.8 Metallographic examination

The metallographic examination (×100 and 500 magnification) is to be carried out close to the surface and at the mid-wall thickness respectively to measure actual grain size. Where the thickness of the product is over 40 mm, additional samples are to be taken at 1/4 thickness.

1.4.3.9 Drop weight test

(1) For the first approval or additional items approval of the plates with steel types other than A, B, AH32/36, the plates with maximum thickness and highest grade of steels are to be selected for drop weight test. Transverse specimens are to be taken.

(2) The standard for the test is ASTM E208 (GB/T 6803).

1.4.3.10 Mechanical test in through-thickness

For plates with mechanical properties of Z-Direction, a tensile test in through-thickness is to be conducted to determine the reduction of area Z.

1.4.3.11 Non-destructive test

Z-direction steels are to be subject to ultrasonic examination.

1.4.3.12 Property test at elevated temperature

For steels requiring elevated temperatures such as boiler steel, a tensile test at elevated temperatures is to be carried out. The test temperatures are 50℃, 100℃, 150℃, 200℃, 250℃, 300℃, 350℃, 400℃ and 450℃.

1.4.3.13 Welding property test

(1) For the first approval and additional items approval of plates from grade E of normal strength hull structural steel, high strength hull structural steel or quenched and tempered steel, the plates with maximum thickness and highest grade are to be selected for welding property test.

(2) A butt specimen is to be welded with heat input about 15 kJ/cm and 50 kJ/cm respectively. The weld is to be perpendicular to the direction of rolling.

For steels requiring high heat input, in addition to less than 50 kJ/cm, the maximum heat input in accordance with the products standard is to be adopted to butt-joint specimens with X or K. The usual welding procedures are to be adopted as much as possible. The weld is to be perpendicular to the direction of rolling. All the welding parameters, such as consumables designation code and diameter, edge preparation, preheating temperature, interposes temperature, current, amperage, voltage, travel speed, heat input value and passes, are to be submitted.

(3) The specimens are to be subject to the following tests:

① two full-thickness specimens (transverse) for tensile test. When the breaking strength of a test specimen exceeds the capacity of the test machine, the test specimen may be divided into several portions and the thickness of each specimen is not to be less than 25 mm. The average value of the tensile results obtained from the several specimens may be taken as the result of the full thickness butt weld joint. The specimens are to be machined flush with the surface of the plate. The tensile strength value and position of fractures of the specimens are to be submitted;

② a weld face bend specimen and a weld root bend specimen. The breadth of specimens is 30 mm and the diameter d of former is 4a, where a is the thickness of the specimen, the bending angle α equals 180°. Where the thickness of the plate is more than 20 mm, two side bend specimens may be prepared;

③ a set of three impact test specimens perpendicular to the weld. The notches of specimens are to be located at the center of weld, on the fusion line and at 2 mm, 5 mm and 20 mm from fusion line. The fusion line is to be determined by corrosion test. The temperature for impact test is taken as the temperature of the approved plates in delivery condition. The sampling position is 1 to 2 mm from the surface of the plates. Where the thickness is more than 50 mm, additional specimens are to be taken from the root of the weld of the X or K edge, and the notches of specimens are located as same to the above;

④ HV5 hardness distribution test: hardness distribution test is to be carried out on the cross section of the weld 1mm from the upper and lower surfaces of the plates respectively. The measuring points are on the weld, the fusion line, at the heat affected zones and on the parent metal. The space between the measuring points is about 0.7 mm, and the heat affected zone of each side is to have at least 3 to 7 measuring points.

The maximum hardness value of steels intended for hull structure is not to be greater than 350HV, and the maximum hardness value of steels intended for offshore installations is not to be greater than 325HV.

The photos of edge preparation, dimension, passes, hardness value and joints are to be submitted to CCS;

⑤ steels requiring high heat input are to be subject to macrostructure and microstructure test. The sectional surface of the welds is to be free from such defects as cracks and lack of fusion. A micro-specimen is to be taken from the weld, fusion line, and 2 mm, 5 mm, 10 mm, 20 mm from the fusion line respectively along the centerline of the through-thickness;

⑥ non-destructive test for the specimens.

1.4.3.14 Dimensional and visual examination

(1) At least five steel plates are to be selected for dimensional and visual examination. The length, width, thickness and irregularities of each plate are to be measured. Thickness measurement methods and requirements are to comply with relevant requirements of 2011 Amendments to CCS Rules for Materials and Welding. Other measurement values are to be in compliance with the specific requirements of GB/T709.

(2) For rolled plates, a coil is to be selected to measure the thickness, width and tower. The values are to be in compliance with the specific requirements of GB/T709.

(3) For sections, at least five products are to be selected for measurement and the values are to be in compliance with the relevant standards.

(4) The external quality is to be in compliance with the relevant standards.

1.4.3.15 Dimensional and visual examination are to be increased for the approval of steel materials.

14.3.16 CTOD test.

1.4.3.17 Other test items where deemed necessary by CCS.

1.4.3.18 In general, the preparation of samples and mark transfer are to be in the presence of the Surveyor.

1.4.3.19 Test items other than those for chemical analysis, tensile, impact, ageing impact and metallographic examination may be dispensed with subject to approval by CCS.

1.5 Unit/batch inspection

1.5.1 The unit/batch inspection of rolled steels is to be carried out after works approval according to CCS Rules for Classification of Sea-going Steel Ships.

1.5.2 The detailed requirements for unit/batch inspection of rolled steels are to be notified in written form to the works when CCS issues a certificate of works approval.

1.5.3 The unit/batch inspection is to be carried out according to the approved test program. The test program is to contain the test items for witness, review and on-site examination. The items include the mechanical test (tensile test, impact test, etc.), and non-destructive test (if required) in the presence of the Surveyor; review of the result of chemical analysis; examination of external appearance and dimension on the selection basis. If necessary, the Surveyor may check the technical or test record, or propose additional test times.

1.5.4 After satisfactory inspection of products, CCS Surveyor is to issue a certificate of marine products or endorse the manufacturer's quality certificate.

(1) The quality certificate is to at least contain: acceptance criteria (rules, standard, technical agreements, etc.), cast number/batch number, steel grade, specification, mass, number, delivery condition, chemical composition (and carbon equivalent for higher strength hull structural steel), mechanical properties, description of identification, ship's name/project number/contract number (if any). The space for stamp and endorsement by CCS Surveyor is to be reserved.

(2) The format of the manufacturer's quality certificate is to be approved by CCS.

CHAPTER 2 ROLLED STAINLESS STEEL PLATES

2.1 Application

2.1.1 This Chapter applies to the works approval and inspection of the rolled stainless steel plates manufactured according to CCS Rules for Materials and Welding.

2.1.2 This Chapter applies austenitic and duplex (austenitic/ferritic) stainless steel plates which are manufactured by RP electric arc furnace, HP electric arc furnace and direct current furnace, and cast in moulds or made by a continuous casting process, with the delivery condition of solid solution or other heat treatments.

2.2 Basis for approval and inspection

2.2.1 Chapters 2 and 3 of PART ONE of CCS Rules for Materials and Welding.

2.2.2 ASTM A 240/A 240M Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

2.3 Plans and documents

2.3.1 A manufacturer intending for approval by CCS is to submit an application to CCS for works approval.

2.3.2 The applicant is to submit the following documents in triplicate to CCS for information.

2.3.2.1 Particulars of the manufacturer: the name, address and history of the manufacturer; the type and specification of the products; the type, specification and delivery condition of the products for approval; production equipment, inspection/test equipment, the quality and property statistics of the products for approval; other recognized qualification certificates.

2.3.2.2 Management documents, including quality system documents: organizational structure, quality control points, responsibilities of management departments / managers, quality management system documents, identification and documentary trail or related descriptions.

For manufactures whose raw materials need to be purchased, the source of the materials is to be stated and listed, and the provisions for control of such purchase and acceptance are to be stated.

2.3.2.3 Main production, inspection/test equipment

Steel production equipment: hot metal pre-treatment converter, BOF, EAF, AOD, LTS, LF, continuous caster, etc.;

Steel rolling equipment: heating furnace, rough rolling mill, finishing mill, high pressure water descaling box, crop fly shear, laminar cooling equipment, etc.;

Heat treatment and pickling process equipment.

Test equipment: those for chemical composition analysis, mechanical property test, nondestructive test, metallographic examination, intercrystalline corrosion test, pitting test.

2.3.2.4 Process documents

Flow chart of manufacturing process, control criteria of the manufacturer, technological specifications (operation guidance) in which the following are to be included:

(1) steel-making
- information on materials;
- parameters of electric furnace;
- deoxidation method;
- ratio of hot metal and compositions, types of discarded steels;
- desulphurization method;
- refining methods (ladle furnace, vacuum degassing, etc.);
- process temperature control target;

(2) casting
- casting method;
- size and mass of ingots, size of continuous cast billets;
- quality control measures;
- tundish temperature and corresponding casting speed control;
- use of tundish covering agent and crystallizer protecting slag.

(3) rolling
- type of heating furnace, relevant parameters, heating system/curve;
- billet/slab heating system;
- size of materials used;
- rough rolling temperature, finishing temperature;
- parameters of roll mill (the power of main motor, maximum rolling force, size of roll, main control means of the roll mill);
- measurement of temperature and thickness;
- descaling, water pressure;
- cooling method and parameters, etc.;

(4) heat treatment
- heat treatment process;
- type, parameters and size of heat treatment furnace (such as normalizing furnace);
- temperature control of the furnace;

- heat treatment system;
- other necessary parameters;

(5) cooling after heat treatment
- cooling system after heat treatment;
- cooling equipment;

(6) pickling
- pickling medium;
- pickling speed;
- hot wind temperature, etc.;

(7) information on shearing and straightening equipment;

(8) for hot rolled steel plates, the following are to additionally be submitted:
- specification and mass of the maximum and minimum coils;
- on-line cooling;
- reeling temperature;
- information on unreeling, straightening, crosscutting, sampling and marking.

2.3.2.5 Qualification certificate of the test and inspection personnel.

2.3.3 The type test program is to be submitted to CCS for approval.

2.3.4 Other documents where deemed necessary by CCS.

2.4 Type test

2.4.1 Determination of the type test program

Prior to works approval, CCS and the applicant are to determine the type test program through negotiation. The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

- the type, specification and delivery condition of the products for approval;
- the steel grade, specification, number and delivery condition of the typical samples for test approval;
- the test items and the standard, rules or methods adopted;
- place of test and qualification of the laboratory (if applicable, the qualification of the subcontractor and the equipment).

2.4.2 Selection of typical samples for type test

2.4.2.1 The principle is to take the products with maximum and minimum thickness for the type test respectively. If the manufacturing, rolling and heat treatment conditions are different, products manufactured by different methods are to be selected respectively for type test.

2.4.2.2 For stainless steel approval, each designation is to be tested.

2.4.2.3 For continuous casting, the samples are to be taken for type test from the plate rolled by the top of the first ladle or the bottom of the final ladle in any casting time, or from the top of the first plate and the bottom of the final plate rolled in the first ladle in any casting time.

2.4.2.4 For mould casting, the samples are to be taken for type test from the corresponding positions of the top and bottom respectively of the maximum ingot.

2.4.3 Type test items and requirements

2.4.3.1 Chemical composition analysis

(1) In addition to the rules requirements, [H] and [O] content is to be added, depending on the designation of stainless steel. The results of C, Si, Mn, P, S, Cr, Ni, Mo, N, V, Cu, Ti, Nb, Als, H, O are to comply with the rules requirements or other standards acceptable to CCS.

(2) Ladle and finished plate are to be subject to chemical composition analysis respectively.

2.4.3.2 Tensile test

(1) The tensile test is to determine the proof strength $R_{p0.2}$ or $R_{p1.0}$, tensile strength R_m and elongation A at the non-proportional elongation being 0.2% or 1.0% of the original gauge length, and graphs or computer records are to be provided.

(2) The specimens are to be taken in longitudinal and transverse directions respectively for products in the first approval.

2.4.3.3 Bend test

The bend test specimens are to be of the full thickness of the material, b=2t in width, d=2t in former diameter and bent to an angle of 180℃. The surface is to be free from defects such as crack after test. Bend test is to be carried out longitudinally and transversely respectively.

2.4.3.4 Charpy V-notch impact test

(1) Charpy V-notch impact test is to determine the energy. The austenitic stainless steel is to be tested at -20 ℃ and -196 ℃ (may also be tested depending on the designation used and the technical conditions of the purchaser), and the austenitic/ferritic stainless steel at 0 ℃, -20 ℃, -40 ℃ and -60℃.

(2) The impact test specimens are to be taken in longitudinal and transverse directions respectively.

(3) For materials of thickness less than 40 mm, the impact specimen is to be taken at 1/4t; for materials of thickness equal to or more than 40 mm, the specimen is to be taken at 1/4t and 1/2t respectively.

(4) For materials of thickness less than 10 mm, an equivalent specimen may be adopted for test and then energy value is to be determined.

(5) The photos of fractures of the austenitic/ferritic stainless steel specimen are to be provided.

(6) The austenitic/ferritic stainless steel specimen is to be subject to ageing impact test:

① with 5% plastic deformation and for one hour at 250℃;

② with the temperatures -20℃ and -40℃ for the test;

③ the test may be carried out only longitudinally.

2.4.3.5 Sulphur print test

(1) The selected materials are of the maximum thickness. The sulphur prints are to be taken for half cross section from the center to the side of the materials.

(2) For finished plates, the sulphur prints are to be taken from the middle with length of 600 mm.

2.4.3.6 Macrostructure

Macrostructure is to be taken from the materials and finished products. The sampling position is the same as that for sulphur prints.

2.4.3.7 Metallographic examination

For austenite stainless steel, the metallographic examination (×100 and 500 magnification) is to be carried out close to the surface and at the mid-wall thickness respectively to measure actual austenite grain size. For duplex stainless steel, the ratio of austenite and ferrite is to be determined.

2.4.3.8 Non-destructive test

The austenitic stainless steel and the duplex stainless steel are to be subject to ultrasonic testing (UT).

2.4.3.9 Welding property test

(1) For stainless steel plates, the plate with maximum thickness is to be selected for welding property test.

(2) A butt specimen is to be welded with appropriate heat input. The joint is to be of V, double V or K. The weld is to be perpendicular to the direction of rolling.

(3) The specimens are to be subject to the following tests:

① two transverse tensile tests;

② two transverse bend tests;

③ a set of three impact test specimens perpendicular to the weld. The notches of specimens are to be located at the center of weld, on the fusion line and at 2 mm, 5 mm and 20 mm from fusion line. The fusion line is to be determined by corrosion test. The temperature for impact test is taken as the temperature of the approved plates in delivery condition. Where the thickness is less than 40 mm, the specimen is to be taken at 1/4t; where the thickness is more than 40 mm, additional specimen is to be taken at 1/2t;

④ HV or HB hardness distribution test: an HV or HB point is to be measured every 3 mm on the cross section of the weld 2 mm from the upper and lower surfaces of the plates respectively. Hardness test is to be carried out on the deposited metal, at the heat affected zones of both sides of weld and on the parent metal. The maximum hardness value is to be referred to in accordance with the requirements of ASTM A240/A240M;

⑤ intercrystalline corrosion test in heat affected zones: the test is to determine the difference between the heat affected zone and the surface of parent metal with photos.

⑥ The welding parameters, such as consumables designation code and diameter, preheating temperature, interposes temperature, heat input value and welding times, are to be submitted to CCS for review. The welding parameters are to be prepared according to actual stipulated welding parameters of stainless steel plates and welding consumables.

⑦ The edge preparation, dimension, passes, hardness value and tested joints photos are to be submitted to CCS.

2.4.3.10 Corrosion test

The austenitic stainless steel is to be subject to intercrystalline corrosion test, while the duplex stainless steel is to be subject to intercrystalline corrosion test and pitting test. The intercrystalline corrosion test is to be in accordance with CCS Rules, and the pitting test is to be in accordance with ASTM A923-03C, with the test condition of 6%$FeCl_3$, $6H_2O$+0.05N HCl, 25 ℃, 24 h. For designation code of duplex stainless steel not listed in the rules, whether pitting test is to be carried out may be determined according to relevant provisions in standards accepted by CCS.

2.4.3.11 Dimensional and visual examination

(1) At least a piece of steel plate is to be selected for measurement of its length, width, thickness, diagonal and irregularities. The thickness is to be measured at not less than 3 points across the width and 5 points along the length. The tolerance of thickness is to comply with the requirements of CCS Rules for Materials and Welding.

(2) The external quality is to be in compliance with the relevant standards.

2.4.3.12 Other test items (such as magnetic permeability, tensile test at elevated temperature, etc.) where deemed necessary by CCS.

2.4.3.13 The preparation of samples and mark transfer are to be in the presence of the Surveyor.

2.4.3.14 Except for the test items of chemical analysis, tensile, impact, bend, metallographic examination, visual examination and corrosion test, the other items for type test may be optional as the case may be.

2.5 Unit/batch inspection

2.5.1 After works approval by CCS, the stainless steel plates as manufactured according to the approved conditions (including equipment, process, etc.) are to be applied by the manufacturer for unit/batch inspection by CCS, which can be used onboard ships only after satisfactory inspection.

2.5.2 The detailed requirements for unit/batch inspection after approval are to be notified in written form to the works when CCS issues a certificate of works approval.

2.5.3 The items and requirements for the inspection are as follows:

(1) confirmation of the process: on-site supervising or review of process record;

(2) check of the result of chemical analysis: samples from each cast;

(3) witnessing of mechanical test: samples from each batch or each unit at discretion of CCS (the sampling process is to be witnessed by the Surveyor);

(4) non-destructive test (if required);

(5) visual examination;

(6) other test or inspection items where deemed necessary by CCS.

2.5.4 After satisfactory inspection of products, CCS Surveyor is to issue a certificate of marine products or endorse the manufacturer's quality certificate.

2.5.5 The quality certificate is to contain at least following items and to be submitted to CCS for information during works approval:

(1) name of the purchaser and order number;

(2) destination for material;

(3) material descriptions and dimension;

(4) technical specifications and grade of material;

(5) cast number and chemical composition;

(6) results of mechanical property test;

(7) delivery condition;

(8) CCS description of identifications on products after satisfactory inspection;

(9) clarifying manufacturer's statement "According to CCS Rules or approval by CCS, accepted acceptance criteria or relevant standards, tests are satisfactory".

CHAPTER 3 ALUMINUM ALLOY PLATES

3.1 Application

3.1.1 This Chapter applies to the works approval and inspection of the rolled aluminum alloy plates manufactured according to CCS Rules for Classification of Sea-going Steel Ships and CCS Rules for Materials and Welding.

3.1.2 This Chapter is applicable to aluminum alloy plates manufactured by mould casting or continuous or semi-continuous casting process, and formed by hot rolling or cold rolling. The delivery condition is to be of deformation hardened and annealed plates.

3.2 Basis for approval and inspection

3.2.1 The basis for approval and inspection of aluminum alloy plates are as follows:

(1) CCS Rules for Classification of Sea-going Steel Ships;

(2) CCS Rules for Materials and Welding.

3.3 Design and technical requirements

3.3.1 The design is to comply with the requirements of PART ONE of CCS Rules for Materials and Welding.

3.4 Plans and documents

3.4.1 A manufacturer intending for approval by CCS is to submit an application to CCS for works approval.

3.4.2 The applicant is to submit the following documents in triplicate to CCS for information.

(1) Particulars of the manufacturer: the name, address and history of the manufacturer; the type and specification of the manufactured products; the type, specification, production equipment, inspection/ test equipment and delivery condition of the products for approval; the quality statistics of the products in recent years; other recognized qualification certificates.

(2) Management documents, including quality system documents: organizational structure, quality control points, responsibilities of the management departments / managers, quality management system documents, identification and the documentary trail or relevant descriptions.

For manufactures whose raw materials need to be purchased, the source of the materials is to be stated and listed, and the provisions for control of such purchase and acceptance are to be stated.

(3) Main production equipment, a list of inspection/test equipment and technological parameters: smelting equipment, casting/continuous casting equipment, heating furnace, heat treatment furnace for rolling mill, shearing equipment, straightening equipment.

(4) Process documents: flow chart of manufacturing process, control criteria of the manufacturer, technological specifications (operation guidance) or a list, in which the following are to be included:

① smelting, refining, casting (including technological specifications and ingots quality control);

② rolling:

- milling and pickling of ingots;
- heating system;
- parameters for hot rolling (such as initial and finishing rolling temperatures, speed, total reduction);
- temperature and thickness measurements, etc.;,
- cold rolling reduction system, finishing;

③ heat treatment process documents;

④ control of inspection in other stages (such as flattening, straightening, shearing, external dimension, sampling and marking);

⑤ qualification certificate of the test and inspection personnel.

3.4.3 The type test program is to be submitted to CCS for approval.

3.4.4 Other documents where deemed necessary by CCS.

3.5 Type test

3.5.1 Determination of the type test program

Prior to works approval, CCS and the applicant are to determine the type test program through negotiation. The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

(1) the type, specification, designation and delivery condition of the products for approval;

(2) the designation, delivery condition and specification of the typical samples for test approval;

(3) the test items and the standard or rules adopted;

(4) sampling scheme and descriptions;

(5) place of test and qualification of the laboratory (if applicable, the qualification of the subcontractor and the agreement);

(6) name of the testing organization.

3.5.2 Selection of typical samples

(1) The requirements: the selected samples are to be capable of representing or covering the types of marine aluminum alloys manufactured, and to be of the largest thickness and width. CCS may require additional approval test for the smallest or medium products as the case may be.

(2) Sampling: the sample for type test is to be taken from the top and bottom of the aluminum alloy plate rolled by the same ingot or billet.

3.5.3 Type test items

(1) Chemical composition analysis: Si, Fe, Cu, Mn, Mg, Cr, Zn, Ti, Ni, Ca, V and other added elements.

(2) The number, position and size of the prepared specimens and the test results are to comply with the requirements of CCS Rules for Materials and Welding.

(3) Corrosion test is to comply with the following requirements:

① the number and cutting position of the specimens for corrosion test are to comply with the requirements of CCS Rules for Materials and Welding;

② the requirements of ASTM G66 are recommended for the size and cutting method of the specimen for exfoliation resistance test. The test result is not to be lower than the requirements for PB. Other testing methods are to be subject to approval by CCS;

③ the requirements of ASTM G67 are recommended for the size and cutting method of the specimen for intercrystalline corrosion. The mass loss of test result is not to exceed 15 mg. Other testing methods are to be subject to approval by CCS.

(4) Macrostructure examination: plates of more than or equal to 6 mm in thickness are to be conducted macrostructure examination. Macrostructure is to be free from laminations.

(5) The manufacture is to control the external dimension and its tolerance. The under-thickness tolerance of the plates is to comply with the requirements of CCS Rules for Materials and Welding.

(6) Surface quality inspection is to comply with the following requirements:

① the surface of the plates is to be well ground, smooth and even, and free from harmful defects that will impair further manufacture processes and proposed application, such as cracks, laps, laminations, corrosion, oxide inclusions, oxide skins, blisters, significant metallic and non-metallic intrusions;

② minor pressing, colliding, rolling, pasting, printing marks may be accepted in the surface, provided that the depth is not over 1/2 of the under-thickness tolerance;

③ slight surface imperfections may be removed by mechanical means or grinding, provided that the prior agreement of CCS Surveyor is obtained. The depth of any rectification is not to exceed the allowable minus deviation, and no unfavorable effects to the material are allowed. Unless otherwise agreed, all such rectifications are to be carried out under the witness of the Surveyor. Defects unable to be repaired are generally not allowed to be weld repaired;

④ the edges of the plates are to be straight and plane, and free from burrs.

(7) The requirements for welding property test of aluminum alloy plates are as follows:

① welding property test is to be carried out for the plates selected according to the chemical composition of the approved designation, i.e. aluminum-magnesium alloy with magnesium content not more than 4%, aluminum-magnesium alloy with magnesium content not less than 4% but less than 6%, aluminum-silicon-magnesium alloys. The thickness of the test plate is to be in accordance with Table 3.1.3.2 (3), Chapter 3, PART THREE of CCS Rules for Materials and Welding. The welding procedure is to be prepared according to the relevant requirements in Chapter 3, PART THREE of CCS Rules for Materials and Welding, and submitted to CCS for approval;

② aluminum alloy plates are generally to be subject to butt welding property test. The test plates are to be cut with the weld parallel to the rolling direction of the plates. It is recommended that tungsten inert gas arc welding (TIG) or metal inert gas arc welding (MIG) be adopted for the welding. The selected wires are to be corresponding to the chemical composition and grade of the parent material, and to be furnished with CCS inspection certificate;

③ the welders engaged in welding of aluminum alloys are to be subject to an operational technique training and a qualification test, and they are strictly required to hold a Qualification Certificate of Welder;

④ the test items are to include:

a) four bend test specimens (two face bend and two root bend);

b) two transverse tensile test specimens and one macro-specimen (which may be prepared from the discard);

⑤ the result of the test is to comply with the following:

a) the tensile strength of butt weld is to comply with Table 3.2.9.1, Chapter 3, PART THREE of CCS Rules for Materials and Welding;

b) After test, the test specimens are not to reveal any crack or any open defect in any direction greater than 3 mm;

c) The macro section examination is to reveal the absence of cracks, lack of fusion or other open defects.

3.6 Unit/batch inspection

3.6.1 The detailed requirements for unit/batch inspection of aluminum alloy plates are to be notified in written form to the works when CCS issues a certificate of works approval.

3.6.2 The unit/batch inspection is to be carried out according to the approved test program. The test program is to contain the test items for witness, review and on-site examination. The items are to include:

(1) surface quality and thickness inspection;

(2) chemical composition analysis;

(3) mechanical property test;

(4) macrostructure examination (if required);

(5) exfoliation corrosion and intercrystalline corrosion test (if required);

(6) other items where deemed necessary by CCS.

3.6.3 When the aluminum alloy plates are submitted to CCS Surveyor for inspection, the ends of the plates are to bear identifications conforming to CCS Rules for Materials and Welding, i.e. code or trade mark of the manufacturer, designation and condition number of aluminum alloy, "M" showing that products are corrosion tested (if applicable), identification mark which will enable the full history of the item to be traced. The aluminum alloy plates accepted by CCS Surveyor are to be stamped by CCS for each piece.

3.6.4 When the aluminum alloy plates are submitted to CCS Surveyor for inspection, the manufacturer is to submit its quality certificate to CCS Surveyor for review. The quality certificate is to contain at least following items and to be submitted to CCS for information during works approval:

(1) name of the purchaser and order number;

(2) destination for material;

(3) material descriptions and dimension;

(4) technical specifications and grade of material;

(5) cast number and chemical composition;

(6) results of mechanical property test;

(7) delivery condition;

(8) CCS description of identifications on products after satisfactory inspection;

(9) clarifying manufacturer's statement "According to CCS Rules or approval by CCS, accepted acceptance criteria or relevant standards, tests are satisfactory".

3.6.5 After satisfactory inspection of the products and review of the documents submitted by the manufacturer, CCS Surveyor is to issue a Certificate of Marine Products.

CHAPTER 4 ALUMINUM ALLOY SECTIONS

4.1 Application

4.1.1 This Chapter applies to the works approval and inspection of the extruded aluminum alloy sections manufactured according to CCS Rules for Classification of Sea-going Steel Ships and CCS Rules for Materials and Welding.

4.1.2 This Chapter applies to aluminum alloy sections manufactured by mould casting or continuous or semi-continuous casting process, and formed by extrusion. The delivery condition is to be of deformation hardened (H), annealed, solution heat treated (O) and naturally aged (T) wrought aluminum alloy.

4.2 Basis for approval and inspection

4.2.1 The basis for approval and inspection of aluminum alloy sections are as follows:

(1) CCS Rules for Classification of Sea-going Steel Ships;

(2) CCS Rules for Materials and Welding.

4.3 Design and technical requirements

4.3.1 The design is to comply with the requirements of PART ONE of CCS Rules for Materials and Welding.

4.4 Plans and documents

4.4.1 A manufacturer intending for approval by CCS is to submit an application to CCS for works approval.

4.4.2 The applicant is to submit the following documents in triplicate to CCS for information.

(1) Particulars of the manufacturer: the name, address and history of the manufacturer; the type and specification of the manufactured products; the type, specification, production equipment, inspection/ test equipment and delivery condition of the products for approval; the quality statistics of the products in recent years; other recognized qualification certificates.

(2) Management documents, including quality system documents: organizational structure, quality control points, responsibilities of the management departments / managers, quality management system documents, identification and the documentary trail or relevant descriptions.

For manufactures whose raw materials need to be purchased, the source of the materials is to be stated and listed, and the provisions for control of such purchase and acceptance are to be stated.

(3) Main production equipment and relevant parameters: smelting equipment, ingots casting method, heating furnace, extruder (capacity, maximum speed, stroke, shearing force, etc.), heat treatment furnace, straightening and cutting equipment.

(4) List of main inspection/test equipment.

(5) Process documents: flow chart of manufacturing process, control criteria of the manufacturer, technological specifications (operation guidance), in which the following are to be included:

① smelting, refining, casting (including technological specifications and ingots quality control);

② extruding:

- main technological parameters (such as temperature, speed);
- preparation system before manufacturing (including quality acceptance of ingots, surface grinding or cleaning of the ingots, surface quality and dimension control);
- heating system;
- equipment preparation system;
- operation specifications;
- heat treatment system;
- process quality control (including surface quality and dimension tolerance of the sections);

③ provisions for disposal of non-conformity or non-conforming products;

④ provisions for inspection before delivery (including final apparent quality, dimension tolerance, sampling test, identification mark).

(6) Qualification certificate of the test and inspection personnel.

4.4.3 The type test program is to be submitted to CCS for approval.

4.4.4 Other documents where deemed necessary by CCS.

4.5 Type test

4.5.1 Determination of the type test program

(1) Prior to works approval, CCS and the applicant are to determine the type test program through negotiation. The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

① the type, specification, temper condition and delivery condition of the products for approval;

② the acceptance criteria (the valid rules and standards adopted);

③ selection of typical samples for type test;

④ the test items and requirements;

⑤ sampling position, type and number;

⑥ place of test and qualification of the laboratory (if applicable, the qualification of the subcontractor and the agreement).

4.5.2 Selection of typical samples

Products manufactured under worst heat treatment condition are to be selected as approved sampling products. For extruded products with pressure welding closed profiles, such closed profiles are to be preferred as typical products.

4.5.3 Type test items and requirements

4.5.3.1 Chemical composition analysis: Si, Fe, Cu, Mn, Mg, Cr, Zn, Ti, Ni, Ca, V and other added elements.

4.5.3.2 Mechanical property test: the number, position and size of the prepared specimens and the test results are to comply with the requirements of CCS Rules for Materials and Welding.

4.5.3.3 Macrostructure examination: the test piece from the bottom of the section is to be free from crack, piping, gas hole and bright grain, and non-metallic intrusions, segregations or intermetallic compounds, lamination or coarse grain ring that may affect the property of the products.

4.5.3.4 Microstructure: for quenched sections, no super burning is allowed in the result.

4.5.3.5 Occasional check of profile dimension and tolerance: the percentage of occasional check or review of inspection record is to depend on the quality control of the manufacturer.

4.5.3.6 Surface quality inspection

(1) The surface of the sections is to be well ground, smooth and even, and free from harmful defects that will impair further manufacture processes and proposed application, such as cracks, laps, nitrate spots, laminations, corrosion, oxide inclusions, oxide skins, blisters, significant metallic and non-metallic intrusions, mechanical damage.

(2) Slight oxidated color, flakes or dark spots are permitted in the surface.

(3) The edges of the sections are to be straight and plane, and free from burrs.

4.5.3.7 The round hollow extruded sections with closed profiles are to be subject to drift expanding test in accordance with the requirements in 2.6.2, Section 6, Chapter 2, PART ONE of CCS Rule for Materials and Welding (2006). Other sections with closed profiles may be subject to fractured surface analysis. The result is to show satisfactory penetration and free from lack of fusion.

4.5.3.8 Other inspection and test items where deemed necessary by CCS, such as corrosion test.

4.6 Unit/batch inspection

4.6.1 The detailed requirements for unit/batch inspection of aluminum alloy sections are to be notified in written form to the works when CCS issues a certificate of works approval.

4.6.2 The unit/batch inspection is to be carried out according to the approved test program. The test program is to contain the test items for witness, review and on-site examination. The items are to include:

(1) surface quality and main dimensions;

(2) occasional check and review of the report of chemical composition analysis;

(3) witnessing of mechanical property test;

(4) microstructure examination (quenched);

(5) macrostructure examination;

(6) drift expanding test or fractured surface analysis of sections with closed profiles (if required);

(7) other items where deemed necessary by CCS.

4.6.3 When the aluminum alloy sections are submitted to CCS Surveyor for inspection, the manufacturer is to submit its quality certificate to CCS Surveyor for review. The quality certificate is to contain at least following items and to be submitted to CCS for information during works approval:

(1) name of the purchaser and order number;

(2) destination for material;

(3) material descriptions and dimension;

(4) technical specifications and grade of material;

(5) cast number and chemical composition;

(6) results of mechanical property test;

(7) delivery condition;

(8) CCS description of identifications on products after satisfactory inspection;

(9) clarifying manufacturer's statement "According to CCS Rules or approval by CCS, accepted acceptance criteria or relevant standards, tests are satisfactory".

4.6.4 After satisfactory inspection of the products and review of the documents submitted by the manufacturer, CCS Surveyor is to issue a Certificate of Marine Products.

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CHAPTER 5 STEEL FORGINGS

5.1 Application

5.1.1 This Chapter applies to steel forgings intended for use in the hull structure, machinery, pressure vessels and piping systems, which are manufactured in accordance with the requirements of CCS Rules for Classification of Sea-going Steel Ships and CCS Rules for Materials and Welding. Where it is proposed to use carbon or carbon-manganese steels or alloy steels other than those specified in CCS Rules, details of the chemical composition, mechanical properties and heat treatment process are to be submitted to CCS for approval, and such steels, subject to consent of CCS, may be accepted in accordance with the relevant standards recognized by CCS.

5.1.2 This Chapter also applies to rolled slabs and billets in stead of steel forgings, and applies to rolled round used for the manufacture (by machining operations only) of shafts, bolts, studs and other components of similar shape.

5.1.3 Forgings are to be made at a manufacturer approved by CCS. The steel used to forging is to be made at a steel works approved by CCS.

5.2 Basis for approval and inspection

5.2.1 CCS Rules for Classification of Sea-going Steel Ships;

5.2.2 CCS Rules for Materials and Welding;

5.2.3 relevant national and international standards.

5.3 Design and technical requirements

5.3.1 The methods of tensile, impact and cold bend tests are to comply with the relevant requirements in Chapter 2, PART ONE of CCS Rules for Materials and Welding.

5.3.2 Macrostructure, sulphur print and microstructure are to comply with the relevant recognized standards.

5.3.3 The methods of ultrasonic, magnetic particle or dye penetration tests are to comply with the relevant recognized standards.

5.3.4 The methods of chemical composition analysis and tolerance are to comply with the relevant recognized standards.

5.4 Plans and documents

5.4.1 A manufacturer intending for works approval by CCS is to submit the following documents to CCS for information, in addition to those specified in 3.2 of PART ONE of the Guidelines.

(1) Details of the products for approval:

grade and use of forgings (such as those for hull structure, shafts, machinery, pressure vessels and piping systems), type of steel (such as carbon or carbon-manganese steels or low alloy steels), mass and dimension of the maximum forging for approval, forging method (such as open die, closed die, continuous grain flow), type of materials (such as ingot, billet), heat treatment method (such as normalizing, normalizing and tempering, quenching and tempering), and surface condition of delivery. The maximum mass and relevant dimension of the forging is interpreted as follows:

For open die forgings, they are grouped into shaft type, pie/disc type and ring type, among which maximum mass and diameter is to be taken for shaft type and height/thickness and diameter is to be taken for pie/disc and ring types.

For closed die forgings, maximum projected area is to be taken.

For continuous grain flow forgings, diameter of connecting rod neck and mass of connecting rod are to be taken.

(2) A list of main production equipment, including the relevant parameters of the following equipment:

① capacity of secondary refining and vacuum treatment equipment (if applicable);

② the ultimate capacity of forging equipment;

③ the types of heating furnace and heat treatment furnace (capacity, fuel types, temperature control, arrangement of measurement points, cooling equipment adopted for heat treatment);

④ surface hardening method of forgings and equipment (if applicable);

⑤ lifting appliances.

(3) A list of inspection/test equipment, including the relevant parameters of the following equipment:

① the methods of chemical composition analysis (such as chemical analysis, spectral analysis) and elements to be analyzed;

② mechanical properties (including hardness);

③ non-destructive test equipment;

④ metallographic examination (if required);

⑤ a unit carrying out statutory survey for the above equipment and the validity of appraisal.

(4) Qualification certificate of the test and inspection personnel.

(5) A flow card indicating each stage of the main technological process and the process for typical samples submitted.

(6) Cast number and batch number, identification mark of forgings, and documentary trail or related descriptions.

(7) The provisions for control of purchase or related descriptions:

① for a forging manufacturer, where the billet steel need to be purchased, the billet material is to be ordered from the billet works as approved by CCS, i.e. the materials for forgings are to be made in a works approved by CCS;

② During works approval, the forging manufacturer is to provide a list of material works with satisfactory results of assessment to CCS for information. Any change of list is to be subject to CCS agreement. Ingots/materials purchased by the forging manufacturer are to be the approved ones by CCS, and at least one chemical composition re-test is to be carried out per cast after delivery.

5.4.2 The type test program is to be submitted to CCS for approval.

5.5 Type test

5.5.1 Determination of the type test program

Prior to works approval, CCS and the applicant are to determine the type test program through negotiation. The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

(1) grade and use of forgings (such as those for hull structure, shafts, machinery, pressure vessels and piping systems), type of steel (such as carbon or carbon-manganese steels or low alloy steels), mass and dimension of the maximum forging for approval, forging method (such as open die, closed die, continuous grain flow),

(2) the name, drawing number, grade/designation, mass and dimension of the typical samples for test approval;

(3) the test items and the standard or rules adopted, and the methods.

5.5.2 Selection of typical samples

The typical samples for type test are to be selected according to the following requirements.

(1) Typical forgings are to be selected for different forging methods respectively (such as open die, closed die, continuous grain flow).

(2) According to each type of forgings (for hull structure, shafts or gears), the selected sample is to be capable of representing and covering the types of product for approval.

(3) In an initial approval, at least one piece of typical forging is to be selected, capable of representing the maximum forging capacity of the manufacturer with more than 80% of the maximum material mass or maximum dimension. Where CCS deems necessary, an additional piece of forging may be taken for relevant test or inspection.

(4) Typical samples may be selected taking purchase order into consideration. For marine forgings, prior approval of the design drawing and technical conditions is to be obtained from CCS. For forgings not for marine use, the technical conditions are in general to comply with the requirements of CCS Rules for such forgings.

5.5.3 Where the selected typical samples are adopted as the samples for approval, the manufacturer is also to provide the following information on the products:

(1) the forging product drawing (including sampling position) and the technical requirements for materials, including the requirements for chemical composition, mechanical properties and non-destructive tests;

(2) forging process and forge ratio;

(3) heat treatment process.

5.5.4 Type test items and requirements

5.5.4.1 Chemical analysis of carbon or carbon-manganese steels or alloy steels is to contain the chemical compositions specified in CCS Rules for Materials and Welding for relevant forgings, and the elements stipulated in technical standards and conditions and patent for alloy steels.

5.5.4.2 The number of specimens for tensile, impact, hardness and cold bend tests is to depend on the mass and dimension of each forging.

(1) The detailed requirements for sampling of different types of forgings are referred to in CCS Rules for Materials and Welding.

(2) Mechanical property test is to be carried out in accordance with the relevant requirements of CCS Rules for Materials and Welding. In case of lack of such provisions, other recognized standards may be adopted.

5.5.4.3 The specimen for hardness test may be taken from tensile specimens or impact specimens (from the intact part).

5.5.4.4 Ultrasonic test and visual examination of the products.

5.5.4.5 Where the Surveyor deems necessary, the following items are to be subject to test:

(1) For large and major forgings, macrostructure, sulphur prints and metallographic (intrusions and grain size) examinations are to be conducted. The location of the test specimens is generally in the riser end.

(2) For forgings delivered in finished condition, dye penetration or magnetic particle examination is to be carried out to examine the defects on the surface or close to the surface.

(3) Where solid forged crankshafts are made by closed die or continuous grain flow, full details of the proposed forging method are to be submitted to CCS for approval. When necessary, the manufacturer is required to carry out tests to demonstrate that a satisfactory structure and grain flow are obtained.

(4) Where forgings are surface treated and chemical heat treated, in addition to surface hardness, the distribution and depth of the hardened zone are to be determined. Property test of the main body of forgings is to be carried out.

(5) Where the forgings are subject to a working temperature equal to or more than 350℃, mechanical properties at elevated temperatures are to be determined.

(6) Where hollow forgings for boilers, pressure vessels and piping systems are supplied in finished condition, pressure tests are to be carried out.

(7) Austenitic stainless steel forgings are to be subject to intercrystalline corrosion test.

(8) Forgings for marine diesel engines manufactured by patent technology are to be subject to tests stipulated in the patent technology approved by CCS.

5.6 Unit/batch inspection

5.6.1 According to CCS requirements for lists of certified products, forgings required to be certified by CCS are to be applied for inspection by CCS, which can be used onboard ships only after satisfactory inspection. For major forgings such as marine shaft and rudder system and diesel engine components and parts, the drawings approved by CCS are to be submitted.

5.6.2 The main procedure of unit/batch inspection: (1) review of forging and heat treatment process (for major forgings); (2) taking specimens; (3) test; (4) visual examination and non-destructive test; (5) report and information review.

Depending on different production stages and surface delivery condition, the test items are given in Table 5.6.2.1.

Tests for forgings **Table 5.6.2.1**

Delivery condition	Test items
Material	Chemical analysis of ladle sample or materials composition re-test
	Taking mechanical test specimens and following up**
	Mechanical test* (test items are in accordance with CCS Rules)
	Visual examination*
Rough machining	Ultrasonic detection**
	Visual examination*
Finishing	Magnetic particle/dye penetration test**
	Check of accuracy of dimensions*

Note: * items to be witnessed by the Surveyor

** items tested in the presence of the Surveyor unless otherwise agreed by the Surveyor.

For small major forgings to be tested in batch (pressure vessels, connecting rods, crankshafts, tie bolts), each of such forgings may be required for hardness test where deemed necessary by the Surveyor. The difference in hardness is in accordance with the corresponding tensile strength given in Table 5.6.2.2.

Difference in hardness **Table 5.6.2.2**

Minimum tensile strength R_m (N/mm^2)	**Difference in Brinell hardness**
$R_m < 600$	25
$600 \leqslant R_m < 900$	35
$R_m \geqslant 900$	42

5.6.3 Each forging after satisfactory inspection is to be marked with CCS stamp.

5.6.4 The quality certificate of the manufacturer is to contain at least:

(1) name of the purchaser and order number;

(2) name, drawing number, steel grade and use of the forgings;

(3) cast number/batch number and grade of steel;

(4) details of heat treatment, including temperature and holding times, surface condition of delivery;

(5) chemical composition and results of mechanical tests;

(6) results of macrostructure examination (if applicable);

(7) forge ratio;

(8) test pressure (if applicable);

(9) method and results of non-destructive examination.

CHAPTER 6 STEEL CASTINGS

6.1 Application

6.1.1 This Chapter applies to works approval and inspection of steel castings intended for use in the hull structure and machinery structure as required in CCS Rules for Materials and Welding.

6.1.2 For manufacturers using intermediate frequency furnace for ladle sample, CCS will not approve such manufactured steel castings for hull structure (stems, stern frames, rudder horns, anchors and screw shaft brackets).

6.1.3 The requirements for castings for crankshafts, propellers, boilers, pressure vessels and piping systems, and ferritic castings for low temperature service and austenitic stainless steel castings may be referred to in this Chapter, and additional properties tests may be carried out for works approval and product inspection under the approval by CCS.

6.2 Basis for approval and inspection

6.2.1 CCS Rules for Classification of Sea-going Steel Ships;

6.2.2 CCS Rules for Materials and Welding.

6.3 Design and technical requirements

6.3.1 Castings are to comply with structural strength design requirements of relevant rules and standards according to application position and actual working condition.

6.3.2 Where it is proposed to use carbon or carbon-manganese steels or alloy steels other than those specified in CCS Rules for Materials and Welding, details of the chemical composition, mechanical properties and heat treatment process are to be subject to consent of CCS plan approval departments, and such steels may be accepted in accordance with relevant recognized standards.

6.4 Plans and documents

6.4.1 A manufacturer intending for approval by CCS is to submit an application to CCS for works approval.

6.4.2 The applicant is to submit the following documents to CCS for information:

(1) Particulars of the manufacturer: the name, address and history of the manufacturer; the type and specification of the manufactured products; the type, specification and delivery condition of the products for approval; the quality statistics of the products in recent years; other recognized qualification certificates.

(2) Management documents, including quality system documents. The documents are to clearly indicate the organizational structure and quality control points.

(3) Main production equipment and inspection/test equipment:

① a list of main production equipment:

- smelting equipment;
- type and dimensions of heating treatment furnace, heating method, temperature control record, arrangement of temperature measuring points;
- welding equipment;

② a list of main inspection/test equipment: equipment for chemical composition analysis, mechanical property and metallographic examination and NDT (including name, modal, manufacturer, a unit carrying out statutory calibration for the above equipment and the validity of appraisal).

The manufacturer is to be equipped with necessary equipment for chemical analysis, mechanical property test and NDT.

(4) Process documents:

① flow chart of manufacturing process (quality control points required to be indicated);

② list of basic procedure specifications (at least including important procedures such as types, smelting, casting, heat treatment and non-destructive testing);

③ welding repair documents relevant to casting material stipulated in CCS rules and corresponding welding procedure qualification report.

(5) Qualification certificate of the test and inspection personnel.

(6) Place of test and qualification of the laboratory (if applicable, the qualification of the subcontractor and the agreement).

6.4.3 The type test program is to be submitted to CCS for approval.

6.4.4 Other documents where deemed necessary by CCS.

6.5 Type test

6.5.1 Determination of the type test program

Prior to works approval, CCS and the applicant are to determine the type test program through negotiation. The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

(1) the type, specification and delivery condition of the products for approval;

(2) details of selection of typical samples for type test;

(3) the test items and the standards or rules adopted;

(4) sampling position, type and number;

6.5.2 Selection of typical samples

6.5.2.1 According to each type of castings, the selected sample is to be capable of representing the types of product for approval. Where materials, shapes or steel grades are similar for different types, reduction of the number of typical samples may be considered.

6.5.2.2 In an initial approval, at least one piece of typical product is to be selected, capable of representativeness and with weight more than 80% of the maximum mass applying for approval. An additional piece of product with other mass may be taken for sampling.

6.5.2.3 In an approval, if selected typical samples are not marine castings, technical conditions need not fully comply with CCS rules, but internal and external quality as well as impact roughness performance of materials are not to lower than the requirements of CCS rules.

6.5.2.4 The final selection of typical samples is to be confirmed by CCS Surveyor.

6.5.3 Type test items and requirements

(1) Chemical composition analysis: C, Si, Mn, P, S, Nb, V, Ti, Cr, Ni, Mo, Cu, Als and other added elements.

(2) Tensile test: to determine the upper yield strength R_{eH}, tensile strength R_m, elongation A_5, and area reduction Z, and graphs or computer records to be provided as far as possible.

(3) Charpy V-notch impact test: to determine the energy at normal temperature or temperature stipulated in technical drawings.

(4) Visual examination: slight defects on the surface of casting for approval may be repaired by grinding. Defects required for welding repair are not to be disposed by the manufacturer, which must be notified to CCS Surveyor for confirmation, and repaired according to approved welding procedure.

(5) Non-destructive test: to at least comply with the requirements of Appendix 7B, Chapter 7 of CCS Guidelines for Inspection of Hull Welds.

(6) Other test items as specified in technical drawings, or as deemed necessary by CCS.

6.6 Unit/batch inspection

6.6.1 After works approval by CCS, the marine castings which are required to be subject to CCS inspection by Appendixes 1, 2 and 3, Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships are to be applied by the manufacturer for unit/batch inspection by CCS, which can be used onboard ships only after satisfactory inspection and a certificate of product obtained.

6.6.2 The detailed requirements for unit/batch inspection of steel castings are to be notified in written form to the works when CCS issues a certificate of works approval.

6.6.3 The unit/batch inspection is to be carried out according to the approved test program. The test program is to contain the test items for witness, review and on-site examination with details as follows.

(1) Chemical composition analysis: samples from each cast. The test report is to be submitted to the Surveyor for review.

(2) Mechanical property test: samples from each unit or each batch. The test is to be witnessed by the Surveyor. The test report/record is to be submitted to the Surveyor for endorsement.

(3) Non-destructive test (if required). The test report is to be submitted to the Surveyor for review.

(4) Visual and dimensional examination.

(5) Repair of major defects under the supervision of the Surveyor.

6.6.4 The manufacturer is to issue a quality certificate for products after satisfactory inspection. The certificate is to contain at least: acceptance criteria (rules, standard, technical agreements, etc.), cast number/batch number, steel grade, specifications, mass, number, delivery condition, chemical composition, mechanical properties, description of identification. Each casting after satisfactory inspection is to be marked with CCS stamp.

6.6.5 After completion of satisfactory inspection, CCS Surveyor is to issue a certificate of products.

CHAPTER 7 ANCHORS

7.1 Application

7.1.1 This Chapter applies works approval and inspection of steel casting anchors and accessories, fabricated steel anchors and accessories, which are manufactured in accordance with the requirements of CCS Rules for Classification of Sea-going Steel Ships and CCS Rules for Materials and Welding.

7.2 Basis for approval and inspection

(1) CCS Rules for Classification of Sea-going Steel Ships;

(2) CCS Rules for Materials and Welding.

7.3 Plans and documents

7.3.1 A manufacturer intending for approval by CCS is to submit an application to CCS for works approval.

7.3.2 The applicant is to submit the following documents to CCS for information.

(1) Particulars of the manufacturer: name, address and organizational structure, history, production capacity, main products, legal person, business license, registered trademark, etc.

(2) Details of the products for approval: types, steel grades, specifications, heat treatment, delivery condition.

(3) Main production equipment and inspection/test equipment: name/purpose, specifications or calibration of metallurgical, casting, welding equipment, heat treatment equipment (including dimension of the furnace hearth, heating methods, temperature control recording, arrangement of temperature measuring points), equipment for lifting and weighing, proof load test, non-destructive test, chemical composition analysis and mechanical property test (tensile and impact test).

(4) Technical process and inspection: flow chart of manufacturing process (indicating quality control points), major process specification, inspection provisions for each stage, inspection record, production record, format of quality certificate.

(5) Qualified products: analysis of the recent quality statistics for the products or similar products, users' comments.

(6) Quality management documents and others: procedures and systems for quality control (a list of the documents may be provided), copies of quality certificate and other qualification certificate issued by a competent unit.

(7) Personnel: a list of welders, NDT personnel, technical inspectors, mechanical test and chemical analysis personnel, with qualification certificates of welder, qualification certificates of NDT personnel, and job certificates for mechanical test and chemical analysis personnel.

7.3.3 The following documents are to be submitted to CCS for approval:

(1) design descriptions (including calculation);

(2) product drawings (including drawings of components and parts and list of materials);

(3) type test program.

7.4 Major components

7.4.1 All anchors and components are to be manufactured by works as approved by CCS, and are to comply with the requirements of CCS Rules for Materials and Welding.

7.4.2 When the anchors are assembled from purchased materials, the anchor heads, shanks and shackles are to be furnished with certificate of products by CCS.

7.5 Design and technical requirements

7.5.1 Anchors designed as high holding power ones or super high holding power ones, when in the process of approval, are subject to holding power tests at sea in accordance with the requirements of CCS Rules for Materials and Welding.

7.6 Selection of typical samples

7.6.1 According to the complexity of casting technique, at least two types of structures are to be selected as typical samples. A product with specification reflecting the manufacturer's casting capacity (more than 80% of maximum mass or maximum dimension) is to be selected from each type for the test.

7.7 Type test

7.7.1 Determination of the type test program

Prior to works approval, CCS and the applicant are to determine the type test program through negotiation. The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

(1) the type, specification and delivery condition of the products for approval;

(2) acceptance criteria (the current rules or standards adopted);

(3) selection of typical samples and reasons;

(4) the test items, methods and requirements;

(5) the type and position of the test specimens;

(6) place of test and qualification of the laboratory (if applicable, the qualification of the subcontractor and the agreement).

7.7.2 Type test items and requirements

(1) Chemical composition analysis: C, Si, Mn, P, S, Cr, Ni, Mo, Cu, V, Als, to comply with the requirements of CCS Rules for Materials and Welding.

(2) Metallographic examination: the components and parts of cast steel anchors are to be fully annealed or normalized and tempered (the tempering temperature is not to be less than 550 ℃) at AC_3 + 50 ～ 150 ℃. The specimens are to be prepared in the position with maximum thickness after heat treatment. The process of preparation is to be free from super heating or deformation. The specimens are to be etched in nitric acid alcohol solution for metallographic examination (×100 magnification) and micrographs are to be provided. Matrix structure is ferrite + detached networks distributed perlite or ferrite + perlite. No structure in the as cast condition or Widmanstatten structure (coarsening) is allowed.

(3) Mechanical property test of the materials: to comply with the relevant requirements of CCS Rules for Materials and Welding.

(4) Drop test: the cast steel anchor arm, shank and shackle to be freely dropped respectively from 4 m height on a solid steel plate of not less than 50 mm in thickness, and peening with a hammer of not less than 3 kg. If drop test is not carried out for the welding anchor, welds may be subject to ultrasonic examination which may be carried out according to CCS requirements or recognized standards.

(5) Product anchors are to be subject to proof-load test. The test methods and results are to comply with the requirements of CCS Rules for Materials and Welding.

(6) Mass and dimension of anchors (including the turning angle of the arms) are to be subject to examination. The deviation of actual mass of anchors from their nominal mass is to be within the range of +7% to -3%. Where the deviation of mass complies with the requirements, the dimension is to comply with the requirements in the drawings approved by CCS and deviation of the dimension is to be within the range of ±4%, but not greater than 20 mm. Fabrication and fitted dimension of the anchors are to comply with the requirements of CCS Rules for Materials and Welding.

(7) Visual examination and non-destructive test are to comply with the following requirements:

① the visual examination and non-destructive test after proof-load test are to comply with the requirements of CCS Rules for Materials and Welding;

② magnetic particle test: the test is to be in accordance with Appendix 7B, Chapter 7 of CCS Guidelines for Inspection of Hull Welds;

Acceptance criteria for surface testing of castings Table 7B.4.6

Inspection zone	Maximum number of indications	Type of indication	Maximum number for each type	Maximum dimension of single indication
Fabrication weld preparation and weld repairs	4	Linear Nonlinear Aligned	4 4 4	3mm 5mm 3mm
Locations other than welds	20	Linear Nonlinear Aligned	6 10 6	5mm 7mm 5mm

③ ultrasonic test of steel castings: the test is to be in accordance with Appendix 7B, Chapter 7 of CCS Guidelines for Inspection of Hull Welds;

Acceptance criteria for ultrasonic testing of steel castings Table 7B.6.2

Inspection zone	Allowable disc shape according to DGS (mm)	Maximum number of indications to be registered ①	Allowable length of linear indications (mm) ②
UT1	>6	0	0
UT2	12~15 >15	5 0	50 0

Notes: ① Grouped in an area measuring 300 x 300mm.
② Measured on the scanning surface.

④ the major defects are to be classified and disposed in accordance with the welding procedure approved by CCS.

(8) Welding/weld repairs assessment

① for fabricated anchors, the welding procedure is to be submitted for assessment and approval;

② for cast steel anchors, the weld repairs procedure is to be submitted for assessment and approval.

7.8 Unit/batch inspection

7.8.1 The detailed requirements for unit/batch inspection of anchors are to be notified in written form to the works when CCS issues a certificate of works approval.

7.8.2 The unit/batch inspection test is to be conducted according to the approved program. The test program is to contain the test items for witness, review and on-site examination. The items are to include:

(1) visual examination;

(2) main dimension and fitted dimension examination;

(3) chemical composition analysis;

(4) mechanical property test;

(5) drop test (applicable to cast steel anchor);

(6) proof-load test of anchors (if required);

(7) non-destructive test;

(8) mass examination;

(9) free turning of anchor;

(10) repairs of major defects, including confirmation of welding/weld repair procedure and test after repair;

(11) other test/inspection items as deemed necessary by CCS.

7.8.3 Each casting after satisfactory inspection is to be marked with CCS stamp. The mark is to comply with the requirements of CCS Rules for Materials and Welding.

7.8.4 After satisfactory inspection and review of the submitted documents, CCS Surveyor is to issue a certificate of marine products.

CHAPTER 8 ROLLED STEEL BARS FOR ANCHOR CHAIN CABLES AND ACCESSORIES

8.1 Application

8.1.1 This Chapter applies to the works approval and inspection of rolled steel bars both for anchor chain cables and accessories onboard ships and for mooring chain cables and accessories onboard offshore installations and accessories, which are manufactured in accordance with the requirements of CCS Rules for Classification of Sea-Going Steel Ships and CCS Rules for Materials and Welding. Reference may be made to rolled steel bars for other purposes (such as directly used for manufacturing marine shafting).

Rolled steel bars for anchor chain cables, mooring chain cables and accessories as well as hot rolled steel bars directly used for manufacturing (only mechanically processing) marine shafting are to be manufactured by works approved by CCS.

8.1.2 This Chapter applies to the works approval and inspection of anchor chain steels, which are manufactured by electric arc furnace (RP, HP, or UHP), direct current furnace, top and bottom blown converter including secondary refining (LF, VD, CAS, RH), cast in moulds or made by a continuous casting process to be square or rectangular materials, and delivered in the condition of AR or CR.

8.2 Basis for approval and inspection

8.2.1 CCS Rules for Classification of Sea-Going Steel Ships;

8.2.2 CCS Rules for Materials and Welding;

8.2.3 relevant national and international standards;

8.2.4 technical specifications or descriptions of order, where necessary.

8.3 Classification of rolled steel bars

8.3.1 Rolled bars for anchor chain cables and accessories are classified into eight grades according to the nominal tensile strength and applicable product type, i.e. AM1, AM2 and AM3 for steels which are used for marine anchor chain cables, OM3, OM3S, OM4, OM4S and OM5 which are used for steels for offshore mooring chain cables.

8.3.2 The classification of rolled steel bars for other purposes may be carried out according to relevant standards.

8.4 Plans and documents

8.4.1 A manufacturer intending for approval by CCS is to submit an application to CCS for works approval.

8.4.2 The documents as specified in 3.2.1 of PART ONE of the Guidelines are to be submitted to CCS for information.

8.4.3 The type test program is to be submitted to CCS for approval.

8.5 Type test

8.5.1 Determination of the Type test program

Prior to type test, CCS and the applicant are to determine the type test program through negotiation. The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

(1) the type, specification and delivery condition of the products for approval (indicating the deoxidation, grain refining elements and delivery condition for each steel grade);

(2) steel grade, specification, number and heat treatment of the selected products for test;

(3) the test items and the standards or rules adopted;

(4) sampling scheme and descriptions;

(5) place of test and qualification of the laboratory (if applicable, the qualification of the subcontractor and the agreement).

8.5.2 Selection of typical samples

The typical samples for type test are to be selected according to the following requirements:

(1) The typical samples are to be taken for type test from the largest products of rolled steel bars for each grade. The products with the maximum specification are to be selected respectively for continuous casting and mould casting. Where electric furnace and converter are for smelting, the products with the maximum specification are to be selected accordingly. CCS may require additional approval test for the smallest or medium products as the case may be.

(2) Depending on the resources of the manufacturer, the sampling process may be confirmed by tracking sampling or production process or by tracing relevant information through production control computer.

(3) The materials (billets, ingots) for rolled steel bars for test are to be designated by the Surveyor. The test samples are to be taken from the top and bottom of the bars.

(4) In application for materials approval, the materials may be rolled into finished products for mechanical property test depending on the agreement with the supplier.

(5) Sampling for hydrogen brittleness test of OM3S, OM4, OM4S and OM5 steel bars is to be carried out according to the requirements of CCS Rules for Materials and Welding.

8.5.3 Type test items and requirements

8.5.3.1 The type test items and requirements are as follows:

(1) Chemical composition analysis: compositions of ladle sample and finished products to be analyzed respectively. The elements to be analyzed are C, Si, Mn, P, S, Cr, Ni, Mo, Cu, Als, Nb, V, Ti and other added ones (Al not required for AM1).

(2) Tensile test: to determine the upper yield strength $R_{eH,}$ tensile strength R_m and elongation A. The test specimens are to be taken from the bars in longitudinal direction at a position of 1/6 diameter from the surface or as close as possible to this position. Yield strength of material is generally not more than 0.92.

(3) Bend test

① the test specimens: for diameter not exceeding 40 mm, to be taken as a cylindrical bar with full cross-section or a cylindrical bar of 25 mm in diameter with one rolled surface; for diameter exceeding 40 mm, to be taken from the bars in longitudinal direction with center line at a position of 1/6 diameter from the surface or as close as possible to this position;

② bending angle of 180°: d= a for AM1, d=1.5a for AM2 and AM3; for diameter not less than 25 mm (uncut test specimens), d=2a for AM1, d=2.5a for AM2 and AM3.

(4) Charpy V-notch impact test

① The test is to determine the energy with a set of three test specimens, and the individual value and average value of energy to be provided. Impact test is not required for grade 1 steel.

② The temperature requirements for impact test: normal temperature, 0℃ and -20℃ for AM2, normal temperature, 0℃ , -20℃ and -40℃ for AM3, OM3 and OM3S, normal temperature, 0℃ , -20℃ , -40℃ and -60℃ for OM4, OM4S and OM5.

③ The test specimens are to be taken from the bars in longitudinal direction with center line at a position of 1/6 diameter from the surface or as close as possible to this position, and for diameter not less than 60 mm, additional specimens are to be taken on the core.

④ The fracture photos and side expansion value are to be provided.

(5) Hardness test: Steels for each grade are to be subject to hardness test. Specimens may be prepared individually or apply residual samples (parts without deformation) of tensile and impact tests. Hardness of OM4S steel is not to be greater than 330HBW, and hardness of OM5 steel is not to be greater than 340HBW

(6) Sulphur prints: sulphur prints to be taken with full cross-section (or 1/2) of the material; for bars, sulphur prints to be taken with a full cross-section or a longitudinal section through axis (length of specimen/diameter ≥ 1.2). The photos of sulphur prints are to be provided.

(7) Hydrogen brittleness test of OM3S, OM4, OM4S and OM5 round steel bars: test requirements and methods and result assessment are to comply with CCS Rules for Materials and Welding.

(8) Macrostructure: the requirements for position and length of the specimen for the materials and finished products are the same as those for sulphur prints.

(9) Microstructure and grain size: microstructure (×100 magnification) to be prepared in longitudinal direction at a position of 1/6 diameter from the surface or as close as possible to this position to determine actual grain size (or ×500 magnification as the case may be).

(10) Welding property test: rolled steel bars for anchor chain cables and mooring chain cables are to be subject to welding property test in an initial approval. The sampling material is to be welded by actual production technology of those chain cables, and the welds (after heat treatment) are to be subject to mechanical property tests (tensile, impact, hardness) and technological test (bend), in which, the hardness test is to determine the maximum hardness and hardness distribution in heat affected zones of welding.

(11) Visual and dimensional examination: at least 5 pieces of bars are to be selected for examination. The diameter, roundness, the curvature per meter and the total curvature are to be examined for each piece. The diameter tolerance and roundness tolerance are to comply with the requirements of CCS Rules for Materials and Welding.

(12) Non-destructive test:

① Steels for all mooring chain cables and accessories are to be subject to ultrasonic test at appropriate stage of manufacturing process. Round steel bars are to be free from gas hole, crack or folding.

② Steels for all offshore mooring chain cables are to be subject to surface inspection by magnetic particle, eddy current or equivalent methods.

③ Non-destructive test is to be carried out according to recognized standards. Non-destructive test technology and acceptance criteria are to be submitted to CCS for information.

(13) Other test items as deemed necessary by CCS (isothermal transformation curve for austenite, tower type test, etc.).

8.5.3.2 For steel mills where the materials are purchased, the material suppliers are to be approved by CCS and subject to sulphur prints/macrostructure examination, chemical composition analysis, visual and dimensional examination. Qualified materials are sent to mills to make steel bars and subject to test according to the above-mentioned requirements. The material suppliers may be approved only after all satisfactory tests.

8.6 Unit/batch inspection

8.6.1 After works approval by CCS, the rolled steel bars as manufactured according to the approved conditions (including equipment, process, etc.) are to be applied by the manufacturer for unit/batch inspection by CCS, which can be used only after satisfactory inspection.

8.6.2 The detailed requirements for unit/batch inspection after approval are to be notified in written form to the works when CCS issues a certificate of works approval.

8.6.3 The unit/batch inspection is to be carried out according to the approved test program. The test program is to contain the test items for witness, review and on-site examination. The items are at least to include:

(1) visual and dimensional examination;

(2) review of the result of chemical analysis;

(3) mechanical property test;

(4) other test items as deemed necessary by CCS.

8.6.4 After satisfactory inspection of products, CCS Surveyor is to issue a certificate of marine products or endorse the manufacturer's quality certificate.

8.6.5 The quality certificate is to contain at least: acceptance criteria (rules, standard, technical agreements, etc.), cast number/batch number, steel grade, specification, mass, number, delivery condition, chemical composition, mechanical properties, description of identifications. For OM4S and OM5 rolled steel bars for mooring chain cables, results of hydrogen brittleness test and non-destructive test as well as results of austenitic micro grain size, non-metallic intrusions and hardenability test are also to be listed. The space for stamp and endorsement by CCS Surveyor is to be reserved.

8.6.6 The format of the manufacturer's quality certificate is to be approved by CCS.

CHAPTER 9 ANCHOR CHAIN CABLES AND ACCESSORIES FOR SHIPS

9.1 Application

This Chapter applies to the works approval and inspection of flash welded stud and studless anchor chain cables and accessories made of forged steel for all types of ships.

Electro-welded anchor chains (including forged accessories) are to be classified into three grades, depending on the nominal tensile strength, i.e. AM1, AM2 and AM3 for stud cables, BM1 and BM2 for studless cables. The detailed class is given in Table 1:

Class of the electro-welded anchor chains (including forged accessories) Table 1

Name	Grade	Nominal diameter of link (mm)
Class I stud	AM1	11-162
Class II stud	AM2	
Class III stud	AM3	
Class I studless	BM1	6-50
Class II studless	BM2	

9.2 Basis for approval and inspection

9.2.1 The following rules and standards are the basis for approval and inspection of anchor chain cables and accessories.

9.2.2 Requirements in the following rules and standards quoted are part of this Chapter. For quoted documents marked with the date, their subsequent amendments (except corrigenda) or revisions will be inapplicable. However it is encouraged that parties concerned agreed with this Chapter may discuss whether the latest edition of these documents can be adopted:

CCS Rules for Materials and Welding

IACS W18 Anchor Chain Cables and Accessories (Rev.5 May 2004)

ISO1704 Shipbuilding Stud Link Anchor Chains

9.3 Terms and definitions

For the purpose of this Chapter, the terms and definitions in CCS Rules for Materials and Welding apply.

9.4 Plans and technical documents

A manufacturer intending for approval by CCS is to submit an application to CCS with the following plans and technical documents for product approval:

9.4.1 Particulars of the manufacturer: the name, address, lay-out plan, production history, production capacity, main products, superior department, legal person, registered trademark, business license, ISO 9000 certificate, the number and qualification certification/experience of the personnel engaged in inspection, test, welding, non-destructive test and in major technical management.

9.4.2 Details of the products for approval: types, specifications, steel grades, delivery condition.

9.4.3 A list of raw materials: information on the anchor chain steel and steel forging manufacturers with their approval by CCS.

9.4.4 Particulars of main production equipment and inspection/test equipment: name/purpose, type and capacity of anchor chains manufacturing equipment, forging equipment, stud equipment, heat treatment furnace, proof-load testing machines, universal materials testing machines, impact testing machines, chemical composition analysis instruments, welding equipment, non-destructive testing machines, as to ensure that all equipment of the manufacturer are to satisfy the requirements for production, test and examination of chain cables and accessories. The inspection/test equipment is to be within the validity of calibration and the valid measurement certificates are to be provided.

9.4.5 Manufacturing process and inspection: flowchart of manufacturing chain cables and accessories from the stock of raw materials to the final products, with main process and corresponding inspection points indicated; major technological documents and inspection/test guidance notes.

The manufacturer is to provide the following detailed requirements for manufacturing process and inspection.

9.4.5.1 Bar heating and bending: including heating method, heating temperature, heating time, weld center tolerance, dislocation control and recording.

9.4.5.2 Flash welding: including link temperature before welding, amperage, voltage, heating time, flash speed, upsetting pressure as well as control and recording of these parameters.

9.4.5.3 Trimming: including methods and acceptance criteria.

9.4.5.4 Stud setting: including stud insertion method, annular ring measurement, stud dimension and tolerance measurement recording after stud assembly.

9.4.5.5 Examination of surface quality and dimensions: acceptance criteria of surface quality, dimension and tolerance, measures of repairs of defects.

9.4.5.6 Stud welding of grade 3 chain cables: welding method, welding equipment, consumables; qualification certificate of welder, acceptance criteria, grinding recording.

9.4.5.7 Heat treatment: including control of parameters such as heating temperature, heating time and holding times, as well as heat treatment methods for chain cables of different grades and accessories.

9.4.5.8 Proof-load test and breaking test: test load, test equipment, test methods, measurement of five links, measurement of a whole length of chain cables, measurement of single links and accessories, and their recording.

9.4.5.9 Mechanical test: grade and specification of chain cables and accessories, the sampling position, number and dimension of specimens, test temperature, acceptance criteria and recording.

9.4.5.10 Non-destructive test: NDT method, equipment, acceptance criteria, qualification certificate of operational personnel.

9.4.6 Acceptance conditions for delivery: products acceptance for chain cables and accessories, including visual and dimension examination, proof-load and breaking-load test, mechanical test, and delivery criteria (including non-destructive test, package, identification and qualification certificate).

9.4.7 Instructions for use of products: specifications, grade, delivery condition, standard satisfied, method of connection of chain cables and anchors onboard ships, instructions for use and operation.

9.4.8 Qualified products: recent quality statistics analysis (including qualified rate, unqualified rate, reasons and measures taken) of chains and accessories, described in the form of table or diagram; users' comments, including feedbacks from customers both at home and abroad.

9.4.9 The quality/qualification certificate of the manufacturer for satisfactory chain cables and accessories when delivery is to contain at least:

9.4.9.1 name, grade and specification of chain cables and accessories;

9.4.9.2 CCS certificate No. of works approval and approval no. of drawing;

9.4.9.3 CCS Rules and relevant standards based for manufacturing and acceptance;

9.4.9.4 handwritten signature of inspector and manager of quality department and the date;

9.4.9.5 serial No. and quantity of chain cables or accessories, weight of chain cables, a single length and the total length;

9.4.9.6 proof loads and breaking loads;

9.4.9.7 heat treatment condition for delivery;

9.4.9.8 marks on chain cables or accessories;

9.4.9.9 mechanical properties of chain cables or accessories (if applicable);

9.4.9.10 non-destructive test report (if applicable).

9.4.10 Quality management documents: including currently valid quality assurance manual, procedures and system for quality control.

9.4.11 Where defects of chain cables or accessories need to be repaired by welding before heat treatment, the weld repair procedure is to be submitted to CCS for examination and approval.

9.4.12 Drawings of chain cables and accessories: general arrangement (including the whole length of chain cables and tolerance, heat treatment condition for delivery, proof-load/breaking load test, mechanical property test, non-destructive test, method of connection of chain cables and anchors); components and parts drawings (including dimension and tolerance of a single link and accessories, pin hole size of accessories, grade 3 chain cables welded stud structure).

9.4.13 Type test program of chain cables and accessories: property test of links (including tensile test, bend test, impact test, metallographic examination, macro-examination, sulphur prints, hardness test), property test of accessories (including tensile test, impact test, metallographic examination, macro-examination, sulphur prints, hardness test), test items for finished chain cables and accessories (including proof-load test, breaking test, visual examination, dimension examination, non-destructive test).

9.5 Requirements for materials

Steels and steel forgings intended for chain cables and accessories are to be furnished with CCS certificate of marine products or equivalent documents, and are to be manufactured at steelmakers approved by CCS. Steel and steel forgings intended for chain cables and accessories without CCS product certificates or equivalent documentation are to be fabricated at steelmakers approved by CCS, and subject to CCS inspection.

9.6 Stud welding procedure approval for grade 3 chain cables

In the initial approval of grade 3 chain cables, the stud welding procedure is to be subject to an approval test in accordance with the requirements in Welding Procedure Tests for Fillet Weld Joints of Section 3, Chapter 3, PART THREE of CCS Rules for Materials and Welding. The test items of welding procedure include hardness test, dye penetration/magnetic particle test, fracture test, macro-examination, and the test results are to comply with the relevant requirements in 3.3.4, Chapter 3, PART THREE of CCS Rules for Materials and Welding.

9.7 Design and technical requirements

The design of chain cables and accessories as well as relevant technical requirements are to comply with relevant requirements of CCS Rules for Materials and Welding.

9.8 Selection of typical samples

9.8.1 The typical samples for works approval are to be, in respect to property, characteristics and manufacturing quality, capable of representing or covering the products or product series to be approved. The chain cables and accessories with maximum specification are to be selected for each grade. Where grade 2 and grade 3 chain cables with the same specifications are to be approved, approval of grade 3 is enough. Samples of accessories for approval may be of different constructions such as Kenter type shackles (KS), swivels (SW), end shackles (ES) (or joining shackles (JS)).

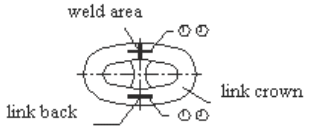
9.8.2 For the first approval, chain cables with maximum diameters by different chain making equipment are to be selected as samples respectively.

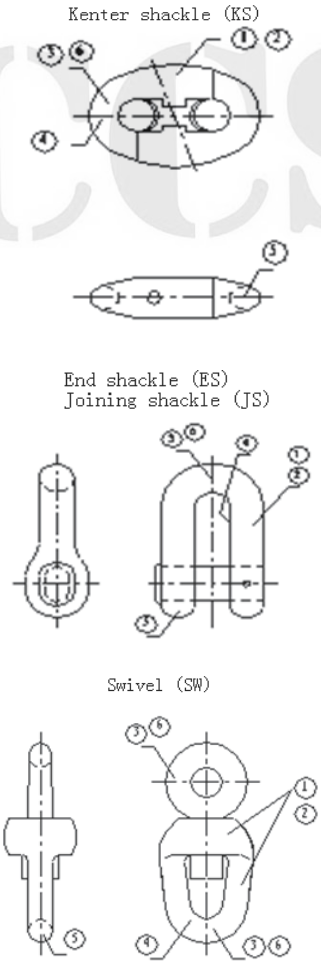
9.8.3 For renewal, change or adding items of works approval certificate, CCS may consider the reduction of test items.

9.8.4 Approval of enlarged links and end links are to be in accordance with the test items and requirements for accessories.

9.9 Test items for works approval are given in Table 2.

Test items for works approval of chain cables and accessories Table 2

Test items		Quantity	Specimen preparation	Test requirements	Remark
property test of links	① tensile test	2	 (1) A tensile specimen to be taken from the link back and welded zone respectively on the center of weld or at a position of 1/6 diameter from the surface as shown in the figure (2) Bending specimen to be taken from the surface of welded zone. The diameter of former is 2 times the thickness of specimen. the bending angle is 180° (3) 3 sets of impact specimens to be taken in the welded zone and link back respectively on the center of weld or at a position of 1/6 diameter from the surface (The test temperature to be -20℃ , 0℃ and +20℃ respectively) . (4) A metallographic specimen to be taken from the link back and welded zone respectively on the center of weld or at a position of 1/6 diameter from the surface as shown in the figure (5) Macro-specimens to be taken in longitudinal direction (6) Sulphur prints to be taken from the longitudinal section of links (7) The hardness test to be carried out on parent metal and welded zone respectively. The locations to be suitably spaced and the distribution diagram to be provided	10.2.7.5 For bending specimen, no cracks or other open defects exceeding 3 mm in dimension on the outside of the bend portion	
	② bend test	1			
	③ impact test	6 sets			
	④ metallographic examination	2		Photos (Í100 magnification) of ferritic elements and austenitic grain size to be taken and free from any defects	
	⑤ macro-examination	1		Photos (Í1 magnification) to be taken to determine the defects and inclusions of chain steels and their size, distribution and shape	
	⑥ sulphur prints	1		Photos (Í1 magnification) to be taken to determine the distribution and segregations of the sulphur in chain steels	
	⑦ hardness test	2		AM1 is not less than 120(HB) AM2 is not less than 145(HB) AM3 is not less than 207(HB) The above data for reference only	

	Test items	Quantity	Specimen preparation	Test requirements	Remark
property test of accessories	① tensile test	1	(1) A tensile specimen to be taken as shown in the figure (2) 3 sets of impact specimens to be taken as shown in the figure (the test temperature to be -20℃ , 0℃ and +20℃ respectively). (3) A metallographic specimen to be taken as shown in the figure. (4) Macro-specimen may be semi-circular (5) Sulphur prints to be taken from the longitudinal section of links (6) The hardness test to be carried out as shown in the figure. The locations to be suitably spaced and the distribution diagram to be provided	10.2.8.4 10.2.7.5	
	② impact test	3 sets			
	③ metallographic examination	1		Photos (Í100 magnification) of ferritic elements and austenitic grain size to be taken and free from any defects.	
	④ macroexamination	1		Photos (Í1 magnification) to be taken to determine the defects and inclusions of steel forgings and their size, distribution and shape.	
	⑤ sulphur prints	1		Photos (Í1 magnification) to be taken to determine the distribution and segregations of the sulphur in steel forgings.	
	⑥ hardness test	1		AM2 is not less than 145(HB) AM3 is not less than 207(HB) The above data for reference only	

Test items		Quantity	Specimen preparation	Test requirements	Remark
Test of finished chain cables and accessories	① proof-load test	1	A length of finished chain cables; one of KS, SW, ES or JS respectively	10.2.7.1-10.2.7.4 10.2.8.1-10.2.8.3	
	② breaking-load test	1	The breaking load specimen and the chain cables and accessories for proof load test are to be made in a single manufacturing cycle and heat treated together. One specimen of chain cables; one specimen of KS, SW, ES or JS respectively		
	③ Visual examination	1	Visual examination	10.2.4-10.2.5	
	④ dimension examination	1	(1) Size of every link, length of five links, the total length of chain, stud position. (2) Size of accessories		
	⑤ non-destructive test	1	Dye penetration/magnetic particle test is usually carried out on the crown, in the plane and at the side (diameter of link is less than 80 mm); ultrasonic test is usually carried out in the plane and at the side for links of diameter greater than 80 mm	CCS accepts relevant standards on non-destructive test	

Notes: ① The content in the Table is from section 2, chapter 10, PART ONE of CCS Rules for Materials and Welding.

② For swivels, specimens are to be taken from link body and bolt respectively for tensile, impact tests, metallographic examination and hardness test. Macro-specimen is to be located in the position where the change of body section is significant.

③ Where the tensile and impact specimens can not be cut due to smaller size of forged accessories, metallographic examination and hardness test are to be carried out.

9.10 Delivery test items for chain cables and accessories are given in Table 3.

Delivery test items for chain cables and accessories Table 3

Test items	Specimen requirements	Remark
① visual examination	(1) measurement of single link, five links, total length of chain, stud position; (2) measurement of chain cables and accessories 10.2.4 ～ 10.2.5	
② dimension examination		
③ proof load test	10.2.7.1 ～ 10.2.7.4; 10.2.8.1 ～ 10.2.8.3	
④ break load test		
⑤ mechanical test	10.2.7.5; 10.2.8.4	
⑥ heat treatment record	10.2.6	

Note: ① The content in the Table is from Section 2, Chapter 10, PART ONE of CCS Rules for Materials and Welding.

CHAPTER 10 COPPER ALLOY PROPELLERS

10.1 Application

10.1.1 This Chapter applies to the integral and fabricated cast copper alloy propellers intended for sea-going and inland waterways ships.

10.2 Basis for approval and inspection

10.2.1 The basis for approval and inspection of copper alloy propellers are as follows:

(1) CCS Rules for Materials and Welding

(2) CCS Rules for Classification of Sea-going Steel Ships;

(3) CCS Rules for Construction and Classification of Sea-going High Speed Craft;

(4) ISO 484/1 Shipbuilding-Ship screw propellers-Manufacturing tolerances-Part 1: Propellers of diameter greater than 2.5 m;

(5) ISO 484/2 Shipbuilding-Ship screw propellers-Manufacturing tolerances-Part 2: Propellers of diameter between 0.80 and 2.50 m inclusive;

(6) ISO 3715 Shipbuilding-Ship screw propellers-List of equivalent terms;

(7) ISO 1940-1 Mechanical Vibration-Balance Quality Requirements for Rotors in a Constant (Rigid) State.

10.3 Definitions

10.3.1 For the purpose of this Chapter, the definitions given in CCS Rules for Materials and Welding, CCS Rules for Construction and Classification of Sea-going High Speed Craft, CCS Rules for Materials and Welding and ISO 3715 apply.

10.4 Plans and documents

10.4.1 A manufacturer (including foundry and machining works) intending for works approval is to submit the following documents to CCS for approval, in addition to those specified in PART ONE of the Guidelines:

(1) type test program;

(2) welding procedure;

(3) drawings and necessary calculations of propellers intended for ships classed with CCS.

10.4.2 In addition to those in 10.4.1, the following drawings are to be submitted to CCS for information:

(1) details of products for approval, including alloy type, specification (maximum diameter and maximum mass) and delivery condition;

(2) main production equipment and inspection equipment, including the name/purpose, specification and capacity of smelting, casting and heat treatment equipment, equipment for physico-chemical examination, non-destructive test, metallographic examination (if applicable) and balancing test;

(3) qualification certificates of the personnel engaged in manufacturing and inspection, including at least that for chemical composition analysis, mechanical property test, metallographic examination, non-destructive test, and welding;

(4) a list of raw materials, including main and auxiliary materials.

10.5 Major components

The bosses, blades, fluid cylinders and fastening bolts of the fabricated propellers are to be subject to inspection by CCS Surveyor.

10.6 Design and technical requirements

10.6.1 The design and technical requirements for propellers are to at least comply with the requirements of CCS Rules for Classification of Sea-going Steel Ships, Rules for Construction and Classification of Sea-going High Speed Craft, Rules for Construction and Classification of Inland Waterways Steel Ships, and Rules for Materials and Welding.

10.7 Selection of typical samples

The selection of typical samples for works approval is based on the following requirements:

(1) The typical samples are selected according to the types of copper alloy material, in which Cu3 may cover Cu4, and Cu1and Cu2 may replace each other.

(2) The diameter of at least one alloy type of propellers is to be more than 90% of the maximum diameter of the products for approval, or the mass more than 80% of the maximum mass of the products declared by the manufacturer.

(3) Products manufactured by complicated technology are preferably selected.

10.8 Type test

The type test items and results are to be carried out according to the following requirements. The typical samples are to be cast according to the requirements in 9.1.5, Section 1, Chapter 9, PART ONE of CCS Rules for Materials and Welding.

(1) Chemical composition analysis: the chemical composition is to be based on the results of product samples analysis. The chemical composition is to comply with the requirements in 9.1.3, Section 1, Chapter 9, PART ONE of CCS Rules for Materials and Welding.

(2) Metallographic examination: the metallographic examination is applicable to propellers made of Cu1 and Cu2. At least one specimen is to be taken from each heat, and the proportion of α phase is to be determined as the average value of 5 counts. The test results are to comply with the requirements in 9.1.3, Section 1, Chapter 9, PART ONE of CCS Rules for Materials and Welding.

(3) Mechanical property test: round proportional tensile test specimens with diameter of 14 mm are to be cut from each test sample in accordance with the requirements given in Item 2 of Table 2.2.2.1 in Chapter 2 of PART ONE of CCS Rules for Materials and Welding. The tensile strength, 0.2% proof strength and elongation are to be determined by mechanical property tests. The test results are to comply with the values given in Table 9.1.6.3, Section 1, Chapter 9, PART ONE of CCS Rules for Materials and Welding.

(4) Visual, dimensional and geometrical tolerances examination: the external quality is to comply with the requirements given in CCS Rules for Materials and Welding. The dimension, dimensional and geometrical tolerances and surface roughness are to be in accordance with the drawings approved by CCS. Where it is not specified, the requirements given in ISO 484 Shipbuilding-Ship screw propellers-Manufacturing Tolerances apply.

(5) Non-destructive test: each propeller and its components are to be subject to NDT in accordance with the relevant requirements in Section 4, Chapter 8 of PART THREE of CCS Rules for Materials and Welding. All propeller castings are to be subject to dye penetration inspections in accordance with three zones A, B, and C. The inspections of Zone A are generally to be carried out in the presence of the Surveyor. Inspections of Zones B and C are to be performed by the manufacturer and a test report is to be submitted to the Surveyor for confirmation, or may be witnessed by the Surveyor as he requires. The NDT results are to comply with the requirements given in Section 4, Chapter 8 of PART THREE of CCS Rules for Materials and Welding.

(6) Static balancing: static balancing test is to be carried out on all propellers. Indifferent equilibrium test is to be carried out first, then followed by weighing test. The frictional moment of the core shaft of static balancing equipment is not to exceed:

$$M = \frac{G}{2}R$$

where: G — calculated weight suspending;
R — radius of propeller.

The calculated weight suspending is to be in accordance with the drawings approved by CCS. Where it is not specified, the following value is to be taken (whichever is lesser):

$$G = C\frac{m}{Rn^2}$$

$$G = Pm$$

where: G — calculated weight suspending, in kg;
m — mass of propeller, in kg;
R — radius of propeller, in m;
n — running, in rpm;
C and P — coefficient, to be determined according to the running n and grade K:

$C = K$ for $n \geq 180r/\min$;

$C = K \cdot \left(\frac{n}{180}\right)^2$ for $n < 180r/\min$.

The coefficient is given in the following Table.

Grade of propeller	S	1	2	3
K	15	25	40	75
P	0.0005	0.001	0.001	0.001

Where propeller diameter $D \leq 1.5$ m, G is to be calculated by the following formula:

$$G = 0.025\, D^2 + 0.02$$

where: G — calculated weight suspending, in kg;
D — propeller diameter, in m.

Where the works is to manufacture only the components (such as blades) of build-up propellers (such as controllable pitch propeller) without fabrication, and the shipbuilder responsible for fabrication has no static balancing conditions, each blade is to be subject to moment balancing test in the works to determine the balancing moment of gravity center of the blade to propeller axis. For controllable pitch propeller with four blades, the balancing moment of each blade to propeller axis is to meet the following formula:

$$\Delta m_i = W_i \cdot X_i - 1/4 \cdot \sum W_i \cdot X_i \leq f\, W / (2.828 + X_n) \cdot N^2$$

where: W_i — mass of number i blade;
X_i — distance between gravity center of number i blade and propeller axis;
N — speed of propeller, in rpm;
Δm_i is in kg.m.

The coefficient f is to be taken according to the following Table:

Grade of propeller	S	1	2	3
f	9	12.5	20	37.5

(7) Dynamic balancing: dynamic balancing is generally required for propellers running above 500 rpm, and the permissible unbalanced moments are to comply with the drawings approved by CCS. Where it is not specified, the remaining unbalance mass of propellers are not to exceed the value u_{per} calculated by the following formula:

$$u_{per} = 30000 G' m / (\pi\, r\, n)$$

where: u_{per} — permissible unbalanced mass, in g;
G' — balance quality, 16, in mm/s, according to ISO 1940;
m — mass of propeller, in kg;
r — balance radius, 0.8R, in mm;
n — speed of propeller, in rpm.

(8) Pressure test: the components of build-up propellers with hydraulic fluid cylinders are to be subject to pressure test in products survey. The test pressure is to be in accordance with the drawings approved by CCS. Where it is not specified, 1.5 times the working pressure apply.

(9) Weighing test: propellers are to be weighed. The mass tolerance of the first finished product of propeller is generally not to exceed ±4% of theoretical mass. The mass of the second and the subsequent products are determined according to that of the first finished product of propeller, and the mass difference is generally not to exceed ±2% of theoretical mass. The mass difference between left-handed propeller and right-handed propeller is not to be greater than the value determined according to following formula:

$$\triangle G = m\ 2\%+0.5$$

Where: $\triangle G$ — actual mass difference between left-handed propeller and right-handed propeller, in kg;
m — theoretical mass of left-handed propeller and right-handed propeller, in kg.

(10) Repairs of defects: the repairs of propellers are to comply with the requirements in Section 4, Chapter 8, PART THREE of CCS Rules for Materials and Welding. Where the propellers have defects in Table 2 subject to weld repair, a detailed welding procedure specification and areas of repairs are to be submitted to CCS for approval, covering the weld preparation, welding procedure, filler metals, preheating, post-heating and inspection. The welding procedure is to be approved by CCS in advance. Detailed requirements are given in Tables 1, 2 and 3.

Table 1 Recommended filler metals and heat treatment temperatures

Table 2 Weld repair region and area

Table 3 Stress relief treatment time for copper alloy propellers

Recommended filler metals and heat treatment temperatures Table 1

Alloy type	Filler metal	Min preheat temp. (℃)	Max. interpass temp. (℃)	Stress relieving temp. (℃)	Hot straightening temp. (℃)
Cu1	Al-bronze[1)] Mn-bronze	150	300	350-500	500-800
Cu2	Al-bronze Ni-Mn-bronze	150	300	350-550	500-800
Cu3	Al-bronze Ni-Al-bronze[2)] Mn-Al-bronze	100	250	450-500	700-900
Cu4	Mn-Al-bronze	100	300	450-600	700-850
Notes: ① Ni-Al-bronze and Mn-Al-bronze are acceptable. ② stress relieving not required, if filler metal Ni-Al-bronze is used.					

Weld repair region and area **Table 2**

Position of defects	Weld repair	Maximum size of single defect for weld repair $S \times h$ (mm^2 x mm)					Total area to be weld repaired
		$D \leq 1.0$m	1.0m$<D \leq$1.5m	1.5m$<D \leq$2.5m	2.5m$<D \leq$4.0m	$D>$4.0m	
Zone A	Generally not allowed	Repair welding is generally subject to special approval by CCS. Where such weld repair is applied, after the welding the stress is to be effectively relieved by heat treatment and tested. The condition for special approval is that the area and depth of the single defect are not to exceed 70% of the maximum size of the single defect permitted in zone B on the pressure face and the total area of defects are not to exceed 3% of the surface area of zone A which is also to be subject to the agreement among relevant parties					
Zone B on the pressure side (B1+B2)	allowed	500×6	1400×7	2500×10	5000×15	7500×15	The total area to be weld repaired for each division on each side is not to exceed 5% of the surface area in the division, but where the total area on one side of a blade doesn't exceed 5% of the area on the side, the total area on zone C on the pressure side or B4 division on suction side and zone C may reach 7%
Zone B from the root to 0.4R on the suction side (B3 division)		700×8	1500×8	2500×10	5000×15	7500×20	
Zone C and zone B from 0.4R to 0.7R on the suction side (B4 division)		700×8	1500×8	4000×10	7500×15	20000×25	
Inside and outside surface of boss		700×8	1000×8	2000×10	4000×15	10000×25	For inside and outside surface of boss, the total area is not to exceed 5% of the surfaces area. For end faces of boss, the total area is not to exceed 10% of the faces
End faces of boss							

Notes:(1) B1 division means the zone B within 0.4R on pressure side, B2 division means the remaining of zone B other than B1 division on pressure side.

(2) The size of propeller in the table is the net size in the drawings and D is diameter of propeller.

(3) The size of defect means the size after the defect is removed.

(4) The maximum length of a single defect allowed to be weld repaired is not to exceed two times the square root of the area of a single defect.

Stress relief treatment time for copper alloy propellers **Table 3**

Stress relief temperature (℃)	Cu1 and Cu2		Cu3 and Cu4	
	Hours per 25 mm thickness (h)	Max. recommended total time (h)	Hours per 25 mm thickness (h)	Max. recommended total time (h)
350	5	15	-	-
400	1	5	-	-
450	1/2	2	5	15
500	1/4	1	1	5
550	1/4 ①	1/2 ①	1/2 ②	2 ②
600	-	-	1/4 ②	1 ②

① Applicable to Cu2 alloys. ② Applicable to Cu4 alloy only.

Note: The heating and cooling is to be carried out slowly under controlled conditions. The heating rate is normally not to exceed 100℃ /h, and the cooling rate after any stress relieving heat treatment is not to exceed 50℃ /h until the temperature of 200℃ is reached.

Notes: (1) Unless considered otherwise, the stress relief temperature is between 450℃ and 500℃ ; in case of weld repair of large area, the annealing temperature is to be between 650℃ and 800℃ .

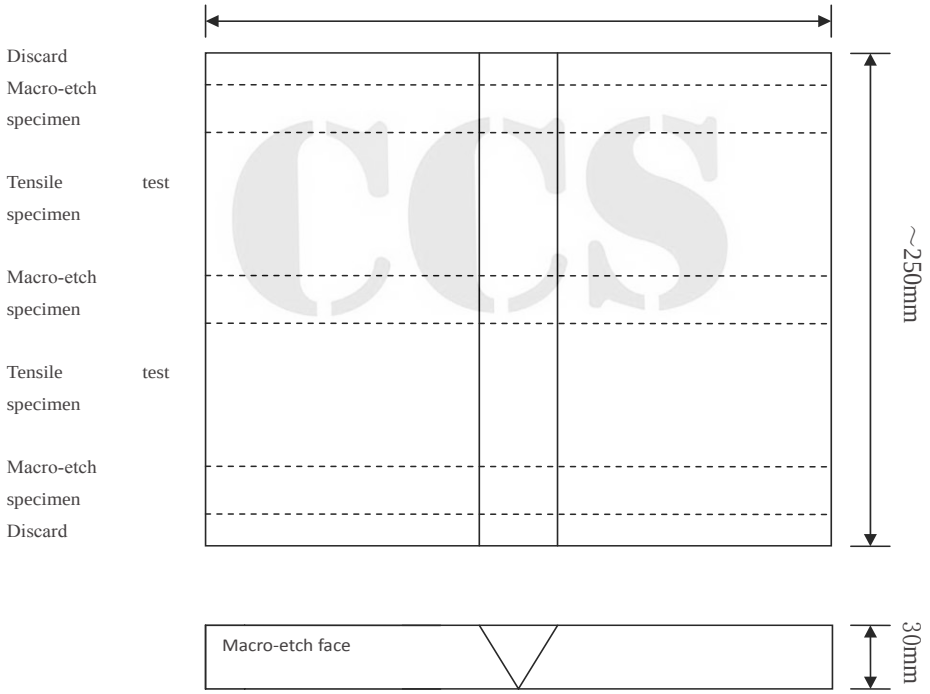
(2) To prevent crack, Cu3 is not to work within 300℃ -500℃ , while Cu4 is not to work within 260℃ -480℃ or be disposed at 350℃ -565℃ for a long time.

Where defects exist in typical samples and weld repair is feasible, the weld repair and stress relief heat treatment for specific defects are to be deemed as type test items. Where the welding quality is found unsatisfactory (such as cracks or openings with size over 3 mm) in the test, the test fails. The inspection of weld repair is to be carried out in accordance with 8.4.8, Section 4, Chapter 8, PART THREE of CCS Rules for Materials and Welding.

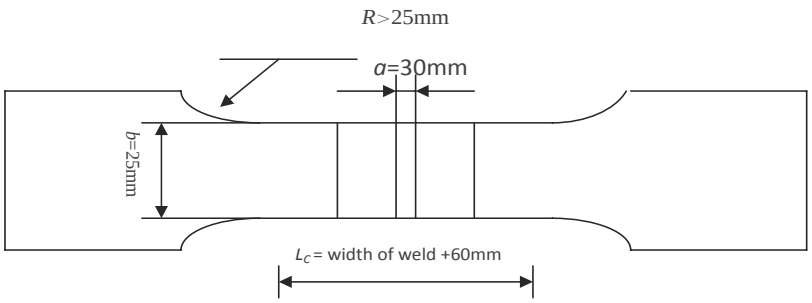
10.9 Assessment of welding procedure

The welding procedure for copper alloy propeller is to be subject to approval by CCS. The approval is a general approval according to different materials, welding method, welding position, welding grooves, preheating and welding conditions (including stress relief heat treatment). The approval is essential for the propeller manufacturer. The approval is not for specific defects of specific propeller, but for butt weld test specimen to check technical conditions of the manufacturer.

The test specimens for approval are down-hand and butt-weld specimens, as shown in the following figure:



The preparation of tensile test specimen is as shown in the following figure.



The tensile strength of two test specimens is to comply with the requirements in the following Table:

Alloy type	Tensile strength（minimum）N/mm^2
Cu1	370
Cu2	410
Cu3	500
Cu4	550

Macro-etching: The corrosive liquid for the three macro-etch specimens are to be prepared according to the following proportion:

Ferric trichloride 5 g
Hydrochloric acid 30 ml
Water 100 ml

The macro-etch specimens are to be free from cracks or blowholes exceeding 3 mm.

Non-destructive test: after welding, the welded area is to be subject to dye penetrate and radiographic testing. No cracks or open voids exceeding 3mm are permitted in dye penetrate test. Radiographic test is to be carried out referring to the standard on class II of aluminum pressure vessels in JB 4730-2005. This regulation is not to exclude the adoption of subsequent national or industry standards on ultrasonic testing and radiographic testing.

Welding procedure: in the development of welding procedure, Table 1 and Table 2 may be used as a guidance to select consumables and determine pre-heating temperature, interpass temperature, post-weld heat treatment temperature and time.

10.10 Unit/batch inspection

10.10.1 Each propeller and its components are to be subject to test in accordance with CCS Rules. The following tests are to comply with the requirements of CCS Rules for Materials and Welding and the drawings approved by CCS: chemical composition, matrix structure, mechanical properties, appearance (including surface roughness), size, dimensional tolerance, NDT, static balancing, dynamic balancing (if applicable), pressure (if applicable) and weighing, among which, size, dimensional tolerance, static balancing, dynamic balancing (if applicable), and pressure (if applicable) tests are to be carried out in accordance with 10.8(4), (6), (7), (8) and (9) of this Chapter. The chemical composition and matrix structure may be submitted by the manufacturer to the Surveyor for review. The weighing test in type test of works approval or for the first propeller product may be witnessed by the Surveyor as he requires. The NDT of zone A of propeller is to be in the presence of the Surveyor. For NDT of zones B and C, the manufacturer may submit test report to the Surveyor for review. The remaining items are to be carried out in the presence of the Surveyor. For build-up propellers, static balancing test is to be carried out as much as possible after assembly. For build-up propellers with hydraulic fluid cylinders, the test pressure is to be 1.5 times the working pressure in approved drawings and a tightness test is to be carried out after installation onboard ships with 1.25 times the working pressure.

10.10.2 After inspection, the manufacturer is to submit quality certificate to the Surveyor for review and as a basis for issue of a certificate of products. The quality certificate is to contain:

(1) name of the purchaser and order number;

(2) vessel identification (if known);

(3) drawing number of propeller;

(4) diameter, number of blades, pitch, direction of turning;

(5) heat number, alloy type and chemical composition;

(6) cast number;

(7) final mass;

(8) NDT methods and result;

(9) proportion of α phase (only applicable to Cu1 and Cu2);

(10) results of the mechanical tests

(11) castings number;

(12) skew angle for high skew propellers;

(13) angle of rake;

(14) static balancing test report;

(15) dynamic balancing test report (if applicable);

(16) pressure test report (if applicable);

(17) measurement report.

10.10.3 Identification and certification

After survey, each propeller and its components are to be marked by the manufacturer with the following items. For solid propeller, the items are to be marked on the turning face near the small end face of boss and between the two blades.

(1) grade of cast material or corresponding abbreviated designation;

(2) identification of the manufacturer;

(3) heat number, casting number or other marking which will enable the full history of the casting to be traced;

(4) date of final inspection;

(5) CCS certificate number;

(6) ice class notation, if applicable;

(7) skew angle for high skew propellers;

(8) CCS stamp for accepted castings;

(9) mass;

(10) for build-up propellers, in addition to the above items on the surface of the boss, the fillet area of blades are to be marked with serial number of blades and spare blades are to be marked with "BY". Two digits are to be marked on the end face of blade anchor nut and bolt, the first number being that for blade and the second that for nut or bolt.

CHAPTER 11 MOORING CHAINS AND ACCESSORIES FOR POSITIONING OF OFFSHORE INSTALLATIONS

11.1 Application

11.1.1 This Chapter is applicable to the products of mooring chains and accessories for the positioning of mobile offshore units, mooring of floating production units, mooring of offshore loading systems and mooring of gravity based structures, including common links, connecting common links, enlarged links, end links, Kenter shackles, swivels, swivel shackles, excluding studless mooring chains. Depending on the nominal tensile strength, chains are to be divided into five grades, i.e., OM3, OM3S, OM4, OM4S and OM5.

11.1.2 This Chapter is applicable to works approval and inspection of the above products.

11.2 Basis for approval and inspection

11.2.1 The requirements in Section 3, Chapter 10, PART ONE of CCS Rules for Materials and Welding.

11.3 Terms and definitions

11.3.1 For the purpose of this Chapter, the terms and definitions given in CCS Rules for Materials and Welding apply.

11.3.2 The term “mooring chains and accessories for positioning of offshore installations” are hereinafter referred to as “mooring chains and accessories”.

11.4 Plans and documents

11.4.1 A manufacturer intending for works approval of mooring chains and accessories is to submit the following documents to CCS.

11.4.2 The following documents are to be submitted to CCS for information:

(1) Documents as required in 3.2.1, PART ONE of the Guidelines.

(2) Source of raw materials: information on the manufacturer and its approval.

(3) Production, inspection and test equipment: name/purpose, specification and capacity of chains manufacturing equipment, proof-load testing machines, forging equipment, mechanical properties and NDT equipment, together with copies of calibration certificates of the equipment.

(4) Manufacturing process: flow chart of manufacturing from the materials to the final products of mooring chains and accessories (including connecting common links), with main process and corresponding inspection points indicated, and the following details are to be provided:

- bar heating and bending including method, temperatures, temperature control and recording;
- flash butt welding, including current, force, time and dimensional variables as well as control and recording of parameters;
- burr removal, including method and inspection;
- stud insertion, including method and impression, plastic yielding after heating, measurements and recording of impression;

- heat treatment, including furnace types, means of specifying, controlling and recording of temperature, and chain speed and allowable limits, quenching bath and agitation;
- proof and break 1oading tests, including method and equipment, means of horizontal support (if applicable), method of measurement, recording;
- NDT procedure, including method, equipment, standard, and qualification of operators.

11.4.3 The following documents are to be submitted to CCS for approval:

(1) drawings giving detailed design of chains and accessories, including drawings showing the detailed design of the stud;

(2) design drawings of connecting common links;

(3) the type test program.

11.5 Approval of chain manufacturer and steelmaker

11.5.1 An approval of chain manufacturer is only restricted to a single manufacturer and to one type and grade of chains made of materials from a designated or approved steelmaker. Where the materials are supplied by more than one steelmaker and used to make different types and grades of chains, the approval tests are to be carried out respectively.

11.6 Design and technical requirements

11.6.1 The requirements are given in the following Table.

Number	Content	Requirements in CCS Rules for Materials and Welding	Remark
1	Steel for welded chain cables	10.3.3	
2	Forged steel	10.3.3	
3	Materials for studs	10.3.3	
4	Shape and dimension of chains	10.3.4 10.3.8	
5	Manufacture of chains	10.3.5	
6	Mechanical properties	10.3.8	
7	Proof and break tests	10.3.8	
8	Welding of studs	10.3.6 10.3.4	
9	Connecting common links	10.3.5.3 10.3.7	
10	Non-destructive examination	10.3.8.10 10.3.8.11	
11	Testing and inspection of chains	10.3.8 10.3.9 10.3.11	
12	Testing and inspection of accessories	10.3.11	
13	Marking	10.3.10	

11.7 Selection of typical samples

11.7.1 The largest product with maximum diameter is to be selected for each grade of chain cables or accessories for approval. The approval of enlarged links and end links are to be in accordance with the test items and requirements for links. The chain cables tested are to have adequate number of links for the items in the table.

11.7.2 In an initial approval, the capacity of different units to manufacture chains of maximum diameter is to be verified.

11.7.3 The added items, change and renewal of the works approval certificate are in principle to be in accordance with the requirements for the initial approval.

11.7.4 The test items for connecting common links are the same as those for links.

11.8 Type test

11.8.1 The test items and requirements are given in Table 11.8.1.

Table 11.8.1

No.	Test items	Test requirements (corresponding paragraphs from CCS Rules for Materials and Welding)	Links	Accessories	Remark
1	Chemical composition	10.3.3	√	√	Materials for links and accessories
2	Tensile test	10.3.8.8	√	—	
		10.3.11 Specimens of swivels to be taken on the body and pin respectively.	—	√	
3	Impact test	10.3.8.8 Test temperatures to be -40 ℃ , -20 ℃ and 0 ℃ respectively	√	—	The value at -40℃ for reference only
		10.3.11 Specimens of swivels to be taken on the body and pin respectively	—	√	
4	Break load test	10.3.8.5 (links)，10.3.11 (accessories)	√	√	
5	Proof load test	10.3.8.5 (links)，10.3.111 (accessories)	√	√	
6	Magnetic particles test	10.3.8.10 (links) 10.3.11.11 (accessories)	√	√	
7	Ultrasonic test	10.3.8.11	√	—	
8	Stud weld examination	10.3.6	√	—	
9	Dimensions	10.3.4 10.3.8 (links) 10.3.11.6 (accessories)	√	√	
10	Visual examination	10.3.8.3 (links)，10.3.11.2 (accessories)	√	√	
11	Stud impression examination	Specimen to be the section at the centerline of links, the depth of impression and radius of corner are to be measured, recorded and photographed	√	—	Applicable to stud chain cables

No.	Test items	Test requirements (corresponding paragraphs from CCS Rules for Materials and Welding)	Links	Accessories	Remark
12	Micro-examination	Three micro-specimens to be taken to show flash weld, the impression corner and parent materials respectively. Corrosion of micro-specimens to be photographed (×100 magnification and ×500 magnification)	√	—	
		Three micro-specimens to be taken on the surface, at the center and 1/3r to the surface of the accessories. Specimens of swivels to be taken on the body and pin respectively. Corrosion of micro-specimens is to be photographed (×100 magnification and ×500 magnification)	—	√	
13	Macro-examination	Two macro-specimens, one of which is longitudinal section of links to show flash weld side stud impression area and two crown cross sections, the other is section at the centerline of links to show flash weld, stud impression depth and corner radius and stud weld (if applicable). Corrosion of macro section to be photographed (×1magnification). Impression area (×10 magnification) to be examined and free from cracks, laps or other defects	√	—	Macro-examination may be exempted where the compression ratio is not less than 7:1
		The macro-specimens to be cross sections of accessories. Corrosion of macro section to be photographed (×1magnification) and free from cracks, laps or other defects	—	√	
14	Hardness test	Vickers or Rockwell hardness tester to be adopted to measure hardness distribution through diameter. The maximum space between two measuring points to be 2.5mm. The distribution diagram to be submitted	√	√	
15	Crack tip opening displacement (CTOD)	8 links to be selected for test. The CTOD specimens and impact test specimens to be taken from the 8 links. The CTOD specimen to be standard 2×1 specimen with one open side. Where the diameter of chain cable is less than 120mm, the minimum dimension of specimen is 50×25mm. Where the diameter of chain cable is over 120mm, the minimum dimension of specimen is 80×40mm. Two test samples to be taken at 1/3r on the surface of each link, one from non-welded area (opposite to the flash weld), the other from flash weld area with crack tip precisely on the weld. The value of CTOD not to be less than that specified in 11.8.2 of this Chapter. The test temperature to be -20℃	√	—	
16	Assessment of welding procedure	The welding procedure of studs to be assessed	√	—	At discretion of CCS
Note: "√" indicates "applicable"; " — " indicates "not applicable".					

11.8.2 Specified value of CTOD

Grade/Place	OM3		OM3S		OM4		OM4S&OM5	
	link back	weld	link back	weld	link back	weld	link back	weld
With stud link	0.20mm	0.10mm	0.22mm	0.11mm	0.24mm	0.12mm	0.26mm	0.13mm
Without stud link	0.20mm	0.14mm	0.22mm	0.15mm	0.24mm	0.16mm	0.26mm	0.17mm

11.9 Unit/batch inspection

11.9.1 The test items and requirements are given in Table 11.9.1.

Table 11.9.1

No.	Test items	Test requirements (corresponding paragraphs from CCS Rules for Materials and Welding)		Remark
		links	accessories	
1	Mechanical properties test (tensile and impact tests)	10.3.8.8	10.3.11	
2	Break load test	10.3.8.5	10.3.11	
3	Proof load test	10.3.8.5	10.3.11	
4	Magnetic particles test	10.3.8.10	10.3.11.11	
5	Ultrasonic test	10.3.8.11	———	
6	Stud weld examination	10.3.6	———	
7	Dimensions	10.3.4 10.3.8	10.3.11.6	
8	Visual examination	10.3.8.3	10.3.11.2	

11.9.2 The relevant records or reports submitted by the manufacturer is to contain the materials certificate, mechanical property test, breaking test, proof-load test, non-destructive test, stud weld examination, dimensions, external quality, heat treatment, photograph, non-conforming links, repairs, number and location of connecting common links.

CHAPTER 12 STEEL WIRE ROPES

12.1 Application

12.1.1 This Chapter is applicable to works approval and inspection of steel wire ropes manufactured in accordance with the requirements of CCS Rules for Materials and Welding.

12.1.2 This Chapter is applicable to wire ropes in carbon steel intended for mooring lines, towlines, stream wires and lifting appliances of ships and offshore installations. For low-alloy and alloy steel wire ropes, reference may be made to this Chapter.

12.1.3 Steel wire ropes (galvanized, plain) intended for ships and offshore installations are to be subject to works approval by CCS.

12.1.4 The supplier of completed steel wires is to obtain works approval by CCS.

12.2 Basis for approval and inspection

12.2.1 CCS Rules for Materials and Welding;

12.2.2 Relevant national and international standards.

12.3 Test method and standard

12.3.1 For steel wires before stranding or steel wires after unstranding for test, the tensile strength, twisting, repeated bending, knotting, drawing, wrapping and mass of coating are to comply with the requirements in Section 4, Chapter 10, PART ONE of CCS Rules for Materials and Welding and other relevant requirements.

12.3.2 Breaking test methods and requirements for steel wire ropes are to comply with the relevant recognized standards. Where the summation of the breaking load of individual wires is accepted as the breaking load of the rope, a conversion factor in recognized standards is to be applied.

12.4 Plans and documents

12.4.1 The following documents are to be submitted to CCS for information.

(1) Particulars of the manufacturer: the name, address and history, production capacity, type and specification of the products, qualification of the personnel.

Details of products: approved range of diameter for steel wires and wire ropes, the construction of wire ropes, grade of strength, grade of coating.

Source of raw materials: name of the manufacturer of wire rod or completed wires, delivery condition, type and specification, grade of material or designation, approval by CCS.

Particulars of main production equipment, inspection and test equipment: name, type, manufacturer, manufacturing date, capacity, condition, quantity, calibration, model to be indicated.

Quality statistical analysis of products: quality statistical analysis and properties analysis of wires and wire ropes in recent years.

(2) Quality management and control documents: organizational structure, quality control points, responsibilities of the management departments and relationship in-between, quality system documents, quality manual, quality management-related procedural documents, operation guidance.

(3) Production technology: flow chart of production, internal control criteria of the manufacturer, operation procedures and operation guidance, mainly including:

- drawing, details of drawing equipment, pass design, size of each drawing pass;
- heat treatment, the type of furnace, parameters, dimension, temperature control, treatment system;
- galvanizing, kinds, equipment type, treatment capacity, temperature control, pre- and post-treatment, quality of zinc ingots;
- stranding (including fiber core);
- rope manufacturing.

12.4.2 The type test program is to be submitted to CCS for approval.

The program may be proposed by the applicant and confirmed and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to contain:

(1) the range of diameter of wire ropes and wires for approval, coating, construction, grade of strength;

(2) the typical samples selected for approval;

(3) place of test, laboratory, and the qualification of personnel.

12.5 Selection of typical samples

12.5.1 The selection requirements are to take into consideration the coverage of the range of diameter of wires and wire ropes, construction, grade of strength and coating.

12.5.2 In an initial approval, products with minimum steel wire diameter and 80% maximum wire rope diameter within product approval range and representative on such manufacturing process as construction, strength level and zinc coating thickness are to be selected.

12.6 Type test

The test items and requirements are to contain:

12.6.1 Chemical composition analysis: C, Si, Mn, P, S, Cr, Ni, Mo, Cu and Als to be analyzed. For low-alloy or alloy steels, relevant and added elements are to be analyzed.

12.6.2 Test items for steel wire, including:

(1) tensile strength: tensile strength to be tested for wires before stranding and wires after unstranding;

(2) twisting: the maximum twisting speed and minimum number of twists of the test machine to be in accordance with the rules requirements and relevant national standards;

(3) repeated bending: to be in accordance with the relevant national standards;

(4) knotting and drawing: may be used in lieu of bending and twisting for wires with diameter less than 0.5 mm;

(5) metallographic examination: wires after heat treatment to be tested to examine the decarburized depth and grain size;

(6) wrapping test: to be tested for galvanized wires. The diameter of cylindrical mandrel is to be selected depending on the grade of coating and diameter of wires in accordance with relevant standards;

(7) mass of zinc coating: to be tested for galvanized wires, and in accordance with the standards acceptable to CCS or other recognized standards.

12.6.3 Breaking test of wires. The test is to be made on completed ropes. Where the test is on unstranded wires (completely unstranded in an initial approval), the summation of the tests of individual wires is calculated, then a conversion factor of equivalent construction is applied to the calculated breaking load.

12.6.4 Visual and dimensional examination. The examination is to be carried out for wires and wire ropes respectively, including:

(1) for wires: diameter, roundness, drawing cracks, split layers, scabs, drawing stamps, dent, laps, rust spots, ring, pock mark, zinc deficiency, zinc accumulation, in which no defects such as drawing cracks, split layers, scabs, drawing stamps, laps and rust spots are permitted, while the others are to be accepted according to the relevant standards;

(2) for wires ropes: construction, stranding methods, diameter, wire arrangement, fracture, short of wire, transposition, irregular joining, slack of wire in strand, untwisting of wires in strand, variation in pitch, untwisting of strands, waviness, kinking, discovery of fiber core, irregular greasing, corrosion, in which no defects such as fracture, short of wire, untwisting of strands, waviness, kinking, corrosion are permitted, while the others are to be accepted according to the relevant standards.

12.6.5 Anti-rotating performance test: approved steel wire rope products include non-rotating steel wire ropes whose construction is to comply with standards accepted by CCS or recognized standards. Representative products are to be selected for anti-rotating performance test. Anti-rotating performance test is to be carried out for three-strand or four-strand non-rotating steel wire ropes designed by the manufacturers. Test methods are to comply with standards accepted by CCS or recognized standards.

12.7 Unit/batch inspection

12.7.1 After works approval by CCS, the marine steel wires as manufactured according to the approved conditions (including equipment, process, etc.) are to be applied by the manufacturer for unit/batch inspection by CCS, which can be used onboard ships only after satisfactory inspection.

12.7.2 The detailed requirements for unit/batch inspection are to be notified in written form to the works when CCS issues a certificate of works approval.

12.7.3 The unit/batch inspection test is to be conducted according to the approved program. The test program is to contain the test items for witness, review and on-site examination. The items are to include:

(1) visual and dimensional examination;

(2) review of the result for chemical composition analysis;

(3) mechanical properties and technical properties test of wires;

(4) mass test of zinc coating of wires (only for galvanized wire ropes);

(5) test of breaking load of completed ropes or aggregate breaking load of individual wires.

12.7.4 After satisfactory inspection of product, CCS Surveyor is to seal on the end of wire or mark on the nameplate with CCS stamp and issue a certificate of marine product or endorse the manufacturer's quality certificate.

12.7.5 The quality certificate of the manufacturer is to contain at least the following particulars:

(1) name of the purchaser and order number;

(2) construction, grade of tensile strength, diameter, gross mass, net mass and length of the wire ropes;

(3) maximum and minimum number of twisting of wires, maximum and minimum value of tensile strength;

(4) minimum breaking load of wire ropes or the aggregate breaking load of individual wires;

(5) grade of coating for galvanized ropes;

(6) rope number or product number;

(7) anti-rotating performance test of steel wire ropes;

(8) space for stamp and endorsement by CCS Surveyor.

CHAPTER 13 STEEL PIPES AND TUBES

13.1 Application

13.1.1 This Chapter is applicable to the works approval and inspection of the seamless steel pipes and tubes, which are manufactured in accordance with the requirements of CCS Rules for Materials and Welding.

13.1.2 This Chapter is applicable to the manufacture of seamless pressure steel pipes of carbon and carbon-manganese steels, which are made of killed steel by rolling, expanding or drawing. Reference may also be made to in this Chapter for pipes of low-alloy steel, alloy steel or stainless steel pipes and tubes. This Chapter does not apply to welded steel pipes.

13.1.3 The classification of pressure piping systems is to comply with the requirements of CCS Rules for Classification of Sea-going Steel Ships.

13.2 Basis for approval and inspection

13.2.1 CCS Rules for Materials and Welding;

13.2.2 Relevant national standards or industry standards for grade of material or designation.

13.3 Test methods and requirements

13.3.1 The tensile, impact, bend, flattening, drift expanding, flanging, mechanical properties at elevated temperatures, hydraulic tests and intercrystalline corrosion test of stainless steel are to comply with the relevant requirements of CCS Rules for Materials and Welding.

13.3.2 Macrostructure, sulphur prints and metallographic examinations are to be in accordance with the relevant recognized standards.

13.3.3 Ultrasonic, magnetic flux leakage and magnetic particle examinations are to be in accordance with the recognized test methods and evaluation standards.

13.4 Plans and documents

13.4.1 The following documents are to be submitted to CCS for information:

13.4.1.1 Particulars of the manufacturer: name, address and history, design manufacturing capacity and actual annual manufacturing capacity; the type, specifications and delivery condition of the current products; qualification of the personnel; registered trademark and qualification certificates obtained.

13.4.1.2 Quality system documents

(1) Quality management documents, such as organizational structure, quality control points, responsibilities of the management departments / managers.

(2) Control documents, such as raw material purchase, production process and quality control.

13.4.1.3 Information on main production equipment, inspection and test equipment, including relevant technical parameters.

(1) Steelmaking, secondary refining and vacuum treatment equipment (if applicable), the specifications of the ingot or pipe billet manufactured.

(2) Heating equipment.

(3) Rolling, drift expanding and drawing equipment.

(4) Heat treatment equipment;

(5) Inspection and test equipment for chemical composition analysis and mechanical property, technological, metallographic, hydraulic tests and non-destructive test, and the information on calibration of the equipment.

13.4.1.4 Production process documents and flowchart, control standard, technological specifications and operation guidance, mainly including:

(1) steel-making and casting;

(2) heating or continuous casting or rolling;

(3) rolling;

(4) heat treatment;

(5) sampling and sample delivery;

(6) inspection and test.

13.4.1.5 Certified personnel and levels for special work, such as physico-chemical analysis or NDT.

13.4.2 The type test program is to be submitted to CCS for approval.

The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

(1) the type, specification and delivery condition of the products for approval;

(2) selection of typical samples for type test;

(3) the test items and the standard or rules adopted;

(4) type and number of test specimens and sampling position;

(5) place of test and qualification of the laboratory (if applicable, the qualification of the subcontractor and the agreement).

13.5 Selection of typical samples

13.5.1 The selection of typical samples in the program is to fully reflect the production capacity and quality control of the applicant. The largest products (the ratio of pipe outer diameter to wall thickness) manufactured by a certain type of rolling mill in boundary condition are to be selected for type test.

13.5.2 In the case of same composition and same delivery condition, a higher ratio (pipe diameter to wall thickness) may be adopted in lieu of a lower one, subject to agreement by CCS.

13.5.3 For continuous casting, the samples are to be taken from the top of pipe in the first ladle or the bottom of the pipe in the final ladle in any casting time, or from both top and bottom of the pipe in the first ladle in any casting time.

13.5.4 For mould casting, the samples are to be taken from the corresponding positions of the top and bottom respectively of the ingot with the maximum specification.

13.5.5 For ingot or billet approval, the steel is to be rolled into pipes to check and accept.

13.5.6 In principle, a representative product is to be selected for each grade, covering the types of rolling mill (cell type), and the edge products of each rolling mill are to be taken for test.

13.6 Type test

The test items and requirements are as follows.

(1) Chemical composition analysis

The analysis is to contain ladle sample analysis and finished product analysis: C, Si, Mn, P, S, Cr, Ni, Mo, Cu, V, Al for carbon and carbon-manganese steels, and relevant alloy elements and other added elements for low-alloy steel, alloy steel and stainless steel.

The carbon equivalent is to be calculated by the following formula:

$$C_{eq} = C + Mn/6 + (Cr + Mo + V)/5 + (Ni+Cu)/15$$

(2) Tensile test

Tensile strength, yield strength and elongation are to be determined by tensile test. For materials showing no yield limit, Rp0.2 is to be determined. The yield-tensile ratio is generally not to be greater than 85%.

Tensile specimens are generally to be of full-thickness flat ones. For thick wall, round specimens may be adopted, the diameter of which is to be as great as possible and to meet the dimensional requirements of proportional specimen.

(3) Charpy V-notch test

The specimens are generally presented for impact test in longitudinal direction. Where the external diameter and wall thickness of the tubes satisfy the requirements for sampling in transverse direction, additional impact test on a set in transverse direction may be considered, but not as a criterion for acceptance.

Charpy V-notch impact test is to determine the energy value, the percentage of crystalline fracture, and side expansion value, and a temperature-energy curve is to be drawn to determine brittle transition temperature.

Steel pipes with wall thickness less than 6 mm are free from impact test.

(4) Bend test

The test is to be carried out in accordance with the requirements of CCS Rules for Materials and Welding.

(5) Flattening test

The test is to be carried out in accordance with the requirements of CCS Rules for Materials and Welding.

(6) Flanging test and drift expanding test

The tests are to be carried out in accordance with the requirements of CCS Rules for Materials and Welding, and the acceptance criterion may be referred to relevant standards.

(7) Mechanical property test at elevated temperature

The test is to be carried out in accordance with the requirements of CCS Rules for Materials and Welding and relevant standards.

(8) Intercrystalline corrosion test of stainless steel

The test is to be carried out in accordance with the requirements of CCS Rules for Materials and Welding and relevant standards.

(9) Macrostructure examination

The examination is to be carried out on pipe billets.

(10) Sulphur prints test

The test is to be carried out on billets and finished pipes respectively.

(11) Metallographic examination

Microscopic examination (×100 and ×500 magnification) is to be carried out to measure actual grain size and nonmetallic intrusions.

(12) Hardness test

HV hardness test is to be carried out on specimens and finished pipes respectively. The finished pipes are to be tested at a quarter of the length to pipe end.

(13) Hydraulic test

The test is to be carried out in accordance with CCS rules, with the test pressure not exceeding 14.7 MPa. Subject to special approval by CCS, an eddy current test may be accepted in lieu of the hydraulic test. An ultrasonic test is not to be accepted in lieu of the hydraulic test.

(14) Non-destructive test

The test includes ultrasonic, eddy current, magnetic particle and magnetic flux leakage examination.

(15) Decarburization

For quenched and tempered steel pipes, both the internal and external surfaces are to be examined for decarburized depth.

(16) Visual and dimensional examination

- outside diameter and wall thickness;
- bending angle and roundness;
- length;
- edge preparation, beveling, included angle and root face;
- surface quality inspection. The internal and external surfaces of the pipes and tubes are to be free from defects such as cracks, laps, laminations, scabs, pinches and thick scale. In case of the foregoing defects, they are to be removed. The removal depth is not to exceed the allowable minus deviation. Thin scale not affecting surface inspection may be allowed.

13.7 Unit/batch inspection

13.7.1 After works approval by CCS, the marine steel pipes and tubes as manufactured according to the approved conditions (including equipment, process, etc.) are to be applied by the manufacturer for unit/batch inspection by CCS, which can be used onboard only after satisfactory inspection.

13.7.2 The detailed requirements for unit/batch inspection after approval are to be notified in written form to the works when CCS issues a certificate of works approval.

13.7.3 The test is to be conducted according to the approved program. The program is to contain the test items for witness, review and on-site examination. The items are to include:

(1) visual and dimensional examination: including diameter, wall thickness, bending angle, roundness, length, edge preparation and surface quality;

(2) review of the result for chemical composition analysis;

(3) Mechanical property test: including tensile, impact and hardness test;

(4) technical properties test: flattening, drift expanding, bending and flanging;

(5) hydraulic test;

(6) non-destructive test (if applicable).

13.8 Identification

After satisfactory inspection, the pipes and tubes are to be clearly marked by the manufacturer at one end (or both ends) with CCS stamp and the following:

(1) manufacturer's name and trade mark;

(2) specification of the pipe and grade of steel;

(3) cast number, batch number;

(4) abbreviation of phonetic alphabet of surveyor carrying out the inspection;

(5) date of inspection.

CCS stamps are to be encircled with paint for easy recognition.

13.9 Issue of certificate

13.9.1 After satisfactory inspection of products, CCS Surveyor is to issue a certificate of marine products or endorse the manufacturer's quality certificate.

13.9.2 The quality certificate of the manufacturer is to contain the following particulars:

(1) name of the purchaser and order number;

(2) steel grade, specification, pressure rating, purpose;

(3) cast number, batch number;

(4) chemical composition of ladle samples;

(5) results of mechanical and technical properties tests;

(6) results of macro and microscopic examination (if applicable);

(7) hydraulic test pressure and result;

(8) types of NDT and results;

(9) acceptance criteria (rules, standards, technical agreements, etc.);

(10) delivery condition;

(11) result of the intercrystalline corrosion test (if applicable);

(12) result of the mechanical property test at elevated temperature (if applicable);

(13) space for stamp and endorsement by CCS Surveyor.

13.9.3 The format of the manufacturer's quality certificate is to be approved by CCS.

CCS

CHAPTER 14 STEEL WIRE ROPE SLING

14.1 Application

14.1.1 This Chapter is applicable to the type approval and inspection of sling for steel wire ropes, and the end securing ways include aluminum alloy swaged ferrules, alloy or resin cast joints and inserted joints. Other securing ways may also be referred to in this Chapter.

14.1.2 Steel wire rope sling mentioned in this Chapter is used for lifting, mooring and towing of ships and offshore installations, other services such as hoisting in ports may be referred to in this Chapter.

14.2 Basis for approval and inspection

(1) CCS Rules for Classification of Sea-going Steel Ships;

(2) CCS Rules for Lifting Appliances of Ships and Offshore Installations;

(3) CCS Rules for Materials and Welding;

(4) Technical Regulations for Statutory Surveys of Lifting Appliances;

(5) Technical Regulations for Statutory Surveys of Towage at Sea;

(6) Relevant international or national standards.

14.3 Terms and definitions

14.3.1 Aluminum alloy swaged sling for steel wire rope means one end or both ends of the wire ropes are swaged into eye or ring shape (ring swaged sling) with aluminum alloy tube by mechanical means, including wire ropes, aluminum alloy swaged ferrules and the attachments such as rings, suspension lug, crane hook.

Inserted sling for steel wire rope means end of strand is inserted reversely to main body of steel wire rope to form a hole or ring at the end of steel wire rope.

Cast sling for steel wire rope means steel wire rope and sling joint (socket) are connected by alloy or resin casting. Cast sling for steel wire ropes is grouped into open type and closed type according to different cast sling joints (sockets).

14.3.2 Safe working load of the sling means the maximum load for which the sling has been designed and tested. This load is not to be less than the maximum load to which the sling will be subject when the lifting appliance is operating at its SWL.

14.4 Plans and documents

14.4.1 The applicant is to submit the following documents to CCS for information:

(1) particulars of the applicant, qualification documents and details of the products for approval, including the specification and the construction;

(2) particulars of main production equipment, inspection and test equipment and personnel qualification;

(3) main production technology and quality control documents.

14.4.2 The type test program is to be submitted to CCS for approval, which is to clearly state the products name, specification of specimens, test items, methods and technical requirements, development basis, test place, evaluation standards for non-conforming products.

14.5 Raw materials and parts

14.5.1 Steel wire ropes

Steel wire ropes are to comply with the requirements of Chapter 10, PART ONE of CCS Rules for Materials and Welding and standards accepted by CCS, and to be furnished with certificate of marine products by CCS or equivalent certificates. The construction and relevant technical parameters of steel wire ropes are to be the same as those in purchase technical agreements. Steel wire ropes generally adopt round strand wire ropes with tensile strength 1420MPa to 1960MPa.

14.5.2 Attachments such as crane hook, shackle and suspension lug

Attachments such as crane hook, shackle and suspension lug are to comply with the requirements of CCS Rules for Lifting Appliances of Ships and Offshore Installations and CCS relevant guidelines. Purchased attachments are to be furnished with certificate of products by CCS.

14.5.3 Aluminum alloy casing material of aluminum alloy swaged sling for steel wire ropes

Chemical composition and mechanical property of aluminum alloy casing are to comply with the requirements of recognized securing sling standards accepted by CCS. The specification and tolerance are to comply with relevant requirements of aluminum alloy swaged sling for steel wire ropes accepted by CCS. Series 5 aluminum and aluminum alloy heat-pressed seamless tube such as 5A02H112 is selected preferably.

The surface of aluminum alloy casing is to be smooth and free from burrs, cracks, mechanical damages and other significant defects. Seamless manufacturing process is applied for aluminum alloy casing. No shrinkage holes, cracks, laminations, slags, etc. are allowed for aluminum casing. Any doubts on the internal quality of aluminum casing by the surveyor, necessary non-destructive test may be required to carried out by the work.

14.5.4 Sockets of cast sling of steel wire ropes

Type and dimension: sockets of cast sling of steel wire ropes generally include open type and closed type. Other constructions are to be subject to special consent of CCS. The construction and dimension are to comply with the requirements of standards accepted by CCS.

Manufacturing: sockets may be manufactured by means of forging, casting or welding after hot formation of steel plates, and be subject to necessary heat treatment and mechanical processing. The manufacturing method of sockets is to be submitted to CCS during works approval.

Properties: chemical composition and mechanical properties of sockets are to comply with relevant requirements of CCS Rules for Lifting Appliances of Ships and Offshore Installations, CCS Rules for Materials and Welding and standards accepted by CCS on steel castings, steel forgings or welding construction.

Non-destructive test: sockets are to be subject to necessary non-destructive test after final heat treatment to verify whether there are internal defects such as shrinkage holes or cracks. Non-destructive test methods are to comply with the requirements of standards accepted by CCS.

Purchased sockets are to be furnished with certificate of products by CCS.

If sockets are subject to independent approval, material test and welding test (if any) are to be carried out according to CCS Rules for Materials and Welding and relevant socket standards accepted by CCS. Sockets are to be subject to proof test and breaking test during approval. When necessary, tools are to be made in accordance with the requirements of standards accepted by CCS to ensure smooth performance of proof test and breaking test.

14.6 Assessment of welding procedures (if any)

During welding of sockets of cast sling for steel wire ropes, the manufacturer is to assess welding procedures of main stressed parts and prepare welding procedure specifications according to relevant requirements of CCS Rules for Materials and Welding. Welding procedure specifications may be applied only after CCS approval.

14.7 Design and technical requirements of products

The design, manufacture, inspection and use of steel wire rope sling are to comply with the requirements of standards accepted by CCS.

Slings manufactured based on the requirements of ship design drawings or purchase technical agreements or beyond the range of standard specifications are to be subject to necessary strength assessment according to standards accepted by CCS. The drawings and technical documents are to be submitted to CCS for approval or information.

The manufacturer is to design the construction of slings based on the purpose of the products and users' requirements and calculate the safe working load. The calculated safe working load is not to be less than that required by users and that for lifting appliances, otherwise, the design is to be modified.

14.8 Selection of typical samples

In an initial approval, different products are to comply with following sampling principles:

(1) Aluminum alloy swaged sling for steel wire ropes: Products of each joint type are to be tested. During sampling, steel wire ropes with both maximum and another diameters for at least one construction is to be sampled for the type test respectively.

(2) Cast sling for steel wire ropes: manufacturing process (forging, casting and welding) of different sockets and casting material (alloy or resin) of cast sling for steel wire ropes applying for approval are to be tested respectively. During sampling, samples with maximum diameter of steel wire ropes applying for approval are to be selected for all type tests. For other types of products, typical specification may be selected for partial type test.

(3) Inserted sling for steel wire ropes. Products of each joint construction are to be tested. During sampling, steel wire rope with maximum diameter for at least one construction is to be sampled for all type tests. For other types of products, typical specification may be selected for partial type test.

14.8.2 For change (addition) of works approval, sampling of the additional part is to be carried out according to initial approval. When product specification (diameter range) is increased, only the maximum specification is selected for type test. For approval renewal, sampling specification and type test items may be decreased properly.

14.9 Type test

The manufacturer is to carry out type test according to the CCS relevant rules, standards accepted by CCS and relevant technical requirements. Main test items and requirements are as follows:

14.9.1 Tests of raw material and main components and parts

(1) Tests of raw material and main components and parts such as steel wire ropes, sockets and aluminum casing are to comply with relevant requirements on raw material and parts in 14.5 of this Chapter.

(2) Welding examination of sockets for cast sling for steel wire ropes (if welding is carried out). Prior to welding, edge and type examinations are to be carried out based on drawings. After welding, welds are to be subject to visual examination and welding records are to be checked. Major welding parts are to be subject to non-destructive test. Type and range of non-destructive tests depend on importance and load condition of components. Non-destructive test procedures are to comply with the requirements of standards accepted by CCS. Welding examination is to comply with relevant requirements of Section 6.5, Chapter 6 of CCS Rules for Lifting Appliances of Ships and Offshore Installations.

(3) Non-destructive test (if any): Sockets of cast sling for steel wire ropes are to be subject to non-destructive test, and the results are to comply with the requirements of standards accepted by CCS. During approval, non-destructive test methods (ultrasonic and magnetic particle) and procedure specifications are to be determined based on actual condition of products.

14.9.2 Visual and dimensional examination

The surfaces of ferrules of steel wire rope sling are to be smooth and free from cracks, flashes or burrs. Steel wire ropes are to be free from damage during manufacturing and proof test.

Items, methods and results of dimensional examination are to comply with the requirements of standards accepted by CCS and relevant technical documents.

14.9.3 Proof test (proof load test)

Loads of proof test are to comply with the requirements of standards accepted by CCS and relevant technical documents. In general, ferrules are subject to 2 times safe working load or 40% minimum theoretical breaking load of steel wire ropes (whichever is lesser) along the axial direction of rope for at least 5 minutes. Visual examination and dimensional measurement are to be carried out after unloading, and ferrules are to be free from visual defects such as slipping and cracks.

14.9.4 Vibration impact test

Swaged sling for steel wire ropes and inserted sling for steel wire ropes are to be subject to vibration impact test and the results are to comply with the requirements of recognized standards.

14.9.5 Static load test (static tensile test)

For samples of swaged sling for steel wire ropes which are subject to vibration impact test mentioned in 14.9.4, after vibration impact test, it is to slowly increase the test load to reach 90% of minimum breaking load of wire ropes. After unloading, it is to observe deformation and cracks and the results are to comply with the requirements of recognized standards.

14.9.6 Breaking test

During type test, sling for steel wire ropes is to be subject to breaking test to verify theoretical breaking load. Breaking test is to use samples after proof test. Breaking test force is to reach the requirements of theoretical breaking load stipulated in standards accepted by CCS. Breaking test may be unloaded at a certain period of time (30s) after the products are damaged or loaded to breaking force. The results are to comply with the requirements of recognized standards.

14.9.7 Test items and evaluation

Type test and delivery test items are given in Table 14.9.7. During approval, test is to be carried out based on the requirements of test program. If external dimension does not comply with requirements, the product can not be accepted. If other test results do not comply with requirements, it is to find reason. If tests fail due to test equipment or test methods other than product performance, specimens may be remade for test, otherwise re-test is to be carried out for double sampling. The test is to be deemed satisfactory only after compliance with requirements, otherwise this batch of products or this type test is to be deemed unsatisfactory.

Test items and requirements **Table 14.9.7**

No.	Test item	Type test	Unit/batch inspection
1	Raw material and parts examination	×	×
2	Visual and dimensional examination	×	×
3	Proof test	×	×
4	Vibration impact test (if any)	×	—
5	Static load test (if any)	×	—
6	Breaking test (if any)	×	×

Notes: × — Applicable; — — Not applicable.

14.10 Unit/batch inspection

14.10.1 After type approval by CCS, the ferrules for steel wire ropes as manufactured according to the approved conditions are to be applied by the manufacturer for unit/batch inspection by CCS.

14.10.2 The unit/batch inspection for products after approval is to be carried out according to the approved test program, and the test items are given in Table 14.9.7.

14.10.3 The test for unapproved products includes confirmation of technical process, on-site supervision or review of process record, and the test items are the same as those of type test. The inspection is to include the check of construction and sketches of the sling and strength assessment.

14.10.4 For proof test, 3% of the products of the same batch, ropes construction and strands specification are to be selected, or at least one product is selected. When breaking test is carried out according to the requirements of relevant technical regulations on inspection (e.g. Technical Regulations for Statutory Surveys of Towage at Sea) or purchase technical agreements, at least one specimen for each specification is to be made for test.

14.10.5 After satisfactory unit/batch inspection, CCS is to issue a certificate of marine products or equivalent certificates. The manufacturer is to submit product quality certificate for confirmation by CCS. The quality certificate is to contain at least following:

(1) manufacturer's name or identification;

(2) name or the purchaser;

(3) acceptance criteria (rules, standards, technical agreement, etc.)

(4) product name, number and quantity;

(5) diameter, construction and anti-rotating performance of steel wire ropes;

(6) specification, length, safe working load, proof load and theoretical breaking load of wire rope sling;

(7) test date, test condition and endorsement of relevant personnel;

(8) product name, number and specification of attachments of wire rope sling (if any);

(9) identification with related description.

14.10.6 The satisfactory sling for steel wire ropes or product nameplate is to be identified with:

(1) product number;

(2) construction, specification and safe working load of sling for steel wire ropes;

(3) permanent marks such as CCS stamp.

CHAPTER 15 STEEL PIPE FITTINGS

15.1 Application

This Chapter is applicable to the works approval and unit/batch inspection of steel pipe fittings intended for use in the ship's piping system. Reference may also be made to in this Chapter for steel pipe fittings intended for use in the piping system of offshore installations.

15.2 Basis for approval and inspection

15.2.1 CCS Rules for Classification of Sea-going Steel Ships;

15.2.2 CCS Rules for Materials and Welding.

15.3 Definitions

15.3.1 Steel pipe fittings mean the fittings made of steel for the use of pipe junction, such as bends, Tee joints, cross, reducing pipes, flanges, caps, laps, branch bedplates. The fittings may be of hot formed or cold formed steel sections or forgings, or welded by one or more casings that are hot formed or cold formed by steel plates.

15.4 Plans and documents

A manufacturer intending for works approval by CCS is to submit the following documents as required in this Chapter.

15.4.1 The following documents as required in 3.2.1, PART ONE of the Guidelines are to be submitted to CCS for information. A welding pipe fittings manufacturer required to obtain approval by CCS is to submit the welding procedure specifications to CCS, which include all the details for approval, such as the weld characteristic of pipe fittings, welding technical specifications, welding materials, welding procedure, heat treatment and weld inspection methods.

15.4.2 The documents to be submitted to CCS for approval include:

(1) the type test program;

15.5 Assessment of welding procedure

Assessment of welding procedure is to be carried out for welding pipe fittings manufacturers in accordance with requirements of CCS Rules for Materials and Welding.

15.6 Design and technical requirements

15.6.1 The requirements for approval of pipe fittings are to be determined in accordance with CCS rules or recognized standards.

15.6.2 Requirements for raw materials of pipe fittings

(1) The pipes and forgings used for making fittings are to be selected in accordance with the requirements in Chapters 4 and 5, PART ONE of CCS Rules for Materials and Welding; the steel plates and materials for making fittings are to be selected in accordance with the requirements in Chapter 3, PART ONE of CCS Rules for Materials and Welding or standards acceptable to CCS.

(2) Generally, the materials are to be adopted manufactured by the steel makers approved by CCS. Class I and II materials for fittings are to be inspected by CCS and class III materials are to be manufactured by the steel makers approved by CCS.

(3) Where the materials adopted for fittings are not manufactured by steel makers approved by CCS, the Surveyor is, in the approval test, to inspect the materials in accordance with the requirements in Chapters 3, 4 and 5, PART ONE of CCS Rules for Materials and Welding or standards acceptable to CCS.

(4) Generally, pipe flanges are to be made of forgings, while steel plates and sections are not recommended. Steel plates are to be only used for blind flange, lining blind flange, plate flanges, loose flanges with welding neck collar and loose flanges with welding-on collar. Casting materials only apply to integral flanges.

15.6.3 Requirements for heat treatment of pipe fittings

(1) All the materials for fittings are to be subject to heat treatment or hot working in accordance with CCS Rules for Materials and Welding or other recognized standards or material technical instructions.

(2) For ferritic steels required to be normalized and heat-formed, where heat forming operation can achieve the corresponding grain structure, the subsequent heat treatment may be exempted.

(3) Cold formed fittings are generally to be heat treated. If not, the maker is to demonstrate the required properties of the finished components are satisfied.

(4) For fittings welded by hot formed or cold formed components, the heat treatment methods are to be determined in the test of welding procedure approval.

15.6.4 Requirements for properties of fittings: all of the finished fittings are to have all the properties of the materials. For example, the permissible pressure of fittings made of seamless pipes is calculated according to the internal pressure of the straight section of the seamless pipes of the same materials.

15.6.5 Identification

All fittings which have been inspected with satisfactory are to be clearly marked on the surface as follows:

(1) manufacturer’s name or trade mark;

(2) specifications, including the nominal size and schedule of wall thickness;

(3) batch number;

(4) grade of material or designation and/or grade of steel;

(5) product code (according to actual manufacturing standards);

(6) standard number;

(7) CCS inspection marks.

Where the specification of fittings can not be fully marked, marks may be omitted according to the reverse order of the above items, or labels are to be taken for identification.

15.7 Selection of typical samples

15.7.1 The selection of typical samples is to be capable of representing and covering the types of product for approval.

15.7.2 It is not required for any combination of specifications, wall thickness and materials to be tested one by one. A representative fitting verified to be satisfactory is to represent the other fittings in the following range:

(1) Range of specifications: a test pipe fitting may be used to evaluate the qualification of DN 0.5~2 times the fittings with similar proportion. The proof test for non-reducing fittings may be used on the qualification evaluation of reducing fittings of the same type. The proof test for reducing fittings may be used on the qualification evaluation of reducing fittings of smaller specification.

(2) Range of thickness: a test pipe fitting may be used to evaluate the qualification of fitting design 0.5~3 times the ratio of t/D (t—nominal wall thickness of the fitting; D—nominal diameter).

(3) Grade of materials: the bearing pressure of the same geometrical dimension fittings made of steels of different grades is proportional to the tensile strength of the grades. Consequently, the test for a sample fitting made of a single grade of material or designation is sufficient to check the design of the fitting.

15.8 Type test

15.8.1 Type test items

15.8.1.1 The test items for fittings are as follows:

(1) visual examination;

(2) dimensional tolerance;

(3) chemical composition analysis;

(4) hardness test;

(5) tensile test;

(6) V-notch impact test (steels for low temperature service);

(7) metallographic examination;

(8) intercrystalline corrosion test (austenitic stainless steel);

(9) non-destructive test;

(10) pressure-tight test;

(11) bursting test;

(12) other test.

15.8.1.2 The type test items of fittings are different depending on different materials and uses. The items are to be determined subject to negotiation between CCS and the manufacturer according to specific requirements.

15.8.2 Test requirements

(1) Visual examination

The internal and external surfaces of all finished fittings are to be smooth and free from stains, cracks, over-heating, scabs, laminations, laps, mechanical drawings, dents which can impair strength and appearance.

(2) Dimensional tolerance

The geometrical and dimensional tolerances are to comply with the relevant requirements of recognized standards.

(3) Chemical composition analysis

The chemical composition of fittings are to be the same as that of the materials and comply with the requirements in Chapters 3, 4 and 5, PART ONE of CCS Rules for Materials and Welding and/or other recognized standards.

(4) Hardness test

The hardness value of fittings is to comply with the relevant requirements in recognized standards. In general, the differential of Brinell hardness value is to be within HB25 for the same fitting.

(5) Tensile test

① To prepare specimen, the pipe fittings manufacturer is to provide additional fittings or fittings with elongation; forged pipe fittings manufacturer may also provide the same batch of parental material with the same final heat treatment. Transverse or longitudinal specimens are to be taken for tensile test according to the geometrical shape of fittings.

② The preparation and means of test for the specimen in the tensile test are to be in accordance with the requirements in Chapter 2, PART ONE of CCS Rules for Materials and Welding. The test result is to be in accordance with the requirements in Chapters 3, 4 and 5, PART ONE of CCS Rules for Materials and Welding and/or recognized standards.

③ For fittings of DN 100 or smaller, tensile test may be exempted.

(6) V-notch impact test (steels for low temperature service)

① The requirements for sampling are referred to in 15.7.2 and 15.8.2(5).

② The test is only applicable to fittings with wall thickness ≥6 mm and geometrical shapes permissible for impact tests.

③ For fittings made of austenitic steel pipes and heat treated, if the design temperature intended is not less than -105℃, the test may be exempted subject to approval by CCS.

(7) Metallographic examination

The test methods and results are to comply with the requirements in recognized standards.

(8) Intercrystalline corrosion test (austenitic stainless steels)

Fittings made of austenitic stainless steel are to be subject to intercrystalline corrosion test. The test methods and results are to comply with the requirements in Section 7, Chapter 2, PART ONE of CCS Rules for Materials and Welding and/or recognized standards.

(9) Non-destructive test

The finished fittings are to be subject to non-destructive test in accordance with CCS recognized standard. Fittings of magnetic materials are to be subject to magnetic particle examination; fittings of austenitic stainless steel are to be subject to dye penetrant examination. Welds in fittings made of steel plates are to be subject to 100% radiographic examination. The result of non-destructive test is to comply with the relevant requirements of recognized standards.

(10) Pressure-tight test

For fittings manufactured and approved in accordance with the Guidelines, an independent pressure-tight test is not required. However all the fittings are to be capable of withstanding the same pressure for seamless steel tube of the same material, dimension and wall thickness, and free from any leakage or defects that may impair its property. The specific requirements may be referred to in 4.1.8, PART ONE of CCS Rules for Materials and Welding.

(11) Bursting test

① Bursting test is a destructive test intended for the demonstration of fittings design. Water and other suitable fluids are often used as media in bursting test. Bursting test is to be carried out in a competent test unit acceptable to CCS. The junction of fittings for bursting test and the determination for conformity of the bursting test are to comply with the requirements of manufacturing standard for different fittings.

② The bursting pressure load of fittings are to be calculated as appropriate to different fittings:

(i) for butt-welding seamless steel fittings and butt-welding fittings made of steel plates, the bursting pressure load is not to be less than 105% of the calculated P for welded straight section of the same wall thickness, specification and material:

$$P = 2R_mT/D \quad \text{MPa}$$

where: P — bursting pressure load calculated for straight section, in MPa;

R_m — the actual tensile strength of straight section material (measured from specimen of test pipe fittings), to meet the requirements of minimum tensile strength in the Rules or standards, in MPa;

T — the nominal wall thickness of steel straight pipe, in mm;

D — the outside diameter of steel straight pipe, in mm;

(ii) in works approval, fittings covering the range for approval (usually 90° elbow or Tee joints) are to be selected for bursting test;

(iii) in works approval, where the manufacturer can provide the qualified bursting test report by a competent unit acceptable to CCS (the period of time between the bursting test and approval is not to exceed 2 years), and the specification of the fitting meet the sampling requirements for works approval, the bursting test for the fittings of such materials may be exempted.

15.9 Unit/batch inspection

15.9.1 The fittings are to be manufactured in the works as approved by CCS. The unit/batch inspection items are to contain:

(1) visual examination;

(2) dimensional tolerance;

(3) chemical composition analysis;

(4) hardness test;

(5) tensile test;

(6) V-notch impact test (steels for low temperature service);

(7) non-destructive test;

(8) other items as required by the purchaser.

15.9.2 Requirements of materials test for sets and groups

(1) Fittings are to be divided into several groups as required for their mechanical property tests. The base number of test groups is to be in accordance with Table 15.9.2(1).

Test group **Table 15.9.2(1)**

***DN* (mm)**	**Base number of test group (piece)**
<100	⩽ 200
⩾ 100 ～ <200	⩽ 100
⩾ 200 ～ <350	⩽ 50
⩾ 350	⩽ 25

Notes:
① The test group in the table is applicable to 90° elbow.
② For the quantity of elbow of each group, if it is 180°, the base number is 1/2 of the tabled value and if 45°, the base number is twice the tabled value.
③ Reference may be made for other fittings.

(2) Hardness test is to be carried out with 10% minimum (but not less than 3 pieces); while the test for fittings of DN>200 are to be carried out with 100%.

(3) At least one specimen is to be subject to tensile test in one test group, unless the requirements of 15.8.2(5) are satisfied.

(4) V-notch impact test (steels for low temperature service): at least a set of specimen are to be subject to the impact test in one group, unless the requirements of 15.8.2(6) are satisfied.

CHAPTER 16 SACRIFICIAL ANODES

16.1 Application

16.1.1 This Chapter is applicable to inspection of marine sacrificial anodes.

16.2 Basis for inspection

(1) CCS Rules for Classification of Sea-going Steel Ships (hereinafter referred to as the Rules);

(2) GB/T4948 Sacrificial Anode of Al-Zn-In Series Alloy;

(3) GB/T4950 Sacrificial Anode of Zn-Al-Cd Alloy;

(4) GB/T17848 Test Methods for Electrochemical Properties of Sacrificial Anodes.

16.3 Terms and definitions

16.3.1 Sacrificial anode means the metal or alloy with negative electrode potential in electrolyte attached to metal structure with positive electrode potential. The metal or alloy protects the metal structure by the current from its continuous decomposition.

16.3.2 Theoretical current capacity means the electric quantity (A·h/kg) generated by sacrificial anodes of per unit mass calculated according to Coulomb Law.

16.3.3 Practical current capacity means the measured electric quantity (A·h/kg) generated by sacrificial anodes of per unit mass.

16.3.4 Current efficiency means percentage of actual capacitance to theoretical capacitance.

16.3.5 Reference electrode means the electrode with stable potential used to other potentials.

16.3.6 Open circuit potential means the natural corrosion unit of sacrificial anode (V) in electrolyte.

16.3.7 Working potential means the potential of sacrificial anode (V) short-circuit connected with cathode in electrolyte.

16.4 Plans and documents

16.4.1 The applicant intending for products inspection is to submit the following documents to CCS for approval:

(1) main characteristic particulars of products;

(2) a list of chemical composition of the main body of sacrificial anodes;

(3) the test program.

16.4.2 The applicant intending for products inspection is to submit the following documents to CCS for information:

(1) main acceptance criteria;

(2) main technological process.

16.5 Design and technical requirements

16.5.1 Technical requirements

16.5.1.1 Chemical composition: the chemical composition of sacrificial anodes is to comply with Table 16.5.1.1.

Zinc anode **Table 16.5.1.1(1)**

Chemical elements	Al	Cd	Maximum impurities				Zn
			Fe	Cu	Pb	Si	
Content, %	0.3 ～ 0.6	0.05 ～ 0.12	0.005	0.005	0.006	0.125	Residual

Aluminum anode **Table 16.5.1.1(2)**

Varieties	Chemical composition %										
	Zn	In	Cd	Sn	Mg	Si	Ti	Impurities, not greater than			Al
								Si	Fe	Cu	
Al-Zn-In-Cd Al1	2.5 ~ 4.5	0.018 ~ 0.050	0.005 ~ 0.020	-	-	-	-	0.10	0.15	0.01	Residual
Al-Zn-In-Sn Al2	2.2 ~ 5.2	0.020 ~ 0.045	-	0.018 ~ 0.035	-	-	-	0.10	0.15	0.01	Residual
Al-Zn-In-Si Al3	5.5 ~ 7.0	0.025 ~ 0.035	-	-	-	0.10 ~ 0.15	-	-	0.15	0.01	Residual
Al-Zn-In-Sn-Mg Al4	2.5 ~ 4.0	0.020 ~ 0.050	-	0.025 ~ 0.075	0.50 ~ 1.00	-	-	0.10	0.15	0.01	Residual
Al-Zn-In-Mg-Ti A21	4.0 ~ 7.0	0.020 ~ 0.050	-	-	0.50 ~ 1.50	-	0.01 ~ 0.08	0.10	0.15	0.01	Residual

Note: The chemical composition of sacrificial anodes may be adjusted at the user's request, however, the properties and quality are to comply with the requirements in the Guidelines.

16.5.1.2 The electrochemical properties of sacrificial anodes are to comply with Table 16.5.1.2.

Table 16.5.1.2

Anode material	Open circuit potential (V)	Working potential (V)	Actual capacitance (Ah/kg)	Current efficiency (%)	Dissolution
Zinc anode	-1.09 ～ -1.05	-1.05 ～ -1.00	≥ 780	≥ 95	Corrosion products are apt to shed; surface dissolution is even
Aluminium anode of type 1	-1.18 ～ -1.10	-1.12 ～ -1.05	≥ 2400	≥ 85	Corrosion products are apt to shed; surface dissolution is even
Aluminium anode of type 2	-1.18 ～ -1.10	-1.12 ～ -1.05	≥ 2600	≥ 90	Corrosion products are apt to shed; surface dissolution is even

Note: The medium is to be artificial seawater. The reference electrode is to be saturated calomel electrode. A11, A12, A13 and A14 are of type 1, while A21 is of type 2.

16.5.1.3 Anodes are to be fitted with iron core. In case of steel cores, they are to be so designed as to retain the anode even when the anode is wasted. Anodes are to be of typical design and sufficiently rigid to avoid resonance in the anode support.

16.5.1.4 The contact resistance between base and core of sacrificial anodes is not to be greater than 0.001Ω.

16.5.1.5 The working surface of the sacrificial anode is to be free from oxide skins, burrs, flashes or cracks with length exceeding 50 mm and depth exceeding 5 mm. The depth of shrinkage hole is to be less than 10% of the thickness of anodes and the depth is not to exceed 10 mm.

16.5.1.6 The working surface of the sacrificial anode is to be clean and free from paints or stains.

16.6 Selection of typical samples

16.6.1 The requirements for selection of typical samples: to prepare test specimens for each type of materials respectively.

16.6.2 The sacrificial anodes in the same materials and manufactured by the same process and within the same time frame (shift) are classified as a group.

16.6.3 Preparation for chemical composition analysis: three sacrificial anodes to be selected at random from a group, then more than 20g of debris from each of the three anodes to be taken.

16.7 Type test

16.7.1 The test items for sacrificial anodes are given in Table 16.7.1.

Table 16.7.1

Serial number	Test items	Basis for inspection
1	Visual examination	16.5.1.5 and 16.5.1.6 of this Chapter
2	Chemical analysis of finished products	16.5.1.1 of this Chapter
3	Electrochemical properties	16.5.1.2 of this Chapter
4	Contact resistance	16.5.1.4 of this Chapter

16.8 Unit/batch inspection

16.8.1 The detailed requirements for unit/batch inspection of sacrificial anodes are to be notified in written form to the works when CCS satisfies requirements for typical sample test (may be in the form of test program).

16.8.2 The unit/batch inspection is to be carried out according to the approved test program. The test program is to contain the test items for witness, review and on-site examination. The items are to include:

(1) visual examination: to comply with the requirements in 16.5.1.5 and 16.5.1.6 of this Chapter;

(2) chemical composition analysis: to comply with the requirements in 16.5.1.1 of this Chapter.

16.8.3 Record or report to be submitted by the manufacturer

16.8.3.1 Chemical composition analysis report.

16.8.3.2 Conditions of inspection, measurement and test in the works, and a list of inspection and test equipment, copies of valid calibration certificate.

PART THREE WELDING CONSUMABLES

CHAPTER 1 WELDING CONSUMABLES

1.1 Application

1.1.1 This Chapter applies to the works approval and unit/batch inspection of the following welding consumables such as electrodes, wires and fluxes intended for use in the welding of metallic structures of ships and relevant products.

(1) Electrodes for manual arc welding of structural steel

(2) Wire-flux combinations for submerged arc automatic welding for structural steel

(3) Wires and wire-gas combinations for semi-automatic and automatic welding of structural steel

(4) Consumables for use in electro-slag or electro-gas vertical welding of structural steel

(5) Consumables for use in one-side welding with temporary backing materials of structural steel

(6) Welding consumables for stainless steel

(7) Welding consumables for aluminum alloys

(8) Fluxes.

1.1.2 The manufacturer of welding consumables such as marine electrodes, wires and fluxes is to obtain works approval by CCS.

1.1.3 Wire rods and steel tapes for welding consumables are to be supplied by manufacturers recognized by CCS.

1.2 Basis for approval and inspection

1.2.1 CCS Rules for Materials and Welding.

1.3 Plans and documents

1.3.1 The manufacturer of welding consumables is to submit an application for approval, describing clearly the designation (each designation of wire-flux combinations for submerged arc welding; type of gas for gas shielded arc welding wires), specification, grade, level of hydrogen content (where applicable), applicable welding position, applicable welding current type and/or current polarity.

1.3.2 The following are to be submitted to CCS for information.

1.3.2.1 Source of raw materials and technical specification: list of suppliers (such as wire rods, steel tapes and mineral powder) and technical specification of raw materials, such as chemical composition and mechanical properties of wire rods and steel tapes, grain size, appearance, sampling and testing methods of mineral powder.

1.3.2.2 Information on main production, inspection and test equipment: name, purpose, type (specification), capacity and equipment supplier. The manufacturer is to have appropriate equipment and qualification for unit/batch inspection.

1.3.2.3 Production and inspection procedure, main technical documents (the coating type, formulation design documents, slag system).

1.3.2.4 Manufacturer's instructions:

(1) electrodes: designation (type), grade, purpose, chemical composition and mechanical properties of deposited metal, drying temperature before use, recommended welding parameters;

(2) wires (solid and flux-cored wires): designation (type), grade, purpose, chemical composition of wires (solid wires), chemical composition of deposited metal (flux-cored wires), mechanical properties of deposited metal, reference data (welding amperage, welding voltage), applicable gas components and gas flow, designation (type) of compatible flux;

(3) fluxes: designation (type), grade, purpose, type (melted, sintered), slag system, components, current, polarity, drying temperature before application.

1.3.3 The test program is to be submitted to CCS for approval.

1.3.3.1 The program may be proposed by the manufacturer and submitted to CCS for approval, or proposed by CCS and confirmed by the manufacturer in written form before execution.

1.3.3.2 The manufacturer is to clearly state the applicable welding positions of consumables. CCS is to state the approved welding positions in the certificate of works approval, for instance, down hand (F), horizontal (H), vertical upward (Vu), vertical downward (Vd) or overhead (O).

1.3.3.3 Development of test program

(1) electrodes: the test program is to be developed based on the designation (type), specification and approved grade of the electrodes for approval in accordance with Chapter 1 and Chapter 2 of PART ONE, Chapter 1 and Section 3, 8 and 9 in Chapter 2 of PART THREE of CCS Rules for Materials and Welding respectively;

(2) wires: the test program is to be developed based on the designation (type), specification and approved grade of the wires for approval in accordance with Chapter 1 and Chapter 2, PART ONE, and Chapter 1 and Section 4, 5, 6, 8 and 9 in Chapter 2, PART THREE of CCS Rules for Materials and Welding respectively;

(3) fluxes: the test program is to be developed in accordance with Chapter 1 and Chapter 2 of PART ONE, and Chapter 1 and Section 4 in Chapter 2 of PART THREE of CCS Rules for Materials and Welding.

1.4 Approval test

1.4.1 Place of test

1.4.1.1 The test samples are to be submitted to independent laboratory approved or recognized by CCS for complete or part test in the following circumstances:

(1) the initial approval for manufacturer;

(2) evaluation of the reliability of approval test for manufacturer in present conditions;

(3) the manufacturer doesn't have conditions for approval test;

(4) the Surveyor deems necessary.

1.4.1.2 In addition to the above, where the manufacturer has adequate inspection and test equipment to satisfy the requirements of CCS for effectiveness and accuracy of test result, and has qualified test personnel, the approval test may be carried out in the laboratory of the manufacturer with consent of CCS. In the test items, at least one item for routine (delivery) inspection of relevant consumables is to be carried out in the laboratory of the manufacturer.

1.4.2 Base material for test

1.4.2.1 For structural steel consumables, the manufacturer is to provide for approval the steel plate of grade specified in Section 1, Chapter 2 of PART THREE of CCS Rules for Materials and Welding. Selection of a toughness grade lower than that required in the Table may be allowed. The steel plate is to be satisfactorily inspected by CCS. Any grade of marine structural steel may be used for the preparation of deposited metal test assemblies made from the consumables for welding the structural steels. Replacement of plates is to be subject to approval by CCS.

1.4.2.2 The welding consumables for stainless steel plate are to be selected in accordance with the requirements in Section 8, Chapter 2, PART THREE of CCS Rules for Materials and Welding.

1.4.2.3 The welding consumables for aluminum alloy plate are to be selected in accordance with the requirements in Section 9, Chapter 2, PART THREE of CCS Rules for Materials and Welding.

1.4.2.4 In deposited metal test, where the strength or chemical composition of the base material used for approval is different from that of the consumables, transitional layers may be adopted on the prepared edges and surface of backing plates. The thickness of the layer is not to be less than 3 mm. The manufacturer is to submit test assembly diagram and dimension to CCS for approval.

1.4.3 Preparation of test assembly

1.4.3.1 The manufacturer is to develop a table indicating the number of test specimens, including designation (type), welding positions, specification and number. The number of test specimen is to be kept from welding of the assembly to finishing of the test specimen, otherwise, the test assembly is to be rejected and a new one is to be welded.

1.4.3.2 During approval tests, the preparation and testing of the test specimens are to be carried out in the presence of CCS Surveyor. It is recommended that NDT be carried out after welding of test assembly to ascertain that no defect exists in the welds which will affect the accuracy of the tests. After welding, test assemblies are not to be subject to any heat treatment, except the deposited metal longitudinal tensile test specimens. Heat treatment for hydrogen removal is not to be applied to the deposited metal longitudinal tensile test specimens of low hydrogen consumables.

1.4.3.3 The welding conditions such as amperage, voltage, traveling speed, etc. are to be within the range recommended by the manufacturers. In case of multi-run layers, the direction of deposition of each layer is to change from each end of the plate. The test in the welding of assembly is to be recorded for Surveyor to examine. Where some material is applicable to both alternating current and direct current, the alternating power supply is to be adopted in preparation of specimens.

1.4.3.4 The test assembly may be restrained or subject to initial distortion prior to welding to prevent angular distortion. Where the warping due to the welding exceeds an angular distortion of 5 degrees, the test assembly is to be discarded. The test assembly after welding is not to be subject to any straightening (hammered or flattened).

1.4.3.5 In preparing test assembly, the mark of CCS stamp is to be transferred in the presence of the Surveyor.

1.4.3.6 The prepared test assembly is to be in accordance with the relevant requirements in PART ONE and PART THREE of CCS Rules for Materials and Welding.

1.4.4 Test

1.4.4.1 The test equipment is to have calibration certificate within validity issued by statutory metrological agency.

1.4.4.2 The proportion of V-notch drawing for check of impact test specimens is to be not less than 50:1. The drawing is to be checked by statutory metrological agency and a calibration certificate is to be provided.

1.4.4.3 The tensile test, bend test, impact test, fillet weld fracture test, macro-examination and hardness tests in the manufacturer are to be carried out in the presence of the Surveyor. The preparation of hydrogen test specimens and the readings in the manufacturer are to be carried out in the presence of the Surveyor. The specification of the stainless steel specimen for corrosion test is to be examined by the Surveyor. The preparation of corrosive medium and the bending and flattening tests of the specimens are to be carried out in the presence of the Surveyor.

1.4.4.4 An analysis report of chemical composition of the deposited weld metal (including content of all significant alloy elements) is to be submitted by the manufacturer.

1.4.5 Approval test items and requirements

1.4.5.1 The number of electrodes for manual arc welding of structural steel is to comply with the requirements in 2.3.2, PART THREE of CCS Rules for Materials and Welding. Detailed test items and requirements are given in Table 1.4.5.1. The diameter of electrodes is to be selected in accordance with 2.3.3 and 2.3.4 respectively of PART THREE of CCS Rules for Materials and Welding. In general, two deposited metal test assemblies are to be prepared. One assembly is made with 4 mm diameter electrodes and the other with the largest size manufactured, if electrodes are available in one diameter only, one test assembly is sufficient. The selection of electrodes for down hand butt weld tests is as follows: first run with 4 mm diameter electrode, remaining runs (except the last two layers) with 5mm diameter electrodes. The runs of the last two layers with the largest diameter of the same type of electrode manufactured.

Test items and requirements for structural steel electrodes for manual arc welding Table 1.4.5.1

Serial No.	Test items	Content	Result
1	Deposited metal tests and chemical composition analysis	2.3.3 of PART THREE OF CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.2.2.3 of PART THREE of CCS Rules for Materials and Welding; chemical composition analysis is to comply with recognized standards
2	Butt weld tests	2.3.4 of PART THREE OF CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.2.2.3 of PART THREE of CCS Rules for Materials and Welding
3	Fillet weld tests	2.3.5 of PART THREE OF CCS Rules for Materials and Welding	In accordance with 2.3.5.3 of PART THREE of CCS Rules for Materials and Welding
4	Hydrogen test (if required)	2.3.6 of PART THREE OF CCS Rules for Materials and Welding	In accordance with Table 2.3.1.1 and Table 2.3.6.6 of PART THREE of CCS Rules for Materials and Welding

1.4.5.2 The quantities of test assembly for welding consumables for stainless steel are to comply with the requirements in Section 8, Chapter 2, PART THREE of CCS Rules for Materials and Welding. Detailed test items and requirements are given in Table 1.4.5.2.

Test items and requirements for welding consumables for stainless steel Table 1.4.5.2

Serial No.	Test items	Content	Result
1	Deposited metal tests and chemical composition analysis	2.8.3 of PART THREE OF CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.8.3.4 of PART THREE of CCS Rules for Materials and Welding; chemical composition analysis is to comply with recognized standards
2	Butt weld tests	2.8.4 of PART THREE OF CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.8.4.3 of PART THREE of CCS Rules for Materials and Welding
3	Fillet weld tests	2.3.5.3 of PART THREE OF CCS Rules for Materials and Welding	In accordance with 2.3.5.3 of PART THREE of CCS Rules for Materials and Welding
4	Measurement of ferrite content of deposited metal	2.8.3.5 of PART THREE OF CCS Rules for Materials and Welding	In accordance with 2.8.3.5 of PART THREE of CCS Rules for Materials and Welding
5	Intercrystalline corrosion test for butt joints	According to Section 7, Chapter 2, PART ONE of CCS Rules for Materials and Welding	

1.4.5.3 The quantities of test assembly for welding consumables for aluminum alloy are to comply with the requirements in Section 9, Chapter 2, PART THREE of CCS Rules for Materials and Welding. Detailed test items and requirements are given in Table 1.4.5.3.

Test items and requirements for welding consumables for aluminum alloy Table 1.4.5.3

Serial No.	Test items	Content	Result
1	An analysis of chemical composition of the deposited weld metal	2.9.3.2 of PART THREE OF CCS Rules for Materials and Welding	The report is to include content of all significant elements. The test results are not to exceed the limit values specified by the manufacturer
2	Butt weld test	2.9.3.4 of PART THREE OF CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.9.3.7 of PART THREE of CCS Rules for Materials and Welding

1.4.5.4 The quantities of test specimens for wire-flux combinations for submerged arc automatic welding are to comply with the requirements in Section 4, Chapter 2, PART THREE of CCS Rules for Materials and Welding. Detailed test items and requirements are given in Table 1.4.5.4.

Test items and requirements for wire-flux combinations for submerged arc automatic welding Table 1.4.5.4

Serial No.	Test items	Content	Result
1	deposited metal test for use with multi-run technique and chemical composition analysis	2.4.3 of PART THREE of CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.2.2.3 of PART THREE of CCS Rules for Materials and Welding; chemical composition analysis is to comply with recognized standards
2	Butt weld tests for use with multi-run technique	2.4.4 of PART THREE of CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.2.2.3 of PART THREE of CCS Rules for Materials and Welding
3	Butt weld tests for two-run technique	2.4.5 of PART THREE of CCS Rules for Materials and Welding	
4	Hydrogen test (if required)*	2.3.6 of PART THREE of CCS Rules for Materials and Welding	In accordance with Table 2.3.1.1 and Table 2.3.6.6 in Section 3, Chapter 2, PART THREE of CCS Rules for Materials and Welding

* Where welding consumables are intended to be used for high strength steel with a heat treatment of quenching and tempering and the yield stress of 420 N/mm^2 and above, a hydrogen test is to be carried out in accordance with the method approved by CCS.

1.4.5.5 The quantities of test specimens for wires and wire-gas combinations for semi-automatic and automatic welding is to comply with the requirements in Section 5, Chapter 2, PART THREE of CCS Rules for Materials and Welding. Detailed test items and requirements are given in Table 1.4.5.5.

Test items and requirements for wires and wire-gas combinations for semi-automatic and automatic welding **Table 1.4.5.5**

Serial No.	Test items	Content	Result
1	Deposited metal tests for semi-automatic multi-run technique and chemical composition analysis	2.5.3 of PART THREE of CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.2.2.3 of PART THREE of CCS Rules for Materials and Welding; chemical composition analysis is to comply with recognized standards
2	Deposited metal tests for automatic multi-run technique and chemical composition analysis	2.5.6 of PART THREE of CCS Rules for Materials and Welding	
3	Butt weld tests for semi-automatic multi-run welding	2.5.4 of PART THREE of CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.2.2.3 of PART THREE of CCS Rules for Materials and Welding
4	Butt weld tests for automatic multi-run technique	2.5.6 of PART THREE of CCS Rules for Materials and Welding	
5	Butt weld tests for two-run automatic welding	2.5.7 of PART THREE of CCS Rules for Materials and Welding	
6	Fillet weld tests for semi-automatic multi-run technique	2.5.5 of PART THREE of CCS Rules for Materials and Welding	In accordance with Table 2.3.5.3 of PART THREE of CCS Rules for Materials and Welding
7	Hydrogen test (if required)	Refer to 2.3.6 of PART THREE of CCS Rules for Materials and Welding	In accordance with Table 2.3.1.1 and Table 2.3.6.6 of PART THREE of CCS Rules for Materials and Welding

1.4.5.6 The quantities of test specimens for Consumables for use in electro-slag and electro-gas vertical welding is to comply with the requirements in Section 6, Chapter 2, PART THREE of CCS Rules for Materials and Welding. Detailed test items and requirements are given in Table 1.4.5.6.

Test items and requirements for consumables for use in electro-slag and electro-gas vertical welding **Table 1.4.5.6**

Serial No.	Test items	Content	Result
1	Butt weld tests	2.6.2 of PART THREE of CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.2.2.3 of PART THREE of CCS Rules for Materials and Welding

1.4.5.7 Test items and requirements for fluxes are given in Table 1.4.5.7(a).

Test items and requirements for fluxes **Table 1.4.5.7(a)**

Serial No.	Test items	Result
1	wire-flux combinations for submerged arc automatic welding and wire-flux combinations electro-slag welding	Mechanical properties of deposited metal for wires combined (CCS grade)
2	Grain size	Requirements in Table 1.4.5.7(b) to be satisfied
3	Content of water	$\leqslant$ 0.10%
4	Mechanical inclusion	$\leqslant$ 0.30%
5	Content of sulphur	$\leqslant$ 0.060%
6	Content of phosphorus	$\leqslant$ 0.080%

Requirements for grain size of fluxes **Table 1.4.5.7(b)**

Average size		Fine size	
< 0.450 mm (40 mesh)	$\leqslant$ 5%	< 0.280 mm (60 mesh)	$\leqslant$ 5%
> 2.50 mm (40 mesh)	$\leqslant$ 2%	> 2.00 mm (10 mesh)	$\leqslant$ 2%

1.4.5.8 The test items and requirements for consumables for use in one-side welding with temporary backing materials are given in Table 1.4.5.8.

Test items for consumables for use in one-side welding with temporary backing materials **Table 1.4.5.8**

Serial No.	Test items	Content	Result
1	Butt weld test for wire-gas combinations for use with semi-automatic multi-run techniques	2.7.2 of PART THREE of CCS Rules for Materials and Welding	Mechanical properties are to be in accordance with Table 2.2.2.3 of PART THREE of CCS Rules for Materials and Welding
2	Butt weld test for wire-flux combinations (or wire-gas combinations) for use with automatic multi-run techniques		
3	Butt weld test for manual arc electrodes		

1.4.6 In general, the welding consumables are to be subject to visual examination.

1.4.7 Approval test report

The works manufacturing the welding consumables are required to submit the approval test report to CCS, which contain the following items:

(1) test date, environmental conditions and pre-treatment of welding consumables;

(2) grade, trade mark or brand, type and dimension of the welding consumables;

(3) material designation, grade, mechanical properties and chemical compositions of test plates;

(4) welding position;

(5) welding parameters, the model of welding machines and composition of shielding gas;

(6) all test results;

(7) welding site records.

1.5 Unit/batch inspection

1.5.1 After obtaining works approval by CCS, the manufacturer is to apply for unit/batch inspection on the welding consumables for marine use manufactured according to the approved conditions (including equipment, process, etc.).

1.5.2 Unit/batch inspection is as follows:

Unit/batch inspection requirements **Table 1.5.2**

Serial No.	Name of consumables	Inspection items
1	Electrodes for manual arc welding of structural steel	(1) examination of quality certificate of wire rods (2) visual examination (3) confirmation of chemical composition of deposited metal (4) deposited metal test (5) additional deep penetration butt welding for electrodes for deep penetration welding in the downhand welding position
2	Wire-flux combinations for submerged arc automatic welding for structural steel	(1) examination of quality certificate of wire rods (2) visual examination (3) confirmation of chemical composition of deposited metal (4) deposited metal test (5) butt welding for wire-fluxes combinations for use only with two-run technique
3	Wires and wire-gas combinations for semi-automatic and automatic welding of structural steel	(1) examination of quality certificate of wire rods (2) visual examination (3) confirmation of chemical composition of deposited metal (4) deposited metal test (5) butt welding test for wires and wire-gas combinations for use with automatic two-run technique
4	Consumables for use in electro-slag and electro-gas vertical welding of structural steel	(1) examination of quality certificate of wire rods (2) visual examination (3) confirmation of chemical composition of deposited metal (4) butt weld test
5	Fluxes	(1) visual examination (2) examination of quality certificate of combined wires (3) deposited metal test

1.5.3 After satisfactory inspection of products, CCS Surveyor is to issue a certificate of marine products or endorse the manufacturer's quality certificate.

1.5.3.1 The quality certificate is to contain at least the purchaser, acceptance criteria, batch number, approved grade, specification, welding position, mass, quantity, chemical composition, mechanical properties, identification with related description. The space for stamp and endorsement by CCS Surveyor is to be reserved.

1.5.3.2 The format of the manufacturer's quality certificate is to be approved by CCS.

1.5.4 Package and identification

1.5.4.1 All the packages of approved consumables are to be clearly identified with:

(1) trade mark or brand;

(2) name or mark of manufacturer;

(3) approved grade of consumables (and combined consumables for submerged arc welding and gas-shielded welding);

(4) groups of shielding gases adopted;

(5) applicable welding current type and/or current polarity;

(6) applicable welding position;

(7) manufacturing date and batch number;

(8) drying temperature;

(9) Dimension (diameter of welding core, length of electrodes, grain size of fluxes for automatic submerged arc welding).

1.5.4.2 The welding consumables approved by CCS may be allowed to use the following dedicated logo according to the use license of CCS product approval logo, subject to the requirements given in 3.1.7 of PART 0 of CCS Rules for Materials and Welding.



Figure 1.5.4.2 CCS Works Approval Logo

PART FOUR NON-METALLIC MATERIALS

CHAPTER 1 PAINTS

1.1 Application

1.1.1 This Chapter applies to the works approval and inspection of paints intended for use in ships. For paints intended for use in offshore installations, reference may be made to this Chapter.

1.1.2 In this Chapter, the ship paints are classified, according to different positions and purposes used for ships, as marine shop primer, hull anti-corrosive paint, hull anti-fouling paint, anodic shield coating, marine anti-corrosive paint, marine waterline paint, hull paint, deck paint, marine cargo hold paint, internal compartment finish paint, marine drinking water tank paint, ship ballast tank coating, marine oil tank paint, engine room bilge coating, etc., with details in Table 1.1.2.

Classification and purpose of ship paint Table 1.1.2

Classification and name		Purposes
Marine shop primer		Applicable to coating for marine steel plates, sections and molding parts which have achieved the required grade after shot blasting, used for temporary protection of steel
Coating bellow ship's waterline	Hull anti-corrosive paint	Applicable to external surface below ship design waterline of various types of material, including hull waterline parts
	Hull anti-fouling paint	Applicable to external surface below ship design waterline of various types of material, including hull waterline parts
	Anodic shield coating	Applicable to auxiliary anodic shield coating of impressed current cathode protection system used for ships and offshore installations
Coating above ship's waterline	Marine anti-corrosive paint	Applicable to parts above design waterline of ship hulls and offshore platforms as well as internal structures (except tanks)
	Marine waterline paint	Applicable to the waterline paint of exterior shell between full-load and light-load waterlines, but not to the anti-fouling waterline paint
	Hull paint	Applicable to the construction exterior above full-load waterline, as well as to masts and cranes, etc.
	Deck paint	Applicable to the protection for steel surface of decks, docks and other offshore installations
	Marine cargo hold paint	Applicable to the protection for ship's dry cargo tank and inter-tank steel construction. Partially applicable to cargo tanks carrying bulk grain
	Internal compartment finish paint	Applicable to the internal exposed surfaces of engine room, superstructure and/or deck room
Coating of ship's tanks	Marine drinking water tank paint	Applicable t the internal surface of ship's water drink tank
	Ship ballast tank coating	Applicable to protection of internal surface of dedicated seawater ballast tanks in all types of ships and double-side skin spaces of bulk carriers
	Marine oil tank paint	Applicable to the internal surface of oil tank carrying petroleum hydrocarbon oil except for special types of oil like avgas, aviation kerosene
	Engine room bilge coating	Applicable to main engine, auxiliary engine and pump room bilge of ship

1.2 Basis for approval and inspection

(1) CCS Rules for Classification of Sea-going Steel Ships and Rules for Materials and Welding;

(2) IACS PR34 (2009.08 Rev.0 Corr.1) Procedural Requirement on Application of the IMO Performance Standard for Protective Coatings (PSPC), Resolution MSC.215(82), under IACS Common Structural Rules for Bulk Carriers and Oil Tankers;

(3) IMO 1974 International Convention for the Safety of Life at Sea and the amendments thereto;

(4) IMO International Convention on Control of Harmful Anti — fouling System (AFS) on Ships;

(5) IMO MSC.215(82) Performance Standard for Protective Coatings for Dedicated Seawater Ballast Tanks in All Types of Ships and Double-side Skin Spaces of Bulk Carriers, MSC.244(83) Performance Standard for Protective Coatings for Void Spaces on Bulk Carriers and Oil Tankers and MSC.288(87) Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers;

(6) IMO MEPC.102(48) Guidelines for Survey and Certification of Anti-fouling Systems on Ships, MEPC104(49) Guidelines for Brief Sampling of Anti-fouling Systems on Ships and MEPC.105(49) Guidelines for Inspection of Anti-fouling Systems on Ships;

(7) National standards and other standards acceptable to CCS.

Any changes of these above-mentioned standards, CCS will follow the latest provisions of the valid standards.

1.3 Terms and Definitions

(1) Paint means a general name for a type of liquid or solid materials coated on a surface to form a protective, decorative or especially functional (e.g. insulation, anticorrosion, indication, etc.) solid film.

(2) Primer coat is the first coat of the coating system applied in the shipyard after shop primer application.

(3) Marine shop primer is the prefabrication primer coating applied to steel plates, often in automatic plants.

(4) Coating means a continuous film obtained by one-time painting.

(5) Paint film means a continuous film formed by one or several layers of coating on substrate.

(6) Painting dressing means the procedure of applying paint on substrate surface to form a protective, decorative or especially functional coating, namely, painting coating.

1.4 Plans and documents

1.4.1 The applicant is to submit works approval application to CCS, which is to clearly state manufacturer, address, names, models, classification and purposes (to be listed for multi-purposes) and primary filming substances of products applying for approval, involved coating system plan. CCS provides the service for the whole coating system (except for marine shop primer).

1.4.2 The applicant is to submit the following documents to CCS for approval when submitting application:

(1) Particulars of manufacturer: the history and current situations, manufacturing history and adoption of relevant products, list of production equipment, list of test standards and equipment used, list of responsibility and qualification of main technicians and inspection personnel and trade mark;

(2) Technical conditions for delivery and acceptance/industry standards: technical requirements for products are to comply with the requirements of rules and standards accepted by CCS. If product performance is evaluated by test methods of other standards, it is to be agreed by CCS;

(3) Technical data sheet/products instructions: containing detailed technical instruction and information relevant to the coating and its application to guide users how to perform coating selection, painting and maintenance, at least including product name, identification mark and/or number; materials, components and composition of the coating system, colors; coating interval; minimum and maximum dry film thickness; application methods, tools and/or machines; condition of surface to be coated (de-rust grade, cleanness, profile, etc.) and environmental limitations (temperature and humidity);

(4) Approval test program: clearly stating name of product for approval, approval test items, relevant methods and requirements, technical standards, test location and treatment principle for unsatisfactory tests;

(5) Main raw materials: including names, models/specifications, methods of acceptances and source as well as names and address of suppliers of main raw materials;

(6) Main manufacturing techniques: manufacturing technical flow chart to indicate inspection/test control points during application of product approval;

(7) Quality assurance system documents: quality manual, list of test procedures and instructions and records, data of quality control (procedure) personnel, subcontract agreements;

(8) Material safe data sheet (MSDS);

(9) The manufacturer is to provide the active compositions and Chemical Abstract Service Registry (CAS registry) of anti-fouling paint and demonstration of not containing substances (such as organotin and DDT) forbidden by conventions for anti-fouling paint;

(10) Other relevant certificates: quality management system certificate, safe production license and asbestos free statement.

1.5 Technical requirements

1.5.1 Marine shop primer

1.5.1.1 The compositions of marine shop primer are neither to affect the subsequent welding quality, nor to bring about significantly harmful impact during the welding operation in future. They are to be adaptable to the paint or coating related to the structural anti-corrosive system applied subsequently, extensively compatible with the paint of next process and favorable re-coatability for worn painting film of long-term exposed shop primer. Shop primer includes prime with zinc power (type I) and prime without zinc power (type II).

1.5.1.2 Test items and result requirements of marine shop primer are as follows:

(1) drying time: according to the second method of GB/T1728 Surface Drying Measuring Time Method, surface drying not more than 5 min;

(2) adhesion: according to GB/T1720, not lower than Grade 2 ;

(3) film thickness: according to GB/T13452.2, thickness of film on steel plate in stream line is measured according to Appendix A.1 of GB/T6747. Shop primer with zinc powder 15 μm - 20 μm, shop primer without zinc powder 20 μm - 25 μm;

(4) metal zinc content in non-volatile composition (shop primer with zinc powder): in compliance with technical requirements for products;

(5) weather resistance: in accordance with GB/T9276, result evaluation in accordance with GB/T1766, satisfying following requirements:

Shop primer	Grade	Test condition	Acceptance requirements
Shop primer with zinc powder	I-12	Exposed to maritime climate for 12 months	Rust grade not higher than Grade 1
	I-6	Exposed to maritime climate for 6 months	
	I-3	Exposed to maritime climate for 3 months	
Shop primer without zinc powder	II	Exposed to maritime climate for 3 months	Rust grade not higher than Grade 1

(6) welding and cutting: test program may be prepared with reference to Appendix 1 "Welding and Cutting Tests of Marine Shop Primer" of the Guidelines. CCS will supervise the preparation of test plates, confirm test unit with welding quality and witness mechanical property test. The painting film is little impacted in area (heat affected zone) during welding, cutting and hot working fairing, with the cutting speed-down no more than 15%.

1.5.2 Hull anti-corrosive paint

1.5.2.1 Hull anti-corrosive paint system may be multi-run single anti-corrosive paint product, or be composed of anti-corrosive primer and anti-corrosive finish paint. According to period of validity, a complete hull anti-corrosive paint system is divided into grade I anti-corrosive period of validity, grade II anti-corrosive period of validity and grade III anti-corrosive period of validity.

1.5.2.2 Requirements for test items and results of hull anti-corrosive paint are as follows:

(1) Non-volatility: in accordance with GB/T9272 or under the condition of temperature 23℃ ±2℃, humidity 50%±5% and dryness for 7 days, volume in compliance with technical requirements for products;

(2) density: in accordance with GB/T6750 and in compliance with technical requirements for products;

(3) viscosity: in accordance with GB/T1723 or GB/T9269 or GB/T9751 or agreed methods and in compliance with technical requirements for products;

(4) flashing point: in accordance with GB/T5208 and in compliance with technical requirements for products;

(5) drying time: in accordance with GB/T1728, for surface drying, technical requirements for products; for hard drying, no more than 24h;

(6) adhesion: adhesion of hull anti-corrosive paint system and base material is in accordance with GB/T5210 and meets following requirements:

Hull anti-corrosive paint system	Period of validity	Adhesion
Grade I anti-corrosive period of validity	Not less than 5 years	Not less than 3MPa
Grade II anti-corrosive period of validity	Not less than 3 years but less than 5 years	
Grade III anti-corrosive period of validity	Less than 3 years	Not less than 2MPa (except for single-component solvent volatile asphalt system)

(7) immersion resistance: specimen with dimension 150mm x 300mm x 3mm and surface roughness Ra 40μm~80μm, plate preparation and test condition are in accordance with GB/T10834. Painted sample plates are submerged for 20 cycles (7 days for one cycle) (or till invalidity), coating conditions are recorded during each cycle. If after 20 cycles, coating conditions are good, then it is to wipe the surface gently with soft cloth and water and dry 48h under room temperature, after surface treatment, recoat is to be applied in way of 1/3 above center of one side of each specimen with a layer of finish paint of coating system (if applicable, a layer of primer and a layer of finish paint) and edge sealing is of 13mm. Condition treatment is for 7 days and then add 5 cycles for full-submerging test. On recoated side, it is deemed unsatisfactory if recoated adhesion is determined to be reduced to half of original coating adhesion. When anti-corrosive paint system is subject to submerging test, paint film is not to be damaged (except for paint film damage with adequate change of visual color and total area less than 1%), no pinhole rust spot and bubbling with diameter more than 1.5mm is allowed, adhesion of grade I and grade II anti-corrosive paint systems is not to be less than 3MPa, and adhesion of grade III anti-corrosive paint system (except for single-component solvent volatile asphalt system) is not to be less than 2MPa;

(8) bubbling resistance (applicable to bil-component anti-corrosive paint): plate preparation and salt solution are to be in accordance with GB/T10834, for the first cycle, test temperature is 88℃ ±3℃ and condition is kept for 14 days. It is to take out sample plate, wash and dry, and grind one side of each sample plate gently by manual with emery cloth (100#), then wash and dry again and apply a layer of finish paint, after 7 days' drying, second cycle of test is to be carried out. The sample plate is to be submerged to salt water or natural sea water at 38℃ ±2℃. It is to take out sample plate, examine and record bubbling degree (excluding edge inward 6mm). Anti-corrosive paint system is to be free from bubbling after hot salt water submerging test;

(9) resistance of cathodic peeling: in accordance with method B of GB/T7790, anti-corrosive paint system is to be commensurate with ship's cathode protection method. After test, the mean distance between peeled-off coating and external edge of artificial holiday hole is not to be more than 8mm, i.e. the diameter of calculated equivalent circle of peeled-off coating around the whole artificial holiday hole is 19mm. If the anti-corrosive paint system is subject to cathode protection test together with the associated anti-fouling paint, test method and requirements are in accordance with 1.5.3.2(11).

1.5.3 Hull anti-fouling paint

1.5.3.1 Hull anti-fouling paint is classified as self-polishing anti-fouling paint and non-self-polishing anti-fouling paint according to toxic release mechanism, and classified as short-term, medium-term and long-term anti-fouling paint according to term of validity.

1.5.3.2 Requirements for test items and results of hull anti-fouling paint are as follows:

(1) Non-volatility: in accordance with GB/T9272 or under the condition of temperature 23℃ ±2℃, humidity 50%±5% and dryness for 7 days, volume in compliance with technical requirements for products;

(2) density: in accordance with GB/T6750 and in compliance with technical requirements for products;

(3) color: in accordance with GB/T9761 and in compliance with technical requirements for products;

(4) viscosity: in accordance with GB/T1723 or GB/T9269 or GB/T9751 or agreed methods and in compliance with technical requirements for products;

(5) flashing point: in accordance with GB/T5208 and in compliance with technical requirements for products;

(6) drying time: in accordance with GB/T1728, for surface drying, technical requirements for products; for hard drying, no more than 24h;

(7) toxicity: paint products are to be free from asbestos or dyestuff containing asbestos, mercury compound, DDT and chemical substances forbidden to use by relevant departments of the State. Measuring for anti-fouling agent content is as follows:

a) measuring for copper content of copper type anti-fouling agent: in accordance with ASTM D6632;

b) measuring for organotin content of anti-fouling agent: in accordance with MEPC.104(49) Guidelines for Brief Sampling of Anti-fouling Systems on Ships, see Appendix 2 Methods for Measuring Total Tin Content and Organotin Content of Hull Anti-fouling Paint, the total tin content is to be less than 2500 mg/kg dry paint sample with tolerance range ±500 mg/kg dry paint sample;

c) measuring for other types of anti-fouling agent: in accordance with methods provided by the manufacturer;

(8) shallow sea immersion: in accordance with GB/T5370 Method for Testing Antifouling Panels in Shallow Submergence and satisfying following requirements:

Hull anti-fouling paint system	Period of validity	Test cycle	Acceptance requirements
Short-term anti-fouling paint	Less than 3 years	One sea organism growth boom season	Evaluate at least once per half year, anti-fouling coating is to be free from peeling and scaling.
Medium-term anti-fouling paint	Not less than 3 years but less than 5 years	Two sea organisms growth boom seasons	
Long-term anti-fouling paint	Not less than 5 years	Three sea organisms growth boom seasons	

(9) polishing of anti-fouling coating (applicable to self-polishing anti-fouling paint): in accordance with GB/T7789 Requirements for Dynamic Test of Anti-fouling Performance of Ship Anti-fouling Paint. Anti-fouling coating is to be free from peeling and scaling, and polishing or wearing rate of anti-fouling coating is to be consistent with qualification characteristic performance of polishing rate;

(10) dynamic simulation test: in accordance with GB/T7789 Requirements for Dynamic Test of Anti-fouling Performance of Ship Anti-fouling Paint. For short-term anti-fouling paint system, test cycle is required to be not less than 3 but less than 5; for medium-term anti-fouling paint, test cycle is required to be not less than 5 but less than 10; for long-term anti-fouling paint, test cycle is required t be not less than 10. Evaluation is to be carried out upon the completion of each test cycle and anti-fouling coating is to be free from peeling and scaling;

(11) compatibility of cathode protection

Four specimens are to be prepared for each anti-corrosive and anti-fouling system. The size of tested panels is 250mm x 150mm x 2mm.One end of copper conductor with length 600mm, core diameter 1mm and containing plastic insulation is to be fixed to the connecting hole of each test panel by M5 copper screw of 10mm in length, copper nut and copper gasket prior to painting. Another end of copper conductor is to be connected with zinc anode. The resistances of anode surface and tested panel center are to be less than 0.01Ω. The connecting hole of conductor is to be sealed by epoxy adhesive. Painting is to be carried out in turn according to the associated requirements of anti-corrosive paint and anti-fouling paint. An artificial holiday hole is to be made at the center of coated specimen after coating, which is a round hole without whole coating and the diameter of naked metal base is 6mm, and the hole is to be located to expose the luster of base metal. Cathode protection compatibility test is to be carried out according to GB/T7790 Test Methods for the Resistance of Cathodic Disboundment of Anticorrosive Paint. Two specimens are to connect anode while another two are to be as the benchmarking and not to be connected with zinc anode. Test cycle is 182 days. On completion of test, it is to examine the conditions of adhesion decrease (i.e. coating disboundment), scaling, bubbling or other coating damage of coating around artifical holiday hole for each specimen.

Test paints are to be free from peeling, scaling, bubbling, dissolving or other damage. It is permitted for anti-corrosive primer and anti-fouling painting to disbond 10mm in way of external edge of man-made holiday hole. The test is not applicable to anti-fouling system of non metal substrate.

1.5.4 Anodic shield coating

1.5.4.1 Requirements for test items and results of anodic shield coating are as follows:

(1) color appearance: smooth and even by visual under natural light;

(2) density: in accordance with GB/T6750, 1.2~1.4g/ml;

(3) drying time: in accordance with GB/T1728, 23±2℃, for surface drying, no more than 4h; for hard drying, no more than 24h;

(4) adhesion: in accordance with GB/T5210, no less than 10MPa;

(5) impact resistance test: in accordance with ASTM D2794, impact resistance value not less than 0.408Kg m;

(6) sea air resistance: in accordance with GB/T1771, 1000h, the paint film is free from bubbling, peeling and rust;

(7) potential resistance test: in accordance with GB/T7788 Appendix A, test potential (-3.5±0.02) V (relative to silver/silver chloride reference electrode), for 30 days, the paint film is free from bubbling, peeling and rust.

1.5.5 Marine ant-corrosive paint

1.5.5.1 Marine anti-corrosive paint's drying time, tin plate as substrate for flexibility test, steel plate as substrate for sea air resistance and salt solution resistance test, steel plate or metal column as substrate for adhesion test, requirements for test items and results are as follows:

(1) solid content: in accordance with GB/T1725, in compliance with technical requirements for products;

(2) density: in accordance with GB/T6750, in compliance with technical requirements for products;

(3) viscosity: in accordance with GB/T1723 or GB/T9269 or GB/T9751 or agreed methods and in compliance with technical requirements for products;

(4) flashing point: in accordance with GB/T5208 and in compliance with technical requirements for products;

(5) drying time: in accordance with GB/T1728, applying one layer of paint with film thickness of 20μm~26μm, for surface drying, in compliance with technical requirements for products; for hard drying, no more than 24h;

(6) adhesion: in accordance with GB/T5210, applying one layer of paint with film thickness of 40μm~70μm, for single-component paint, not less than 3MPa, for bi-component paint, not less than 5MPa;

(7) flexibility: in accordance with GB/T1731, applying one layer of paint with film thickness of 20μm~26μm, flexibility not more than 2mm;

(8) salt solution resistance: in accordance with GB/T10834, may be coated in single layer or multi-layer with interval of 24 hours, total thickness of dry film 100μm~150μm, 27±6 ℃ , submerge coating for 96h, with film free from peeling, bubbling and rust spots, but permitting slight color fading and loss of gloss;

(9) sea air resistance: in accordance with GB/T1771, may be coated in single layer or multi-layer with interval of 24 hours, total thickness of dry film 100μm~150μm, for single-component paint, 168h; for bi-component paint, 336h, with film free from bubbling, peeling and rust;

(10) adaptability of finish paint: in accordance with GB/T1727, select appropriate accessory finish paint. The paint film is coated with a layer of marine anti-corrosive paint and then a layer of finish paint after drying in accordance with technical requirements for products, and simultaneously brushability is to be observed. After finish paint is dried for 24h, observe if the paint film surface is free from craterring, cracks, pin holes, bubbling, peeling, lifting and bleeding, etc.

1.5.6 Marine waterline paint

1.5.6.1 Performance and test methods of marine waterline paint all refer to the accessory system of waterline paint and marine anti-corrosive paint. Except where otherwise specified, all the tests are to be performed after the plates are kept for 7 days under the condition specified in GB/T9278. Requirements for test items and results are as follows (either artificial climate aging resistance or weather resistance):

(1) paint film appearance: sample plate is observed by visual under scattered sunlight, if it is coated evenly without runs, floating, pin holes, cracking and peeling, it is to be deemed in good condition;

(2) drying time: in accordance with GB/T1728, no more than 4h; for hard drying, no more than 24h;

(3) impact resistance: in accordance with GB/T20624, use a round punch with diameter of 20±0.3mm, heavy hammer is 1kg in mass, depth control ring is not installed, the heavy hammer is dropped in way of 500mm. If there is no paint film peeling and cracking within impacting deformation area, it is to be deemed satisfactory at such impacting point. Two specimens are tested, each specimen with 5 impacting points, if there are no less than 3 points without paint film peeling and cracking on one specimen, the test item is deemed satisfactory;

(4) adhesion: in accordance with GB/T5210, not lower than 3MPa;

(5) salt solution resistance: in accordance with GB/T10834, for natural sea water or artificial sea water, paint film is free from bubbling, rust and peeling at 27±6℃ for 7 days;

(6) oil resistance: in accordance with GB/T9274, submerged in 15W-40 diesel engine lubricant oil for 48h, paint film is free from bubbling and peeling;

(7) sea air resistance: in accordance with GB/T1771, for single-component paint, 400h, for bi-component paint, 1000h, paint film is free from bubbling, peeling and rust;

(8) artificial climate aging resistance: for ultraviolet aging, in accordance with GB/T14522, with irradiance 0.68W/m^2, ultraviolet UVB-313: 200h or agreed; or for xenon lamp aging, in accordance with GB/T1865 for 300h or agreed, the color change of paint film is not to exceed grade 4, pulverization not exceed grade 3 (epoxy paint may be agreed) and cracks grade 0;

(9) weather resistance: in accordance with GB/T9276, result evaluation in accordance with GB/T1766, after 12-month insulation in sea atmosphere, the color change of paint film is not to exceed grade 4, pulverization not exceed grade 2 (epoxy paint may be agreed) and cracks grade 0;

(10) thrash resistance: in accordance with GB/T9260 Appendix A, in two cycles, paint film is free from bubbling and peeling.

1.5.7 Hull paint

1.5.7.1 Hull paint is to be used in combination with marine shop primer and anti-corrosive paint. For following specimens, the dry film thickness of primer is to be controlled to (50±10)μm, the dry film thickness of hull paint is to be controlled to (60±10)μm, and the total dry film thickness is to be controlled to (100±10)μm. Except where otherwise specified, all the tests are to be performed after the plates are kept for 7 days under the condition specified in GB/T9278. Requirements for test items and results are as follows:

(1) paint film appearance: sample plate is observed by visual under scattered sunlight, if it is coated evenly without runs, floating, pin hole, cracking and peeling, it is to be deemed in good condition;

(2) fineness: in accordance with GB/T6753.1, not more than 40μm;

(3) solid content: in accordance with GB/T1725, for bi-component paint, it is to be measured after being mixed evenly according to product mixture ratio, the percentage of non-volatile substance is not to be less than 50%;

(4) drying time: in accordance with GB/T1728, for surface drying, no more than 4h; for hard drying, no more than 24h;

(5) impact resistance: in accordance with GB/T20624.1, use a round punch with diameter of 20±0.3mm, heavy hammer is 1kg in mass, depth control ring is not installed, the heavy hammer is dropped in way of 500mm. If there is no paint film peeling and cracking within impacting deformation area, it is to be deemed satisfactory at such impacting point. Two specimens are tested, each specimen with 5 impacting points, if there are no less than 3 points without paint film peeling and cracking on one specimen, the test item is deemed satisfactory;

(6) flexibility: in accordance with GB/T1731, no more than 1mm;

(7) gloss: in accordance with GB/T9754, in compliance with technical requirements for products;

(8) adhesion: in accordance with GB/T5210, not lower than 3MPa;

(9) salt solution resistance: in accordance with GB/T10834, for natural sea water or artificial sea water, paint film is free from bubbling, rust and peeling at 27±6℃ for 48h;

(10) sea air resistance: in accordance with GB/T1771, for single-component paint, 400h, for bi-component paint, 1000h, the paint film is free from bubbling, peeling and rust;

(11) artificial climate aging resistance: for ultraviolet aging, in accordance with GB/T14522, with irradiance 0.68W/m^2, ultraviolet UVB-313: 300h or agreed; or for xenon lamp aging, in accordance with GB/T1865 for 500h or agreed, the color change of paint film is not to exceed grade 4, pulverization not exceed grade 2 (epoxy paint may be agreed) and cracks grade 0;

(12) weather resistance: in accordance with GB/T9276, result evaluation in accordance with GB/T1766, after 12-month insulation in sea atmosphere, the color change of paint film is not to exceed grade 4, pulverization not exceed grade 2 (epoxy paint may be agreed) and cracks grade 0.

1.5.8 Deck paint

1.5.8.1 Deck paint system is divided into general system and skid-proof system. The following mentioned paint performance and test methods refer to deck paint accessory system. The dry film thickness of primer is to be controlled to (50±10)μm, the dry film thickness of deck paint is to be controlled to (60±10)μm, and the total dry film thickness is to be controlled to (100±10)μm. Except where otherwise specified, all the tests are to be performed after the plates are kept for 7 days under the condition specified in GB/T9278. Requirements for test items and results are as follows:

(1) paint film appearance: sample plate is observed by visual under scattered sunlight, if it is coated evenly without runs, floating, pin hole, cracking and peeling, it is to be deemed in good condition;

(2) solid content: in accordance with GB/T1725, for bi-component paint, it is to be measured after being mixed evenly according to product mixture ratio, the percentage of non-volatile substance is not to be less than 50%;

(3) drying time: in accordance with GB/T1728, for surface drying, no more than 4h; for hard drying, no more than 24h;

(4) impact resistance: in accordance with GB/T20624.1, use a round punch with diameter of 20±0.3mm, heavy hammer is 1kg in mass, deep control ring is not installed, the heavy hammer is dropped in way of 500mm. If there is no paint film peeling and cracking within impacting deformation area, it is to be deemed satisfactory at such impacting point. Two specimens are tested, each specimen with 5 impact points, if there are no less than 3 points without paint film peeling and cracking on one specimen, the test item is deemed satisfactory;

(5) adhesion: in accordance with GB/T5210, not lower than 3MPa;

(6) abrasion resistance: in accordance with GB/T1768, the type of rubber grinding wheel used is CS-10, 500 turns for 500g, agravity not to exceed 100mg;

(7) salt solution resistance: in accordance with GB/T10834, for natural sea water or artificial sea water, paint film is free from bubbling, rust and peeling at 27±6℃ for 48h;

(8) oil resistance: in accordance with GB/T9274, 0# diesel oil as medium, paint film is free from bubbling and peeling for 48h;

(9) resistance to secondary alkyl sodium sulfate: in accordance with GB/T9274, 1% secondary alkyl sodium sulfate solution as medium, paint film is free from bubbling and peeling for 48h;

(10) sea air resistance: in accordance with GB/T1771, for single-component paint, 400h, for bi-component paint, 1000h, the paint film is free from bubbling, peeling and rust;

(11) artificial climate aging resistance: for ultraviolet aging, in accordance with GB/T14522, with irradiance 0.68W/m^2, ultraviolet UVB-313: 300h or agreed; or for xenon lamp aging, in accordance with GB/T1865 for 500h or agreed, the color change of paint film is not to exceed grade 4, pulverization not exceed grade 2 (epoxy paint may be agreed) and cracks grade 0;

(12) weather resistance: in accordance with GB/T9276, result evaluation in accordance with GB/T1766, after 12-month insulation in sea atmosphere, the color change of paint film is not to exceed grade 4, pulverization not exceed grade 2 (epoxy paint may be agreed) and cracks grade 0;

(13) skid proof: skid-proof deck paint is to measure dry friction factor of paint to rubber, rubber is to be sulphide rubber with hardness 60~80. Test specimens are subject to 15 kg load evenly according to 5.2 of GB/T9263, and dry friction factor is not to be less than 0.85.

1.5.9 Marine cargo hold paint

1.5.9.1 Marine cargo hold paint will be used in combination with shop primer, anti-corrosive paint and intermediate paint. A complete tank paint accessory system is composed of shop primer, anti-corrosive paint, intermediate paint and finish paint. Test items of cargo hold paint and chemical tank paint may make reference to cargoes carried. Drying the period, tin plate is used as substrate for flexibility test, glass plate or aluminum plate is used as substrate for abrasion resistance test, steel plate is used as substrate for impact resistance and sea air resistance tests, metal column is used as substrate for adhesion test. Except where otherwise specified, one layer for drying time, flexibility and impact resistance (single component) test, dry film thickness (20~26)μm; two layers for abrasion resistance test, with interval of 24h, dry film thickness (70~80)μm; adhesion test is to be carried out with primer in combination with finish paint, with interval of 24h, primer dry film thickness (35~40) μm, finish paint dry film thickness (35~40)μm, total dry film thickness (70~80)μm. Sea air resistance test is to be carried out with primer in combination with finish paint, with interval of 24h, primer dry film thickness (75~100)μm, finish paint dry film thickness (75~100)μm, total dry film thickness (150~200)μm. Single-component paint is to be tested after being kept for 48h and bi-component paint is to be tested after being kept for 7 days.

1.5.9.2 Requirements for test items and results are as follows:

(1) paint film appearance: sample plate is observed under scattered sunlight, if it is coated evenly and smoothly without bubbling, craterring and other abnormal state, it is to be deemed in good condition;

(2) drying time: in accordance with GB/T1728, for surface drying, no more than 4h; for hard drying, no more than 24h;

(3) adhesion: in accordance with GB/T5210, not lower than 3MPa;

(4) abrasion resistance: in accordance with GB/T1768, the type of rubber grinding wheel used is CS-10, 500 turns for 500g, agravity not to exceed 100mg;

(5) flexibility: in accordance with GB/T1731, not more than 3mm (applicable to single-component paint);

(6) impact resistance: in accordance with GB/T1732, not less than 40cm;

(7) sea air resistance: in accordance with GB/T1771, result evaluation in accordance with GB/T1766, for single-component paint, without peeling for 500h, the color change is permitted not to exceed Grade 3, bubbling 1(S2), rust 1(S3), for bi-component paint, without peeling for 1000h, the color change is permitted not to exceed Grade 3, bubbling 1(S1), rust 1(S1);

(8) sanitary requirements: the paint for tanks carrying bulk grain is not to cause pollution to cargo and risk to human body, and is to be granted with sanitary inspection report from nationally recognized test organizations. The paint coating of refrigeration tank will not release odor which leads to cargo pollution or corrosion and deterioration.

1.5.10 Internal compartment finish paint

1.5.10.1 Paint, varnish and other finishing paint used on exposed surface are not to cause excessive smoke and toxic effects. Low flame spread is to comply with Part 5 of IMO FTPC; smoke and toxicity with Part 2 of IMO FTPC.

1.5.10.2 Fineness, appearance and color are to comply with the technical requirements for products.

1.5.11 Marine drinking water tank paint

1.5.11.1 Marine drinking water tank paint is not to cause risk to human body and not to be used in combination with shop primer containing toxic materials like lead and chromium.

1.5.11.2 The composition of drinking water tank paint is determined by manufacturer. The following mentioned paint performance, test methods all refer to drinking water tank paint accessory system. Requirements for test items and results are as follows:

(1) fineness: in accordance with GB/T1724, not more than 70μm;

(2) adhesion: in accordance with GB/T5210, the adhesion between coating and substrate, and between coatings are not to be less than 3 MPa. Paint film preparation is to comply with technical requirements for products;

(3) drying time: in accordance with GB/T1728, for surface drying, no more than 4h; for hard drying, no more than 24h;

(4) flexibility: in accordance with GB/T1731, not more than 5mm;

(5) sea air resistance: in accordance with GB/T1771, after continuous 600h sea air test, without bubbling, peeling and rust;

(6) water resistance: in accordance with GB/T1733, immerge in distilled water of 25±1℃ for 700h, the paint film is to be free from bubbling, rusting and peeling;

(7) sanitary requirements: to be granted with sanitary inspection report from nationally recognized test organizations and in accordance with GB5369 Appendix A. Soaking water quality is to meet the provisions of sanitary standard for drinking water; in addition, extracts are to be inspected according to paint composition, and carry out toxicological tests on the extracted toxic substances from soaking water and coating so as to ensure that the coating is harmless to human health.

1.5.12 Seawater ballast tank coating

1.5.12.1 The target service life of seawater ballast tank coating is 15 years. The products are divided to epoxy coating system and non-epoxy coating system according to base material and hardener component.

1.5.12.2 Individual ballast tank coating

Non-volatility, density, base material and hardener component qualification: in compliance with technical requirements for products.

1.5.12.3 Intact ballast tank coating system

1.5.12.3.1 Requirements for test items and results of intact ballast tank coating system are as follows:

(1) appearance and color: paint film straight, multi-run coating system, the color of each layer of coating is to be with contrast, surface coating is to be of light color;

(2) nominal dry film thickness: coating of epoxy-based coating system reaches 320μm under 90/10 rule, non-epoxy-based coating system complies with technical requirements for products. Mean dry film thickness of specimen is not to exceed 15% of nominal value;

(3) test on simulated ballast tank conditions: test condition and requirements are in accordance with Appendix 3 Test on Simulated Ballast Tank Conditions of Ship Ballast Tank Coating;

(4) condensate tank test: test condition and requirements are in accordance with Appendix 4 Condensate Tank Test for Ship Ballast Tank Coating;

(5) compatibility with shop primer: test on simulated ballast tank conditions and condensate tank test: test are carried out with shop primer. After satisfactory test, approval certificate is to clearly describe combined shop primer and ballast tank coating, and the shop primer is to be approved by CCS. Test on simulated ballast tank conditions and condensate tank test may also be carried out on treated bared steel plate and not together with shop primer. After satisfactory test, approval certificate is to clearly state that it is only allowed to be used on treated bared steel plate.

If a kind of shop primer as one part of ballast tank coating system has passed test on simulated ballast tank conditions and condensate tank test, the primer may be used in combination with epoxy coating passing test on simulated ballast tank conditions and condensate tank test, provided that the compatibility of such primer is confirmed by the main coating supplier and test under non-wave condition (which is called cross test) mentioned in paragraph 1.7 of Appendix 3 is satisfactory.

1.5.12.3.2 If meeting following two conditions, coating may be treated as substitute for 1.5.12.3.1, and the adopted substitute plan is to be stated on the certificate. According to the future condition, CCS may refuse second substitute plan, which may cause invalidity of certificate or retest by the manufacturer according to 1.5.12.3.1.

(1) Five-year site exposure check is to be carried out according to following requirements:

a) It is to check records of paint manufacturer to confirm that coating system has been subject to five-year site exposure;

b) It is to carry out combined survey to all ballast tanks of selected ships by paint manufacturer and CCS to verify that requirements of paragraphs a and b are complied with. Paint manufacturer representatives are to have at least 2 years coating survey experience and NACE-II or PROSIO-III inspector qualification or equivalent qualification recognized by the Administration;

c) The selected ship's ballast tanks are to be those in normal operation, among which at least one tank is 2000m^3 in volume, at least one tank is adjacent to heated tank and at least one tank is below exposed weather deck;

d) If selected ship does not meet the requirements of above c), limitations are to be specified on the approval certificate, for example, corresponding paint can not be used for the tank adjacent to heated tank or tank below deck or tank with volume greater than the inspected dimension;

e) All ballast tanks are to be in “good” condition, and coating was not repaired in previous 5 years. “Good” condition is defined as only with minor spot rusting distributed less than 3% area and without visible coating damage. Distribution of rust at edge or weld is to be less than 20% edge or weld within the calculated area. For report example of coating condition within the calculated area, reference may be made to IACS Rec.87 Appendix 1. If NDFT used exceeds PSPC requirements, NDFT is to be minimum thickness for construction, and this is to be clearly marked on the approval certificate.

(2) Paint with Marintek B1* approval is to meet following requirements: Paint is to be coated according to PSPC Table 1 rather than other used during approval test, except that the coating condition of approval test is more strict than PSPC Table 1.

1.5.13 Marine oil tank paint

1.5.13.1 Requirements for test items and results of oil tank paint are as follows:

(1) drying time: in accordance with GB/T1728, tin plate as substrate for drying time test, for surface drying, no more than 6h; for hard drying, no more than 24h;

(2) paint film appearance: sample plate is observed by visual under scattered sunlight, if it is coated evenly and smoothly without bubbling, craterring and other abnormal state, it is to be deemed in good condition;

(3) adhesion: in accordance with GB/T5210, metal column as substrate for adhesion test, not lower than 3MPa;

(4) sea air resistance: in accordance with GB/T1771, result evaluation in accordance with GB/T1766, after continuous 800h sea air test, the paint film is free from bubbling, rust and peeling, and slight color change is allowed;

(5) salt solution resistance: in accordance with GB/T10834, soaked in salt solution at the temperature of 23℃ ±2℃ for 7 days, then soaked in hot salt solution at the temperature of 80℃ ±2℃ for 2h, which forms one cycle, and three cycles are to be carried out, the paint film is free from bubbling and peeling;

(6) oil resistance: in accordance with GB/T9274, normal temperature for 21 days, gasoline (120#) resistance, diesel oil (0#) resistance, the paint film is free from bubbling, peeling and softening.

1.5.13.2 Requirements for protective coatings for cargo oil tanks of crude oil tankers

Protective coatings for cargo oil tanks of crude oil tankers are to comply with the requirements of Resolution MSC.288(87) Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers, and the target service life is 15 years.

(1) appearance and color: multi-layer coating system, the color of each layer of coating is to be with contrast, surface coating is to be of light color;

(2) nominal dry film thickness: 320μm with 90/10 rule for epoxy-based systems, other systems in compliance with technical requirements for products;

(3) gas-tight cabinet test for crude oil tank at vapor phase under simulated loaded condition: test conditions and requirements are in accordance with Appendix 5 “Gas-tight Cabinet Test for Cargo Hold at Vapor Phase under Simulated Loaded Condition”;

(4) immersion test for crude oil tank under simulated loaded condition: test conditions and requirements are in accordance with Appendix 6 “Immersion Test for Crude Oil Tank under Simulated Loaded Condition”;

(5) compatibility with shop primer: gas-tight cabinet test and immersion test are carried out with shop primer. After satisfactory test, shop primer and cargo oil tank coating are to be clearly described in the approval certificate, and the shop primer is to be approved by CCS. Gas-tight cabinet test and immersion test may also be carried out on treated bared steel plate without shop primer. After satisfactory test, it is to be stated on the approval certificate that it is only allowed to be used on treated bared steel plate.

If a kind of shop primer as a part of coating system of cargo oil tank of crude oil tanker has been subject to satisfactory gas-tight cabinet test and immersion test, the primer can be used in combination with other epoxy coating which has been subject to satisfactory gas-tight cabinet test and immersion test, provided that the compatibility of primer is confirmed by coating supplier, and the primer has been subject to satisfactory immersion test in Appendix 6 or the test is carried out according to Performance Standard for Protective Coatings for Dedicated Seawater Ballast Tanks in All Types of Ships and Double-side Skin Spaces of Bulk Carriers.

1.5.14 Engine room bilge coating

1.5.14.1 Engine room bilge coating will be used in combination with shop primer. The requirements for test items and results are as follows:

(1) fineness: in accordance with GB/T1724, not more than 80μm (except for squama paint);

(2) solid content: in accordance with GB/T1725, percentage of non-volatile substance not less than 70%;

(3) drying time: in accordance with GB/T1728, for surface drying, not more than 8 h; for hard drying, not more than 24 h;

(4) adhesion: in accordance with GB/T5210, not lower than 3 MPa;

(5) sea air resistance: in accordance with GB/T1771, after continuous 600 h sea air test, the paint film is free from bubbling, cracks, peeling, wrinking and rust stains;

(6) hot salt solution resistance: in accordance with GB/T10834, 40±2℃, after continuous 336 h hot salt solution test, the paint film is free from bubbling, cracks, peeling, wrinking and rust stains;

(7) diesel resistance: in accordance with GB/T9274, kept at the temperature of 23±2℃ for half a year, the paint film is free from bubbling, softening, peeling and rust stains.

1.6 Approval test

1.6.1 Approval test is to be carried out according to test program approved by CCS. CCS and the applicant are to discuss on the determination of type test program.

(1) Test program is to specify the names of approved products, approval test items, relevant methods and requirements, technical standards, test place and dealing-with principles when test is failed;

(2) Test results are to comply with the requirements of the Guidelines and/or technical condition for product delivery and acceptance/industry standard;

(3) Dealing-with principles when test is failed: when test of any item is failed, retest may be carried out to the same sample. If retest is unsatisfactory, sampling may be carried out again for test of all items with the consent of CCS.

16.2 Selection of test samples

(1) CCS Surveyor will supervise and select samples for test on the scene of the manufacturer's product lines or finished product warehouse, and perform identification, sample sealing and record as well. The identity of samples are to include: manufacturer name, sample name, model, and production lot number, production date and sampling date, total quantity of delivered products, sampling position and the personnel performing sampling, etc.

(2) Samples are required to be stored and used in accordance with the conditions prescribed by the manufacturer and sample reservation system. The quantity of samples is to be sufficient for completion of all tests and for re-test where necessary. Where samples are used to assess the manufacturer's inspection level, the same sample is to be sent respectively to the manufacturer's laboratory and the test organization approved or recognized by CCS, subject to the same test items.

(3) For samples which are to be delivered after preparation, preparation is to be witnessed by CCS surveyor and following parameters are to be recorded: shop primer, coating number, coating interval, dry film thickness, thinner, humidity, environmental temperature and steel plate temperature, dry film thickness of coating during specimen preparation is to comply with requirements of relevant standards and the value recommended by the paint manufacturer, the composition of associated system is to be determined by paint manufacturer.

(4) For paints which are of same name and manufactured by same manufacturer but at different place, if the manufacturer can demonstrate that these paints are same (by infrared analysis and specific gravity measurement), individual approval test may not be required to be carried out to paint manufactured at each place.

(5) Winter type and summer type paints are deemed as different ones, unless infrared evaluation and specific gravity verify that they are same.

1.6.3 Approval test location

Test samples are to be sent to test organization approved or recognized by CCS to be subject to approval test. If a manufacturer is equipped with complete and valid test equipment as well as trained and qualified test personnel, test may be carried out in the manufacturer's laboratory under the witness of CCS surveyor with the consent of CCS, except that it is the initial approval or CCS requires a comparison of the results for the same test items performed by the manufacturer and the test organization, in order to evaluate manufacturer's test reliability in its current conditions;

1.6.4 Approval test items

(1) Approval test is carried out according to Table 1.6.4 "A checking list of approval test items for ship paint", X refers to approval test items, which may be adjusted according to practical situations.

(2) If the product applies for multi-service, approval test items are to include test items of paint applying for service.

(3) For weather resistance test for marine waterline paint, hull paint and deck paint as well as shallow sea immersion test for hull anti-fouling paint, if the works can provide original test report and experience certificate, based on checking quality management system of product development by the works, CCS can accept the results of artificial climate aging test and dynamic simulation test of anti-fouling paint as temporary certification basis. At the same time, weather resistance test and shallow sea immersion test may be carried out continuously. If the test results are unsatisfactory when the test is finished, the product approval is to be cancelled. The works are to provide recall guarantee of delivered products if the test result is not satisfactory.

A checking list of approval test items for ship paint Table 1.6.4

Serial No.			1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Test items	Test methods Standard applied	Marine shop primer	Hull anti-corrosive paint	Hull anti-fouling paint	Anodic shield coarting	Marine anti-corrosive paint	Marine waterline paint	Hull paint	Deck paint	Marine cargo hold paint	Internal compartment finish paint	Marine drinking water tank paint	Marine ballast tank coating	Marine oil tank paint	Engine room bilge coating
1	Fineness	GB/T 6753.1							X			X				
		GB/T1724														X
2	Drying time	GB/T1728	X	X	X	X	X	X	X	X	X				X	X
3	Solids content	GB/T1725					X		X	X						X
4	Density	GB/T6750		X	X	X	X							X		
5	Non-volatile component content	GB/T9272		X	X									X		
6	Adhesion	GB/T1720	X													
		GB/T5210		X		X	X	X	X	X	X		X		X	X
7	Flexibility	GB/T1731					X		X		X		X			
8	Abrasion resistance	GB/T1768								X	X					
9	Paint film color and appearance				X	X		X	X	X	X	X		X	X	
10	Viscosity	GB/T1723 or 9269, 9751.1		X	X		X									
11	Impact resistance	GB/T 20624.1						X	X	X						
		ASTM D2794				X										
		GB/T1732									X					
12	Salt solution resistance	GB/T 10834					X	X	X	X					X	X
13	Sea air resistance	GB/T1771				X	X	X	X	X	X		X		X	X
14	Water resistance	GB/T1733											X			
15	Oil resistance	GB/T9274						X		X					X	X
16	Weather resistance	GB/T9276	X					X	X	X						
17	Artificial climate aging resistance	GB/T 14522 or GB/ T1865						X	X	X						
18	Welding and cutting	GB/T6747	X													
19	Paint film thickness	GB/T 13452.2	X													
20	Metal zinc content in non-volatile component	HG/T3668	X													
21	Thrash resistance	GB/T9260						X								
22	resistance to secondary alkyl sodium sulfate	GB/T9274								X						

23	Low flame spread, smoke and toxicity	IMO.FTPC Parts 2, 5										X				
24	Flashing point	GB/T5208		X	X		X									
25	Gloss	GB/T9764							X							
26	Immersion resistance	GB/T 10834		X												
27	Bubbling resistance	GB/T 10834		X												
28	Resistance to cathodic peeling	GB/T7790		X												
29	Toxicity				X											
30	Shallow sea immersion				X											
31	Polishing of anti-fouling coating				X											
32	Dynamic simulation test				X											
33	Compatibility with cathode protection				X											
34	Applicability to finish paint						X									
35	Potential resistance					X										
36	Skid-proof	GB/T9263								X						
37	Sanitary requirements										X		X			

1.7 On-site audit

1.7.1 CCS surveyor is, in conjunction with the approval test, to carry out a quality assurance system audit at the manufacturer's relevant departments, workshops, laboratory and warehouse, to confirm that the manufacturing and relevant control of products are in compliance with the submitted documents and the applicable rules/standards; to check the organizational units within the approval scope of the applicant and their interrelations, and human resources; to be familiar with the main production equipment used in manufacturing the products to be approved; to confirm compliance of the quality assurance system; to witness compliance of the applicant's inspection and test of his products.

1.7.1.1 Requirements for paint manufacturer:

(1) The manufacturer is to have production equipment and test equipment commensurate with product manufacturing requirements and quality control, laboratory, measurement room and test methods commensurate with environmental condition as well as physical and chemical operation personnel subject to necessary training and with the qualification to undertake the testing, valid test equipment is to meet delivery requirements for variety and precision.

(2) Except the early stage of "addition according to proportion" from laboratory to full production, unless it is proved reasonable by test of coating system development plan or subsequent verification, adjustment beyond the limitation listed in QC instructions is not acceptable. Any adjustment must be agreed by prescription technology center.

(3) For the expected prescription adjustment during manufacturing, maximum allowable limitation is to be approved by prescription technology center and clearly indicated in QC working procedure.

(4) Quality control system of manufacturer is to ensure that all current products and products with approval certificate adopt same prescription. Prescription change is not allowed unless retest is carried out according to relevant provisions and approval certificate is issued by CCS.

(5) Batch manufacturing records, including all QC test results such as viscosity, specific gravity and spraying without air, are to be recorded accurately, including details of any additional test item.

(6) When practicable, raw material supply and distribution of each batch are to be traceable. But for a large amount of raw material, except for solvent stored in tank or pre-dissolved solid epoxy, supplier's ingredient may only be recorded.

(7) Date of contract, batch number and quantity of each paint are to be clearly recorded.

(8) The packaging barrel is to be clearly marked with details of CCS approval certificate, such as name, type, approval certificate number, etc.

(9) The manufacturer is to establish product sample system to carry out sampling and store the product properly.

1.7.1.2 Requirements of raw material control for paint manufacturer:

(1) According to the importance of products, CCS may require manufacturer to carry out inspection or relevant test.

(2) All raw material supply is to be furnished with supplier's certificate of compliance which includes all requirements listed by QC system of manufacturer.

(3) If there is no raw material supplier compliance certificate, paint manufacturer must verify that raw material complies with all requirements listed by QC system of manufacturer.

(4) Technology center setting down QC procedure is to verify that all production units comply with above provisions and all raw material suppliers are approved by technology center.

1.7.2 For non-conformities found by audit, it is to inform the responsible personnel of the manufacturer to carry out corrective actions which are to be traced and verified.

1.8 Approval maintenance condition

1.8.1 The manufacturer is to monitor the change of product or production process. For significant change (such as description change), it is to report CCS and subject to evaluation. Except it is to be submitted to CCS for reexamination and reaudit, following conditions will cause invalidity of works approval certificate:

(1) Significant change of production condition, equipment or quality control and quality assurance system does not comply with works approval condition;

(2) Rules or standards as basis of product approval have been revised or cancelled, and the manufacturer can not or does not intend to meet current valid rules or standards;

(3) Change of production method;

(4) Significant change of management organization;

(5) Annual audit not been applied;

(6) Significant non-conformity of product covered by approval due to quality assurance system;

(7) Non-conformities found during periodical audit are not corrected according to provisions.

1.8.2 If there is description change, the approval certificate is invalid. The manufacturer is responsible for informing CCS of any description change. Not informing CCS of description change will cause cancellation of works approval certificate.

1.9 Unit/batch inspection

1.9.1 For approved paint product, CCS will confirm that the quality of approved product is the same as that of initial approval by periodical audit, and batch inspection and certification are not necessary. The manufacturer may deliver products based on copy of approval certificate and quality certificate of manufacturer.

1.9.2 In necessary case or in the case that product certificate is required by user, products are to be inspected and certified according to inspection program confirmed during approval after inspection application is submitted by the manufacturer.

1.9.3 For unapproved paint products, CCS will not carry out unit/batch inspection in general, unless unit/batch inspection is subject to verification of manufacturing process, on-site supervision and review of process record, and all test items are satisfactory.

Appendix 1 Welding and Cutting Tests of Marine Shop Primer

Appendix 2 Methods for Measuring Total Tin Content and Organotin Content of Hull Anti-fouling Paint

Appendix 3 Test on Simulated Ballast Tank Conditions of Ship Ballast Tank Coating

Appendix 4 Condensate Tank Test for Ship Ballast Tank Coating

Appendix 5 Gas-tight Cabinet Test for Cargo Hold at Vapor Phase under Simulated Loaded Condition

Appendix 6 Immersion Test for Crude Oil Tank under Simulated Loaded Condition

Appendix 1 Welding and Cutting Tests of Marine Shop Primer

1 Test for effect of marine shop primer to welding performance

1.1 Test condition

(1) Specimen plate: specimen plate is marine steel plate, 20mm in thickness and furnished with CCS certificate.

(2) Welding consumables: welding consumables are to be furnished with CCS certificate, the grade of welding consumables and test steel may refer to following Table 1.1 of CCS Rules for Materials and Welding.

Table 1.1

Grade of welding consumables	Grade of test steel	Grade of welding consumables	Grade of test steel	Grade of welding consumables	Grade of test steel
1	A	4Y40	F40	5Y50	F500
2	B、D	3Y42	D420	3Y55	D550
3	E	4Y42	B420	4Y55	E550
1Y	A32、A36	5Y42	F420	5Y55	F550
2Y	D32、D36	3Y46	D460	3Y62	D620
3Y	E32、E36	4Y46	E460	4Y62	E620
4Y	F32、F36	5Y46	F460	5Y62	F620
2Y40	D40	3Y50	D500	3Y69	D690
3Y40	E40	4Y50	E500	4Y69	E690

(3) Welding method: manual arc welding or CO_2 welding;

(4) Specimen surface condition: after cutting, specimen is subject to edge processing and sand blasting (or shot) treatment to reach Sa2½, then it is to apply shop primer, including groove;

(5) Paint film thickness is: A. according to manufacturer's instructions; B. about twice the thickness in manufacturer's instructions; c. sand blasting rather than coating;

(6) specimen joint type: butt weld and fillet weld.

a) butt weld: After flame cutting, butt weld specimen is to be not less than 150mm in width and the length is to be sufficient to provide specimens with stipulated quantity and size. Then the specimens are to be coated according to three requirements of A, B and C and assembled after drying of marine shop primer. The steps are as follows: It is to adopt downhand butt weld with 4mm electrode. Back chipping is to be carried out for full welding and sealing is to be carried out by 4mm electrode. Strengthened height of face and foot weld is not to be more than 3mm. In order to keep the test assembly smooth and straight after welding, it is to be subject to initial distortion prior to welding. During welding, between each run, the test plate is to be left in still air until it has cooled to below 250℃. Two transverse tensile specimens, two bend specimens and three sets of impact specimens (3 for each set) are to be selected for tensile, face and root bend test and impact test according to Rules for Materials and Welding.

b) fillet weld: The specimens are to be coated according to requirements of A and B and not coated according to requirements of C, and then to be assembled and welded. The specimen is 150mm in width and of length sufficient to allow at least the deposition of the entire length of the largest diameter electrode being tested. Both sides are to be welded in single run with leg size of 6mm.

1.2 Requirements for test results

1.2.1 Requirements for butt weld test items and results

(1) visual examination: full length observation of weld is to be carried out by the aid of five-fold magnifying glass. The weld surface is to be even and free from cracks, obvious overlap and undercuts;

(2) non-destructive test: there is to be no unacceptable defects in the welds;

(3) inspection of mechanical properties: see Table 1.2.1;

a) tensile test: two transverse tensile specimens whose tensile strength is to be not lower than minimum specified tensile strength of the parent metal;

b) face and root bend test: one specimen for each test, there is no crack or other defects exceeding 3mm in dimension on the outside of the bent portion;

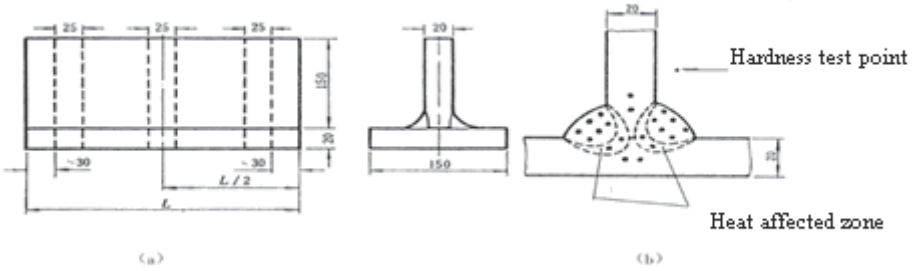
c) impact test: 3 sets of impact specimen (3 for each set), the notch is located at weld center, fusion line and heat affected zone 2mm from fusion line respectively. Individual value of impact test is not to be lower than 70% of specified value and three average values are to be greater than specified value.

Mechanical property of welding consumables of structural steel Table 1.2.1

Grade of welding consumables			**1,2,3**	**1Y,2Y 3Y,4Y**	**2Y40 3Y40 4Y40**	**3Y42 4Y42 5Y42**	**3Y46 4Y46 5Y46**	**3Y50 4Y50 5Y50**	**3Y55 4Y55 5Y55**	**3Y62 4Y62 5Y62**	**3Y69 4Y69 5Y69**
Butt weld test	Tensile strength of joints % (N/mm^2)		≥400	≥490	≥510	≥530	≥570	≥610	≥670	≥720	≥770
	Charpy V-notch impact test	Test temperature (℃)	1 The temperature of impact test for welding consumables of Grade 1Y is to be 20℃; 2 The temperature of impact test for welding consumables of Grades 2Y and 2Y40 is to be 0℃; 3 The temperature of impact test for welding consumables of Grades 3Y, 3Y40, 3Y42, 3Y46, 3Y50, 3Y55, 3Y62 and 3Y69 is to be -20 ℃; The temperature of impact test for welding consumables of Grades 4Y, 4Y40, 4Y42, 4Y46, 4Y50, 4Y55, 4Y62 and 4Y69 is to be -40℃; The temperature of impact test for welding consumables of Grades 5Y42, 5Y46, 5Y50, 5Y55, 5Y62 and 5Y69 is to be -60℃.								
		Average impact energy (J)	≥47			≥47		≥50	≥55	≥62	≥69
	Bend test		After test, length of crack or other defects on specimen surface is not to be more than 3mm.								

1.2.2 Requirements for fillet weld test items and results

(1) Three macro-sections, each about 25mm thick, are to be taken from the test assembly according to Rules for Materials and Welding, see Figure (a).



(2) Hardness test: Three macro-sections are to be polished for hardness test for the purpose of determining the hardness of the welded joint. The distance between measuring points is 0.5mm~2mm, and the result of hardness test is not to exceed HV350, see Figure (b);

(3) Fillet weld fracture test: Two remaining sections are to be examined at both sides of weld respectively. When one side of weld is examined, the other side is to be processed. Defects of fracture weld root are to be examined at both sides. The fractured surfaces are to show satisfactory penetration, freedom from cracks and reasonable freedom from porosity. Where slag inclusions or pores are found in the weld, the number, dimensions, locations and density of such defects are to be recorded and submitted to CCS for audit. The fillet weld is to reveal a regular profile and full penetration of weld.

1.2.3 Requirements for results: After above tests, test results are to meet Rules for Materials and Welding and above mentioned requirements, and the difference between test data of welding after painting according to A and B and test data of welding without painting according to C is small, which shows that painting before welding will not cause harmful effect to welding.

1.3 Test report

Test report is to include manufacturer's name, shop primer's product name/identification, batch number, data of steel plate surface treatment, test unit, test date and following in the Table.

1.3.1 Test record

No.	Joint type	Welding method	Quantity (set)	Test plate material	Test plate size (mm)	Welding consumables	Steel grade	Design film thickness	Actual film thickness (μm)
1-1	Butt weld	Manual welding	1					A	
1-2			1					B	
1-3			1					C	
1-4	Fillet weld		1					A	
1-5			1					B	
1-6			1					C	

1.3.2 Test report of mechanical property of butt weld test plate

No. of test plate	Welding position	Transverse tensile test		Cold bend test (180°)		Impact test			
		Tensile strength	Notch position	Face bend	Root bend	Notch position	Impact energy (J)		
1-1	Butt weld					Weld center			
						Interface			
						Heat affected zone			
1-2	Butt weld					Weld center			
						Interface			
						Heat affected zone			
1-3	Butt weld					Weld center			
						Interface			
						Heat affected zone			

1.3.3 Test equipment

Test equipment	Type	Equipment No.	Expiry date of equipment
Welding equipment			
Test machine of all-purpose material			
Impact test machine			
Hardness tester			

2 Test for effect of cutting to paint film of marine shop primer

2.1 Test condition: two test plates 305mm x 300mm x 20mm in size, cutting requirements: oxygen pressure not more than 0.6MPa, cutting speed 20cm/min, and the test plate is cut to 150mm x 305mm.

2.2 Test results and acceptance standards: Test is to be carried out after applying marine shop primer according to the requirements of paint film thickness in manufacturer's instructions. Reduction of cutting speed is not to exceed 15%, and damage width of paint film at both sides of weld or cut is not to exceed 20mm.

2.3 Test report: including manufacturer's name, shop primer's product name/identification, batch number, data of steel plate surface treatment, test unit, test date, type of gas cutting machine, size of test plate and following in the Table.

Cut No.	Cutter No.	Gas pressure (Mpa)	Oxygen pressure (MPa)	Cutting speed (cm/min)	Distance between cutter and item (mm)	Cut width (mm)	Affected paint film width (mm)
1							
2							

Appendix 2 Methods for Measuring Total Tin Content and Organotin Content of Hull Anti-fouling Paint

The test is in accordance with IMO International Convention on the Control of Harmful Anti-fouling System on Ships and Appendix "Possible Methods for Brief Sampling and Analysis of Anti-fouling Systems on Ships — Organotin" of MEPC.104(49) Guidelines for Brief Sampling of Anti-fouling Systems on Ships.

1 Method 1

This method has been developed in order to describe a rapid methodology appropriate for the identification of anti-fouling systems on ship hulls containing organotin compounds acting as biocide. This method is based on a two-step analysis. The first step detects total tin as an indicator for organotin; the second step, detecting specific organotin compounds, is only necessary in the case of the first step proving positive.

1.1 Sampling: two components are to be sampled in parallel, which are to be clearly marked as specimen A and specimen B for detection of analytical procedure.

1.2 Analytical procedure

1.2.1 The two components comprising the analytical procedure are illustrated in following Table 1.2.1. The two components or steps, are as follows:

STEP 1 An analysis of Specimen A for the presence of total tin; and

STEP 2 A more cost- and time-consuming analysis of Specimen B, that is applied only when Step 1 produces positive results. This test involves organotin analysis by gas chromatography/ mass spectrophotometry (GC/MS) after derivatisation and provides specific data on the respective organotin species.

1.2.2 Step 1: Investigation of total tin content in Specimen A. Specimen A is analyzed for mass of total tin per kilogram of dry paint (or mass of tin per sample) by applying inductively coupled plasma/mass spectrometry (ICP/MS), once the material had been solubilized by digestion using aqua regia. It is to be noted that any other scientifically recognized procedure for tin analysis (such as AAS, XRF and ICP-OES) is acceptable.

1.2.3 Step 2: Characterization of organotin in Specimen B.

Should Specimen A produce positive results, organotin compounds are to be identified and quantified in Specimen B. Specimen B may be analyzed using the following procedure:

(1) solvent extraction of Specimen B as supported by sonication in an ultrasonic bath;

(2) derivatisation with ethylmagnesium bromide;

(3) clean-up of the extract;

(4) analysis using high resolution gas chromatography/mass spectrophotrometry (GC/MS); and

(5) quantifications using tripropyltin as a standard.

Any equally reliable method for the chemical identification and quantification of organotin compounds is acceptable.

1.3 Threshold and tolerance range

1.3.1 The threshold value for the brief sampling method as described here is: "2,500mg tin (Sn) per kg of dry paint."

1.3.2 Tolerance range: The tolerance range is 500mg Sn / kg of dry paint (20%) in addition to the threshold value.

1.3.3 Organotin containing compounds acting as biocides or catalysts

1.3.3.1 Organotin compounds not acting as biocides: As stated in the appendix of resolution MEPC.102(48), for the purposes of defining compliance with annex 1 of the Convention, it is to be noted that small quantities of organotin compounds, acting as chemical catalysts (such as mono- and di-substituted organotin compounds) are allowed, provided they are not acting as a biocide.

1.3.3.2 Inorganic impurities in the constituents of the paints: Inorganic impurities in the constituents of the paints are to be considered.

1.3.3.3 Discrimination between anti-fouling paints as biocides: At present neither organotin catalysts nor inorganic impurities are found at concentrations which will be close to the threshold level (2,500mg Sn/kg of dry paint) or higher. However, organotin-containing compounds, when present in paint in order to act as a biocide, were found in concentrations up to 50,000mg Sn/kg of dry paint. Thus the discrimination between antifouling systems containing organotin compounds acting as a biocide and anti-fouling systems not containing these compounds or not containing these compounds at concentrations where they act as a biocide, is reliably possible.

1.4 Definition of compliance: two-step procedure

1.4.1 The analytical verification of the compliance with the Convention is performed in a two-step procedure according to the flow-diagram (Figure 1.2.1).

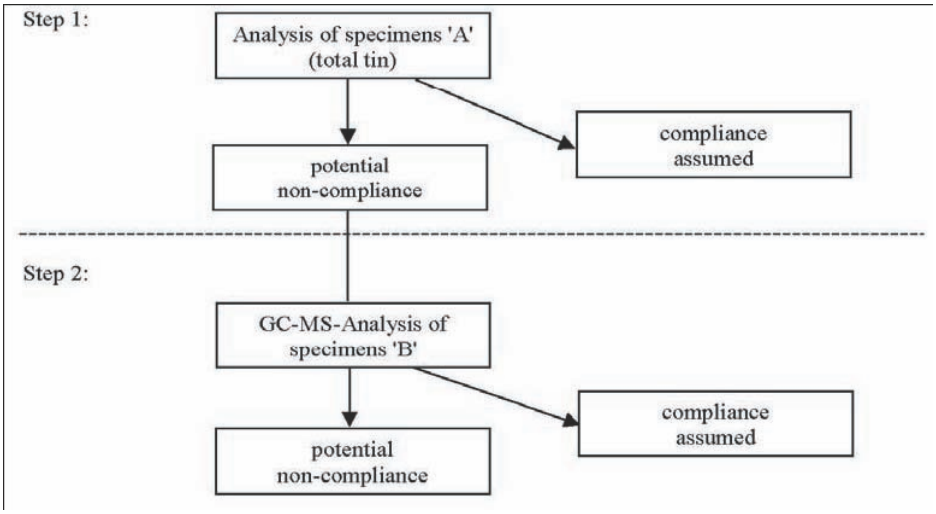


Figure 1.2.1 Flow diagram illustrating the two-step analysis procedure

1.4.2 Compliance with the criteria at the step 1-level

Compliance with the Convention is assumed when the results from the specimens A, analyzed in step 1, meet the following:

(1) no more than 25% of the total number of samples yield results above 2,500 milligrams total tin per kilogram dry paint (2,500 mg Sn/kg of dry paint); and

(2) no sample of the total number of at least eight samples shows a concentration of total tin higher than the sum of threshold value plus the tolerance range, i.e. no sample must exceed the concentration 3,000 mg Sn/kg of dry paint.

If the results in specimen A indicate that no organotin acting as biocide is present, then performing step 2 is not necessary.

1.4.3 Non-compliance with the criteria at the step 1-level

A positive result (non-compliance) is indicated if provisions of paragraph 1.4.2 are not met. A positive result at step 1 (specimen A) would indicate that step 2 is to be undertaken, and those samples labeled specimen B are to be analyzed in order to determine and characterize the organotin present (see Figure 1.2.1).

1.4.4 Compliance with the criteria at the step 2-level

Compliance with the Convention is assumed when the results from the specimens B, analyzed in step 2, meet the following requirements at the same time:

(1) no more than 25% of the total number of samples yield results above 2,500 milligrams total tin per kilogram dry paint (2,500 mg Sn/kg of dry paint); and

(2) no sample of the total number of at least eight samples shows a concentration of total tin higher than the sum of threshold value plus the tolerance range, i.e., no sample must exceed the concentration 3,000 mg Sn/kg of dry paint.

1.4.5 Non-compliance at step 2-level

A positive result in step 2 indicates non-compliance if the provisions of paragraph 1.4.4 are not met. Such results are to be interpreted to mean that organotin compounds are present in the anti-fouling system at a level at which it would act as a biocide.

2 Method 2

2.1 First-stage analysis

(1) The first-stage analysis is assumed to be carried out on the spot of the survey or inspection, e.g. dry docks and sea ports. In order to accomplish the on-site analysis, X-ray fluorescence analysis (XRF) is used in this method to detect total tin content.

(2) Analytical characteristics, such as detection limit and accuracy, are highly dependent on the type of the instrument, i.e. type of X-ray tube, spectrometer, optical arrangement (filters or collimators), etc. Among several types of the XRF instruments, an energy-dispersive spectrometer with a silicon drift detector (SDD), which is compact in size and be able to be operated without liquid nitrogen, is preferable to the present analytical system for a field use, whereas wave-length dispersion system or solid-state detector are also available if the analysis carried out at laboratories.

(3) Software customized for the tin analysis is prepared to assist the operator, who is assumed to be a ship surveyor or PSCO, to detect total tin in the specimens

(4) The customized software may in advance need a calibration curve of the characteristic X-ray intensity of tin in relation to the tin content particularly in the range of 0.1 to 0.5%.

(5) After the preparation including the warming-up of the XRF instrument and starting-up of the computer, a specimen (sampling disc) is placed on the sample stage of the instrument. Afterwards, analysis is executed by the customized software. A single batch of analysis for one specimen normally takes 5 minutes and the result is shown on a display automatically.

(6) Since the XRF analysis does not affect any properties of the specimens, all of the collected specimens (six to nine specimens), including those for the second analysis and storage, are able to be used for this analysis.

2.2 Interpretation of the result at the first-stage analysis

(1) Following the procedures above, XRF data of six, or nine, specimens are obtained for each sampling point. Omitting the maximum and minimum values from the data, an average of the tin content is calculated from the intermediate values for the representing value of the sampling point.

(2) Compliance with the Convention is assumed when none of the tin contents (average values) from the samples do not exceed the sum of the threshold (2,500 mg per kg) and a tolerance (500 mg per kg).

(3) When one or more average values of samples from different sampling points do not meet the above criteria, the samples are to be sent to a laboratory for the second stage analysis. Regardless of the results, it is also possible to undergo the second stage analysis when the surveyor or PSCO considers that it is necessary to do so.

2.3 Second-stage analysis

(1) Since the second-stage analysis provides the final and definitive results of the samples, the method is to be thoroughly reviewed by experts based on scientific evidence. The following is a brief summary of a tentative methodology for the second stage analysis.

(2) The collected paint specimens are removed from the abrasive paper and total mass is measured with an electronic balance to an order of 0.1 mg. The specimens are hydrolyzed with sodium hydroxide aqueous solution, extracted with organic solvent, and then derivatized with propylmagnesium bromide. After cleaning up the extract, analysis using high resolution gas chromatography/mass spectrometry (GC/MS) is carried out. For quantification analysis, tetrabutyl tin d36 is added as the internal standard.

(3) These analyses provide the data of chemical species and their content (mg per kg of the specimens). The content of organotin is obtained in a unit of mg per kg of dry paint.

2.4 Determination of compliance with the Convention

2.4.1 Compliance with the Convention: Compliance with the Convention is assumed when the results from the second-stage analysis meet the following requirements at the same time:

(1) no more than 25% of the total number of samples yield results above 2,500 milligrams tin as organic form per kilogram dry paint (2,500 mg Sn/kg of dry paint); and

(2) no sample of the total number of specimens shows a concentration of tin as organic form higher than the sum of the threshold value plus the tolerance range, i.e., no sample must exceed the concentration 3,000 mg Sn/kg dry paint.

2.4.2 Non-compliance with the Convention: When the result does not meet the above criteria, it is interpreted to mean that organotin compounds are present in the anti-fouling system at a level where they would act as a biocide.

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Appendix 3 Test on Simulated Ballast Tank Conditions of Ship Ballast Tank Coating

The test is prepared in accordance with Appendix 1 of IMO Resolution MSC.215(82) Performance Standard for Protective Coatings for Dedicated Seawater Ballast Tanks in All Types of Ships and Double-side Skin Spaces of Bulk Carriers.

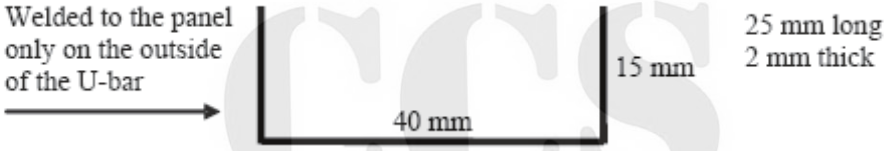
1 Test condition

Test on simulated ballast tank conditions is to satisfy each of the following conditions:

1.1 The test is to be carried out for 180 days.

1.2 There are to be 5 test panels.

1.3 The size of each test panel is 200 mm x 400 mm x 3 mm. Two of the panels (Panel 3 and 4 below) have a U-bar welded. The U-bar is welded to the panel in a 120 mm distance from one of the short sides and 80 mm from each of the long sides.



Selection of coating system of test panels is to be considered by relevant parties in combination with coating condition and planned maintenance. The panels are to be treated according to Table 1.1, 1.2 and 1.3 of IMO Resolution MSC.215(82), and coating system applied according to Table 1, paragraphs 1.4 and 1.5 of IMO Resolution MSC.215(82). The color of each layer of coating is to be with contrast and surface coating is to be of light color. Prepainting and spraying are to be carried out at least twice. Prepainting may be carried out at smooth automatic run, but it is to be ensured that the coating thickness after second spraying has reached NDFT. Shop primer to be weathered for at least 2 months and cleaned by low pressure washing or other mild method. Blast sweep or high pressure washing, or other primer removal methods not to be used. Weathering method and extent is to take into consideration that the primer is to be the foundation for a 15 year target service life system. To facilitate innovation, alternative preparation, coating systems and dry film thicknesses may be used when clearly defined.

1.4 The reverse side of the test piece is to be painted appropriately, in order not to affect the test results.

1.5 As simulating the condition of actual ballast tank, the test cycle runs for two weeks with natural or artificial seawater and one week empty. The temperature of the seawater is to be kept at about 35°C.

1.6 Test panel 1: This panel is to be heated for 12 h at 50°C and cooled for 12 h at 20°C in order to simulate upper deck condition. The test panel is cyclically splashed with natural or artificial seawater in order to simulate a ship's pitching and rolling motion. The interval of splashing is 3 s or faster. The panel has a scribe line down to bare steel across width.

1.7 Test panel 2: This panel has a fixed sacrificial zinc anode in order to evaluate the effect of cathodic protection. A circular 8 mm artificial holiday down to bare steel is introduced on the test panel 100 mm from the anode in order to evaluate the effect of the cathodic protection. The test panel is cyclically immersed with natural or artificial seawater.

1.8 Test panel 3: This panel is to be cooled on the reverse side, in order to give a temperature gradient to simulate a cooled bulkhead in a ballast wing tank, and splashed with natural or artificial seawater in order to simulate a ship's pitching and rolling motion. The gradient of temperature is approximately 20°C, and the interval of splashing is 3 s or faster. The panel has a scribe line down to bare steel across width.

1.9 Test panel 4: This panel is to be cyclically splashed with natural or artificial seawater in order to simulate a ship's pitching and rolling motion. The interval of splashing is 3 s or faster. The panel has a scribe line down to bare steel across width.

1.10 Test panel 5: This panel is to be exposed to dry heat for 180 days at 70°C to simulate boundary plating between heated bunker tank and ballast tank in double bottom.

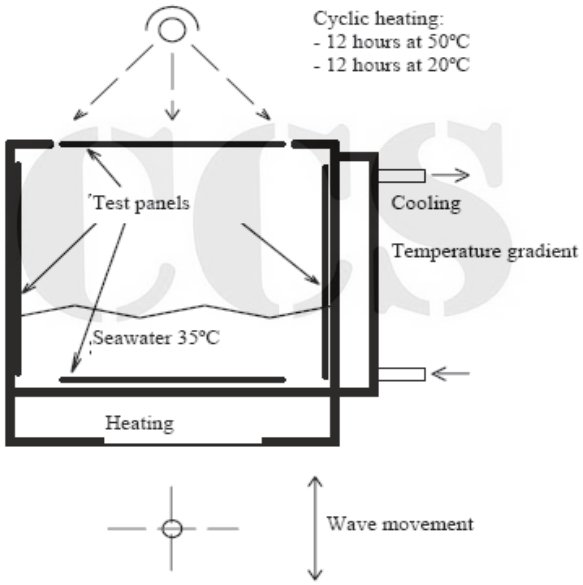


Figure 1 Wave tank for testing of ballast tank coatings

2 Test results

2.1 Prior to the testing, the following measured data of the coating system shall be reported:

(1) infrared (IR) identification of the base and hardener components of the coating;

(2) specific gravity of the base and hardener components of the paint: referring to ISO 2811-4 Paints and varnishes. Determination of density; and

(3) number of pinholes, low voltage detector at 90 V.

2.2 After the testing, the following measured data shall be reported:

(1) bubbling and rust: referring to ISO 4628-2 Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 2. ISO 4628-3 Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of common types of defect – Part 3: Designation of degree of rusting;

(2) dry film thickness (DFT) (use of a template): Nine equally distributed measuring points are used on panel's size 150 mm x 150 mm or 15 equally distributed measuring points on panel's size 200 mm x 400 mm;

(3) adhesion value: referring to ISO 4624 Pull-off test for adhesion;

(4) flexibility modified according to panel thickness: referring to ASTM D4145 Standard Test Method for Coating Flexibility of Prepainted Sheet. 3 mm steel, 300 μm coating, 150 mm cylindrical mandrel gives 2% elongation, for information only;

(5) cathodic protection weight loss/current demand/peeling from artificial holiday; and

(6) undercutting from scribe. The undercutting along both sides of the scribe is measured and the maximum undercutting determined on each panel. The average of the three maximum records is used for the acceptance.

3 Acceptance criteria

3.1 The test results based on section 2 is to satisfy the following criteria:

Item	Acceptance criteria for epoxy-based systems applied according to Table 1 of PSPC	Acceptance criteria for alternative systems
Bubbling on panel	No bubbling	No bubbling
Rust on panel	Ri0 (0%)	Ri0 (0%)
Number of pinholes	0	0
Adhesive failure	>3.5MPa, adhesive failure between substrate and coating or between coats for 60% or more of the area	>5.0MPa, adhesive failure between substrate and coating or between coats for 60% or more of the area
Cohesive failure	>3.0MPa, cohesive failure in coating for 40% or more of the area	>5.0MPa, cohesive failure in coating for 40% or more of the area
Cathodic protection current demand calculated from weight loss	<5mA/m^2	<5mA/m^2
Cathodic protection; peeling from artificial holiday	<8mm	<5mm
Undercutting from scribe	<8mm	<5mm
U-bar	Any defects, cracking or detachment at the angle or weld will lead to system being failed	Any defects, cracking or detachment at the angle or weld will lead to system being failed

3.2 Epoxy-based systems tested when applied according to table 1 of PSPC are to satisfy the criteria for epoxy-based systems as indicated in the table above.

3.3 Alternative systems not necessarily epoxy-based and/or not necessarily applied according to table 1 of PSPC shall satisfy the criteria for alternative systems as indicated in the table above.

4 Test report

The test report is to include the following information:

4.1 name of the manufacturer;

4.2 date of tests;

4.3 product name/identification of both paint and primer;

4.4 batch number;

4.5 data of surface preparation on steel panels, including the following:

(1) surface treatment;

(2) water soluble salts limit;

(3) dust; and

(4) abrasive inclusions;

4.6 application data of coating system, including the following (among which recoat interval, dry film thickness prior to testing, thinner, humidity and air temperature include both of actual specimen data and manufacturer's requirement/recommendation):

(1) shop primed;

(2) number of coats;

(3) recoat interval;

(4) dry film thickness (DFT) prior to testing;

(5) thinner;

(6) humidity;

(7) air temperature; and

(8) steel temperature;

4.7 test results according to section 2; and

4.8 judgment according to section 3.

Appendix 4 Condensate Tank Test for Ship Ballast Tank Coating

The test is prepared in accordance with Appendix 2 of IMO Resolution MSC.215(82) Performance Standard for Protective Coatings for Dedicated Seawater Ballast Tanks in All Types of Ships and Double-side Skin Spaces of Bulk Carriers.

1 Test condition

Condensation chamber test is to be conducted in accordance with applicable standards, with reference to ISO6270-1 Paints and varnishes-Determination of resistance to humidity-Part 1: Continuous condensation.

1.1 The exposure time is 180 days.

1.2 There are to be 2 test panels.

1.3 The size of each test panel is 150 mm x 150 mm x 3 mm. The panels are to be treated according to paragraphs 1, 2 and 3 of Table 1 of IMO Resolution MSC.215(82) and coating system applied according to paragraphs 1.4 and 1.5 of Table 1 of IMO Resolution MSC.215(82). Shop primer to be weathered for at least 2 months and cleaned by low pressure washing or other mild method. Blast sweep or high pressure washing, or other primer removal methods not to be used. Weathering method and extent shall take into consideration that the primer is to be the foundation for a 15 year target life system. To facilitate innovation, alternative preparation, coating systems and dry film thicknesses may be used when clearly defined.

1.4 The reverse side of the test piece shall be painted appropriately, in order not to affect the test results.

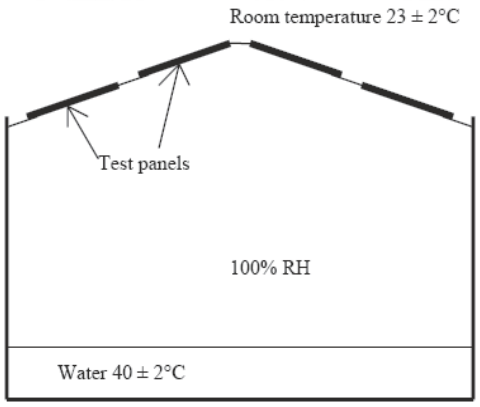


Figure 2 Condensation chamber

2 Test results

According to Section 2 of Appendix 3, but except for undercutting from scribe and cathodic protection weight loss/current demand/peeling from artificial holiday.

3 Acceptance criteria

3.1 The test results based on Section 2 are to satisfy the following criteria:

Item	Acceptance criteria for epoxy-based systems applied according to Table 1 of PSPC	Acceptance criteria for alternative systems
Bubbling on panel	No bubbling	No bubbling
Rust on panel	Ri0 (0%)	Ri0 (0%)
Number of pinholes	0	0
Adhesive failure	>3.5MPa, adhesive failure between substrate and coating or between coats for 60% or more of the area	>5.0MPa, adhesive failure between substrate and coating or between coats for 60% or more of the area
Cohesive failure	>3.0MPa, cohesive failure in coating for 40% or more of the area	>5.0MPa, cohesive failure in coating for 40% or more of the area

3.2 Epoxy-based systems tested when applied according to Table 1 of IMO Resolution MSC.215(82) are to satisfy the criteria for epoxy-based systems as indicated in the table above.

3.3 Alternative systems not necessarily epoxy-based and/or not necessarily applied according to table 1 of this Standard are to satisfy the criteria for alternative systems as indicated in the table above.

4 Test report

According to Section 4 of Appendix 3.

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Appendix 5 Gas-tight Cabinet Test for Cargo Hold at Vapor Phase under Simulated Loaded condition

The test is prepared in accordance with Appendix 1 of IMO Resolution MSC.288(87) Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers.

1 Test condition

The vapor test is to be carried out in a gas-tight cabinet. The dimensions and design of the airtight gas cabinet are not critical, provided the requirements of paragraphs 1.6 to 1.10 below are met. The test gas is designed to simulate the actual crude oil cargo tank environment in ballast condition as well as the vapor conditions of the loaded tank.

1.1 The exposure time is 90 days.

1.2 Testing is to be carried out using duplicate panels; a third panel is to be prepared and stored at ambient conditions to act as a reference panel during final evaluation of the test panels.

1.3 The size of each test panel is 150mm x 100mm x 3mm.

1.4 The panels are to be treated according to paragraph 1.2 of Table 1 of IMO Resolution MSC.288(87) and the coating system applied according to paragraphs 1.4 and 1.5 of Table 1 of IMO Resolution MSC.288(87).

1.5 The zinc silicate shop primer, when used, is to be weathered for at least 2 months and cleaned by low pressure fresh water washing. The exact method of shop primer preparation before being over coated is to be reported, and the judgment issued for that specific system. The reverse side and edges of the test piece are to be coated appropriately, in order not to influence the test results.

1.6 Inside the gas-tight cabinet, a trough is to be present. This trough is to be filled with 2±0.2l of water. The water in the trough is to be drained and renewed prior to each time the test gas is refreshed.

1.7 The vapor spaces inside the gas-tight cabinet are to be filled with a mixture of test gas as per item 5 of Annex 1 of IMO Resolution MSC.288(87). The cabinet atmosphere is to be maintained over the period of the test. When the gas is outside the scope of the test method, it is to be refreshed. The monitoring frequency and method, and the date and time for refreshing the test gas are to be in the test report.

1.8 The atmosphere in the test cabinet is at all times to be 95±5% relative humidity.

1.9 Temperature of the test atmosphere is to be 60±3℃.

1.10 A standard for the test panels is to be made of a suitable inert material to hold the panels vertically spaced at least 20mm between panels. The stand is to be positioned in the cabinet to ensure the lower edge of the panels is at least 200mm above the height of the water and at least 100mm from the walls of the cabinet. If two shelves are in the cabinet, care is to be taken to ensure solution does not drip on to the lower panels.

2 Test results

2.1 Prior to testing, the following measured data of each coating composing the coating system, including the zinc silicate shop primer when used under the coating system, are to be reported:

2.1.1 Infrared (IR) identification of the base and hardener components of the coating;

2.1.2 Specific gravity of the base and hardener components of the paint; and

2.1.3 mean dry film thickness (DFT) (by using a template).

2.2 After completion of the test duration, the panels are to be removed from the cabinet and rinsed with ward tap water. The panels are to be dried by blotting with absorbent paper and, then, evaluated for rust and bubbling within 24h of the end of the test.

2.3 After testing, the following measured data are to be reported: bubbling and rust

3 Acceptance criteria

3.1 The test results based on section 2 are to satisfy the following criteria, the poorest performing of the duplicate test panels is to be used in the report:

Item	Acceptance criteria for epoxy-based systems	Acceptance criteria for alternative systems
Bubbling on panel	No bubbling	No bubbling
Rust on panel	Ri0 (0%)	Ri0 (0%)

3.2 When evaluating test panels, bubbling or rusting within 5mm of the panel edge is to be ignored.

4 Test report

The test report is to include the following information:

4.1 Coating manufacturers' name and manufacturing site;

4.2 Dates of test;

4.3 Product name/identification of each coat and, where applicable, zinc silicate shop primer;

4.4 Batch numbers of each component of each product;

4.5 Details of surface preparation of steel panels, before shop primer application, and treatment of the shop primer before over coating where relevant and at a minimum including the following:

4.5.1 Surface treatment or treatment of weathered shop primer, and any other important information on treatment influencing the performance; and

4.5.2 Water soluble salt level measured o the steel prior to application of the shop primer;

4.6 Details of coating system, including the following:

4.6.1 Zinc silicate shop primer if relevant, its secondary surface pre-treatment and condition under which applied, weathering period;

4.6.2 Number of coats, including the shop primer and thickness of each;

4.6.3 Mean dry film thickness (DFT) prior to testing;

4.6.4 Thinner if used;

4.6.5 Humidity;

4.6.6 Air temperature; and

4.6.7 Steel temperature;

4.7 Details of schedule for refreshing the test gas;

4.8 Test results according to section 2; and

4.9 Results according to section 3.

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Appendix 6 Immersion Test for Crude Oil Tank under Simulated Loaded Condition

The test is prepared in accordance with Appendix 2 of IMO Resolution MSC.288(87) Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers.

1 Test condition

The immersion test is developed to simulate the conditions in a crude oil tank in loaded condition.

1.1 The exposure time is 180 days.

1.2 The test liquid is to be made as per paragraph 1.6 of Appendix 5 of the Guidelines.

1.3 The test liquid is to be added to a container with an inside flat bottom until a column of the test liquid of height of 400 mm is reached, resulting in an aqueous phase of 20 mm. Any other alternative test set-up, using an identical test liquid, which will also result in the immersion of the test panel in 20 mm of the aqueous phase, is also accepted. This can be achieved by using, for instance, inert marbles.

1.4 The temperature of the test liquid is to be 60 ± 2 ℃ and be uniform and maintained constant with recognized methods such as water or oil bath or air circulating oven capable of keeping the immersion liquid within the required temperature range.

1.5 Test panels are to be positioned vertically and fully immersed during the test.

1.6 Testing is to be carried out using duplicate panels.

1.7 Inert spacers which do not cover the test area are to be used to separate test panels.

1.8 The size of each test panel is 150 mm x 100 mm x 3 mm.

1.9 The panels are to be treated according to 1.2 of Table 1 in IMO Resolution MSC.288(87) and the coating system applied according to 1.4 and 1.5 of Table 1 in IMO Resolution MSC.288(87).

1.10 The zinc silicate shop primer, when used, is to be weathered for at least 2 months and cleaned by low pressure fresh water washing. The exact method of shop primer preparation before being over coated is to be reported, and the judgment issued for that specific system. The reverse side, and edges, of the test piece are to be coated appropriately, in order not to influence the test results.

1.11 After the full immersion test period is completed, the panels are to be removed from the test liquid and wiped with dry clean cloth before evaluation of the panels.

1.12 Evaluation of the test panels is to be done within 24 h after completion of the test.

2 Test results

2.1 Prior to testing, the following measured data of each coating composing the coating system, including the zinc silicate shop primer when used under the coating system, are to be reported:

2.1.1 Infrared (IR) identification of the base and hardener components of the coating;

2.1.2 Specific gravity of the base and hardener components of the paint; and

2.1.3 Mean dry film thickness (DFT) (by using a template).

2.2 After testing, the following measured data are to be reported: bubbling and rust.

3 Acceptance criteria

3.1 The test results based on section 2 are to satisfy the following criteria, the poorest performing of the duplicate test panels is to be used in the report:

Item	Acceptance criteria for epoxy-based systems	Acceptance criteria for alternative systems
Bubbling on panel	No bubbling	No bubbling
Rust on panel	Ri0 (0%)	Ri0 (0%)

3.2 When evaluating test panels, bubbling or rusting within 5 mm of the panel edge is to be ignored.

4 Test report

The test report is to include the following information:

4.1 Coating manufacturers' name and manufacturing site;

4.2 Dates of test;

4.3 Product name/identification of each coat and, where applicable, zinc silicate shop primer;

4.4 Batch numbers of each component of each product;

4.5 Details of surface preparation of steel panels, before shop primer application, and treatment of the shop primer before over coating where relevant and at a minimum including the following:

4.5.1 Surface treatment, or treatment of weathered shop primer, and any other important information on treatment influencing the performance; and

4.5.2 Water soluble salt level measured on the steel prior to application of the shop primer;

4.6 Details of coating system, including the following:

4.6.1 Zinc silicate shop primer if relevant, its secondary surface pre-treatment and condition under which applied, weathering period;

4.6.2 Number of coats, including the shop primer, and thickness of each;

4.6.3 Mean dry film thickness (DFT) prior to testing;

4.6.4 Thinner is used;

4.6.5 Humidity;

4.6.6 Air temperature; and

4.6.7 Steel temperature;

4.7 Test results according to section 2; and

4.8 Results according to section 3.

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CHAPTER 2 FIBER ROPES

2.1 Application

2.1.1 This Chapter applies to synthetic fiber ropes for ships engaged on international voyages and domestic voyages:

(1) Ship securing, towing and towed;

(2) Goods securing, hoisting and lashing.

2.2 Basis for approval and inspection

2.2.1 CCS Rules for Materials and Welding, PART TWO, Chapter 7;

2.2.2 ISO1346-2004 Performance and Specification of Polypropylene Rope;

2.2.3 ISO1141-2004 Performance and Specifications of Polyester Rope;

2.2.4 ISO1140-2004 Performance and Specifications of Polyamide Rope;

2.2.5 ISO2307-2005 Ropes — Determination of Certain Physical and Mechanical Properties.

2.3 Terms and definitions

2.3.1 GB3291-82 Textile Terms and Terminology (General Parts of Textile Materials and Textile Products)

2.3.2 Linear density means the mass per unit length of fiber rope under pre-load, in ktex.

2.3.3 Rated breaking load means the nominal value which is to be reached or exceeded during breaking test, and also used to verify the nominal diameters of fiber ropes, in kN.

2.3.4 Actual breaking load means the actually measured value of fiber rope breaking load during breaking test, in kN.

2.3.5 Pre-tension means load applied to determine nominal diameter and linear density of a fiber rope in accordance with recognized standards, which is generally defined as 1‰ of the minimum breaking force, in kN.

2.3.6 Nominal diameter means generally recognized diameter (also named nominal diameter) to indicate rope specification and determine rated breaking strength and linear density, in mm.

2.3.7 Measured diameter means the diameter measured under pre-load, in mm.

2.3.8 Lay length means the length of same stranded rope with n complete strands for stranded rope and length of same twisted rope with n complete twists for plaited rope, in mm.

2.4 Plans and documents

2.4.1 The applicant is to submit the following documents to CCS for approval when applying for works approval to CCS:

(1) technical requirements for acceptance or enterpriser's standard;

(2) type test program.

2.4.2 The applicant is to submit the following documents to CCS for information when applying for works approval to CCS:

(1) the standard applicable to rope;

(2) source of raw materials and technical requirements for acceptance;

(3) quality management and control documents;

(4) particulars of manufacturer, history and relevant description of rope manufacturing;

(5) a list of main equipment for rope producing and inspection;

(6) conditions of inspection personnel;

(7) flow chart of manufacturing process and documents;

(8) format of report for approval and delivery inspection test;

(9) document of entering to the register of enterprise;

(10) specimen of product quality certificate.

2.5 Design and technical requirements

2.5.1 Raw materials are to be attached with a quality certificate by the supplier and be re-tested by the manufacturer incoming inspection.

2.6 Selection of typical samples

2.6.1 Principles for sampling

2.6.1.1 Samples are to be taken from the fiber ropes with the same raw materials lot number, the same structure and sizes, and the same production procedure. Except as agreed otherwise, S samples are to be taken at random from the above mentioned fiber ropes for test. *S* is obtained by the following formula:

$$S = 0.4 \times N^{1/2} \qquad \text{(Number)}$$

where: *S* — number of samples, in number;

N — roll number of fiber ropes to compose of a batch, in roll.

Where *S* is not an integral number, the obtained value is to be rounded off to the nearest number. When $S < 1$, take one sample.

2.6.1.2 In the works type approval test, generally one maximum sized rope is to be taken, and samples must be taken from the complete rope rather than breaking strands.

2.6.1.3 Raw materials subject to sampling test: selecting samples in principle that the ropes of same color and same grade are regarded as a batch, while threads and lines of different materials are sampled respectively. Take 5 packages from a batch in a raw material warehouse and select 2 reels (hanks) from each package as specimen.

2.7 Type test

2.7.1 Inspection items for ropes

2.7.1.1 Visual examination

(1) Visually inspect the strands evenness and smoothness, breaking strands, slack twists and to check if there is any wearing, scratch, cutting or other types of damage existing.

(2) Visually inspect any oil and color variance on rope surface.

2.7.1.2 Test methods and procedures for physical properties may be referred to in ISO2307-2005 or GB8834-2006 Ropes — Determination of Certain Physical and Mechanical Properties.

2.7.1.3 Physical property test items

(1) diameter measuring;

(2) linear density calculation;

(3) breaking force test; (test is to adopt completed rope instead of calculating by breaking strands).

2.7.2 Inspection items for raw materials: to carry out test in accordance with raw materials acceptance technical requirements provided by the manufacturer.

2.7.2.1 Visual inspection: for the same batch of products, their color differences are generally in consistency, surface are smooth, no scratch, and no undrawn yarn is allowed.

2.7.2.2 For physical property, the following items are to be tested:

(1) nominal diameter measuring (only for single thread inspection);

(2) test for fiber breaking elongation;

(3) fiber breaking load;

(4) fiber linear density.

2.7.3 Test procedure

2.7.3.1 Measure the original length, represented by L_0; weigh the sample, represented by m_0; and then take record. Sample rope buckles are to be completed by the manufacturer. According to 5.3.1.1, Chapter 5 of the Rules, the minimum free length of the specimen between grips is 900 mm.

(1) At the same time of measuring initial length L_0 , it is to determine the gauge length of specimen, represented by D_0 before the specimen is installed on testing machine and flared out by manual. Two points symmetrical to the midpoint of specimen are to be marked, and the least length between the two gauge length points is 0.5 m. The ropes are to be marked.

(2) Turn on the tension machine to pull the ropes up to the selected pre-tension (rule specified as 1% of the minimum breaking load) and then stop pulling, measure the current gauge length, represented by D_p.

(3) Measuring for actual diameter: the measured diameter may be obtained by measuring the circumferences of three positions on the gauge length by tape ruler under pre-tension;

(4) Measuring for breaking force: turn on tension machine to start loading at the stretching speed of 75±25mm/min until ropes break. When the breaking occurs between two gauge lengths of the specimen, the value displayed on tension machine is the breaking force of ropes; while breaking happens beyond two marks and lower than rated breaking force, the specimen may also be deemed to be compliable with breaking force index incase the breaking force displayed on tension machine is not less than 90% of the breaking force index. If the specimen fails to pass the test, it is acceptable to re-select 2 specimens from the original ropes for re-test. The results will be accepted when both specimens pass the tests, while one of the specimen fails, such rope will be determined as unaccepted.

(5) Linear density calculation

Linear density may be obtained by formula (1):

$$\rho_x = m_o / L \tag{1}$$

where: ρ_x —linear density, in ktex;

m_o— specimen quality, in g;

L — calculated by formula (2), the specimen length influenced by pre-tension, in m;

$$L = (D_p \times L_O)/D_O \tag{2}$$

where: D_O— initial distance (at least 0.5 m) between measured marks according to 2.7.3.2(1), in m;

D_p— distance between marks measured under pre-tension according to 2.7.3.2(2), in m;

L_O— measured initial overall length of specimen according to 2.7.3.1, in m.

2.8 Unit/batch inspection

2.8.1 Take specimen in accordance with paragraph 2.6.1.1.

2.8.2 Test items and procedures are to be performed in test and inspections according to 2.7.1 and 2.7.3 of this Chapter.

2.8.3 Test reports are to contain the following items:

Rated force	kN	Rope materials	
Structure of rope	Strand	Specifications	(mm×m)
Model of tension machine		Period of validity	
Ambient temperature	(℃)	Relative humidity	(%)
Test No.		Measured diameter	(mm)
Lay length	(mm)	Breaking force	kN
Stretching speed	(mm/min)	Breaking position	
Rated linear density	(ktex)	Linear density	ktex
Results		Test date	

2.9 Mark and certificate

2.9.1 Each roll of finished fiber ropes subject to acceptance is to be obviously tied with a label indicating product name, serial number, materials, structure, specifications, manufacturer name and CCS mark.

2.9.2 The manufacturer is to provide the qualified fiber ropes with qualification certificate containing at least the following:

(1) product names, models and serial numbers;

(2) materials used for fabircating fiber ropes;

(3) length of whole fiber rope roll and diameter of rope;

(4) linear density of fiber ropes;

(5) fabric of fiber ropes;

(6) rated breaking load of fiber ropes (indicate the actual breaking load where necessary).

PART FIVE MACHINERY

CHAPTER 1 DIESEL ENGINES AND THEIR MAIN COMPONENTS AND PARTS

1.1 Application

1.1.1 This Chapter applies to approval and inspection of main propulsion diesel engines, diesel engines for driving generators and other class-related marine diesel engines.

1.1.2 Test of nitrogen oxides emission from diesel engines is to refer to Guidelines for Testing and Survey of Emission of Nitrogen Oxides from Marine Diesel Engines.

1.2 Basis for approval and inspection

1.2.1 Currently effective CCS Rules for Classification of Sea-going Steel Ships.

1.2.2 Currently effective CCS Rules for Materials and Welding.

1.3 Definitions

1.3.1 The definitions in CCS Rules for Classification of Sea-going Steel Ships are applicable to this Chapter.

1.3.2 For the purpose of this Chapter:

(1) Low speed diesel engine is a diesel engine with a rated speed equal to or less than 300 r/min.

(2) Medium speed diesel engine is a diesel engine with a speed over 300 r/min, but equal to or less than 1000 r/min.

(3) High speed diesel engine is a diesel engine with a speed over 1000 r/min.

(4) Rated output is the maximum continuous output developed by diesel engines (i.e. the maximum shaft power for which the machinery is to be classed) based on the ambient conditions in unrestricted service. The rated speed is the speed corresponding to the rated output;

(5) Ambient conditions in unrestricted service:

Total barometric pressure	0.1MPa
Ambient temperature	45℃
Relative humidity	60%
Seawater temperature (charge air coolant-inlet)	32℃

1.4 Plans and documents

1.4.1 When requesting approval, the plans and documents specified in 9.1.10.1, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships are to be submitted.

1.4.2 The following plans and technical information are to be submitted for information:

(1) Those specified in 9.1.10.2, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships;

(2) Equivalent parameters of torsional vibration of diesel engines.

1.5 Main components and parts

1.5.1 A low speed diesel engine has such components and parts as bearing seat, bedplate, frame, cylinder block, crankshaft, cylinder cover, piston head, piston rod, crosshead, connecting rod, cylinder liner, tie rod, cylinder cover bolt, connecting rod bolt, main bearing bolt, transmission gearing, supercharger, air cooler, main starting valve, governing system, high-pressure fuel pipe and alarm, exhaust valve hydraulic pipe, fuel injection valve, fuel injection pump, cylinder cover safety valve, explosion-proof door, overspeed protective device.

A medium or high speed diesel engine has such components and parts as engine body, crankshaft, connecting rod, piston, cylinder liner, heat exchanger, cylinder cover, high-pressure fuel pipe and alarm, connecting rod bolt, supercharger, fuel injection pump assembly.

Note: In addition to basic components and parts of diesel engines as mentioned above, attached systems or equipment of the engine are to be subject to CCS type approval or furnished with CCS product certificate or be subject to survey and test at manufacturer according to the requirements of applicable paragraphs of other Parts of CCS Rules. For example, Class I and II piping and fuel oil and lubricating oil piping (including pressure components such as engine-driven pumps), diesel engine safe and alarm system (including important sensor), electronic injection system and piping (including pump valves), mechanical joints and hoses, etc.

1.5.2 The main components and parts referred to in 1.5.1 are at least to comply with the certification requirements in Appendix 1, Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships. If the components and parts are produced by the diesel engine manufacturer itself, the Surveyor is to carry out related tests and inspections on site and sign the report, certificate of completion may not be issued necessarily. If the components and parts are purchased, the sub-contractor is to apply for inspection and certification by CCS; if any raw material is purchased from another manufacturer, the material manufacturer is to apply for inspection and certification by CCS. The attending Surveyor is to check the material certificate during inspection of completed components and parts.

1.6 Qualification of welding procedure

1.6.1 If any of the main components and parts referred to in 1.5.1 is welded, the welding procedure is to be evaluated and approved according to the relevant requirements of CCS Rules for Materials and Welding.

1.7 Design and technical requirements

1.7.1 Ambient conditions

(1) Marine diesel engines are to operate normally with the ship having a 15° heel, or 22.5° roll, or 5° trim or 7.5° pitch. An emergency diesel engine is to operate normally and start up at 0℃ with both heel and roll being 22.5° or trim and pitch being 10°.

1.7.2 Check of strength and torsional vibration of crankshaft

(1) Crankshaft strength check is to be carried out according to the requirements in Appendix 3, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

(2) Calculation for check of torsional vibration is to be based on the equivalent parameters of torsional vibration submitted according to Chapter 12, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

1.7.3 NO_x emission from diesel engines

(1) The requirements for NOx emission from diesel engines are give in CCS Guidelines for Testing and Inspection of NOx Emission from Diesel Engines.

1.7.4 Materials

(1) The requirements for testing materials of diesel engine components and parts are give in 9.2.2, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

(2) The requirements for non-destructive tests of diesel engine components and parts are given in 9.2.3, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

1.7.5 Requirements for pressure tests of diesel engine components and parts

(1) See 9.10.2, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

1.7.6 Piping arrangement

(1) See Section 4, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships for details.

(2) Diesel engines are to be fitted with high-pressure jacketed pipe assemblies and fuel leak alarms to comply with the requirements in Ch.II-2/Reg.4.2.2.5.2 and Reg.4.2.2.5.4 of 2000 Amendments to SOLAS, 1974.

1.7.7 Starting arrangements

(1) See Section 5, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships for details.

1.7.8 Scavenging and supercharging arrangements

(1) See Section 6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships for details.

1.7.9 Fittings such as valves and governors

(1) See Section 7, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships for details.

1.8 Type test

1.8.1 Selection of typical samples

(1) Low speed diesel engines for type test are to be selected according to the following principles:

① the type of the engines selected is to be representative;

② the engines selected have been manufactured in accordance with the plans and technical documents approved by CCS;

③ internal tests have been carried out by the manufacturer to the engines for ensuring their reliable performance.

(2) Medium and high speed diesel engines for type test are to be selected according to the following principles:

① the type of engines selected is to represent the normal production ability of the manufacturer;

② the engines selected are to comply with enhanced criteria.

1.8.2 Type test items

(1) Type test for non-mass produced engines are to be carried out according to the requirements in Appendix 4, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

(2) Type test for mass produced engines are to be carried out according to the requirements in 1.2 of Appendix 6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, and then according to the requirements in Appendix 5, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

1.8.3 Test conditions

(1) If the test bench of the manufacturer is taken as approval test location, it is to be able to finish the test items specified in the test program. CCS will check the testing ability, testing means and testing personnel to confirm compliance with relevant requirements. Otherwise, the tests are to be carried out in places deemed appropriate by CCS.

(2) The measuring instruments used in the tests are to have valid calibration certificates.

1.9 Unit/batch inspection

1.9.1 Low speed diesel engines

(1) Large low speed marine diesel engines are to comply with the requirements in Appendix 1, Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

(2) The inspections are to be carried out according to the approved inspection plan (related items in quality control plan). The material inspection, welding inspection, non-destructive test, processing inspection, assembly inspection of the parts referred to in 1.5.1 and bench test of complete engines are to be carried out with the attendance of the Surveyor.

1.9.2 Medium and high speed diesel engines

(1) CCS unit/batch inspection may be requested only for those diesel engines which have been satisfactorily inspected/tested by the manufacturer and are ready for delivery.

(2) Unit/batch inspection items for products of manufacturers approved by CCS:

① material inspection: according to the requirements of 1.7.4;

② non-destructive test: according to the requirements of 1.7.4; the testing personnel must have valid qualification certificates approved by CCS;

③ the sampling ratio is to be specified in the inspection plan and specifically agreed by the manufacturer and the Surveyor. However, at least one engine is to be selected randomly from the batch and re-tested according to test items in Appendix 6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships or the test of which is to be witnessed at the manufacturer;

④ raw material quality certificates and related inspection and test records for main parts are to be submitted to CCS Surveyor for review when applying for unit/batch inspection.

(3) Inspection of products of manufacturers with CCS type approval A:

① the inspection is basically to review reports and all test items are to be completed by the manufacturer independently; inspection application is to be submitted before product delivery, together with reports/records/documents covering all tests/inspections in 1.9.1, for review by CCS Surveyor;

② periodical audits are to be requested in time by manufacturers with CCS type approval A according to the requirements in Section 4, Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

CHPATER 3 HEAT EXCHANGERS

3.1 Application

3.1.1 This Chapter applies to approval and inspection of marine heat exchangers, including shell and tube heat exchangers (such as coolers, condensers, heaters and evaporators), finned-tube heat exchangers (such as air coolers), plate heat exchangers (with plates, finned-plates, etc); design pressure is not more than 2.5 MPa and medium temperature not more than 250℃. For other types of heat exchangers, reference may be made to in this Chapter.

3.2 Basis for approval and inspection

3.2.1 CCS Rules for Classification of Sea-going Steel Ships.

3.2.2 CCS Rules for Materials and Welding.

3.3 Terms and definitions

3.3.1 Related definitions in CCS Rules for Classification of Sea-going Steel Ships are applicable to this Chapter.

3.3.2 Heat exchange surface area is the total surface area of metal cooled, heated or contacted by condensing medium.

3.4 Plans and documents

3.4.1 When products are applied for approval, the following plans and technical documents are to be submitted to CCS for approval:

(1) Main performance specifications (including heat exchange surface area, design/working pressure, design/working temperature and working medium of the entire series of products to be approved);

(2) General assembly;

(3) Drawings of main components and parts (shells, tube plates, end plates, bundles of tube, heat exchange plates, clamping plates, clamping bolts, etc.);

(4) List of physical and chemical properties of main components and parts;

(5) Calculations of heat exchange surface area, strength of pressure-containing parts;

(6) Type test program.

3.4.2 The following plans/technical documents are to be submitted to CCS for information:

(1) Technical standards applicable to the products;

(2) Performance test report for the product manufactured for the first time (if any);

(3) Product instructions;

(4) Specimens of product nameplates and manufacturer's quality certificate etc.;

(5) Main workmanship documents, such as welding procedure of shells and connection technology of tube plates.

3.4.3 For manufacturers applying for CCS type approval B, the following documents are additionally to be submitted:

(1) Particulars of the manufacturer (including history and current situation) and description of production history. If the products have been specifically verified or appraised, related reports and certificates may be attached;

(2) A quality control plan for the products to be approved is to be developed by the manufacturer and submitted to CCS for approval. This quality control plan is to specify the quality assurance and control methods used in the manufacturing process according to the technical requirements or standards for the products. The quality control plan is to include an inspection plan after approval, and to reflect in particular the inspection and test requirements of CCS.

3.4.4 For manufacturers applying for CCS type approval A, a whole set of quality management system documents covering the products to be approved and complying with ISO 9000 standard or an equivalent standard is additionally to be submitted, of which the workmanship documents of inspections and tests according to requirements of CCS rules are to be approved by CCS.

3.5 Main components and parts

3.5.1 Main components and parts include shells, tube plates, end plates, bundles of tube, heat exchange plates, clamping plates, clamping bolts and spool pipes, etc.

3.5.2 For pressure-containing parts such as shells, end plates, bundles of tube, 100% hydraulic test is required before being assembled.

3.5.3 If the main components and parts referred to in 3.5.1 are purchased, the applicant must establish perfect means to control subcontractors for ensuring the quality of such parts and must provide material quality certificates.

3.6 Qualification of welding procedures

3.6.1 If the shells of heat exchangers are of welded construction, the welding procedure is to be evaluated and approved according to the relevant requirements of CCS Rules for Materials and Welding.

3.7 Design and technical requirements

3.7.1 Material requirements

(1) The materials of main components and parts of marine heat exchangers are to be selected for the type, temperature and pressure of working medium.

(2) For the steel plates used in manufacturing heat exchangers of a marine refrigerating plant, the lower limit of calibrated tensile strength is not to exceed 430 MPa.

(3) The heat exchange tubes in contact with seawater are not to be made of red copper.

(4) The thickness of copper layer of processed clad interface of copper/steel clap plates is not to be less than 3 mm. Ultrasonic testing is to be carried out to inspect the clad quality. See Section 9, Chapter 3, PART ONE of CCS Rules for Materials and Welding for relevant requirements.

(5) The Ω-shaped expansion joint of shell and tube heat exchangers are usually made of bent seamless steel tubes. The Ω-shaped expansion joint is to have an opening of more than 15 mm and a height more than 1.6 R. The wall thickness of seamless tubes is not to be less than minimum thickness obtained by shell strength calculation (R being external radius of seamless tubes).

(6) The nominal plate thickness of plate heat exchangers is not to be less than 0.5 mm. The thickness reduction in plate molding is not to exceed 25% of plate thickness.

(7) The sealing materials are to be selected for the type, temperature, pressure of working medium and the environmental protection requirements. The gasket thickness of plate heat exchangers is to have positive tolerance, as shown in Table 3.7.1(7).

Tolerance of Gasket Thickness **Table 3.7.1(7)**

Nominal heat exchange surface area of single plate, in m^2	**≤ 0.3**	**> 0.3~1.0**	**>1.0**
Tolerance of gasket thickness, in mm	+0.1 0	+0.2 0	+0.3 0

(8) The deviation of plate corrugation depth and gasket slot depth is given in Table 3.7.1(8).

Deviation of Corrugation Depth, Gasket Slot Depth **Table 3.7.1(8)**

Depth deviation, in mm	**Nominal heat exchange surface area of single plate, in m^2**		
	≤ 0.3	> 0.3~1.0	>1.0
Corrugation	± 0.1	± 0.15	± 0.20
Gasket slot			

(9) The fin of air coolers is to be of disturbing construction with a thickness of 0.15 ~ 0.2 mm to intensify heat transfer.

(10) The heat exchange tube is to be tested as follows:

① Flattening test: the tube is to be flattened till the interior surfaces of the tube contact each other without damage and crack.

② Expanding test: the end of the tube is to be expanded with a punch having an angle of 45° to increase its outside diameter by 30% without damage and crack.

③ Tensile test: the test is to be carried out on a universal material test machine according to the requirements not inferior to material standards.

3.7.2 Requirements for manufacturing

(1) For shell heat exchangers, the clearance between the cylindrical shell inside wall and the baffle is not to be more than that specified in the following Table.

Clearance between Cylindrical Shell Inside Wall and Baffle Table 3.7.2(1)

Cylindrical shell inside diameter	Fit clearance, in mm
<150	1.8
≥150~800	2.6
>800	3.6

(2) The number of bolts joining the tube plate and cylindrical shell flange is not to exceed half of the total number of bolts.

(3) The steel balls with diameters specified in Table 3.7.2(3) are to be capable of smoothly passing finished U-tubes and coil tubes.

Ball Diameter Table 3.7.2(3)

r/*d* bending radius/tube diameter	Ball diameter		r/d bending radius/tube diameter	Ball diameter	
	Without connector	With connector		Without connector	With connector
2~3.5	0.70d	0.65d	>5~10	0.85d	0.80d
>3.5~5	0.75d	0.70d	>10	0.90d	0.85d

(4) If the heat exchange tube and tube plate are joined by expansion, the minimum size of tube bridge of tube plate hole is to be greater than 3 times wall thickness of the tube.

(5) The roughness of tube plate hole is to be up to 6.3μm. The expansion joint length of heat exchange tube and tube plate is not to exceed 90% of thickness of tube plate. The reduction of wall thickness of joined heat exchange tube and tube plate is to be calculated as follows and the value obtained is not to exceed 12%:

$$q = (t_0 - t_1)/ t_0 \times 100\%$$

where: q —— wall thickness reduction, in %;

t_0 —— wall thickness of heat exchange tube and tube plate before joining, in mm;

t_1 —— wall thickness of heat exchange tube and tube plate after joining, in mm.

(6) Zinc cure is to be provided if the end cover of heat exchanger is in contact with seawater.

(7) The joint of air cooler fin and heat exchange tube is to be firm and close. The joint perimeter is not to be less than 85% of the total perimeter of tube hole.

(8) The joint of air cooler heat exchange tube and tube plate is to be firm and reliable.

3.7.3 Strength requirements

(1) The strength of pressure-containing parts (shell, tube plate, end cover and heat exchange tube, etc) is to be calculated according to relevant requirements in Chapter 6, PART THREE of CCS Rules for Classification of Sea-going Steel Ships. The strength of pressure-containing parts of the heat exchanger of a refrigeration system is also to comply with the requirements in Section 3, Chapter 2, PART FIVE of CCS Rules for Classification of Sea-going Steel Ships.

(2) The strength of spool pipe of heat exchanger shell is to be calculated according to relevant requirements in Chapter 2, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

(3) The joint type of welded flange of heat exchanger shell is to comply with the relevant requirements in Chapter 2, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

(4) The hole and strengthening of heat exchanger shell is to be calculated according to relevant requirements in Chapter 6, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

(5) The minimum thickness of heat exchanger tube plate is not to be less than 14 mm.

(6) For threaded tubes (integral low ribbed tubes usually used for lubricating oil coolers), the outside diameter of outside ribbed wall is not to be more than the outside diameter of smooth portions at both ends. The minimum wall thickness of finished integral threaded tubes is to comply with the requirements of 3.7.3(1).

3.7.4 Pressure testing requirements

(1) Main pressure-containing parts including shell, end cover and bundle of tube of heat exchanger are to be subjected to hydraulic test separately or as an assembled unit.

(2) Both sides of assembled heat exchangers are to be hydraulically tested to 1.5 times the design pressure but not less than 0.4 MPa (except the air side of air cooler).

3.8 Type test

3.8.1 Selection of typical samples

(1) When applying for approval for the first time, the heat exchangers selected are to cover the manufacturer's processing ability and manufacturing level. Usually 1~2 heat exchangers are to be selected from each product series to be approved, according to maximum working pressure, maximum heat exchange surface area and medium value of working pressure/heat exchange surface area. If the product series has a narrow performance scope, either one with maximum working pressure and one with maximum heat exchange surface area or a single one with maximum working pressure may be selected.

(2) When renewing the approval, only one type which is the most representative or the most demanded in market may be selected from each product series.

(3) In order to ensure that approved products meet prospective operating requirements, the manufacturer is responsible for carrying out thermal performance test and fluid resistance test or function test and ensuring satisfactory results.

3.8.2 Type test items are to include:

(1) tests of chemical composition and mechanical properties of materials of main parts such as heat exchange tube/plate, tube plate, shell and end plate;

(2) inspection of heat exchange tubes;

(3) inspection of heat exchange plates;

(4) hydraulic test of main pressure-containing parts such as shell, end plate and bundle of tube;

(5) vibration test (only for air cooler);

(6) non-destructive test (shell, finished heat exchange plate);

(7) whole set pressure test;

(8) welding procedure testing;

(9) other type test items required by CCS plan examination department for special type heat exchangers.

3.8.3 Testing conditions are to be in accordance with the following requirements:

(1) CCS Surveyor is to check the manufacturer's test laboratory/test bench used as approval test location and confirm compliance with the requirements of 3.8.3(2). Otherwise, all tests are to be carried out at certification and test organizations recognized by CCS.

(2) Measuring instruments/meters used in the tests are to have valid calibration certificates. The precision of pressure gauges is not to be less than 1.6%.

3.8.4 Testing methods and requirements are as follows.

(1) Test of physical and chemical properties of raw materials of main components and parts is to be in accordance with the following requirements:

① tests of physical and chemical properties of raw materials are to be carried out for main components such as heat exchanger shell, end cover, heat exchange tube/plate, tube plate, except for those purchased raw materials or castings furnished with CCS product certificates;

② where appropriate, castings are to be sampled and sealed at the casting manufacturer supplying the applicant, in the presence of CCS Surveyor. If sampling on site is not convenient, the additionally cast samples attached to delivered castings may be accepted instead;

③ testing method and result evaluation are to be in accordance with requirements in related Chapters of CCS Rules for Materials and Welding.

(2) Inspection of heat exchange tubes is to be carried out according to 3.7.1(10) of this Chapter. Inspection of threaded tubes, U-tubes and coil tubes are to be carried out according to the following requirements:

① threaded tubes are to be inspected in accordance with 3.7.1(10) and in addition, 3.7.3(6) of this Chapter;

② U-tubes and coil tubes are to be inspected in accordance with 3.7.1(10) and in addition, 3.7.2(3) of this Chapter.

(3) Inspection of heat exchange plates is to be carried out according to 3.7.1(6) ~ 3.7.1(9) of this Chapter.

(4) Hydraulic strength tests of main pressure-containing parts are to be in accordance with the following requirements:

① main pressure-containing parts includes shell, end cover and bundle of tube of the heat exchanger and are normally to be subjected to hydraulic test separately or as an assembled unit;

② the hydraulic test pressure of different types of heat exchanger pressure-containing parts is to be determined as follows:

a) for shell, end cover and bundle of tube of the heat exchanger, the testing pressure is to be 1.5 times the design pressure and last for 15 min;

b) if the cast iron or copper end cover has not gone through anti-corrosion processing, the testing pressure for heat exchange tube is to be 2 times the design pressure and last for 15 min;

③ the surface of test pieces is to be clean and have no coating, free from leakage and "sweat".

(5) The vibration test of air coolers is to be in accordance with the following requirements:

① the aim of vibration test is to check the reliability of joining technology for heat exchange tube and tube plate;

② the test is to be carried out on a vibration test machine with the test cooler being installed horizontally and its weather side in rigid screwed connection with the test machine; the water jacket space is to be full of water; water pressure is to be water side working pressure of the tested heat exchanger;

③ tentative vibration test is to determine whether any resonance occurs throughout the testing frequency (4 ~ 50 Hz). Test frequencies and amplitudes are given in Table 3.8.4(5):

Table 3.8.4(5)

Vibration frequencies, in Hz	Frequency interval, in Hz	Amplitude, in mm	Residence time, in s
4~33	1	±0.25	15
34~50	1	±0.076	15

④ if a resonance frequency is revealed during tentative vibration test, the vibration test is to be carried out at the resonance frequency for at least 2 h; if no resonance occurs, the vibration test is to be carried out with 50Hz frequency and ±0.4 mm amplitude for 2 h;

⑤ a thorough examination of the tested heat exchanger is to be carried out for loosening, disordering, distortion and leakage upon the completion of testing;

⑥ vibration test may be carried out in conjunction with durability test of diesel engines.

(6) Non-destructive test (for shell of heat exchangers, finished heat exchange plate of plate heat exchangers) is to be in accordance with the following requirements:

① the welded shell of heat exchangers is to be subjected to non-destructive test according to the requirements in Chapter 7, PART THREE of CCS Rules for Materials and Welding;

② the finished heat exchange plate of plate heat exchangers is to be tested by penetration means, and discarded where any minor crack is revealed.

(7) The whole unit test is to be in accordance with the following requirements:

① both sides of assembled heat exchangers are to be hydraulically tested to 1.5 times the design pressure but not less than 0.4 MPa (except air cooler) for 15 min, clean water with normal temperature is to be used as test medium and no leakage is allowed;

② the air side of air coolers is to be tested to design pressure for 15 min and no leakage is allowed;

③ the vacuum space of vacuum heat exchangers is to be tested to design pressure plus 0.1 MPa for 15 min and no leakage is allowed;

④ the refrigerant side of satisfactorily hydraulically tested heat exchangers of refrigeration systems is to be tested for airtightness to design pressure for 30 min and no leakage is allowed;

⑤ both jacket spaces of plate heat exchangers are to be hydraulically tested respectively to 1.25 times the design pressure for 15 min; clean water with normal temperature is to be used as test medium and no leakage and interconnection of the two jacket spaces are allowed;

⑥ if the tube-side design pressure of shell and tube heat exchangers is greater than the shell-side design pressure, the joint pressure test is to be carried out in accordance with the plan or by the method agreed with CCS. In the case of pressure test of the whole unit, equal pressure may be applied to tube/shell if the shell-side material stress is less than or equal to 0.9 times σs; alternatively, if the test is not to be carried out in the above way, the shell-side is to be tested for ammonia leakage in addition to the original pressure test.

(8) The welding procedure test is to be in compliance with 3.6 of this Chapter.

(9) In addition to the above items, the test items for special or strange type products and those deemed necessary by CCS or specified by plans/specifications are to be agreed between CCS Surveyor and the applicant.

3.8.5 Determination of test items and exemption

(1) Usually all test items applicable in 3.8.2 of this Chapter are to be carried out when the applicant applies for approval for the first time. The applicant may apply for exemption from the test items specified in 3.8.2(5) of this Chapter in written form, and CCS will consider the application according to the applicant's production, history of production and usage record of his products provided that the following conditions are met:

① the applicant is to be able to provide a test report of corresponding test items issued by an authoritative technical organization (General Administration of Quality Supervision, or a national defense laboratory) recently (within last 12 months);

② the applicant is to be able to provide a test report of corresponding test items signed by an IACS member society within last 12 months;

③ the products to be approved are to be manufactured upon technology transfer or authorization, and the products so manufactured are to have been approved by CCS for their design;

④ the applicant is to be able to provide a test report of corresponding test items issued by the user (associated diesel engine manufacturer) recently (within last 12 months).

(2) Re-approval is to be requested when the approval certificate is to be renewed. If there is no change to design plans and production process of products and if there is no change to technical requirements of CCS Rules for Classification of Sea-going Steel Ships for such type of products, the tests specified in 3.8.2(2)~3.8.2(5) and in 3.8.2(8) may be omitted. However, CCS still reserves the right to require type test again.

3.9 Unit/batch inspection

3.9.1 Upon CCS design/type approval, the marine heat exchangers manufactured according to approval conditions (including equipment, workmanship, etc) may be installed on board only after satisfactory unit/batch inspection by CCS.

3.9.2 Specific inspection methods after approval will be notified by CCS to the manufacturer in written form when issuing the design/type approval certificate.

3.9.3 The unit/batch inspection is to be carried out in accordance with Table 3.9.3.

Table 3.9.3

Inspection upon type approval B	Inspection upon design approval
1. Review of test reports of material properties of main parts	1. Review of test reports of material properties of main parts
2. Review of manufacturer's pressure test report for whole units	2. Review of manufacturer's pressure test report for whole units
3. Review of non-destructive test report (if required)	3. Review of non-destructive test report (if required)
4. Visual examination	4. Visual examination
5. 5% sample of each product type for pressure test of whole units	5. Pressure test of whole unit one by one

3.9.4 Inspection of products by the manufacturer with CCS type approval A

(1) Periodical audits are to be requested by manufacturers with CCS type approval A according to the requirements in Section 4 Chapter 3 PART ONE of CCS Rules for Classification of Sea-going Steel Ships;

(2) The inspection is basically to review reports and all test items are to be completed by the manufacturer independently; inspection application is to be submitted before product delivery, together with reports/records/documents covering all tests/inspections in items 1~4 of Table 3.9.3, for review by CCS Surveyor.

3.9.5 Reports or documents of completed tests (except those required to be witnessed by CCS) and product quality certificates are to be submitted by the manufacturer when applying for product inspection. If CCS requires witnessing related tests, the certificate is to be issued by the Surveyor after completion of inspection.

3.9.6 During heat exchanger approval/inspection, the relevant requirements in this Chapter are to be applied and in addition, reference is to be made to specific requirements in Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

PART SIX HYDRAULIC EQUIPMENT

CHAPTER 1 HYDRAULIC DEVICES AND THEIR COMPONENTS AND PARTS

1.1 Application

1.1.1 This Chapter applies to marine hydraulic devices intended for installation onboard sea-going ships classed with CCS.

1.1.2 The hydraulic devices referred to in this Chapter include:

(1) hydraulic power devices;

(2) hydraulic automatic control devices;

(3) hydraulic remote control devices.

1.1.3 This Chapter does not cover:

(1) hydraulic actuating units/parts of hydraulic devices, such as hydraulic cylinders, hydraulic motors and remote control valves;

(2) start-up and control devices (including frequency controllers) of pump-driving power units (such as electric motors);

(3) associated electrical operating and control devices (such as electrical control devices of servo valves and proportional valves);

(4) monitoring, indication and alarm systems/devices.

The above parts and devices associated with hydraulic devices are to be certified in compliance with the requirements of Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

1.1.4 This Chapter refers only to the relevant requirements clearly specified for hydraulic power units and control devices in the International Convention for the Safety of Life at Sea, 1974 (hereinafter referred to as "SOLAS") and CCS Rules for Classification of Sea-going Steel Ships, not covering requirements which are not clearly specified therein for "hydraulic" means.

1.1.5 Although the relevant requirements for hydraulic power units and control devices of certain specific equipment and systems are not specified clearly or perfectly in SOLAS and CCS Rules for Classification of Sea-going Steel Ships, the configuration, function, capacity, protection, inspection and test of such equipment and systems, if fitted with hydraulic power units and control devices, are to comply with the equivalent technical requirements for non-hydraulic power units and control devices of corresponding equipment and systems in addition to the general requirements for hydraulic devices in this Chapter, due to the rapid development of science and technology and the continuous development and improvement of hydraulic control techniques.

1.1.6 In respect to specific requirements for steering gear hydraulic power systems, reference is to be made to certain general requirements of this Chapter and in addition, to the relevant requirements in Section 1, Chapter 13, PART THREE of CCS Rules for Classification of Sea-going Steel Ships and in Chapter 1, PART SEVEN of the Guidelines.

1.1.7 In respect to requirements for windlass hydraulic power systems, reference is to be made to certain general requirements of this Chapter and in addition, to the relevant requirements in Section 2, Chapter 13, PART THREE of CCS Rules for Classification of Sea-going Steel Ships and in Chapter 2, PART SEVEN of the Guidelines.

1.2 Basis for approval and inspection

1.2.1 The approval and inspection in this Chapter are to be based on the following documents:

(1) CCS Rules for Classification of Sea-going Steel Ships;

(2) CCS Rules for Materials and Welding;

(3) CCS Rules for Lifting Appliances of Ships and Offshore Installations;

(4) SOLAS.

1.2.2 The paragraphs in the above mentioned basis for approval and inspection quoted are part of this Chapter. For quoted documents marked with the date, their subsequent amendments (except corrigenda) or revisions will be inapplicable, hence, it is to meet the requirements of the latest edition of these documents during the product design, manufacture and inspection. However, for those quoted documents without any date marked, the latest edition applies to this Chapter.

1.3 Terms and definitions

1.3.1 The terms and definitions given in SOLAS and CCS Rules for Classification of Sea-going Steel Ships are applicable to this Chapter.

1.3.2 The following definitions are added in this Chapter:

(1) Nominal pressure in respect to hydraulic devices is usually taken as being equal to design pressure:

① for a system, nominal pressure usually is not less than the maximum permissible working pressure at the outlet of each pump unit of the system, i.e. not less than the maximum set value of the safety valve/relief valve at pump outlet;

② for hydraulic components, nominal pressure is their maximum permissible working pressure (such as the rated pressure);

③ for a multi-power/output control system, nominal pressure is also known as the maximum permissible working pressure of each power/output control subsystem, usually not greater than the set pressure of the safety valve installed therein.

(2) Working pressure usually is a combination of maximum pressure difference required for rated output power of the hydraulic actuator and pressure loss of the hydraulic system through its piping:

① for single power/output control systems, working pressure usually is the working pressure of pump outlet of each pump unit, not greater than the set pressure of the relief valve at pump outlet;

② for multi-power/output control systems, working pressure is also known as the maximum working pressure of each power/output control subsystem, usually not greater than the set pressure of the relief valve and pressure-reducing valve installed therein.

(3) Rated flow is the maximum flow possible for a piping or component:

① for non-constant power systems, rated flow usually is a combination of maximum flow required for rated output power of the hydraulic actuator and loss of capacity efficiency of the hydraulic system; for single power/output control systems, it usually is the maximum set flow of each pump unit;

② for constant power systems, rated flow usually is a combination of maximum flow required for the hydraulic actuator and loss of capacity efficiency of the hydraulic system; for single power/output control systems, it usually is the maximum set flow of each constant power pump unit;

③ for multi-power/output control systems, rated flow is also known as the maximum flow of each power/output control subsystem.

(4) Single power/output control system is a system in which the pump unit (including the standby pump unit) supplies hydraulic power for only one hydraulic actuator.

(5) Multi-power/output control system is a system in which at least one pump unit (including the standby pump unit) supplies hydraulic power for several hydraulic actuators.

(6) Hydraulic power unit is a device which directly supplies hydraulic power for hydraulic actuators (such as hydraulic cylinders, hydraulic motors) of machineries (such as hydraulic steering gears, windlasses, winches and cranes), usually including hydraulic pumps, power units (such as electrical motors, diesel engines) which drive such pumps, and related piping, fittings, control valves and oil tanks, etc.

(7) Hydraulic automatic control device is a device using a controller (such as solenoid valve, hydraulic servo valve, proportional valve) to control hydraulic power so that the controlled object (such as machine, equipment) runs automatically to the preset order in a certain working condition or at a certain parameter (i.e. controlled value), without direct manual attendance. Such control devices usually include controllers, hydraulic piping systems, fittings, hydraulic pumps supplying controlled hydraulic power, power units driving such hydraulic pumps (e.g. electrical motors) and hydraulic actuators.

(8) Hydraulic remote control device is a device using hydraulic power to remotely control the object (such as machine, equipment) so that it runs automatically according to the operator's order in a certain working condition or at a certain parameter (i.e. controlled value), with direct manual operation of means of transmitting hydraulic power. Such remote devices usually include means of transmitting hydraulic power (such as control valves, control pumps), means of receiving hydraulic power (such as servo hydraulic cylinders, remotely controlled valves), piping systems, fittings, hydraulic pumps supplying hydraulic power for remote control, power units driving such pumps (e.g. electrical motors) and hydraulic actuators.

1.4 Plans and documents

1.4.1 Unless expressly provided otherwise by CCS, the following plans and technical documents are to be usually submitted to CCS when the applicant applies for inspection or approval of marine hydraulic devices for the first time.

1.4.1.1 The following plans and documents are to be submitted to CCS for examination:

(1) List of main specifications and performance parameters (which may be included in general arrangement or hydraulic system drawing) usually covering:

① nominal pressure of each system (MPa);

② working pressure of each system (MPa);

③ set value of safety valves, relief valves, pressure-reducing valves and back pressure valves (MPa);

④ rated flow of each system (l/min);

⑤ specification, type, nominal pressure, capacity and nominal speed of hydraulic pumps;

⑥ specification, type, power, rated speed and electrical power supply of driving devices (electrical motors);

⑦ specification, type, nominal flow or diameter, nominal pressure and control power of associated solenoid/proportional/servo valves; if these valves are controlled by direct current, the voltage fluctuation data of the applicable power source which controls these valves are to be provided;

⑧ effective capacity of each oil tank (power unit oil tank, storage tanks), taken usually as 80% of total theoretical capacity of the oil tank;

⑨ arrangement of monitoring alarm points;

⑩ recommended type and applicable temperature range of hydraulic oil (compliance with the requirements for minimum and maximum ambient temperatures is necessary);

⑪ intended purpose of the product, etc.

(2) General arrangement of products, usually stating the following clearly:

① scope of supply of products for inspection (delivery);

② match relations between components of each system;

③ required installation height of hydraulic oil tank (if the hydraulic pump is not integrated with oil tank);

④ main technical parameters of products;

⑤ external dimensions.

(3) General assembly of hydraulic power/control units, usually stating the following clearly:

① relevant technical requirements for manufacturing, installation and inspection;

② main dimension (capacity), shell material;

③ fitting of oil level indicator;

④ oil suction position of hydraulic pump;

⑤ fitting of monitoring alarm sensors, such as those for oil temperature, oil level, low pressure, filter block;

⑥ setting of alarm points;

⑦ fitting of cooler (if applicable);

⑧ fitting of heater (if applicable).

(4) Drawings of following parts (if self-made):

① assembly of isolating valves and related documents;

② assembly of safety valves and related documents;

③ non-standard seals, etc.

(5) (Schematic) Diagram of hydraulic system, usually stating the following clearly:

① arrangement of complete sets of hydraulic power/control systems and their relationships (including internal oil circuit control);

② specification, type and main parameters (nominal pressure, nominal flow/diameter, rated speed, capacity, filter precision, etc.) of main components, usually including hydraulic hoses, hydraulic pumps, electrical motors, safety valves, relief valves, pressure-reducing valves, back pressure valves, solenoid valves, proportional valve/servo valves, filters, accumulators, pressure gauges and their switches, stop valves, pressure/flow/temperature measuring means, and coolers;

③ specification, type, diameter, wall thickness and material of piping systems;

④ table of (solenoid) control valve actions in working cycles of each system;

⑤ setting of safety valves, relief valves, pressure-reducing valves and back pressure valves (MPa);

⑥ main technical parameters of actuating unit (if applicable);

⑦ setting of monitoring alarm sensors, such as those for pressure, oil temperature, oil level, filter block;

⑧ recommended oil.

(6) Assembly drawing of oil manifold block, usually stating the following clearly:

① schematic hydraulic diagram;

② serial number or code name of external interfaces;

③ material type of manifold block;

④ relevant technical requirements for manufacturing and inspection.

(7) Type test programme, usually stating the following clearly:

① test items and acceptance criteria;

② test method;

③ requirements for test instrumentation;

④ requirements for ambient conditions of the test;

⑤ requirements for oil used in the test;

⑥ requirements for load-applying equipment used for the test.

1.4.1.2 The following plans and documents are to be submitted to CCS for information:

(1) Applicable technical standards.

(2) Hydraulic system calculations, usually covering check of the following:

① rated flow of the system;

② calculation or description for selection of nominal pressure of the system;

③ calculation for driving power of pumps and selection of electrical motors;

④ piping specification and rules-required wall thickness;

⑤ related calculation of isolating valves/safety valves (if self-made);

⑥ calculation or description for selection of oil pump coupling.

(3) Product instructions, usually including the following:

① rules and standards with which product design is in compliance, application of product;

② scope of supply of products and their main technical parameters (including recommended hydraulic oil);

③ working principles (with related schematic diagram);

④ requirements for installation and maintenance;

⑤ necessary safety caution;

⑥ emergency troubleshooting.

(4) Table of physical and chemical properties of material of main components and parts (if hydraulic manifold blocks and steel pipes etc. are of non-standard or non-Chinese-standard materials).

(5) Main procedure documents, such as welding procedures (if applicable) of flanges and steel tubes, heat treatment procedure.

(6) Main acceptance criteria for welding and non-destructive testing, etc., if applicable.

1.5 Main components and parts

1.5.1 Components of hydraulic devices:

Components of Hydraulic Devices **Table 1.5.1**

<table>
<tr><td rowspan="5">Hydraulic devices</td><td rowspan="3">Power unit</td><td colspan="3">Hydraulic pump</td></tr>
<tr><td rowspan="2">Pump driver</td><td>Electrical motor</td><td>Starter box (including frequency controller)</td></tr>
<tr><td colspan="2">Diesel engine</td></tr>
<tr><td colspan="3">Coupling</td></tr>
<tr><td>Fittings of piping</td><td colspan="3">Control valve (solenoid valve, proportional control valve, servo valve, etc.),safety valve, relief valve, back pressure valve, balance valve, oil filter, oil cooler, (main/standby) oil tank, steel pipe, high pressure hose, mechanical pipe joint, accumulator, heater, etc.</td></tr>
<tr><td rowspan="2">Monitoring and indicator components</td><td>Indicator</td><td colspan="2">Pressure gauge, level gauge, thermometer, lamp, etc.</td></tr>
<tr><td>Monitoring</td><td colspan="2">Pressure sensor/relay, temperature sensor, fluid level relay, travel switch, etc.</td></tr>
</table>

1.5.2 The following purchased parts of marine hydraulic devices are to have CCS marine product inspection certificates and meet their intended purposes:

(1) Electrical motors (50 kW or above) are to comply with the relevant technical requirements for motors in Chapter 3, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships and PART ELEVEN of the Guidelines.

(2) Accumulators are to comply with the relevant technical requirements for pressure vessels in Chapter 6, PART THREE of CCS Rules for Classification of Sea-going Steel Ships and PART NINE of the Guidelines. For accumulators intended to be used at ambient temperature below -19 ℃ , the shell material is to be low temperature vessel material; accumulators in which air and fluid are not isolated effectively are not to be used.

(3) Hydraulic pumps used by essential systems.

1.5.3 The following purchased parts of marine hydraulic devices, if any, are to be subject to CCS type approval, have the manufacturer's quality certificate, comply with CCS rules and meet their intended purposes:

(1) Hydraulic hoses are to comply with the relevant technical requirements in Chapter 2, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

(2) Electrical motors (below 50 kW) are to comply with the relevant technical requirements for motors in Chapter 3, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships and PART ELEVEN of the Guidelines.

1.5.4 The following purchased parts of marine hydraulic devices, if any, are to have the manufacturer's quality certificate, comply with CCS rules and meet their intended purposes:

(1) Solenoid valves and proportional valves/servo valves are to comply with the relevant technical requirements in Chapter 2 of PART THREE, in PART FOUR and PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships and in this Chapter of this PART, clearly identifying the withstand level of voltage variations.

(2) Sensors intended to be used in automatic control systems are to comply with the relevant technical requirements in Section 8, Chapter 2, PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

(3) Safety valves.

1.6 Evaluation of welding procedures

Welding structures related to equipment and system safety in hydraulic devices are to be in accordance with CCS Rules for Materials and Welding.

1.7 Design and technical requirements

1.7.1 Technical requirements

1.7.1.1 General technical requirements for marine hydraulic devices are given in Table 1.7.1.1.

General Technical Requirements for Marine Hydraulic Devices Table 1.7.1.1

No.	Specific requirements	Basis of inspection	Remarks
1	General		
1.1	Submission of plans and documents	3.3.2.1, PART ONE of CCS Rules for Classification of Sea-Going Steel Ships	Also to comply with the requirements of 1.4 of this Chapter
		1.1.3.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
		1.1.3.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
1.2	Ambient conditions	1.2.1.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. For column "main and auxiliary machinery", fitting of pump oil suction and level sensor is to comply with the requirements. 2. All components installed on hydraulic actuating unit (such as hydraulic cylinder) or connected with hydraulic actuating unit are to be secured to prevent loosening caused by impact and vibration
		1.2.1.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	For column "air", selection of hydraulic oil and control of system temperature rise are to comply with the requirements.
1.3	Corrosion protection	1.3.5.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	The manufacturer is to ensure the following: 1. All internal surfaces of oil tank are cleaned thoroughly, free from humidity, dirt, chips, fluxes, scales, slag, fibrous substances and any other contaminants; 2. All internal coatings in oil tank are to be compatible with the hydraulic oil used for the system and with the atmospheric environment, and applied according to supplier's recommendation. If such coating is not used, internal steel surfaces are to be coated with rust inhibitors compatible with the hydraulic oil; 3. For important hydraulic device on deck (such as launching arrangements of survival craft), it is recommended that seawater (salt mist) resistant material be used for oil tank
1.4	General safety	1.3.6.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Hydraulic pumps and motors are to be installed in places protected against foreseeable, or they are to be suitably protected. 2. All drive shafts and couplings are to be suitably protected, in particular rotating parts of pumps are to be additionally fitted with protective cover
		1.3.6.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Requirements for specific equipment: 1. For gas-loaded accumulators, the manufacturer is to ensure: 1) The following are to be marked on accumulators or their nameplate: — "Warning – Pressure vessel, oil is to be discharged before dismantling" — Rated air charging pressure — "Only … is to be used as charging medium (such as nitrogen) 2) Warning label is to be attached on hydraulic systems fitted with gas-loaded accumulators, indicating "Warning – system with accumulator, pressure to be reduced before repair"; the same is to be indicated on the diagram of hydraulic system
		1.3.6.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Hydraulic systems are to be so designed that protective device is arranged or fitted to prevent personnel from being hurt by surface temperature exceeding touch limit
1.5	Associated electrical components, apparatus and installations	PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships	For apparatuses controlled by direct current, e.g. solenoid valves, proportional valves and servo valves, particular attention is to be given to their capability of withstanding power and voltage variations in compliance with the requirements in 1.2.2.2, PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships. None of these apparatuses which do not meet the criterion of 25% voltage drop is allowed in systems supplied directly by accumulators. Unless the requirements in 1.2.2.3, PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships are complied with, none of these apparatuses which do not meet the criterion of 10% voltage drop is allowed. In practical application, consideration is to be given to testing voltage of electromagnetic coil terminals in operating condition of electromagnets/ relays, and the sum of total voltage drops of cables is to comply 2.12.4.2, PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships

No.	Specific requirements	Basis of inspection	Remarks
2	Materials		
2.1	General	1.2.8.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Mainly for pressure components and parts (such as steel pipes, accumulators, valves, oil manifold blocks)
		4.7.1.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	The manufacturer is to ensure the following: 1. Materials of seals and sealing devices are to be compatible with oil used, materials of adjacent parts and their working conditions and ambient conditions; 2. Components and parts are to be designed to facilitate servicing and replacing of seals and sealing devices
		4.7.1.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Essential components and parts in hydraulic power transmission systems usually include pumps, piping, valves and accumulators
2.2	Hydraulic oil	4.7.1.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. In selection of hydraulic oil, the manufacturer is to ensure compliance with service limits of hydraulic oil for hydraulic components and apparatuses in use; 2. The manufacturer is to specify the type, viscosity and temperature of recommended "hydraulic oil" medium clearly in operating instructions, complying with ambient conditions required for intended purpose of hydraulic devices; 3. Special consideration is to be given to high-water-based medium as hydraulic oil
2.3	Use of materials containing asbestos	SOLAS Reg. II-1/3-5 1.2.8.2, PART THREE of CCS Rules for Classification of Sea-going Steel Ships	Materials containing asbestos are prohibited
3	Hydraulic systems		
3.1	Hydraulic systems are not to be used for lubrication purposes	4.7.2.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.2	Strength of pipes and fittings	4.7.2.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	The manufacturer is to ensure the following: 1. All components in the system are to be selected and specified to guarantee their safe use. Components are to be selected and specified to ensure reliable operation for their intended purposes within rated limits. Special attention is to be paid for the reliability of components which might cause danger when failed or inadvertently operated; 2. Strength check is to be carried out according to piping design pressure; 3. Transmission couplings and seats are to be capable of repeatedly withstanding the maximum torque in all conditions; 4. The rated pressure of pipe connection is not to be less than maximum working pressure at its position in the system
3.3	Fitting of filters	4.7.2.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	The manufacturer is to ensure the following: 1. The fitting of filters is to limit particle contamination of the system to a level suitable for the components selected and required for intended usage; 2. All filter assemblies are to be fitted with indication for maintenance. The indication is to be easily seen by operators or maintenance personnel; 3. Bypass valve is to be provided for filter assemblies which would be damaged due to their cartridge being not capable of withstanding total pressure difference of the system; 4. The filters are to be fitted for easy access and enough space is to be provided for replacing cartridge; 5. Unless agreed between customer and supplier, the pump oil suction line is not to be fitted with (fine) filter. However, oil suction screen or coarse filter is allowed; 6. For fitting of coarse filters, the pump inlet is to be in the condition defined by the manufacturer. Special attention is to be paid to this for cold start

No.	Specific requirements	Basis of inspection	Remarks
3.4	Fitting of relief valves	4.7.2.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Design is required to prevent the pressure of all parts in the system from exceeding maximum working pressure of the system or any part of it as well as rated pressure of any specific component. Otherwise, protective measures are to be taken; 2. Relief valves or safety valves satisfying rated flow are to be installed in all (manifold/sub)systems or pipelines requiring restriction of excessive pressure; 3. Systems are to be designed, manufactured and adjusted to minimize impact pressure and charge pressure without causing danger; 4. Personnel are not to be subjected to danger at pressure loss or critical pressure drops
3.5	Fitting of escape valves	4.7.2.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.6	Fitting of accumulators	4.7.2.5, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Requirements for hydraulic systems with gas-loaded accumulators: 1) Oil pressure of gas-loaded accumulator is to be relieved automatically or the accumulator is to be isolated reliably when stopping the hydraulic system; 2) If pressure is needed after stopping the system, above requirement is not necessary; 3) All associated pressure compoments are to be used in rated range of pressure, temperature and ambient conditions, and protective device may be needed to prevent overpressure at the air side in special cases; 4) If design of the accumulator requires isolation of oil pressure when stopping the system, complete information of safe maintenance is required on the accumulator or in an obvious place near it; 5) Main routine maintenance is examination or adjustment of charge pressure. Only devices and procedures recommended by the supplier are to be used for charge of accumulator. The dial of pressure gauges used for routine pressure monitoring is to have color code or other equivalent means to clearly indicate minimum and maximum allowable working pressure ranges of the system. The gas charged is to be nitrogen or another applicable gas. 2. No fuse plug, but only a safety valve is to be provided for an accumulator supplying emergency power source. Special consideration is to be given to reliability of the safety valve and selection of its orifice (safety valves may be selected according to ISO 4126 standard); 3. If the system has effective control to charging pressure of the hydraulic accumulator, relief valve need not be fitted at inlet of accumulator, only safety valve protecting the accumulator is required at fluid side (such as on the accumulator itself or at its hydraulic oil inlet). Unless proper precautions are taken, no stop valve is allowed between safety valve and accumulator. Special consideration is to be given for selecting orifice of the safety valve with the adjusted pressure being the lesser of the following: 1) not greater than design pressure of the accumulator; 2) maximum permissible pressure of service piping system of the accumulator. 4. The opening pressure of safety valve at air side (if any) is to be more than 10% of the set pressure of safety valve at liquid side, and the relief of safety valve at air side is to limit the inside pressure of the accumulator to not more than 120% of set pressure of safety valve at fluid side in any case; 5. Accumulators in which air and liquid are not isolated effectively are not to be used

No.	Specific requirements	Basis of inspection	Remarks
3.7	Use of flexible hoses	4.7.2.6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Use of flexible hoses between fixed pipelines or between fixed pipelines and fixed equipment parts is forbidden, unless specially approved by CCS; 2. Production date of flexible hoses and flexible hose assemblies (such as season and year) is to be marked; 3. The longest storage time of flexible hoses recommended by the manufacturer is to be indicated; 4. Service life recommended by the supplier of the system is to be indicated and if possible, ambient conditions are to be considered, such as indoor or outdoor use, or any other heat source; 5. The bending radius of the flexible hose is not to be less than the maximum value recommended; 6. If failure of the flexible hose assembly will cause danger of hitting, it is to be fixed or sheltered; 7. If failure of the flexible hose assembly will cause danger of oil injection or burning, it is to be sheltered
3.8	Conditions for fitting of emergency hand pumps	4.7.2.7, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	If a solenoid valve is to be operated for the sake of safety or other reasons when its electrical control fails, it is to be provided with a manual emergency control button or similar means. Such means is to be designed and selected to prevent inadvertent operation. Unless specified otherwise, manual control is to be automatically reset when such control is relieved
3.9	Fitting of standby power pumps	4.7.2.8, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.10	Independent arrangement of the system	4.7.3.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.11	Fitting of general alarm devices	SOLAS Reg. II-1/53.4.3	Including oil temperature monitoring and alarm requirements

1.7.1.2 General technical requirements for marine hydraulic power units

(1) Marine hydraulic power units are to comply with the requirements of Table 1.7.1.1 of this Chapter and in addition, the general technical requirements of Table 1.7.1.2.

General Technical Requirements for Marine Hydraulic Power Units Table 1.7.1.2

No.	Specific requirements	Basis of inspection	Remarks
1	General		
1.1	Submission of plans and documents	2.1.2.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships 2.1.2.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	To comply with the requirements of 1.4 of this Chapter
1.2	System design pressure	2.1.3.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Unless specially required for parts such as actuators, pressure of the safety valve at pump outlet usually is simply the maximum working pressure of entire corresponding system of the pump unit; 2. For hydraulic devices with multi-purposes, separate safety valves/relief valves/pressure-reducing valves are to be installed for different intended purposes where additional protection is needed for the system and actuators. Different design pressures may be given for different parts of the system, and different settings of safety valves/relief valves are to determined. Hydraulic test and tightness test of such parts will be changed accordingly

No.	Specific requirements	Basis of inspection	Remarks
1.3	Hydraulic system design temperature	2.1.4.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Usually from maximum ambient temperature to the temperature when the inside temperature of circulating oil tank (of open-type systems) reaches 60℃ ~ 65℃ (i.e. maximum ambient temperature + system temperature rise). The system temperature rise is usually controlled within 20 K. Unless special consideration is given to selection of hydraulic oil and hydraulic components, oil cooler is to be installed; 2. The working temperature range of the system and any component is not to exceed the limits required for safe use; 3. When a heater is used, its dissipation power per unit area is not to exceed the range recommended by the hydraulic oil manufacturer. Automatic temperature control is to be adopted to keep the expected hydraulic oil temperature
1.4	Classes of pipes	2.1.5.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	There are flammable and non-flammable hydraulic oils, so the manufacturer is to specify the type and combustion properties of the hydraulic oil recommended for the system
1.5	Basic requirements for materials	2.1.6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships 4.1.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Consideration is mainly to be given to compatibility of special hydraulic media (such as seawater, pure water, high-water-based medium) with materials. The low temperature property of hydraulic oil is to meet ambient conditions for the system's intended purposes. For example, in the case of hydraulic equipment on deck, the effects on equipment performance because of viscosity variation of hydraulic oil at minimum ambient temperature are to be considered. Salt air corrosion protection within oil tank is also to be considered
2	Structure and design		
2.1	Carbon, low alloy steel pipes and valves	2.2.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. For cold-drawn steel pipes, usually the pipes delivered in annealed condition are to be purchased to ensure necessary elongation and compliance with the requirements in Chapter 4, PART TWO of CCS Rules for Materials and Welding; 2. The elongation of hydraulic manifold block material is not to be less than 12%
2.2	Check of wall thickness of steel pipes and permissible stress	2.2.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
2.3	Copper, copper alloy pipes and valves	2.3.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
2.4	Check of wall thickness of copper and copper alloy pipes and permissible stress	2.3.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
2.5	Grey cast iron pipes, valves and fittings	2.4.1.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Brittle material with impact toughness α_k less than 50 Nm/cm^2 and elongation δ less than 5% is not to be used for marine hydraulic valve casing, unless specified otherwise by CCS; 2. For Class I and Class II duplicated piping systems which could operate as each other's standby or those provided with independent emergency means, consideration may be given to using grey cast iron as casing material of hydraulic valve between power pump and oil cylinder isolating valve (not including isolating valve)
2.6	Nodular graphite cast pipes, valves and fittings	2.4.2.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
2.7	Flexible hoses	2.4.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Flexible hose is not to be used between fixed pipelines or between fixed pipelines and fixed equipment parts, unless specially approved by CCS
2.8	Connection of pipe lengths	2.5.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Leakage is to be prevented for pipe connection. No pipe threading or stuffed structure is to be used
2.9	Flange connections	2.5.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	

No.	Specific requirements	Basis of inspection	Remarks
2.10	Mechanical joints	2.5.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
2.11	Heat treatment	2.5.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
2.12	Non-destructive testing	2.5.5, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3	Arrangement of hydraulic system		
3.1	Securing of pipes	2.8.1.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.2	Corrosion protection of pipes	2.8.3.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.3	Fitting of drain valves and cocks	2.8.5.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.4	Principle of fitting of safety valves	2.8.5.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.5	Considerations after installation of pressure-reducing valves	2.8.5.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.6	Restricted use of slip type expansion joints	2.8.7.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.7	Valves with remote control	2.8.8.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4	Test by manufacturer		
4.1	Pressure tests of piping	2.7.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.2	Hydraulic tests of valves and fittings	2.7.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5	Tests after installation on board		
5.1	Leakage test of hydraulic systems	2.7.3.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Inspection is to be carried out in normal working condition of the equipment
5.2	Tightness test of hydraulic systems	2.7.3.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.3	Conditions for exemption of welded pipes from hydraulic tests	2.7.3.3 and 2.7.3.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6	Functioning of hydraulic system of ships with ice notations	14.1.1.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Consideration is to be given in particular to effects of low temperature influence to system

1.7.1.3 General technical requirements for marine hydraulic automatic control devices and hydraulic remote control devices

(1) In addition to the requirements of Table 1.7.1.1 and Table 7.1.1.2 of this Chapter, marine hydraulic control devices covered mainly by PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships are also to comply with the general technical requirements for marine hydraulic automatic control devices and hydraulic remote control devices of Table 1.7.1.3.

General Technical Requirements for Marine Hydraulic Automatic Control Devices and Hydraulic Remote Control Devices Table 1.7.1.3

No.	Specific requirements		Basis of inspection	Remarks
1	General			
1.1	Submission of plans and documents		1.1.3, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	To comply with the requirements of 1.4 of this Chapter
1.2	Ambient conditions	Ambient air temperature	2.1.1.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
		Relative humidity	2.1.1.2, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
		Vibration	2.1.1.3, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
		Inclination and rolling	2.1.1.4, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
		Salt-air, oil-laden atmosphere, etc.	2.1.1.5, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
1.3	Applicability of associated electrical installations and parts to power source		2.1.2.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
1.4	Electromagnetic compatibility of system		2.1.2.2, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
1.5	Range of pressure variations of power source		2.1.2.3, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	1. ±20 % pressure variations are in respect to controlled part (actuator). The pressure variation is a combination of output control pressure variation of hydraulic control devices and pressure loss through its piping, so the manufacturer of hydraulic control devices is to provide the deviation range to keep the control pressure in allowed ambient conditions, the values in the range being less than ±20% of the control pressure variations; 2. If an accumulator is used to control pressure, the minimum pressure for recharge is to comply with the above requirements
1.6	Application of fail-safe principle and reliability of system installations		2.1.3, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
1.7	Independence principle of system/ equipment design		2.1.4, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
1.8	Examination and lock-in of settings		2.1.5, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
1.9	Power supply		2.1.6, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
1.10	Fault indication, identification and alarm		2.1.7.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	

No.	Specific requirements	Basis of inspection	Remarks
2	Design of control systems		
2.1	Categories of control systems	2.2.1.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
2.2	Properties and accuracy of control devices	2.2.1.2, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
2.3	Safety independence	2.2.1.3, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
2.4	Measures to be taken after failure of control system	2.2.1.4, 3.7.2.1(5), 4.2.2.1(2) ⑤ and 4.3.2.1(4), PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
2.5	Independence of control of essential equipment	2.2.1.5, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
2.6	Conditions for local relaxation of independence	2.2.1.6, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
3	Hydraulic power source and piping		
3.1	When the pressure of pump is less than the set value	2.2.2.1(1), PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
3.2	When system pressure is less than the set value	2.2.2.1(2), PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
3.3	Construction and arrangement of pipeline	3.9.1.2(1), PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
4	Safety systems		
4.1	In case of faults of equipment	2.3.1.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
4.2	Handling safety system faults	2.3.1.2, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
4.3	Safety system response after alarming	2.3.1.3, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
4.4	Requirements for maintaining the operation of safety systems	2.3.1.4, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
4.5	Override setting	2.3.2.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
4.6	Alarming in case of overriding	2.3.2.2, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
4.7	Preclusion of inadvertent operation of overriding push button	2.3.2.3, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	
5	Inspection and test		
5.1	Test of system after installation on board	1.1.5, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships	

1.7.1.4 Special technical requirements for categories of marine hydraulic devices

(1) Marine hydraulic devices are to comply with the requirements of Table 1.7.1.1, Table 1.7.1.2 and Table 1.7.1.3 (if applicable) and in addition, the special technical requirements for their categories in Table 1.7.1.4.

Special Technical Requirements for Categories of Marine Hydraulic Devices Table 1.7.1.4

No.	Specific requirements	Basis of inspection	Remarks
1	Hydraulic system of hatch covers		
1.1	Hydraulic securing of hatch covers of bulk carriers	8.11.5.1, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships	
2	Hydraulic control system of doors of ro-ro ships		
2.1	Hydraulic locking of doors	9.4.7.1(3), PART TWO of CCS Rules for Classification of Sea-Going Steel Ships 9.5.6.3, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships	
2.2	Relationship between securing system and other systems	9.4.7.1(3), PART TWO of CCS Rules for Classification of Sea-Going Steel Ships 9.5.6.3, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships	
3	Hydraulic devices of dredgers	14.9.3, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships	
3.1	Power of hydraulic system connected to two half hulls	14.9.3.1, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships	
3.2	Dynamic load acting on hydraulic device	14.9.3.7, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships	
4	Hydraulic transmission arrangements of shafting	11.3.5, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.1	Emergency means for failures	11.3.5.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.2	Independence of lubrication oil system of hydraulic transmission arrangements	11.3.5.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.3	Parts of lubrication oil system of hydraulic transmission arrangements	11.3.5.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.4	Fitting of standby pumps	11.3.5.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.5	Monitoring, indication and alarm of lubricating oil system of hydraulic transmission arrangements	11.3.5.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.6	Hydraulic couplings	11.3.5.5, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.7	Oil charging and discharging of hydraulic transmission arrangements	11.3.5.6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.8	Control positions of hydraulic transmission arrangements	11.3.5.7, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.9	Fitting of interlocking device	11.3.5.8, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.10	Condition indication of controlled object of hydraulic transmission arrangements	11.3.5.9, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5	Hydraulic transmission system for controllable pitch propeller	11.3.6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	

No.	Specific requirements		Basis of inspection	Remarks
5.1	Conditions for fitting of standby pumps or manual emergency pumps and their capacities		11.3.6.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships 3.2.5.5, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.2	Interlocking of control system		11.3.6.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.3	Fitting of standby manual control system		11.3.6.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.4	Accuracy of control		11.3.6.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.5	Propeller locking ability		11.3.6.5, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.6	Pitch adjusting range		11.3.6.7, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.7	Time required for control of propeller blade		11.3.6.6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.8	System alarm	Excessively low pressure of system	11.3.6.9(1), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Requirements in item 10 of Table 3.10.1.1, item 9 of Table 4.2.6.1 and item 4 of Table 4.3.4.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships
		Low oil level of main hydraulic oil tank	11.3.6.9(2), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Requirements in item 10 of Table 3.10.1.1, item 9 of Table 4.2.6.1 and item 4 of Table 4.3.4.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships; 2. The influence of roll of the ship is to be considered for fitting of low hydraulic oil level sensors
		Blocked oil filter	11.3.6.9(3), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Usually it is in accordance with the set value provided by the filter manufacturer for pressure difference sensors. Otherwise, alarm value is to be set for the pressure not exceeding 0.35 MPa at both ends of the filter
		Excessively high oil temperature	11.3.6.9(5), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Requirements in item 10 of Table 3.10.1.1, item 9 of Table 4.2.6.1 and item 4 of Table 4.3.4.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships; 2. The system temperature rise is usually controlled within 20K. Unless special consideration is given to selection of hydraulic oil and hydraulic components, otherwise oil cooler is to be installed. Usually set value is 60℃ ~ 65℃ , not higher than 70℃
		Failure of pitch adjusting function	11.3.6.9(6), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Requirements in item 10 of Table 3.10.1.1, item 9 of Table 4.2.6.1 and item 4 of Table 4.3.4.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships
		Failure of power supply to control system	11.3.6.9(7), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Requirements in item 10 of Table 3.10.1.1, item 9 of Table 4.2.6.1 and item 4 of Table 4.3.4.1, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships
5.9	Handling of control system failures		11.3.6.11, PART THREE of the Rule; SOLAS Reg. II-1/26.3.10	
5.10	Means of emergency control		11.3.6.12, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.11	Hydraulic test and tightness test		11.3.6.13, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	

No.	Specific requirements		Basis of inspection	Remarks
6	Hydraulic Z propulsion arrangement		11.3.7, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.1	Control locations		11.3.7.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.2	Rudder indicator		11.3.7.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.3	Provision of spare power equipment and emergency control measures		11.3.7.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.4	Position of alarm indication		11.3.7.7, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.5	System alarm	Low level of hydraulic oil	11.3.7.7(3), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.6		Low pressure of hydraulic oil	11.3.7.7(4), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.7		High temperature of hydraulic oil	11.3.7.7(5), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.8		Oil filter blocks	11.3.7.7(6), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.9	Requirements for hydraulic test and tightness test		11.3.7.9, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.10	Special requirements for hydraulic systems		11.3.7.10, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Hydraulic systems are also to comply with the relevant requirements in Chapter 1, PART SEVEN of the Guidelines, corresponding to 13.1.7, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships
7	Hydraulic transverse propulsion arrangement		11.3.8, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
7.1	Materials and tests		11.3.8.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
7.2	Driving motor		11.3.8.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
7.3	Position of alarm indicator		11.3.8.8, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
7.4	System alarm	Low level of hydraulic oil	11.3.8.8(6), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
		Low pressure of hydraulic oil	11.3.8.8(7), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
7.5	Automated equipment		11.3.8.11, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
8	Hydraulic system of steering gear		13.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
8.1	Power system of hydraulic steering gear		13.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	To comply with the relevant requirements in Chapter 1, PART SEVEN of the Guidelines
8.2	Arrangement of main steering gear control system		13.1.8.1(1), 13.1.8.1(2), 13.1.8.2 and 13.1.8.5(5), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Local manual emergency control is to be provided for controlled valves and pumps in steering gear room according to the requirements in 13.1.8.1(1) and 13.1.8.2(1), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships; 2. For hydraulic equipment with steering wheel, idle running of the hand wheel is not to exceed half circle
8.3	Arrangement of auxiliary steering gear control system		13.1.8.1(3), 13.1.8.2 and 13.1.8.5(5), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
8.4	Design pressure		2.1.3.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	

No.	Specific requirements		Basis of inspection	Remarks
8.5	Design temperature of hydraulic servo unit		2.1.4.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	It is usually to be -10 ℃ ~ 65 ℃ and ambient temperature plus system temperature rise. The system temperature rise is usually controlled within 20K. Unless special consideration is given to selection of hydraulic oil and hydraulic components, oil cooler is to be installed
8.6	Power failure of steering gear control system		13.1.9.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Hydraulic remote control systems are to be additionally fitted with pressure loss alarm
9	Hydraulic system of windlass		13.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	To comply with the relevant requirements in Chapter 2, PART SEVEN of the Guidelines
9.1	Connection with hydraulic pipelines of other deck machinery		13.2.5.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
9.2	Overload protection of prime mover		13.2.5.7, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
9.3	General requirements for hydraulic systems		13.2.5.8, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
9.4	Inspections by the manufacturer	Tests valves, etc. in piping system	13.2.6.1(1), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
		Diesel engine of power unit	13.2.6.1(2), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
		Electric motor of power unit	13.2.6.1(3), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
		Final inspection and functional test	13.2.6.1(4), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	To confirm compliance with the technical design requirements for windlasses
9.5	Test of hydraulic system after installation on board		13.2.6.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
10	Pusher tug-barge combinations			
10.1	Local control		7.5.1.4, PART EIGHT of CCS Rules for Classification of Sea-Going Steel Ships	
10.2	Independent control		7.5.1.5, PART EIGHT of CCS Rules for Classification of Sea-Going Steel Ships	
10.3	Provision of power units		7.5.1.6, PART EIGHT of CCS Rules for Classification of Sea-Going Steel Ships	
10.4	Emergency disconnection in case of loss of power		7.5.1.7, PART EIGHT of CCS Rules for Classification of Sea-Going Steel Ships	
10.5	Limiting of actuator stroke		7.5.1.9, PART EIGHT of CCS Rules for Classification of Sea-Going Steel Ships	
10.6	Hydraulic connectors		7.5.1.10, PART EIGHT of CCS Rules for Classification of Sea-Going Steel Ships	Relevant technical requirements both in CCS Rules for Classification of Sea-Going Steel Ships and Chapter 1, PART SEVEN of the Guidelines are to be complied with. The return oil of safety valve used to protect actuator is not to return to the low pressure space of the actuator
11	Lifting appliances			To comply with relevant requirements in Chapter 1, PART EIGHTEEN of the Guidelines
11.1	Submission of plans and documents		1.3.6 of CCS Rules for Lifting Appliances of Ships and Offshore Installations	
11.2	Conditions for relaxation of test requirements for hydraulic cranes		7.4.2.5 of CCS Rules for Lifting Appliances of Ships and Offshore Installations	

No.	Specific requirements		Basis of inspection	Remarks
12	Launching arrangements of survival craft			To comply with the requirements both in Chapter 5, PART FIFTEEN of the Guidelines and MSC.81(70)
12.1	No special requirements			
13	Remote control systems			
13.1	Emergency control of remote control valve of oil fuel system		4.2.6.2 and 4.2.6.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
13.2	Emergency control of remote control valve of lubricating oil system		4.6.4.3, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
13.3	Emergency control of remote control valves of cargo oil tanks		5.2.4.1 and 5.2.4.2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
14	Hydraulic control devices of watertight doors			2.9.8 and 2.9.9, PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships
14.1	Watertight doors of passenger ships	Arrangement of hydraulic piping of controls	SOLAS Reg. II-1/15.6.3	
		Conditions for fitting of hydraulic equipment	SOLAS Reg. II-1/15.7.1.3	
		Control locations	SOLAS Reg. II-1/15.7.1.5	
		Audible alarm for closing doors	SOLAS Reg. II-1/15.7.1.6	
		Time required for door closing	SOLAS Reg. II-1/15.7.1.7	
		Provision of hydraulic power source and its capacity	SOLAS Reg. II-1/15.7.3	
		Provision of accumulator and its capacity	SOLAS Reg. II-1/.15.7.3	
		Hydraulic oil	SOLAS Reg. II-1/15.7.3	
		Failure isolation	SOLAS Reg. II-1/15.7.3	
		Alarm of low hydraulic fluid level	SOLAS Reg. II-1/15.7.3	
		Alarm of low pressure of accumulator	SOLAS Reg. II-1/15.7.3	
		Separation of power system from other systems	SOLAS Reg. II-1/15.7.3	
		Relationship between hydraulic power-operated systems and manual operation	SOLAS Reg. II-1/15.7.3	
		Fitting of control handles	SOLAS Reg. II-1/15.7.4	
		Associated electrical components	SOLAS Reg. II-1/15.7.6	
		Handling of single electrical fault	SOLAS Reg. II-1/15.7.8	
		Master mode	SOLAS Reg. II-1/15.8.1	
14.2	Watertight doors of cargo ships		SOLAS Reg. II-1/25-9.2	
15	Integrated cargo and ballast systems on tankers		2.6.7.3 and 2.6.7.4, PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships	

1.7.2 Additional technical requirements

1.7.2.1 Design, manufacturing and inspection of hydraulic devices are to comply with the requirements of ISO 4413:1998 Hydraulic fluid power – General rules relating to systems. The manufacturer is to ensure the following:

(1) Design considerations

① When designing hydraulic systems, all aspects of possible methods of failure (including control supply failure) are to be considered.

② In each case, components are to be selected, applied, fitted and adjusted as follows:

a. in the event of a failure, safety of personnel is to be the prime consideration;

b. where the hydraulic motor is required to lock the load, the balance valve is to be installed directly and reliably on the body of the hydraulic motor, and no any other valve (such as pilot operated safety valve) is to be installed on pressure space, unless there are other reliable means approved by CCS;

c. where the hydraulic cylinder is required to lock the load, the balance valve and/or explosion-proof valve is to be installed on the oil port flange of the oil cylinder (explosion-proof valve may be installed inside the cylinder) to prevent pipe explosion etc., and no any other valve (such as pilot operated safety valve) is to be installed on pressure space, unless there are other reliable means approved by CCS;

d. the setting of protection pressure of the balance valve is to be identified.

③ The prevention of damage to the system and the environment is to be considered.

④ Leakage (internal or external) is not to cause a hazard.

⑤ Attention is to be paid to the direction in which components are fitted, which is to comply with the requirements recommended by the manufacturer. For example, the core of solenoid valves is to be axially horizontal.

⑥ The selection of control pressure of electrohydraulic valves is to comply with the requirements for their use.

(2) Fitting of hydraulic components and units

① The pressure at the pump inlet port is not to be less than the minimum specified by the pump supplier for the operating conditions and the system fluid used. Where the design is such that the pressure oil is to be supplied by an independent auxiliary pump unit, the start sequence of the auxiliary pump unit and main pump unit is to be considered.

② Means are to be provided to ensure that valves cannot be incorrectly mounted.

③ Hydraulic components are to be fitted with original bolts provided by the manufacturer for delivered components, or bolts with equivalent strength grade and specification.

(3) Adjustments

① Valves that permit adjustments of one or more controlled parameters are to have the following characteristics:

a. provision for securing the valve adjustment;

b. provisions for locking the adjustment to prevent unauthorized change, as agreed between purchaser and supplier;

c. provisions for monitoring the parameter being adjusted;

d. all adjustable valves and devices with adjusted parameters are to be reliably locked by mechanical means to prevent loosening caused by vibration.

(4) Design requirements for fluid tanks

① Provisions are to be made to prevent spilled fluid returning directly to the tank.

② Suction pipes are to be so located that adequate fluid supply is maintained at the minimum operating level and that air ingestion and the formation of vortices in the fluid are eliminated.

③ Fluid level indicators are to be permanent marked with system “high” and “low” levels.

④ Fluid level indicators are to be fitted at each filling point so that they are clearly visible when filling.

⑤ Means are to be provided to prevent the system fluid draining from pump casing back into the tank when the system is switched off.

(5) Design of layout of piping

① Piping is to be designed to discourage its use as a step or ladder. External loads are not to be imposed upon piping.

② Piping is not to be used to support components where they would impose undue loads on the piping. Undue loads may arise from component mass, shock, vibration and surge pressure.

③ Any connection to piping is to be accessible for tightening without disturbing adjacent piping or equipment, particularly where piping terminates in a cluster of fittings.

④ Piping is to be identified or located in such a manner that it is not possible to make an incorrect connection that might cause a hazard or malfunction.

⑤ Piping, both rigid and flexible, is to be mounted to minimize installation stresses and be located to protect against foreseeable damage and not restrict access for adjustment, repairs and replacement of components or work in progress.

(6) Prevention of unexpected start-up

① The system is to be designed to facilitate positive isolation from energy sources and also to facilitate dissipation of the pressurized fluid in the system in order to prevent unexpected start-up. In hydraulic systems this can be done by:

— mechanical locking of isolation valves to the shut-off position, and dissipation of pressure from hydraulic systems;

— isolation of the electrical supply.

(7) Control or power supply failure

① Hydraulic components controlled electrically, pneumatically and/or hydraulically are to be selected and applied so that the failure of the control power supply does not cause a hazard.

② Whatever the type of control supply or power used (e.g. electrical, hydraulic, etc.), the following actions or occurrences (unexpected or intentional) are not to cause a hazard:

— switching the supply on or off;

— supply reduction;

— supply cut-off or re-establishment.

③ When control power supply is restored (unexpectedly or intentionally), hazardous situations are not to occur.

(8) Adjustable control components and mechanisms

① Adjustable control mechanisms are to maintain their settings within specified limits until reset.

② Pressure and flow control valves are to be selected so that changes in working pressure, working temperature and load do not cause malfunction or a hazard.

③ Pressure and flow control devices or their enclosures are to be fitted with tamper-resistant devices where an unauthorized alteration to pressure or flow can cause a hazard or malfunction.

④ Means are to be supplied for locking the setting of adjustable components or for locking their enclosures, if changes or adjustment can cause a hazard or malfunction.

⑤ Safe manual controls are to be provided for each actuator for convenience of setting up.

⑥ Any actuator required to maintain its position or to adopt a specific position for safety in the event of a control system failure is to be controlled by a valve that is either spring biased or detent located to a safe position.

⑦ Where actuators are controlled by servo or proportional valves and malfunction of the control system may result in the actuators causing a hazard, then means are to be provided to maintain or recover control of these actuators.

⑧ Restarting a system after an emergency stop or emergency return is not to cause a hazard or damage.

1.7.3 Calculation and check of system parameters

1.7.3.1 Check of system rated flow Q_0:

Output flow Q_p of power system oil pump:

$$Q_p \geq qn\eta_v \times 10^{-3} \geq \text{system rated flow } Q_0 \quad \text{l/min}$$

where: q —— theoretical capacity of the oil pump, in ml/r;

n —— rated speed of driving oil pump, in r/min;

η_v —— capacity efficiency at oil pump rated speed and specific pressure output.

1.7.3.2 Calculation of system nominal pressure P_0

$$P_0 = \triangle P_i + \triangle P_{in} + \triangle P_{out}$$

where: P_0 —— system nominal pressure (pressure value at oil pump outlet), in MPa;

$\triangle P_i$ —— pressure difference between oil inlet and oil outlet of hydraulic actuating unit, in MPa;

$\triangle P_{in}$ —— pressure loss through piping between pump outlet and cylinder oil inlet at the maximum system design flow, in MPa;

$\triangle P_{out}$—— pressure loss through piping between cylinder oil outlet and oil tank or pump oil inlet at the maximum system design flow, in MPa.

Caution: For hydraulic oils of different types and different reference test temperatures and flows, flow path loss of the system is different due to factors such as change of viscosity of hydraulic oil, and the manufacturer is to make clear the condition in which a value is taken. The first product is usually to be tested to verify the correctness of pressure loss of the system through its piping, with the same configuration and at the maximum flow.

1.7.3.3 Calculation of driving power of pumps and calculation for selection of electrical motors

$$N \geq P\,Q_p/(60\eta_b\,n_b) \quad \text{kW}$$

$$N_s \geq P_s\,Q_p/(60\eta_b\,n_b) \quad \text{kW}$$

where: N —— driving power needed in normal working condition (power of electric motor), in kW;

N_s—— driving power needed when the relief valve or safety valve is opened (power of electric motor), in kW;

P —— working pressure of the system, in MPa;

P_s —— set pressure of the relief valve or safety valve, in MPa;

Q_p—— the actual maximum flow of the oil pump calculated according to 1.7.3.1 of this Chapter, in l/min;

n_b —— overload coefficient of the electric motor, usually taken as 1 in normal working condition and not more than 1.3 when the relief valve or safety valve is opened (for short time), unless evidence is provided to show that the overload ability of the selected motor meets design purposes of the system;

η_b —— total efficiency of the oil pump, to be selected according to data (such as pressure – flow – efficiency curve) provided by the manufacturer, usually with total efficiency of plunger pumps being 0.80 ~ 0.85, that of vane pumps being 0.60 ~ 0.75, and that of gear pumps being 0.60 ~ 0.70.

1.7.3.4 Check of pipe specification and wall thickness

The requirements in 2.2.2 and 2.3.2 of PART THREE of CCS Rules for Classification of Sea-going Steel Ships are to be complied with.

1.8 Strength requirements

1.8.1 Permissible stress

To determine the dimensions of parts, the permissible stress is not to exceed the following values:

$$\sigma_m \leq [\sigma]$$

$$\sigma_1 \leq 1.5\ [\sigma]$$

$$\sigma_n \leq 1.5\ [\sigma]$$

$$\sigma_1 + \sigma_n \leq 1.5\ [\sigma]$$

$$\sigma_m + \sigma_n \leq 1.5\ [\sigma]$$

$$[\tau_j] = (0.6 \sim 0.8)\ [\sigma]$$

$$[\tau_n] = (0.5 \sim 0.6)\ [\sigma]$$

$$[\sigma_{jy}] = (1.7 \sim 2)\ [\sigma]$$

where: σ_m —— equivalent primary general membrane stress, in N/mm^2;
σ_1 —— equivalent primary local membrane stress, in N/mm^2;
σ_n —— equivalent primary bending stress, in N/mm^2;
$[\tau_j]$ —— permissible shear stress of steel, in N/mm^2;
$[\tau_n]$ —— permissible torsional shear stress of steel, in N/mm^2;
$[\sigma_{jy}]$ —— permissible compression stress, in N/mm^2;
$[\sigma]$ = the lesser of R_m/A or R_{eH}/B, in N/mm^2;
R_m —— tensile strength of material at ambient temperature, in N/mm^2;
R_{eH} —— yield point or proof stress of material at ambient temperature, in N/mm^2.

The values of A and B are to be selected respectively according to requirements for related equipment in CCS Rules for Classification of Sea-going Steel Ships. If there is no requirement to the specific equipment, such values may be selected according to 2.2.2.4, 2.3.2.2 and 6.2.5.1 of PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

1.8.2 Strength check of valves and flange bolts (the depth the thread screws in is not to be less than the diameter of the bolt)

Composite stress of the thread:

$$\sigma_L = 1.66\ (K_0 + K_c)\ F_L/d_L^2 \leq [\sigma] \qquad \text{MPa}$$

where: K_0 —— preloaded thread coefficient, with static load $K_0 = 1.2 \sim 2$, dynamic load $K_0 = 2 \sim 4$;
K_c —— coefficient of rigidity, with $K_c = 0.2$ for connecting rod bolts and $K_c = 0.2 \sim 0.3$ for steel plate (or with metal gasket) connection;
F_L —— maximum tensile force acting on a single bolt, in N;
d_L —— inner diameter of thread, in mm.

1.9 Selection of typical samples

1.9.1 One sample is to be selected randomly for type test when the manufacturer applies for approval of products with single specification or it is the first application for products in batches.

1.9.2 One sample which is the most representative or one with maximum specifications (pressure and flow) is to be selected for type test when the manufacturer applies for approval of product series with the same type/drawing number but different specifications. Categories may be based on principles of hydraulic power and control systems. For each type of hydraulic systems of which the parts are basically the same and only the nominal pressure or required flow is different, consideration is to be given to the maximum nominal pressure and flow in selection of samples.

1.9.3 Approved products are to be subject to inspection and test either one by one or in batches for sampling, as appropriate.

1.10 Type test

1.10.1 According to the requirements in Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships, hydraulic devices are to be inspected and certified by CCS. However, the design approval or type approval may be selected by the applicant or manufacturer on his own.

1.10.2 The type test programme provided by the applicant or manufacturer is usually at least to cover the following:

(1) Test items for which CCS surveyor is to be present:

① general inspection and test requirements for hydraulic devices in CCS Rules for Classification of Sea-going Steel Ships;

② test and verification requirements for design performance of specific equipment in SOLAS or CCS rules, corresponding to intended purposes of hydraulic devices.

Unless agreed by CCS, the items for test after installation on board and sea trial, as required by SOLAS or CCS rules, must be replaced by equivalent tests at the manufacturer.

(2) Inspection items to be completed by the manufacturer: Test items and requirements specified in the design standard(s) selected and shown in public by the manufacture.

1.10.3 For pumps driven by diesel engines, the conditions at both minimum and maximum running speeds are to be checked.

1.10.4 If the general arrangement (system drawing) includes operation controls and/or actuating units, mechanical and electrical equipment are to be adjusted together in type test.

1.10.5 The type test of the first set of marine hydraulic device usually is to include the following items:

(1) hydraulic test prior to assembly of components and parts (to be carried out in accordance with the standards accepted by CCS, but the test pressure is not to be less than 1.5 times design pressure);

(2) tightness test (1.25 times design pressure of the system, but not exceeding design pressure plus 7 MPa);

(3) measurement of output of rated flow (for different output pressures);

(4) measurement of electric motor power (at rated condition of the system, possibly at combined power output for the multi-system type);

(5) measurement of resistance loss through piping (for specific hydraulic oil, oil temperature and flow);

(6) examination and setting of safety valves, relief valves, back pressure valves, pressure reducing valves, etc.;

(7) examination of adjustment of other adjusting valves (such as speed control valves, proportional valves, servo valves, etc.);

(8) examination of built-in monitoring, indication and alarm sensor apparatuses of hydraulic devices and their settings;

(9) test of temperature rise;

(10) tests of changeover, interlock and simultaneous running of units are to meet the intended purposes;

(11) performance test in connection with associated control equipment and actuating units (verification by analog test is acceptable in special cases) is to meet the intended purposes;

(12) verification of troubleshooting and emergency control functions and abilities.

1.11 Unit/Batch inspection

1.11.1 Quality assurance

(1) The manufacturer is to ensure the hydraulic devices are so designed, manufactured, inspected and tested as to meet the performance characteristics of sample approved by CCS or type test sample.

(2) The manufacturer is to ensure to carry out quality control for product design, manufacture, inspection and identification in accordance with the relevant requirements of this Chapter. The hydraulic devices which do not meet the requirements of this Chapter are not allowed to sale with the mark related to inspection requirements of CCS,

1.11.2 Inspection

(1) The manufacturer is to provide all necessary suitable conditions to the CCS site surveyor in order to verify that the provided documents are in compliance with the requirements of this Chapter, at least including:

① quality documents of the main components and parts;

② manufacturer's inspection and test report (inspection and test items are to meet the requirements in 1.11.3 ~ 1.11.4);

③ document of compliance or certificate of product.

1.11.3 According to the requirements in Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships, marine hydraulic devices are to be subject to unit/batch inspection and certified by CCS. The unit/batch inspection after CCS approval usually is to include the following items:

(1) General inspection and test requirements for hydraulic devices in CCS Rules for Classification of Sea-going Steel Ships:

① hydraulic test prior to installation of components and parts onboard the ship (to be carried out in accordance with the standards accepted by CCS, but the test pressure is not to be less than 1.5 times design pressure);

② examination of safety valves, relief valves, back pressure valves, pressure reducing valves,etc.;

③ examination of adjustment of other adjusting valves (such as speed control valves, proportional valves, servo valves, etc.);

④ examination of built-in monitoring, indication and alarm sensor apparatuses of hydraulic devices and their settings;

⑤ emergency control function test.

(2) Test and verification requirements for design performance of specific equipment in SOLAS or CCS rules, corresponding to intended purposes of hydraulic devices (verification by analog test is acceptable).

Specific test items may be agreed with local CCS inspection organizations after product approval.

1.11.4 The manufacturer is also to ensure completion of the following inspection items:

(1) routine inspection and test items specified in the design standard(s) selected and shown in public by the manufacture;

(2) special test items added in the technical contract for delivery, if applicable.

1.11.5 The manufacturer is to carry out inspection and test for the hydraulic devices intended to apply for survey in accordance with the above-mentioned items, if it is qualified, then to apply CCS for survey. Where the manufacturer or product has been approved by CCS, the sampling proportion and sampling inspection and test items made by CCS site surveyor are to be in accordance with the inspection programme issued together with the certificate of type approval by CCS.

1.11.6 Necessary mechanical and electrical commissioning test, load test and operational test are to be carried out after hydraulic device is fitted on equipment or installed onboard (if it has not been assembled in manufacturer) in order to be in compliance with the relevant requirements of the CCS rules and the intended purposes.

PART SEVEN DECK MACHINERY

CHAPTER 1 HYDRAULIC STEERING GEAR

1.1 Application

1.1.1 This Chapter applies to hydraulic steering gears associated with classed sea-going ships. For other types of steering gears, reference may be made to in this Chapter.

1.1.2 The main constructional types of hydraulic steering gear rudder actuators to which this Chapter is applicable:

(1) Ram type rudder actuators;

(2) Piston type rudder actuators;

(3) Rotary vane type rudder actuators.

Other types of rudder actuators may be referred to in this Chapter.

1.1.3 Specific requirements for associated steering gear control systems (including autopilots, follow-up pilots and other steering consoles in navigation bridge, simple steering box in steering gear room, steering gear hydraulic servo control systems, etc.), start-up controls (including frequency inverters) of steering gear power units, electrical rudder angle indicators, steering gear

monitoring/indication and alarm systems are referred to the relevant requirements for related products in CCS Rules for Classification of Sea-going Steel Ships and the Guidelines.

1.2 Basis for approval and inspection

1.2.1 The approval and inspection in this Chapter are to be based on the following documents:

(1) CCS Rules for Classification of Sea-going Steel Ships;

(2) International Convention for the Safety of Life at Sea (hereinafter referred to as “SOALS”).

1.2.2 The paragraphs in the above mentioned basis for approval and inspection quoted are part of this Chapter. For quoted documents marked with the date, their subsequent amendments (except corrigenda) or revisions will be inapplicable, hence, it is to meet the requirements of the latest edition of these documents during the product design, manufacture and inspection. However, for those quoted documents without any date marked, the latest edition applies to this Chapter.

1.3 Definitions

1.3.1 The terms and definitions given in SOALS and CCS Rules for Classification of Sea-going Steel Ships are applicable to this Chapter.

1.3.2 For the purpose of this Chapter:

(1) Steering gear is a combination of power actuating systems, steering gear control systems, monitoring/indication and alarm systems and rudder indicator.

(2) Hydraulic steering gear is hydraulic power actuating system in this Chapter, consisting of rudder actuator, power equipment (not including start-up control or frequency inverter of electric motors) and auxiliary pipe fittings.

(3) Nominal steering torque is obtained by multiplying the theoretical torque output of single rudder actuator calculated according to 1.7.2(1) of this Chapter by number of sets of rudder actuators.

(4) Nominal system pressure is to be calculated according to 1.7.2(2) of this Chapter, consisting of the difference between inlet and outlet pressures of rudder actuator cylinder at theoretical torque output of single power actuating system and pressure loss of the hydraulic power system through its piping.

1.4 Plans and documents

1.4.1 Unless expressly provided otherwise by CCS, the following plans and documents are to be submitted to CCS for examination when applying for approval of hydraulic steering gear:

(1) Main performance specifications (which may be included in general arrangement or hydraulic system drawing), usually covering:

① nominal steering torque: if the maximum rudder angle is more than ±35°, the corresponding torque output value between ±35°and maximum rudder angle is also to be determined;

② nominal system pressure;

③ the maximum rudder angle;

④ limit rudder angle, identifying the internal limit of rudder actuator cylinder or the external limit of rudder actuator and indicating the structural rudder stops or mechanical buffers (if fitted on rudder actuator);

⑤ time required for rudder movement (in case of constant delivery pump) or time range required for rudder movement (in case of variable delivery pump), with the minimum time being dependent on electric motor power, and giving necessary description if requiring simultaneous running of double units;

⑥ specification, type, nominal flow or diameter and setting pressure (usually 1.25 times the nominal system pressure) of safety valves (including relief valves which protect hydraulic pumps);

⑦ specification, type, nominal pressure, capacity and nominal speed of hydraulic pumps;

⑧ specification, type, power, rated speed and electrical power supply of prime movers (electric motors);

⑨ specification, type, nominal flow or diameter, nominal pressure and control power of associated solenoid valves; if these valves are controlled by direct current, the voltage fluctuation data of the applicable power source of these valves are to be provided;

⑩ specification, type, diameter of piston rod, bore diameter of cylinder, piston stroke, installation dimension and nominal pressure of rudder actuator cylinder, if purchased;

⑪ drawing number or type of steering gear servo control system, if applicable;

⑫ effective capacity of each oil tank (power unit oil tank, storage tank), taken usually as 80% of the total theoretical capacity of the oil tank);

⑬ arrangement of monitoring alarm points;

⑭ recommended type and applicable temperature range of hydraulic oil, complying with the minimum and maximum ambient temperatures;

⑮ intended purposes of products, indicating whether they are intended for ships complying with additional requirements of CCS Rules for Classification of Sea-going Steel Ships or for ships of which the rudder stock is to be strengthened for ice.

(2) General arrangement of products, usually stating the following clearly:

① scope of supply of products for inspection (delivery), e.g. including navigation bridge consoles, hydraulic servo controls, storage tanks or not;

② match relations between components, e.g. any tiller connecting rod being installed between rudder actuators or not, connection between power systems (including oil tanks, pipes and valves) and connection relationship between rudder actuators, etc.;

③ required installation height of hydraulic oil tank (if the hydraulic pump is not integrated with oil tank).

(3) General arrangement of rudder actuator, usually stating the following clearly:

① main installation dimensions of rudder actuator, including the maximum permissible length of tiller connecting rod, (steering) tiller radius, etc.;

② relationship between parts which transfer mechanical forces to rudder stock;

③ requirements for means of connection of rudder actuator and hull and fitting of thrust plates (including forces acting thereon);

④ fitting of travel switches which limit max. rudder angle (including number and location of travel switches);

⑤ location of fitting mechanical rudder angle indicator.

(4) General assembly of rudder actuator cylinder, usually stating the following clearly:

① main structural dimensions;

② specification, type and dimensions of materials of main components and parts, including specifications, type and dimensions of main stress bolts;

③ nominal pressure;

④ fitting of seals and specification, type and material of seals;

⑤ specification, type and related parameters (such as nominal pressure, diameter) of isolating valves, bleeding air valves, pressure gauges and their switches, internal shuttle valves, if applicable, which provide pre-applied pressure for seals;

⑥ details of welded connections of oil cylinder (including connecting flanges) and requirements for welding consumables, non-destructive test;

⑦ relevant technical requirements for manufacturing inspection.

(5) General assembly of hydraulic power unit, usually stating the following clearly:

① location of oil suction of hydraulic pump;

② fitting of fluid level indicator;

③ fitting of monitoring and alarm sensors, such as those for oil temperature, fluid level, low pressure, filter blocking and hydraulic locking, if applicable;

④ main dimensions (capacity), shell materials;

⑤ relevant technical requirements for manufacturing inspection;

⑥ fitting of heater and/or cooler, if applicable.

(6) Drawings of the following components and parts:

① for ram type rudder actuator: rudder actuator cylinder, ram, ram pin, common seating of rudder actuator cylinder, if applicable;

② for piston type rudder actuator: rudder actuator cylinder, end cover of cylinder, piston and piston rod, end eye joint, base of rudder actuator cylinder;

③ for rotary vane type rudder actuator: rudder actuator cylinder housing, end cover of cylinder, fixed vane, rotary vane and rotor;

④ general components and parts: pin, rudder tiller, connecting rod of rudder tiller (synchronous pull rod of rudder), self-made connecting bolts of rudder tiller, assembly of isolating valve and related information, connection device between rudder stock or rotary vane rotor and rudder stock (if applicable), mechanical rudder angle indicator.

(7) Schematic diagram of hydraulic system, usually stating the following clearly:

① configuration of whole set of powered actuator hydraulic system (including internal control oil line) and interrelationship therein;

② specifications, types and main parameters (nominal pressure, nominal flow/diameter, rated speed, capacity, accuracy of oil filtering, etc.) of main components which usually include hydraulic hoses, hydraulic pumps, electric motors, safety valves, relief valves, pressure-reducing valves, back pressure valves, solenoid valves, filters, accumulators (if applicable), pressure gauges and their switches, shut-off valves, pressure/flow/temperature measuring means, heaters/coolers;

③ specification, type, diameter, wall thickness and material of pipelines;

④ setting of alarm points;

⑤ table of (solenoid) control valve actions in working cycles of each system.

(8) Storage tanks, usually stating the following clearly:

① dimension and effective capacity, shell material;

② fitting of liquid level meters.

(9) Calculations (for hydraulic system and for rudder actuator strength), usually covering check of the following:

① calculation of nominal steering torque;

② calculation for selection of nominal system pressure;

③ calculation of rudder actuator cylinder (system) capacity, which is to be rechecked with flow calculation and time required for rudder movement;

④ calculation for selection of hydraulic pumps;

⑤ calculation for driving power and selection of electric motors;

⑥ check of wall thickness of pipes;

⑦ check of rudder actuator cylinder stroke and its installation dimensions, or recheck of maximum rudder angle and limit angle;

⑧ for ram type rudder actuator: check of wall thickness of cylinder, check of end cover thickness/strength, check of flange cover bolts, strength of ram, strength of ram pin, strength of cylinder seating bolts (including strength requirements for thrust plates if necessary), strength check of rudder tiller fork, strength of artificial rudder stock (if applicable), etc.;

⑨ for piston type rudder actuator: check of wall thickness of cylinder tube, check of end cover connection strength, check of flange cover bolts, strength of piston rod (including thread at both sides or block), strength of support and its bolts (including strength requirements for thrust plates if necessary), check of pin strength, check of ear ring strength, etc.;

⑩ for rotary vane type rudder actuator: check of wall thickness of cylinder housing, check of cylinder cover and its bolts, strength of fixed vane/rotary vane and their connection devices, strength of cylinder seating bolts (including strength requirements for thrust plates if necessary), check of rotor strength, strength of connection between rotor and rudder stock, etc.;

⑪ check of rudder tiller: calculation for selection of dimension, check of section modulus, check of connecting bolts (if applicable), check of strength of connection (such as key or friction ring) with rudder stock (if applicable);

⑫ check of rudder tiller connecting rod strength: maximum permissible length, connecting rod section and section modulus (check of stability of compression rod);

⑬ related calculation of isolating valve, if applicable.

(10) Type test programme, stating the following clearly:

① test items and acceptance criteria;

② test method;

③ requirements for test instrumentation;

④ requirements for ambient conditions of the test;

⑤ requirements for oil used in the test;

⑥ requirements for load-applying equipment used for the test.

1.4.2 The following plans and documents are to be submitted to CCS for reference:

(1) Assembly drawings of non-standard self-made seals and oil manifold block, indicating type of the material.

(2) Product instructions, usually including the following:

① rules and standards with which product design is in compliance, application of product;

② scope of supply of products and their main technical parameters;

③ working principles (with related schematic diagram);

④ requirements for maintenance;

⑤ necessary safety caution;

⑥ emergency troubleshooting.

(3) Table of physical and chemical properties of material of main components and parts (or shown in drawings of parts clearly).

(4) Main procedure documents, such as welding procedure (if applicable) and heat treatment procedure of parts of rudder actuator that transfer mechanical forces to rudder stock, pressure housings, pipelines.

(5) Main acceptance criteria for welding and non-destructive testing, if applicable.

1.5 Main components and parts

1.5.1 Hydraulic steering gear is made up of the following parts as shown in Table 1.5.1.

Parts of hydraulic steering gear **Table 1.5.1**

<table>
<tr><td rowspan="11">Hydraulic steering gear</td><td rowspan="7">Hydraulic rudder actuator</td><td rowspan="2">Ram type rudder actuator</td><td colspan="2">Rudder tiller, connecting rod of rudder tiller, pin</td></tr>
<tr><td>Ram type rudder actuator cylinder</td><td>Cylinder, ram, ram pin, isolating valve, seating, seal</td></tr>
<tr><td rowspan="2">Piston type rudder actuator</td><td colspan="2">Rudder tiller, connecting rod of rudder tiller, pin</td></tr>
<tr><td>Piston type rudder actuator cylinder</td><td>Cylinder, piston, piston rod, isolating valve, support, seal</td></tr>
<tr><td rowspan="2">Rotary vane type rudder actuator</td><td colspan="2">Rudder tiller, connecting rod of rudder tiller, pin</td></tr>
<tr><td>Rotary vane type rudder actuator cylinder</td><td>Cylinder housing, rotary vane, fixed vane, rotor, isolating valve, seal</td></tr>
<tr><td rowspan="4">Hydraulic power unit</td><td colspan="3">Hydraulic pump</td></tr>
<tr><td rowspan="2">Pump driver</td><td colspan="2">Electrical motor</td></tr>
<tr><td colspan="2">Diesel engine</td></tr>
<tr><td colspan="3">Coupling</td></tr>
<tr><td>Pipe fittings</td><td colspan="3">Control valve (solenoid valve, proportional control valve, servo valve), safety valve, relief valve, back pressure valve, balance valve, filter, oil cooler, (main/storage) oil tanks, steel pipe, high pressure hose, mechanical pipe joint, accumulator, heater, etc.</td></tr>
</table>

1.5.2 The following purchased parts (if any) of steering gear are to have CCS marine product inspection certificate and meet their intended purposes:

(1) Rudder actuator cylinders are to comply with the relevant technical requirements in Section 1, Chapter 13, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships and in this Chapter, and common engineering oil cylinders are not to be used.

(2) Hydraulic devices are to comply with the relevant technical requirements in Section 1, Chapter 13, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships and in this Chapter.

(3) Electrical motors (50 kW or above) are to comply with the relevant technical requirements in Chapter 3, PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships and in PART ELEVEN of the Guidelines.

(4) Accumulators are to comply with the relevant technical requirements in Chapter 6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships and in this Chapter. Accumulators in which air and fluid are not isolated effectively are not to be used in power actuating system.

(5) Rudder tillers are to comply with the relevant technical requirements in Chapter 3, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships and in this Chapter.

(6) Diesel engines driven independently are to comply with the relevant requirements in Chapter 9, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships and in PART FIVE of the Guidelines.

(7) Main hydraulic pumps are to comply with the relevant requirements in Section 1, Chapter 13, PART THREE of CCS Rules for Classification of Sea-going Steel Ships and in this Chapter.

1.5.3 The following purchased parts of marine hydraulic devices, if any, are to be subject to CCS type approval, have the manufacturer's quality certificate, comply with CCS rules and meet their intended purposes:

(1) Hydraulic hoses are to comply with the relevant technical requirements in Chapter 2 and Chapter 13, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships and in this Chapter.

(2) Electrical motors (below 50 kW) are to comply with the relevant technical requirements in Chapter 3, PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships and in PART ELEVEN of the Guidelines.

(3) Sensors which are required definitely to provide in Chapter 2 and Chapter 13, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, are to comply with the relevant technical requirements in Section 8, Chapter 2, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships and in this Chapter.

1.5.4 The following purchased parts of steering gears, if any, are to have the manufacturer's quality certificate, comply with CCS rules and meet their intended purposes:

(1) Solenoid valves are to comply with the relevant technical requirements in Chapter 2 of PART THREE, in PART FOUR and PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships and in this Chapter, clearly identifying the range of voltage fluctuation. If a solenoid valve is to be operated for the sake of safety or other reasons when its electrical control fails, as required in 2.8.8.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships, it is to be provided with a manual emergency control (i.e. the solenoid valve is usually to be fitted with a manual emergency control button or similar means).

(2) Safety valves are to comply with the relevant technical requirements in Section 1, Chapter 13, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships and in this Chapter.

1.6 Evaluation of welding procedures

1.6.1 Welding procedures of the following main welded components of the rudder actuator are to be evaluated by CCS before manufacturing and to comply with the relevant requirements in PART THREE of CCS Rules for Materials and Welding:

(1) Rudder actuator cylinder, end cover, if applicable;

(2) Components and parts which transmit hydraulic force directly to the rudder stock: ram, piston and piston rod, rotary vane and rotor of rotary vane type rudder actuator cylinder, rudder actuator cylinder/unit seating, rudder tiller, connecting rod of rudder tiller, etc., if applicable.

1.6.2 Heat treatment procedures are to be approved by CCS and comply with the relevant requirements in PART THREE of CCS Rules for Classification of Sea-Going Steel Ships and PART THREE of CCS Rules for Materials and Welding.

(1) Piping is to comply with the requirements in 2.5.4, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships, if applicable.

(2) Pressure cylinders are to comply with the requirements in 6.2.7, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships, if applicable.

1.7 Design and technical requirements

1.7.1 Technical requirements

(1) The technical requirements for hydraulic steering gears are given in Table 1.7.1.

Technical Requirements for Hydraulic Steering Gear Table 1.7.1

No.	Specific requirements	Basis of inspection	Remarks
1	General		
1.1	Submission of plans	3.3.2.1, PART ONE and 1.1.3.2, 1.1.3.3, 2.1.2.4, 13.1.3.1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	To comply with the requirements of 1.4 of this Chapter
1.2	Certification of purchased components	13.1.1.2 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	To comply with the requirements of 1.5 of this Chapter
1.3	Ambient conditions	1.2.1.1 and 1.2.1.2 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Corresponding to column "Main and auxiliary machinery"; Corresponding to columns "Air" and "In enclosed spaces", but possibly worse conditions in service are to be considered
1.4	General safety	1.3.6 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Exposed rotating parts (such as motor-driven pump unit coupling) are to be additionally fitted with protective cover
1.5	Electrical apparatuses associated with hydraulic steering gear	PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships	For apparatuses controlled by direct current, e.g. solenoid valves, particular attention is to be given to their capability of withstanding power and voltage variations in compliance with the requirements in 1.2.2.2, PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships. None of these apparatuses which do not meet the criterion of 25% voltage drop is allowed in systems supplied directly by accumulators. Unless the requirements in 1.2.2.3, PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships are complied with, none of these apparatuses which do not meet the criterion of 10% voltage drop is allowed. In practical application, consideration is to be given to testing voltage of electromagnetic coil terminals in operating condition of electromagnets, and the sum of total voltage drops of cables is to comply 2.12.4.2, PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships
2	Basic performance of steering gear		

No.	Specific requirements	Basis of inspection	Remarks
2.1	Relationship between main and auxiliary steering gears	13.1.5.1, 13.1.5.6, and 13.1.10.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
2.2	Rudder actuating by hydraulic steering gear as main steering gear	13.1.5.2 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Design, manufacturing and inspection are to be checked with nominal torque of hydraulic steering gear
2.3	Rudder actuating by hydraulic steering gear as auxiliary steering gear	13.1.5.3 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Design, manufacturing and inspection are to be checked with 25% of the nominal torque of hydraulic steering gear
2.4	Manually operated steering	13.1.5.4 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
2.5	Arrangement of power unit of hydraulic steering gears as main/auxiliary steering gears	13.1.5.5 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
2.6	Fitting of power unit of hydraulic steering gear as main steering gear	13.1.5.1, 13.1.5.6 and 13.1.10.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	The "piping system" mentioned in 13.1.5.6.3 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships is to include pipeline valves and related fittings between pump outlet of power unit and isolating valve of rudder actuator cylinder inlet. If the isolating valve is hydraulically controlled, the single failure isolation of its hydraulic control line is to be included
2.7	Conditions for exemption from fitting of auxiliary steering gear	13.1.5.6 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
2.8	Fitting of rudder angle limiter	13.1.5.8 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	At least two sets of limiters (such as electrical limit switches) are to be fitted, unless the failure or damage of the limiter will not cause loss of steering capability. The limiters are to be located at the maximum design rudder angle (usually ±35° ~ ±35.5°)
2.9	Rudder stop	13.1.5.9 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	When the steering gear is not in follow-up or autopilot mode and when the torque of rudder stock is nominal, the rudder movement speed is not to be more then 0.5°/min for ram type rudder actuator and piston type rudder actuator, and not to be more than 1°/min for rotary vane type rudder actuator
3	Construction and design		
3.1	Design of steering gear components subject to internal pressure	13.1.6.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Threaded connection is not to be used directly between related parts with their fittings and the pressure cylinder. Pads may be fitted to the cylinder for transition. Consideration may be given to appropriate relaxation of this requirement only for duplicated cylinders or rudder actuators complying with single failure isolation requirements or cylinders having good elongation regarding their material and with less nominal torque
3.2	Safety factor selection in design of hydraulic steering gear components subject to internal pressure	13.1.6.2 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Cylinder, cylinder cover and its bolts, cylinder flange and its bolts, shut-off valve and isolating valve installed on the cylinder, and internal shuttle valves (if applicable) which provide pre-applied pressure for seals
3.3	Welding of pressure parts	13.1.6.3 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.4	Welding of parts transmitting mechanical forces	13.1.6.3 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.5	Control of construction stress concentration	13.1.6.4 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
3.6	Selection of design pressure	13.1.6.5 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	At least 1.25 times the nominal system pressure is to be taken
3.7	General strength of steering gear components	13.1.6.6 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	

No.	Specific requirements	Basis of inspection	Remarks
3.8	Components which are not duplicated	13.1.6.6 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. The number of bolts of valves (including isolating valves) connected to rudder actuator cylinder directly and that of bolts of flanges of externally connected pipelines is not to be less than 4. The number of bolts of flange of cylinder cover is not to be less than 6, unless special consideration is given for flange connections and strength of bolts). 2. The maximum diameter of shut-off valves, bleeding air valves, non-return valves of pressure gauge switches that directly contact hydraulic oil in the cylinder and can not be isolated, and of internal shuttle valves (if applicable) providing pre-applied pressure to seals is to be limited as necessary. The leakage of hydraulic oil because of failures such as break of spring, block of valve core is not to affect the maintenance of steering capability (not less than that of auxiliary steering gear)
3.9	Strength of components transmitting mechanical forces to the rudder stock	3.1.1.5, 3.1.5.1, 3.1.5.2 of PART TWO and 13.1.6.7 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. The strength of components transmitting mechanical forces (through internal cylinder limiters) between connection of rudder stock with rudder tiller (rotor of rotary vane type rudder actuator cylinder) and bolts connecting rudder actuator and hull seating (including thrust plates) is to be equivalent to the rudder stock strength in way of the tiller. 2. Unless expressly required otherwise in CCS Rules for Classification of Sea-Going Steel Ships or this Chapter, the following strength criterion of components and parts is to be met: Permissible equivalent stress $[\sigma] = 118/K_s$ where: K_s – material factor of rudder stock, as defined in 3.1.5.1 of PART TWO of CCS Rules for Classification of Sea-Going Steel Ships. For ships intended for navigation in ice, strengthening of rudder stock is to be considered. 3. If structural rudder stop or mechanical buffer is installed at the rudder tiller and the limiting inside the cylinder is not reached for functioning of the stop or buffer (at least 10 mm clearance is to be reserved inside the cylinder in this case), the strength of components transmitting mechanical forces from connection of rudder stock and rudder tiller to location of structural rudder stop or mechanical buffer is to be equivalent to the strength of rudder stock in way of the tiller. 4. The strength of non-pressurized components protected by structural rudder stop or mechanical buffer is to comply with the following requirement: When the safety valve of rudder actuator cylinder is opened because of external load imposed on rudder blades, the stress of protected components is $\sigma \leq 90\% R_{eH}$ (where R_{eH} is the yield strength of material of corresponding components). 5. When internal limiting inside rudder actuator cylinder is reached at design pressure, the stress of related non-pressurized components is to be $\sigma \leq 90\% R_{eH}$ (where R_{eH} is the yield strength of material of corresponding components). For rudder actuators with double cylinders or multi-vane rotating cylinders, synchronous limiting is also to be considered, e.g. the condition in which the forces of the 2 cylinders simultaneously act on the limiting part of one cylinder. 6. Internal limit rudder angle is usually to be taken as maximum rudder angle plus 1.5°. 7. Strength check of rudder tiller connection bolts is to be carried out according the requirements of 8.8 of this Chapter. 8. Strength check of rudder tiller connection rod is to be carried out according the requirements of 8.9 of this Chapter. 9. The fitting of safety valve of rudder actuator cylinder is not related to protection by "structural rudder stop or mechanical buffer"
3.10	Securing of rudder actuator and seating	13.1.11.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Thrust plates and bolts etc. are to be designed and fitted to bear all foreseeable forces. The clips are not to be subjected to shear forces so far as possible. 2. The fitted bolts bear the rotating torque and horizontal shear forces of the rudder actuator. In the combination of bolt and thrust plate, bolt bears turning moment imposed by rudder actuator, while thrust plate bears horizontal shear force

No.	Specific requirements		Basis of inspection	Remarks
3.11	Fitting of seals		13.1.6.8 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. For non-duplicated rudder actuator cylinders, a sight port for oil leakage is recommended in the double sealing between moving components which form external force interface so as to find the failure of seal ring as early as possible, unless this is technically impracticable or similar rigid sealing material is adopted. 2. For duplicated hydraulic cylinders of steering gear, double sealing may not be required between moving components which form external force interface, upon agreement of CCS
3.12	Hydraulic piping fittings		3.1.6.9 and 13.1.6.5 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Isolating valves, pressure gauges and bleeding air valves directly connected to rudder actuator cylinder are not included
3.13	Rudder tiller	Section modulus	3.1.15.1 and 3.1.15.2 of PART TWO of CCS Rules for Classification of Sea-Going Steel Ships	Section $2D_t$ which is beyond the axe of rudder tiller pin may be checked as follows: The section modulus W at section $1.5D_t$ is not to be less than the value obtained from the following formula: $W = 0.14 \times (1 - 1.5D_t/R) \times D_t^3$ cm^3 where: D_t – stock diameter, in cm, at the tiller; R – radius of tiller, in cm
3.14		Height of boss of tiller external diameter	3.1.15.2 of PART TWO of CCS Rules for Classification of Sea-Going Steel Ships	The size of rotor of rotary vane type rudder actuator is to be referred to this requirement
3.15		Connection with the rudder stock	3.1.8.7 and 3.1.15.3 of PART TWO of CCS Rules for Classification of Sea-Going Steel Ships	1. If friction ring is adopted to transmit torque for the connection of rudder tiller or rotary vane type rudder actuator cylinder rotor to rudder stock, the friction torque is to be following times the nominal torque (ice strengthening condition not considered): $R_{eH}K_s/118$ where: R_{eH} – yield strength of rudder stock; K_s – material factor of rudder stock, as defined in 3.1.5.1 of PART TWO of CCS Rules for Classification of Sea-Going Steel Ships. 2. If rudder tiller and rudder stock are connected by keyed taper, the key is to be checked according to the requirements in 3.1.8.7, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships. It is only to accept the connection safety allowance required by CCS rules through single method other than the combination method through increase of friction torque to compensate the insufficient key strength (or on the contrary). 3. If rudder tiller and rudder stock are connected by keyless taper, related components are to be checked according to the requirements for non-underhung rudder in 3.1.9, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships. The length of the taper is not to be less than 1.5 times the average diameter of taper at the rudder tiller. 4. If rudder tiller and rudder stock are connected by taperless key, the shear area and compressed area of the key are to be converted according to 【σ】=118/K_s (K_s is to be converted according to the value of R_{eH} of key material in check of shear area of the key. In check of compressed area of the key, compliance of the weakest part of key, rudder tiller or rudder stock with strength requirements is to be considered). 5. If the specific size of rudder stock is not clear in design (e.g. general rudder actuator design), the means and strength of connecting rudder stock and rudder tiller are to be examined and approved by ship plans examination department. 6. For the marine hydraulic steering gear additionally required in 13.1.10, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, if it is matched with a single rudder, bolted tiller (quadrant) hub structure consisted of two-half blocks could not be used for the rudder tiller connecting with rudder stock
4	Materials			
4.1	General		1.2.8.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Mainly pressure components and components transmitting mechanical forces in 1.4.1(6)

No.	Specific requirements	Basis of inspection	Remarks
4.2	Materials of pressure components and components transmitting mechanical forces to rudder stock	13.1.4.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. For the hydraulic valve and its casing between power pump and oil cylinder isolating valve (not including the isolating valve), the requirements for elongation of material may be relaxed appropriately: (1) Unless provided otherwise by CCS, brittle material with impact toughness α_k less than 50 Nm/cm^2 and elongation δ less than 5% is usually not to be used for marine hydraulic valves; (2) For Class I and Class II duplicated piping systems which could operate as each other's standby or those provided with independent emergency means, consideration may be given to using grey cast iron as casing material of hydraulic valve between power pump and oil cylinder isolating valve (not including isolating valve). 2. The elongation of hydraulic manifold block material is not to be less then 12%. 3. For cold-drawn steel pipes used to manufacture hydraulic cylinders, usually the pipes delivered in annealed condition are to be purchased to ensure compliance with elongation requirements
4.3	Conditions for use of hose assemblies	13.1.4.2 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Use of flexible hoses between fixed pipelines or between fixed pipeline and fixed equipment parts is forbidden, unless specially approved by CCS
4.4	Technical requirements for hose assemblies	13.1.4.3 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
4.5	Burst pressure of hose assemblies	13.1.4.4 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5	Hydraulic systems		Consideration is to be given to compliance with the relevant applicable requirements for hydraulic equipment in PART SIX of the Guidelines
5.1	General	4.7 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	No fuse plug, but only a safety valve is to be provided for an accumulator supplying emergency power source. Special consideration is to be given to reliability of the safety valve and selection of its orifice (safety valves may be selected according to ISO 4126 standard)
5.2	Technical requirements for pipes, flanges, valves and fittings	13.1.7.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	To include the required calculation for strength check in respect of wall thickness
5.3	Fitting of safety valves	13.1.7.2 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. For the safety valve or relief valve at power pump outlet, the set pressure is to be 1.25 times the nominal system pressure so that the system will have short-time overload capacity. 2. For the safety valve at rudder actuator cylinder, the set pressure is to be 1.25 times the nominal system pressure, but may be adjusted as follows upon agreement of CCS: (1) Where oil returns from safety valve to the other space of the cylinder, the set pressure may be equal to 1.25 times the difference between cylinder inlet and outlet pressures at nominal torque output of rudder actuator; (2) Where oil return from safety valve to oil tank of the system, the set pressure may be equal to 1.25 times the pressure of inlet at nominal torque outlet of rudder actuator
5.4	Fitting of isolating valves	13.1.7.3 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	For rudder actuators of piston type cylinder etc. with duplicated cylinders, isolating valve may be installed at the outside end of connection between flexible hose and oil cylinder. When the flexible hose breaks and single oil cylinder is isolated, however, hydraulic locking is not to occur in the isolated cylinder and the remaining rudder actuator cylinder is still to be capable of providing necessary steering, unless expressly required otherwise in Chapter 13 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships
5.5	Fitting of filters	13.1.7.4 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	The manufacturer is to ensure that the capacity of filter used in the system or independent filtering device meet the requirements of hydraulic components for oil impurity and particles contained therein. In addition, pressure gauge or alternative equivalent means is to be provided before the filter to reveal blocking of filter in time

No.	Specific requirements		Basis of inspection	Remarks
5.6	Fitting of level alarms		13.1.7.5 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	The effects of inclination and roll of the ship are to be considered
5.7	Fitting of arrangements for bleeding air		13.1.7.6 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.8	Hydraulic locking		13.1.7.7 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	The difference of return oil mass in synchronic running is to be considered. For example, the daily oil circulation tanks in two systems are to be interconnected at high level and isolated from each other at normal level
5.9	Fitting of storage tanks		13.1.7.8 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.10	Arrangement of power piping		13.1.7.9 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
5.11	Design temperature of hydraulic system		13.1.9.1, 1.2.1.2 and 2.1.4.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Usually from maximum ambient temperature to the temperature when the inside temperature of circulating oil tank (of open-type systems) reaches 60 ℃ ~ 65 ℃ (i.e. maximum ambient temperature + system temperature rise). The system temperature rise is usually controlled within 20 K. Unless special consideration is given to selection of hydraulic oil and hydraulic components, oil cooler is to be installed. 2. The working temperature range of the system and any component is not to exceed the limits required for safe use. 3. When a heater is used, its dissipation power per unit area is not to exceed the range recommended by the hydraulic oil manufacturer. Automatic temperature control is to be adopted to keep the expected hydraulic oil temperature
6	Monitoring and alarms			
6.1	Monitoring and alarm items	Failures of steering gear power unit	13.1.5.5.3, 13.1.9.1 and 13.1.9.3 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Where possible, failure signals from monitoring points are to be taken in the following sequence: (1) Failure of hydraulic pump; (2) Failure of driver (electric motor); (3) Failure of power supply
6.2		Power failures of steering gear control system	13.1.9.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Hydraulic remote control systems are to be additionally provided with alarm for pressure loss of control system; 2. If control power is supplied by steering gear power unit, low pressure alarm is not necessary, but alarm for control power failure is to be provided
6.3		Low level of hydraulic oil tank	13.1.7.5 and 13.1.9.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	The effects of roll of the ship are to be considered
6.4		High hydraulic oil temperature	13.1.9.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Alarm is usually set at 60℃ ~ 65℃ , not higher than 70℃ . The rise of system temperature is usually controlled within 20 K. Unless special consideration is given to selection of hydraulic oil and hydraulic components, oil cooler is to be installed to keep oil temperature below 60℃
6.5		Blocked oil Filter	13.1.9.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Usually it is in accordance with the set value provided by the filter manufacturer for pressure difference sensors. Otherwise, alarm value is to be set for the pressure not exceeding 0.35 MPa at both ends of the filter (pressure on filter casing is to be considered)
6.6		Hydraulic locking	13.1.9.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
6.7	Hydraulic locking failures		13.1.9.5 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Following alarm condition may be considered in lieu of hydraulic locking caused by synchronic operation of the steering gear: Alarm is to be initiated when the steering order and the rudder actuator response are not consistent with each other

No.	Specific requirements	Basis of inspection	Remarks
7	Additional requirements for large special ships		
7.1	Provision of power equipment of hydraulic steering gear as main steering gear	13.1.10.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
7.2	Setting of hydraulic steering gear as main steering gear	13.1.10.2(1) of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Automatic or remote control instead of local manual means is to be adopted for failure isolation
7.3	Composition of hydraulic steering gear as main steering gear	13.1.10.2(2) of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
7.4	Conditions for exemption from single failure criterion	13.1.10.3 (1) of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Where duplicated rudder actuators are provided or the single actuator complies with 13.1.10.3 (2) of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships, automatic or remote control instead of local manual means is to be preferred for failure isolation. Otherwise, the manufacturer is to give clear and operable instruction and safety caution for emergency troubleshooting in the product instructions and on the block diagram required in 13.1.11.3 of CCS Rules for Classification of Sea-Going Steel Ships to facilitate emergency control by crew within 45s required by CCS Rules for Classification of Sea-Going Steel Ships
7.5	Setting of single power actuating system	13.1.10.3 (2) and 13.1.10.4 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. The stress analysis required in 13.1.10.3 (2) is to include acceptance criteria. 2. Non-duplicated rudder actuators are to comply with the requirements in Appendix 1, Chapter 13, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships
8	Non-destructive test		
8.1	Non-destructive test of main components of rudder actuator	13.1.12.1 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	
9	Indication of rudder angle		
9.1	Rudder angle indicator	13.1.8.3 of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. The operator is to be able to see the rudder angle indicator of controlled rudder actuator, which may be mechanical rudder angle indicator, at the steering gear or emergency steering gear control position in the steering gear compartment. 2. The deviation of angle displayed by mechanical rudder angle indicator from actual rudder angle is not to be more than ±1°. 3. The graduation of rudder angle indicator is not to be more than 1°. For mechanical rudder angle indicator, clear marks (e.g. different length and color of graduation lines) are to be given at the maximum rudder angle and internal limit rudder angle

1.7.2 Additional technical requirements

(1) The nominal torque of different rudder actuators is to be calculated as follows respectively:

① The following conditions are assumed for calculation of nominal rudder actuator torque in ② ~ ④ :

(i) the torque refers to the theoretical nominal rudder actuator torque output in the condition of single rudder actuator driving single rudder stock. For service conditions in which two or three rudder stocks are driven by artificial rudder stock and rudder tiller connecting rod, additional mechanical efficiency loss is to be considered when selecting the product. For two sets of cylinders of the ram type rudder actuator, four hydraulic cylinders of the piston type rudder actuator and double cylinders of the rotary vane type rudder actuator, the theoretical nominal rudder actuator torques calculated below is to be multiplied by 2 and so on;

(ii) hydraulic oil of a given type (viscosity) is to be used;

(iii) 40℃ is to be taken as reference criterion, if specific temperature conditions are not specified by the manufacturer;

(iv) maximum design rudder actuator speed is to be clearly indicated.

② For output torque M_1 of ram type rudder actuator with one set of cylinder:

$$M_1 = \pi D_1^2 R_1 \Delta P \eta_1 / 4\mathrm{COS}^2\alpha \times 10^{-6} \quad \text{kNm}$$

where: D_1 – diameter of ram, in mm;
R_1 – radius of rudder tiller, in mm;
ΔP – pressure difference between oil inlet and oil outlet of rudder actuator cylinder, in MPa;
α – rotating angle, usually with nominal rudder actuator toque taken as the torque output at $\alpha = \pm 35°$;
η_1 – mechanical efficiency of rudder actuator for $\alpha = \pm 35°$, usually taken as 0.80 ~ 0.85; the correctness of efficiency valve calculated for the first one of rudder actuators of the same type is usually to be verified through test.

③ For output torque M_2 of piston type rudder actuator (with two double acting hydraulic cylinders):

$$M_2 = \pi (2D_2^2 - d_2^2) R_2 \Delta P \eta_2 \mathrm{COS}\alpha / 4 \times 10^{-6} \quad \text{kNm}$$

where: D_2 – bore diameter of rudder actuator hydraulic cylinder, in mm;
d_2 – action diameter of piston rod, in mm;
R_2 – radius of rudder tiller, in mm;
ΔP – pressure difference between oil inlet and oil outlet of rudder actuator cylinder, in MPa;
α – rotating angle, usually with nominal rudder actuator toque taken as the torque output at $\alpha = \pm 35°$;
η_2 – mechanical efficiency of rudder actuator for $\alpha = \pm 35°$, usually taken as 0.90 ~ 0.94; the correctness of efficiency valve calculated for the first one of rudder actuators of the same type is usually to be verified through test.

④ For output torque M_3 of rotary vane type rudder actuator (assuming that the action area of oil pressure of vanes being rectangular):

$$M_3 = 0.125\, i \Delta P\, H(D_3^2 - d_3^2)\, \eta_3 \times 10^{-6} \quad \text{kNm}$$

where: i – number of vanes;
ΔP – pressure difference between oil inlet and oil outlet of rudder actuator cylinder, in MPa;
H – height of working capacity, i.e. theoretical height of the vane, in mm;
D_3 – inside diameter of rudder actuator cylinder, i.e. theoretical outside diameter of the vane, in mm;
d_3 – outside diameter of rotor (rotating shaft), i.e. theoretical inside diameter of the vane, in mm;
η_3 – mechanical efficiency of rudder actuator at $\alpha = \pm 35°$, the value of which being related to type, material of seal and position of sealing and to rotating shaft support, usually taken as 0.80 ~ 0.85; the correctness of efficiency valve calculated for the first one of rudder actuators of the same type is usually to be verified through test.

(2) The nominal system pressure is to be calculated according to the following formula:

$$P_0 = \Delta P_i + \Delta P_{in} + \Delta P_{out}$$

where: P_0 – nominal system pressure, i.e. pressure at pump outlet, in MPa;
ΔP_i – pressure difference between oil inlet and oil outlet of rudder actuator cylinder, in MPa;
ΔP_{in} – pressure loss through piping between pump outlet to cylinder oil inlet at the maximum system design flow, in MPa;
ΔP_{out} – pressure loss through piping between cylinder oil outlet and oil tank or pump oil inlet at the maximum system design flow, in MPa.

The conditions assumed for the above calculation of nominal system pressure are given in 1.7.2(1) of this Chapter. For hydraulic oils of different types and different reference test temperatures and flows, flow path loss of the system is different due to factors such as change of viscosity of hydraulic oil, and the manufacturer is to make clear the condition in which a value is taken. The first product is usually to be tested to verify the correctness of pressure loss of the system through its piping, with the same configuration and at the maximum flow.

(3) The calculation of rudder actuator cylinder system capacity is to be rechecked by calculation of flow needed and time required for steering as follows:

① Calculation of theoretical capacity of rudder actuator cylinder (corresponding to movement of single power rudder actuator from 35° at one side to 30° at the other side):

(i) for ram type rudder actuator (one set of cylinder):

$$V = \pi D_1^2 R(\text{tg}35° + \text{tg}30°)/4\times10^{-6} \quad l$$

(ii) for piston type rudder actuator (with two double acting hydraulic cylinders):

$$V = \pi(2D_2^2 - d_2^2)\, L_3/4 \times 10^{-6} \quad l$$

where: L_3 – the stroke of the rudder actuator cylinder from 35° at one side to 30° at the other side).

(iii) for rotary vane type oil cylinder (for movement to 65°):

$$V = \pi(D_3^2 - d_3^2)\, H \times i \times 65°/(4 \times 360°) \times 10^{-6} \quad l$$

② The determination of flow of main oil pump of power system:

$$Q \geq 60V/T_0\eta_v \text{ l/min}$$

where: Q – the minimum selected flow of main oil pump, in /min;
V – capacity of oil cylinder corresponding to movement of rudder actuator from 35° at one side to 30° at the other side, in l;
T_0 – time required by design for rudder movement, taken as 28 s for sea-going ships;
η_v – capacity efficiency of power system; selected according to different hydraulic systems and rudder actuators.

③ Recheck of time required for rudder movement:

$$T_0 = 60V/Q_0 \quad \text{sec}$$

where: T_0 – time required by design for rudder movement, in sec;
Q_0 – actual flow of pump, calculated according to capacity of pump, speed of driving device and capacity efficiency of pump, in l/min.

(4) Calculation for driving power and selection of electric motors:

$$N \geq P_s\, Q_0/60\eta_b\, n_b \quad \text{kW}$$

where: N – driving power needed (power of electric motor), in kW;
P_s – system design pressure, in MPa;
Q_0 – actual flow of oil pump calculated according to 1.7.2(3) of this Chapter in l/min;
n_b – overload coefficient of electric motor, usually ≤ 1.6 unless specially approved by CCS;
η_b – total efficiency of the oil pump, to be selected according to data (such as pressure – flow – efficiency curve) provided by the manufacturer, usually with total efficiency of ram pumps being 0.80 ~ 0.85, that of vane pumps being 0.60 ~ 0.75, and that of gear pumps being 0.60 ~ 0.70.

For variable delivery pumps the flow of which can be adjusted by the user, the maximum permissible adjustment (corresponding to minimum time required for rudder movement) value is to be given:

$$Q_{0\max} = 61.2\ \eta_b\, n_b\, N/\, P_s$$

$$T_{0\min} = 60\ V/Q_{0\max}$$

(5) Unless stated otherwise, the rudder actuator of hydraulic steering gear is not to be subjected to upward and/or downward axial forces and radial forces produced by rudder stock additionally.

1.8 Strength requirements

1.8.1 In addition to the strength calculation clearly required by CCS Rules for Classification of Sea-Going Steel Ships, the strength of the following components of rudder actuators is to be checked by the manufacturers and meet the relevant requirements of permissible stresses in this Chapter:

(1) Ram type rudder actuator cylinder:

① bolts of flange cover;

② pressure strength and bending strength of ram;

③ bending strength and shear strength of ram pin;

④ strength of bolts of cylinder base against combined horizontal shear forces and combined tensile forces caused by axial and lateral moments of ram, and strength requirements for thrust plates as necessary;

⑤ bending strength and pressure strength (if roller is used) of fork of rudder tiller;

⑥ bending strength and shear strength by means of artificial rudder stock, if applicable;

⑦ compression strength of sliding bearing of cylinder;

⑧ compression strength of upper and lower sliding bearings of ram pin.

(2) Piston type rudder actuator cylinder:

① strength of end cover bolts (or threads, screws);

② tensile strength and stability of piston rod (including threads at both ends) for cylinder stroke $S \geq 10\ D_2$;

③ strength of support;

④ strength of bolts of support (strength requirements for thrust plates as necessary);

⑤ bending strength and shear strength of pin shaft;

⑥ compression strength of pin shaft bearing;

⑦ strength of cylinder and piston rod earring.

(3) Rotary vane type rudder actuator cylinder:

① bolts of cylinder cover;

② fixed vane bending strength and its connection structural strength;

③ rotary vane bending strength and its connection structural strength;

④ strength of bolts of cylinder seating (strength requirements for thrust plates as necessary);

⑤ strength of rotor;

⑥ strength of connection between rotor and rudder stock.

(4) Rudder tiller:

① joining bolts, if applicable;

② strength of connection with rudder stock, if applicable.

(5) Structural strength of rudder tiller connecting rod:

① check of strength of connecting rod sectional area;

② bending strength and shear strength of pin shaft connected with rudder tiller;

③ compression strength of pin bearing;

④ strength of earring.

1.8.2 If the isolating valve is non-standard and self-made, the strength of bolts connected with cylinder pads and bolts of compressing cover of valve core is to be checked.

1.8.3 Permissible stresses

Unless expressly provided otherwise in this Chapter, for the purpose of determining the dimensions of parts of rudder actuators, the permissible stresses are not to exceed the following values:

$$\sigma_m \leq [\sigma]$$

$$\sigma_l \leq 1.5\,[\sigma]$$

$$\sigma_n \leq 1.5\,[\sigma]$$

$$\sigma_l + \sigma_n \leq 1.5\,[\sigma]$$

$$\sigma_m + \sigma_n \leq 1.5\,[\sigma]$$

$$[\tau_j] = (0.6 \sim 0.8)\,[\sigma]$$

$$[\tau_n] = (0.5 \sim 0.6)\,[\sigma]$$

$$[\sigma_{jy}] = (1.7 \sim 2)\,[\sigma]$$

where: σ_m – equivalent primary general membrane stress, in N/mm^2;

σ_l – equivalent primary local membrane stress, in N/mm^2;

σ_n – equivalent primary bending stress, in N/mm^2;

$[\tau_j]$ – permissible shear stress of steel, in N/mm^2;

$[\tau_n]$ – permissible torsional shear stress of steel, in N/mm^2;

$[\sigma_{jy}]$ – permissible compression stress, in N/mm^2;

$[\sigma]$ – the lesser of R_m/A or R_{eH}/B, in N/mm^2;

R_m – tensile strength of material at ambient temperature, in N/mm^2;

R_{eH} – yield point or proof stress of material at ambient temperature, in N/mm^2.

The values of A and B are to be selected respectively according to related definitions in Chapter 13 (Table 13.1.6.2, or Table 1.2.3 of Appendix 1), PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

1.8.4 Requirements for check of normal stresses:

(1) Check of pure shear strength:

$$\tau_j = Q_j / F_j \leq [\tau_j]$$

where: Q_j – shear stress acting on the shear area, in N;

F_j – shear area, in mm^2.

(2) Check of shear strength for bending:

For beams of rectangular section: $\tau_j = 3Q_j / 2bh \leq [\tau_j]$

where: h – height, in m;

b – breadth, in m.

For beams of circular section: $\tau_j = 4Q_j / 3\pi R^2 \leq [\tau_j]$

where: R – radius of circle, in m.

(3) Check of pure compression strength:

$$\sigma_{jy} = Q_{jy} / F_{jy} \leq [\sigma_{jy}]$$

where: Q_{jy} – compressive force on the compressed area, in N;

F_{jy} – compressed area surface, in mm^2.

(4) Check of pure bending strength:

$$\sigma_n = (M / W_z) \times 10^{-6} \leq 1.5 [\sigma]$$

where: M – bending moment, in Nm;

W_z – bending section modulus, in m^3.

For rectangular section: $W_z = bh^2/6$

where: h – height, in m;

b – breadth, in m.

For circular section: $W_z = \pi D^3/32$

where: D – diameter of circle, in m.

(5) Check of pure torsional strength:

$$\tau_n = (M_n/W_n) \times 10^{-6} \leq [\tau_n]$$

where: M_n – torque, in Nm;

W_n – torsional section modulus, in m^3.

For circular section: $W_n = \pi D^3/16$

where: D – diameter of circle, in m.

For hollow circular section: $W_n = \pi (D^4 - d^4)/16\ D$

where: D – outside diameter of circle, in m;

d – inside diameter of circle, in m.

(6) Check of strength for combined bending and torsional moments:

$$(\sigma_n^2 + 3\tau_n^2)^{1/2} \leq [\sigma]$$

where: σ_n – pure bending stress, in N/mm^2;

τ_n – pure torsional stress, in N/mm^2.

1.8.5 Check of strength of thread of preloaded bolts and screws (the depth the thread screws in is not to be less than the diameter of the bolt)

Composite stress at the thread:

$$\sigma_L = 1.66\ (K_0 + K_c)\ F_L/d_L^2 \leq [\sigma] \quad \text{MPa}$$

where: K_0 – preloaded thread coefficient, with static load $K_0 = 1.2 \sim 2$; dynamic load $K_0 = 2 \sim 4$;

K_c – coefficient of rigidity, with $K_c = 0.2$ for connecting rod bolts and $K_c = 0.2 \sim 0.3$ for steel plate (or with metal gasket) connection;

F_L – maximum tensile force acting on a single bolt, in N;

d_L – inside diameter of thread, in mm.

1.8.6 Check of strength of seating and its fastening bolt group subjected to capsizing moment:

(1) The conditions assumed for calculation of (2):

① diameter and preloaded force of bolts are the same;

② the axis of capsizing moment is at the lower opposite angles of the seating in the direction of forces;

③ each row of bolts are symmetrically the same in the vertical direction of forces.

(2) The maximum tensile force acting on bolts due to capsizing moment:

$$F_L = L_{max} M/z\,(L_1^2 + L_2^2 + \ldots\ldots + L_i^2) \times 10^3 \quad \text{N}$$

where: F_L – maximum tensile force acting on a single bolt, in N;

L_{max} – the maximum distance between axis of capsizing moment and the farthest bolt, in mm;

M – capsizing moment, in Nm;

z – number of rows of the bolts in transverse direction;

$L_1, L_2, \ldots\ldots, L_i$ – distance between axis of capsizing moment of bolt group and bolts, in mm.

Combination of forces in different direction is to be considered.

1.8.7 Check of stability of compression rod

The stability of piston rod is to be checked for oil cylinder stroke $S \geq 10d_2$. For hydraulic cylinders with a steel piston rod articulated at both ends:

when $L > 21.25d_2$:

$$F_k = d_2^4/L^2 \times 10^5 \geq n_k F \quad \text{N}$$

when $L \leq 21.25d_2$:

$$F_k = 1.2d_2^4/(312.5d_2^2 + L^2) \times 10^5 \geq n_k F \quad \text{N}$$

where: F_k – limit force of stability of the compression rod of piston rod, in N;

F – maximum design thrust of oil cylinder, in N;

L – calculated length of piston rod (maximum distance between the two articulation holes), in mm;

n_k – safety factor; generally $n_k = 2 \sim 4$.

1.8.8 The strength of connecting bolts of rudder tiller may be checked according to the following requirements:

If the boss of tiller consists of two abutted plates, each end is to be fastened with at least 2 bolts, and the total area A_L of sections of all bolts is not to be less than the value calculated according to the following formula:

$$A_L = 0.2D_r^3/L_L \quad \text{mm}^2$$

where: D_r – diameter of rudder stock at the rudder tiller, in mm;

L_L – distance between centers of bolts at both ends, in mm.

1.8.9 The strength of rudder tiller connecting rod may be checked according to the following requirements:

Sectional area A_g and moment of inertia I_g of connecting rod are not to be less than the values calculated according to the following formulas:

$$A_g = 0.12\, D_r^3/R \qquad \text{mm}^2$$

$$I_g = 6.6\, D_r^3\, L_b^2/R\times 10^{-6} \qquad \text{mm}^4$$

where: R – radius of tiller of passive rudder, in mm;

L_b – maximum design length of connecting rod, in mm.

1.9 Approval

1.9.1 Principles of selection of typical samples

(1) One sample is to be selected randomly for type test when the manufacturer applies for design approval of products with single specification.

(2) One sample which is the most representative or one with maximum specification is to be selected for type test when the manufacturer applies for type approval of product series with the same type but different specifications. When main technical data do not cover all the products, the number of samples may be increased appropriately or combined sampling is to be adopted to reach an effective coverage of the products.

(3) Samples may be taken in groups or batches when the manufacturer applies for type approval of products with different types and specifications, i.e. hydraulic power systems, steering gear control systems and rudder actuators may be examined either separately or in combination:

① hydraulic systems: Categories may be based on principles of hydraulic power and control systems. For each type of hydraulic systems of which the parts are basically the same and only the nominal pressure or required flow is different, consideration is to be given to the maximum nominal pressure and flow in selection of samples;

② rudder actuators: For rudder actuators with the same drawing number/type which are only different in nominal pressure and (rotating) speed, the specifications with maximum nominal pressure and (rotating) speed are to be considered in selecting samples, covering different types of rudder actuators;

③ conditions at minimum and maximum speeds are to be examined for pumps driven by diesel engine;

④ if the general arrangement (system drawing) includes controls such as steering gear operation console, mechanical and electrical equipments are to be adjusted together in type test.

(4) Approved products are to be subject to inspection and test either one by one or in batches for sampling, as appropriate.

1.10 Type test

1.10.1 According to the requirements in Chapter 3, PART ONE of CCS Rules for Classification of Sea-Going Steel Ships, steering gears are to be subject design approval. However, the type approval may be selected by the manufacturer.

1.10.2 The type test programme provided by the applicant for design or type approval of hydraulic steering gears is usually at least to cover the following:

(1) Test items for which CCS surveyor is to be present:

Inspection and test items in 1.10.3 and 1.10.4 of this Chapter are involved.

Steering gears above 630kNm, which have mature structure and under normal working pressure on the base of sufficient design, manufacture and use experience may not carry out the load test in 1.10.4(5) ~ (9) in the manufacturer with the special approval by CCS, and navigational test results could be in lieu of load test. If the new designed steering gear does not meet these requirements, load test is to be carried out by proportionally reduced samples. The requirements of load test are the same as those for type test.

(2) Inspection items to be completed by the manufacturer:

Test items and requirements specified in the design standard(s) selected and shown in public by the manufacture.

1.10.3 At least the inspections and tests required in Table 1.10.3 are to be carried out at the manufacturer.

Tests at manufacturer **Table 1.10.3**

No.	Specific requirements	Basis of inspection	Remarks
1	Tests of pipes, flanges valves and fittings	13.1.12.2(1) of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Regarding requirements for Class I piping systems in Chapter 2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships , hydraulic test is to be carried out according to 2.7.1 and 2.7.1, with test pressure being kept for 5 min
2	Test of hydraulic steering gear components subject to internal pressure	13.1.12.2(2) of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. Mainly, the rudder actuator cylinder and the first closing device connected to the cylinder are to be tested according to the requirements for Class I pressure vessels in Chapter 6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships s, i.e. hydraulic test is to be carried out according to the requirements of 6.5.2, with test pressure being kept for 5 min (30 min for accumulators). 2. For purchased components, certification may be required in lieu of test
3	Type test of pump of power unit	13.1.12.2(3) of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. If the self-made hydraulic pump has been inspected satisfactorily by CCS Surveyor, it may be exempted from the 100 h individual test; 2. For purchased components, certification may be required in lieu of test
4	Test of diesel engine of driving power unit	13.1.12.2(4) of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Certification may be required in lieu of test
5	Test of electric motor of driving power unit	13.1.12.2(5) of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	Certification may be required in lieu of test
6	Final inspection and operation test after general assembly	13.1.12.2(6) of PART THREE of CCS Rules for Classification of Sea-Going Steel Ships	1. It is to be carried out in accordance with the requirements of 1.10.4 of this Chapter, in special case, other equivalent test methods may be accepted by CCS. 2. During the matching test with electrical control system of steering gear, its test items, methods and requirements are also to comply with the applicable provisions of Chapter 3, PART NINTEEN of this Guidelines

1.10.4 Type test items, methods and requirements

(1) Trial test:

Recommended methods:

① The tested steering gear is under no-load operation condition, steering is to be carried out three times for each unit in turn within the range of ±5°,±10°,±15°,±20°,±25°,±30°and ±35°respectively. The error of rudder angle is to be inspected. When the rudder angle α of pump controlled hydraulic steer gear is inspected, the indicated location 5 s after the rudder reaches the angle（α-1）°is regarded as the stopping location.

② Two units are to be transferred each other for three times, if the two units are designed to run synchronously, they are to work simultaneously and steering is to be carried out for three times within the range of ±35°, where the double units of pump control system run simultaneously, synchronous steering test may be carried out after the units run for 15 min at the meanwhile under the working condition of the oil pump displacement of zero.

Note: if the drawing includes the greater rudder angle exceeding ±35°, the maximum rudder angle is to be covered in the test.

The test is to verify:

① the maximum rudder angle, mechanical limit rudder angle inside the cylinder, time required for rudder movement (effect of volume capacity of system is to be considered) are to meet the design settings of the approved drawings;

② that two sets of stroke limit switches for maximum rudder angle are to be provided and located as far as possible, consideration is to be given that the steering actuator could not be damaged during its running to the mechanical limit rudder angle if the switches fail;

③ for the manually operated emergency steering gear, test is to be carried out and the operation is to be quickly and reliably;

④ the design performances verification, including operation correctness is to meet the settings of the approved drawings;

⑤ synchronic running of double units (if applicable), monitoring and alarm of hydraulic locking is also to be verified, as appropriate;

⑥ that the oil temperature sensors (if applicable), filter blocking sensors (indicators), pressure sensors (gauges), etc. are in normal working order;

⑦ no other abnormal phenomena.

(2) No-load operation test:

Recommended methods:

① The loading system is to be connected with the tested steering gear;

② According to the trial conditions, steering is to be carried out for 10 min for each power unit in turn within the range of ±35°. If the two units are designed to run synchronously, they are to work simultaneously, and steering is to be carried out for 5 min within the range of ±35°.

Note: if the drawing includes the greater rudder angle exceeding ±35°, the maximum rudder angle is to be covered in the test.

The verification requirements of test are referred to trail test.

(3) Tightness test:

Tightness test is to be carried out for hydraulic steering gear with the pressure of 1.25 times design pressure and maintained for 5 min. There are to be no leakage and other abnormal phenomena.

(4) Safety valves test:

The settings of safety valves at maximum displacement (rudder movement speed) and pressure changing with the displacement are to meet the design requirements of approved drawings and the requirements in 13.1.7.2, PART THREE of CCS Rules for Classification of Sea-going Steel Ships. The test is to be repeated for three times, and the average value is to be taken.

The safety valves are to be operated quickly and reliably, without any abnormal phenomena.

(5) Load test:

Recommended methods:

The loading system is to be adjusted so that the steering gear could be operated at the 25%, 50%, 75% and 100% maximum working pressure, respectively, steering is to be carried out for 15 min for each power unit in turn within the range of ±35°. If the two units are designed to run synchronously, they are to work simultaneously and steering is to be carried out for 5 min within the range of ±35°.

The relevant test data are to be recorded, including rudder angle, oil pressure (including the outlet of main pumps, the inlet/outlet of rudder actuator cylinders, etc), output torque, time required for rudder movement, power of motor, oil temperature, etc.

Note: if the drawing includes the greater rudder angle exceeding ±35°, the maximum rudder angle is to be covered in the test. The load selection corresponding to the rudder angle is to meet the design requirements of drawings.

The test is to verify:

① that the output torques within the range of ±35°and at the maximum rudder angle are to meet the nominal torque requirements of the drawings;

② for mechanical or hydraulic operated steering gears, the sluggish rudder time is not to be less than 1s;

③ for the hydraulic or mechanical steering gears with wheels, the idling of hand wheel could not be exceeding half circle, the force on the hand wheel is not to be more than 160 N;

④ the rush rudder angle of non-mechanical feedback hydraulic steering gear is not to be greater than 2°.

⑤ the time required for rudder movement and overload of motor are to meet the design requirements;

⑥ transfer of hydraulic power source unit and operational mode is to be quickly and reliably;

a. the transfer of power unit is to be quickly;

b. the transfer period of power source operational mode made by one person is not more than 10s;

⑦ no obvious leakage for the system and the temperature rise is to meet the design requirements;

⑧ the rudder runs in a stable way, without serious overspeed, creep, hydraulic impact, etc.

(6) Rudder hold test:

Recommended methods:

When the hydraulic steering gear is not in follow-up or autopilot mode, the rudder runs to the position of ±35°, the loading system is adjusted so as that the torque of rudder stock is the nominal torque of rudder movement required by drawings, the rudder movement speed is to be measured.

The test is to verify:

that the rudder movement is not to exceed 0.5°/min for ram type rudder actuator and piston type rudder actuator, and not to exceed 1°/min for rotary vane type rudder actuator, and without any abnormal phenomena.

(7) Steering test with minus torque (if applicable):

Recommended methods:

① steering is carried out at no-load operation condition, and the time required for rudder movement t from the range from ±35°to ±5°is to be recorded;

② When the hydraulic steering gear is not in follow-up or autopilot mode, the rudder runs to the position ±35°, the loading system is adjusted (for the displacement and pressure of oil pump for loading system) so as that the equivalent speed of rudder movement corresponding to the displacement of oil loading pump is obviously more than the no-load running speed of tested rudder when the loading system pushes counter to the tested rudder, the torque of rudder stock reaches the nominal torque required by drawings, the simulated working conditions with minus torque occurs for the steering from the range of ±35°to ±5°, the time required for rudder movement t is to be recorded. Each unit is to be carried out for three times in turn.

The test is to verify:

that the ratio between the time t' required for rudder movement from 35° to 5° with balance valve acting at minus torque and the time required for rudder movement t from 35° to 5° in normal condition without minus torque is not to be less than 0.9, and without any abnormal phenomena.

(8) Overload test:

Recommended methods:

The loading system is to be adjusted so as that the steering gear is tested at 110% maximum working condition. Steering is carried out for 5 min for each unit within the range of ±35°(safety valve and time required for rudder movement are not required to adjust).

The test is to verify:

that the steering gear has a certain capability of working under overloading condition, the rudder movement speed is not to be reduced obviously and without any other abnormal phenomena.\

(9) Continuous running test:

Recommended methods:

① The loading system is to be adjusted so as that the steering gear runs reciprocately at maximum design rudder angle and the maximum working pressure. The test period: the two power units run simultaneously for 12h for the steering gear with the nominal steering torque less than or equal to 100kNm; totally run 12h for the steering gear with the nominal steering torque more than 100kNm; the test period for novel structured or special required steering gear is to be of 50h. Test data are to be recorded every 2h.

② If the continuous running test is stopped due to the failure other than the tested steering gear, the repairing time is to be deducted from accumulated test period.

③ After the continuous running test is finished, the output torque of steering gear is to be retested, the method is the same as load test in (5).

The test is to verify:

① the temperature rise of the system meets the design requirements and the output torque of steering gear after test is still to be in compliance with the design requirements of drawings.

② there is no abnormal phenomena.

(10) Dismantling

Recommended methods:

The main components and parts under force, friction parts and sealed parts (excluding purchased standard hydraulic equipment units) are to be dismantled, the clearness of hydraulic oil in the system is to be inspected.

The test is to verify:

there is no excessive wear of components and parts, the clearness of hydraulic oil is normal without any abnormal phenomena.

(11) Low level test:

Recommended methods:

Each tank of steering gear power unit is discharged in turn and the liquid level indicator is to be observed.

The test is to verify:

① the level of tank is to meet the design requirements of the approved drawings when the liquid level indicator is working, the unit of steering gear could still be in normal working order when the ship's inclination is taken into consideration and there is no abnormal phenomena.

② the pumps are to be capability of starting quickly and reliably at the working critical point of liquid level indicator.

(12) Pressure loss test of auxiliary piping (if applicable):

Recommended methods:

① One power unit is started to simulate the failure of pressure loss for the steering gear by discharging oil or reducing pressure of the auxiliary piping system, each indicator of alarm and isolation of single failure of steering gear and transfer device is to be observed.

② Another unit is transferred to carry out the simulation test as above-mentioned.

③ The above-mentioned tests are to be repeated for three times.

The test is to verify:

the alarm output of single failure, (automatic or manual) isolation and transfer time of unit, steering capability after isolation due to single failure, etc. are to meet the relevant requirements of CCS Rules for Classification of Sea-going Steel Ships, this Chapter and the design requirements of the approved drawings.

(13) Pressure loss test of main piping (if applicable):

Recommended methods:

① One power unit is started to simulate the failure of pressure loss for the steering gear by discharging oil or reducing pressure of the main piping system, each indicator of alarm and isolation of single failure of steering gear and transfer device is to be observed.

② Another unit is transferred to carry out the stimulation test as above-mentioned.

③ The above-mentioned tests are to be repeated for three times.

The test is to verify:

the alarm output of single failure, (automatic or manual) isolation and transfer time of unit, steering capability after isolation due to single failure, etc. are to meet the relevant requirements of CCS Rules for Classification of Sea-going Steel Ships, this Chapter and the design requirements of the approved drawings.

(14) Double units failure transfer test (if applicable):

Recommended methods:

Two power units are started at the meanwhile to simulate the single failure of steering gear by discharging oil of the main and auxiliary piping systems at any side of the steering gear in turn. Each indicator of alarm and isolation of single failure of steering gear and transfer device is to be observed. The above-mentioned tests are to be repeated for three times.

The test is to verify:

the alarm output of single failure, (automatic or manual) isolation and transfer time of unit, steering capability after isolation due to single failure, etc. are to meet the relevant requirements of CCS Rules for Classification of Sea-going Steel Ships, this Chapter and the design requirements of the approved drawings.

1.10.5 Test conditions

(1) The test is to be carried out on a special test bench. The load characteristics of loading device are to simulate the ship's actual steering conditions. It is recommended to carry out the test in accordance with the requirements of CB/T3130 Test Methods for Hydraulic Steering Gears.

(2) The test oil is to meet the following requirements:

① oil temperature: during the test, it is usually maintained within the range of 40 ℃ ~ 55 ℃ . Where it is not permitted or it has special requirement, other consideration may be taken after discussion. If necessary, all the test data are to be converted to the performance values at the specified oil temperature of the test. Ambient temperature and oil temperature of tested hydraulic steering gear system are to be recorded.

② viscosity: test oil of the tested hydraulic steering gear is to be used in accordance with the specifications provided by the manufacturer. Brand of test hydraulic oil is to be recorded.

③ requirements of test instruments:

a. direct reading instrument: its accuracy doesn't lower than Grade 1 for type test and does not lower than Grade 1.6 for routine test, instrument installed in the steering gear could be accepted for use in the special cases.

b. sensors and associated secondary instrument are to be provided with certificates, term of service and calibration card.

1.11 Unit/batch inspection

1.11.1 Quality assurance

(1) The manufacturer is to ensure the hydraulic steering gear is so designed, manufactured, inspected and tested as to meet the performance characteristics of sample approved by CCS or type test sample.

(2) The manufacturer is to ensure to carry out quality control for product design, manufacture, inspection and identification in accordance with the relevant requirements of this Chapter. The hydraulic steering gear which does not meet the requirements of this Chapter are not allowed to sale with the mark related to inspection requirements of CCS,

1.11.2 Inspection

(1) The manufacturer is to provide all necessary suitable conditions to the CCS site surveyor in order to verify that the provided documents are in compliance with the requirements of this Chapter, at least including:

① quality documents of the main components and parts;

② manufacturer's inspection and test report (inspection and test items are to meet the requirements in 1.11.3 ~ 1.11.4);

③ document of compliance or certificate of product.

1.11.3 According to the requirements in Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships, The test items after CCS approval usually is to include the followings:

(1) Pressure test prior to assembly;

(2) Operational test after assembly, unless expressly provided otherwise in inspection programme mentioned in 1.11.5 of this Chapter, the test items and requirements usually include the contents in 1.10.4(1) ~ (7) and (11) ~ (14) of this Chapter, in which load test may only be carried out at 50% and 100% maximum working pressure.

1.11.4 The manufacturer is also to ensure completion of the following inspection items:

(1) routine inspection and test items specified in the design standard(s) selected and shown in public by the manufacture;

(2) special test items added in the technical contract for delivery, if applicable.

1.11.5 The manufacturer is to carry out inspection and test for the hydraulic steering gear intended to apply for survey in accordance with the above-mentioned items, if it is qualified, then to apply CCS for survey. Where the manufacturer or product has been approved by CCS, the sampling proportion and sampling inspection and test items made by CCS site surveyor are to be in accordance with the inspection programme issued together with the certificate of type approval by CCS.

1.11.6 Necessary mechanical and electrical commissioning test, load test and operational test are to be carried out in accordance with the requirements of 13.1.12.4, PART THREE of CCS Rules for Classification of Sea-going Steel Ships after hydraulic steering gear is installed onboard in order to be in compliance with the relevant requirements of the CCS rules and the intended purposes.

PART EIGHT PIPING EQUIPMENT AND FITTINGS

CHAPTER 1 PUMPS

1.1 Application

1.1.1 This Chapter applies to centrifugal pumps, regenerating pumps, axial flow pumps, mixed-flow pumps, screw pumps, gear pumps, reciprocating pumps, etc. For other types of pumps, reference may be made to in this Chapter.

1.2 Basis for approval and inspection

1.2.1 The approval and inspection in this Chapter are to be based on the following documents:

(1) CCS Rules for Classification of Sea-Going Steel Ships;

(2) CCS Rules for Materials and Welding;

(3) IACS UR_G3 (Rev.4 2011).

1.3 Terms and definitions

1.3.1 For definitions of terms such as products inspection, approval, type test, sample and unit/batch inspection, refer to the relevant requirements of CCS Rules for Classification of Sea-Going Steel Ships.

1.3.2 Displacement pump means screw pump, gear pump and reciprocating pump.

1.3.3 Design pressure is to be taken as the maximum pressure on the characteristic curves for centrifugal pumps and regenerating pumps, and as the full backflow pressure of the safety valve for displacement pumps.

1.3.4 Cargo pump means crude/product oil pump, liquid chemical pump, low-temperature liquefied gas pump, etc.

1.4 Plans and documents

The applicant is to submit an approval application together with the following plans and documents according to the requirements of this paragraph.

1.4.1 The following plans and documents are to be submitted to CCS for approval:

(1) Main performance specifications (covering the entire series for which approval is sought: capacity, pressure, speed, shaft power, cavitation performance, medium, etc. In the case of pump assemblies, type and parameters of associated electrical motors are also to be included);

(2) General assembly (sectional drawing);

(3) Bearing and seal construction and arrangement (if reflected in the general assembly drawing, submission is not necessary);

(4) List of physical and chemical properties of main components and parts;

(5) Drawing of main components and parts, such as casing, cover, screw, gear, impeller, shaft, liner, etc.;

(6) Type test programme.

1.4.2 The following plans and documents are to be submitted to CCS for information:

(1) Operation instructions for the products;

(2) Main technological documents, such as heat treatment procedure of parts, welding procedure for casing and if necessary, casting procedure;

(3) Specimens of product nameplates and manufacturer's certificate, etc.

1.4.3 Other documents to be submitted

Documents to be submitted as required in 3.2.1, PART ONE of the Guidelines.

1.5 Main components and parts

1.5.1 Main components and parts include casing, cover, safety valve casing, screw, gear, impeller, shaft, liner, etc.

1.5.2 100% of casings, covers, safety valves and other pressure parts are to be subjected to hydraulic pressure test prior to assembly, and the hydraulic pressure test report is to be reviewed and confirmed by CCS Surveyor or the test is to be witnessed by CCS Surveyor.

1.5.3 If the main components and parts referred to in 1.5.1 are purchased, the applicant is to establish perfect means to control subcontractors for ensuring the quality of such parts.

1.5.4 If the purchased pressure parts such as casings, covers, safety valve casing, etc. are made of castings or forgings, they are to hold CCS product certificates or be purchased from the manufacturers approved by CCS and hold the quality certificates provided by the manufacturers. Where they are purchased from the manufacturers not approved by CCS, the tests or retests of physical and chemical properties for castings or forgings are to be witnessed by CCS surveyor when the manufacturers apply for product inspection.

1.6 Evaluation of welding procedures

1.6.1 Where the main components and parts listed in 1.5.1 above are of welded construction, the welding procedures are to be evaluated and approved according to the relevant requirements of CCS Rules for Materials and Welding.

1.7 Design and technical requirements

1.7.1 Marine ambient conditions

Marine pumps are to operate normally with the ship having a 15° heel, or 22.5° roll, or 5° trim or 7.5° pitch. Emergency fire pumps and pumps associated with emergency generating sets are to operate normally with the ship having both heel and roll being 22.5° or trim and pitch being 10°.

1.7.2 Materials

(1) Materials of main components and parts of marine pumps are to be selected for types, temperatures and pressures of medium to be conveyed. In the case of conveying dangerous chemicals, the manufacturer is to provide sufficient evidence for compliance of the material selected with operational requirements.

(2) Casings of thermal oil pump or other pump conveying high-temperature medium (including safety valves) are to be of steel or equivalent ductile material and suitable for related operating temperatures.

(3) If fuel oil pump casings (including safety valves) are of gray cast iron, the maximum working pressure is not to exceed 0.7MPa and the maximum operating temperature not to exceed 60℃.

(4) In the case of conveying a low-temperature medium, material of casings (including safety valves) is to be selected according to the relevant requirements of CCS Rules for Materials and Welding.

(5) If the pump is fitted on the piping connecting with cargo tank onboard the ship carrying liquefied gases in bulk, the melting point of casing material is not to be lower than 925°C (IACS UR_G3 Rev.4 2011).

1.7.3 Vibration

When operating in rated conditions, maximum vibration severity V_{rms} (in mm/s) of marine pumps is to comply with the following requirements:

(1) for centrifugal pumps and regenerating pumps, $V_{rms} < 7.1$;

(2) in the case of displacement pumps, $V_{rms} < 11.2$ for vertical ones, and $V_{rms} < 7.1$ for horizontal ones.

1.7.4 Temperature of bearings

The actual working temperature of bearings is not to exceed the maximum value specified by the manufacturer, in general, the maximum surface temperature of bearings is not to exceed 75℃ and the temperature rise is not to exceed 35℃ during operation.

1.7.5 Pressure parts

All pressure parts including casings, covers and safety valves are to be hydraulically tested to 1.5 times the design pressure for not less than 5 min prior to assembly.

1.7.6 Safety valves

(1) In general, all displacement pumps are to be fitted with a safety valve. Each safety valve is to be so arranged as to discharge back to the suction side of the pump.

(2) The opening pressure of the safety valve is to be 1.1 – 1.15 times the rated working pressure.

(3) When the safety valve is in a full backflow condition, the discharge pressure of the pump (the full backflow pressure of the safety valve) is not to exceed 1.5 times the rated discharge pressure; when the rated discharge pressure is not more than 0.5 MPa, the discharge pressure is not to exceed the rated discharge pressure plus 0.25 MPa.

(4) When the safety valve returns to the closed condition from the full backflow condition, the pump capacity at rated pressure point is not to be less than that before the safety valve being opened.

1.7.7 Self-priming performance

The marine pumps intended for emergency fire pumps or power bilge pumps are to be of self-priming type. The self-priming height of the intended emergency fire pumps is not to be less than 4.5m.

1.7.8 The fire pumps and emergency fire pumps are also to meet the relevant requirements of Chapter II-2 in SOLAS and Chapter 12 in FSS Code.

1.7.9 The pumps intended for conveying liquefied dangerous chemical medium are also to meet the relevant requirements of CCS Rules for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk and IBC Code.

1.7.10 The pumps intended for conveying liquefied gas medium are also to meet the relevant requirements of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk and IGC Code.

1.8 Selection of typical samples

1.8.1 When applying for approval at the first time, the selected sample pumps are to be typical products capable of representing or covering the products or product series for which approval is sought, in respect of performance, characteristics, manufacturing quality.

1.8.2 When renewing the approval, one or several types which are the most representative or the most demanded in market may be selected as samples.

1.8.3 For pumps intended for conveying low-temperature liquefied gas medium, type test is to be carried out for each type and specification in accordance with the requirements of 1.9 of this Chapter (IACS UR_G3 Rev.4 2011).

1.9 Type test

1.9.1 Test items

(1) Generally, type test items are to include:

① test of physical and chemical properties of raw materials of pressure parts;

② hydraulic strength test of main pressure parts;

③ operation test;

④ full performance test;

⑤ safety valve test (for displacement pumps fitted with safety valves only);

⑥ cavitation test (if cavitation performance is required);

⑦ self-priming performance test (for pumps required for self-priming capability only, such as self-priming centrifugal pumps intended for emergency fire use);

⑧ self-induced vibration test;

⑨ fixed-inclination test (for pumps required for self-priming capability only, such as emergency fire pump, etc.);

⑩ dismantling after test.

(2) Exemption from test items

① Approval for the first time

Normally all test items applicable in 1.9.1(1) above are to be carried out when the applicant applies for approval at the first time. The manufacturer may apply for exemption from some of the test items in writing, and CCS Surveyor will consider the application according to the manufacturer's production, history of production and usage record of his products and will fax the manufacturer's written application together with comments to the Classed Newbuildings Department/Product Management Department of the Headquarters, and can grant an exemption from some test items only upon approval by the Classed Newbuildings Department/Product Management Department, provided that the following conditions are met:

(a) the applicant is to be able to provide a test report of corresponding test items issued by an authoritative technical organization (e.g. General Administration of Quality Supervision, or a national defense laboratory) recently;

(b) the applicant is to be able to provide a test report of corresponding test items signed by an IACS member society recently;

② Re-approval at renewal of approval certificate

If there is no change to design and if there is no change to technical requirements of CCS Rules for Classification of Sea-Going Steel Ships for the type of products, the type test may be omitted. However, CCS still reserves the right to require type test again

1.9.2 Test requirements

(1) Test location

CCS Surveyor is to check the manufacturer's test laboratory/test bench used as approval test location and confirm compliance with the requirements of 1.9.2(2), 1.9.2(3) and 1.9.2(4) below. Otherwise, all tests are to be carried out at certification and test organizations recognized by CCS.

(2) Measuring instruments

Measuring instruments used in the tests are to be calibrated and hold with valid calibration certificates, and the accuracy of test instruments is to meet the test requirements.

(3) Test medium

Unless special cases provided otherwise, tests are generally to be carried out with the following medium:

① Petroleum distillate is generally used in three-screw pumps and gear pumps as test medium. The viscosity and temperature characteristic of the test oil is to be measured as required or provided by the test oil supplier.

② Clean fresh water is generally used in single-screw pumps, centrifugal pumps and regenerating pumps as test medium.

③ Petroleum distillate or clean fresh water is used in double-screw pumps, reciprocating pumps and other pumps, as appropriate.

(4) Test apparatus

Typical arrangement of test apparatus is given in Appendix B.

(5) Measurement of test parameters

① Capacity measurement

Pump capacity may be measured by the turbine flowmeter, tube flowmeter, electromagnetic flowmeter, gravimetric method or volumetric method.

② Pressure measurement

(a) Pump pressure is the converted inlet pressure or outlet pressure on the reference surface, and the full pressure is the difference between inlet pressure and outlet pressure. The reference surface of horizontal pumps is the horizontal surface with centerline of rotor axis; the reference surface of vertical pumps is the horizontal surface with suction centerline.

(b) The pressure may be measured by liquid column manometer, spring pressure gauge, piston pressure gauge or other types of pressure gauge.

③ Speed measurement

Speed may be measured directly by the digital photoelectric tachometer.

④ Shaft power measurement

Shaft power is to be obtained by:

(a) measuring the torque and speed of the shaft by the dynamometer, and then to obtain the value through calculation; or

(b) measuring the output power of drive motor by an electrotechnical instrument, and then multiplying the measured value by efficiency of motor.

1.9.3 Test methods

(1) Test of physical and chemical properties of raw materials of pressure parts

① Scope

Tests of physical and chemical properties of raw materials are to be carried out for pressure parts such as casings, covers, safety valves, etc. , except those purchased raw materials or castings having CCS product certificates.

For the pumps intended to use for medium with the temperature below -55℃ , its raw material is to be tested at its minimum design temperature.

② Sampling

Where appropriate, castings are to be sampled and sealed at the casting manufacturer supplying the applicant, in the presence of CCS Surveyor. If sampling on site is not convenient, the additional casting samples attached to delivered castings may be accepted instead.

③ Testing method and result evaluation are to be in accordance with requirements in related Chapters of CCS Rules for Materials and Welding.

(2) Hydraulic strength tests of main pressure parts

① Scope

Main pressure parts include casings, covers and safety valves (if any), which may generally be subject to a hydraulic test either separately or as an assembled unit; for pumps driven by compressed air or steam, or fitted with casing steam-heating apparatus, the hydraulic test is also to be carried out at air/steam sides.

② Test pressure

The hydraulic test pressures of pressure parts for different pump types are as follows:

(a) For centrifugal pumps and regenerating pumps, test pressure is to be 1.5 times the design pressure;

(b) For screw pumps, gear pumps and reciprocating pumps, test pressure is to be 1.5 times the design pressure or the design pressure plus 7 MPa (whichever is the lesser), but in no case less than 0.6 MPa;

(c) For pumps driven by compressed air or high-pressure steam, or fitted with steam-heating apparatus, the hydraulic test pressure at air/steam sides is to be 1.5 times the maximum working pressure of compressed air or steam.

③ Evaluation of test results

The surface of test pieces is to be clean and have no coating, free from leakage after testing for at least 5 min.

(3) Operation test

① The operation test is mainly to examine the assembling quality of pumps and pumping sets. Attention is to be given to whether the temperature and temperature rise of pump bearings and shaft seals are within the required limits and whether leakage of shaft seals is in compliance with the relevant requirements and whether any abnormal vibration or noise occurs.

Temperature of bearings and leakage of mechanical seals are to be as follows:

(a) the surface temperature and temperature rise of bearings are not to be more than as required in 1.7.4 of this Chapter;

(b) unless the special requirements, the leakage of mechanical seals is not to exceed 10 mL/h and that of packing seals not to exceed 6 mL/min.

② The pressure of the pump in testing is to increase gradually to the required pressure at rated speed and the pump is to operate at the rated pressure point for a sufficient duration to ensure the mechanical sealing conditions and temperature rise to comply with the relevant requirements.

③ If any abnormal vibration, noise or excessive bearing temperature occurs, the test is to be stopped immediately and can be continued only after failure causes are identified and eliminated.

④ The operation test is to be made for the pumps intended for conveying low-temperature liquefied gas medium in accordance with the following requirements (IACS UR_G3 Rev.4 2011):

(a) for submerged pumps (both the prime motor and pump are submerged in medium), the operation test is to be carried out by adoption of low-temperature medium designed for the pumps or other medium with temperature lower than the design value;

(b) for deep well pump with long shaft (only the pump submerged in medium, and driven by prime motor through one or several associated long shafts), water could be used as medium for the operation test at its rated working point. However, an additional operation test is to be carried out under the minimum design temperature at random working point to verify that the bearing clearance, friction ring and sealing device are reliable. It is unnecessary for such additional low-temperature operation test to be carried out as the driving shaft in whole length is fitted, but its length is ensured to be sufficient to install at least one bearing with sealing device.

(4) Full performance test

① Full performance test is to determine the relationship between pressure (lift), capacity, shaft power and efficiency of the pump at rated speed for verifying the correctness of pressure – capacity curve, pressure – shaft power curve and other characteristic curves submitted by the manufacturer (applicant for approval). The full performance test is to be carried out upon satisfactory operation test.

② Test speed is to be close to the required one so far as possible, with certain allowable deviation:

(a) for displacement pumps, actual test speed may be within ±5% of rated speed;

(b) for centrifugal pumps, mixed-flow pumps and axial flow pumps, etc., the actual test speed range is to be as follows:

when measuring capacity and lift, the actual test speed is to be within 50% ~ 120% of rated speed;

when measuring efficiency of the pump, the actual test speed is to be within ±20% of rated speed.

③ Selection of operating condition (measuring points):

(a) for displacement pumps, the test is to start from zero pressure point (or close to zero pressure) when the outlet pressure control valve is fully opened. Generally at least six pressure points are selected including zero pressure point and required pressure point, evenly distributed within the required pressure range;

(b) for centrifugal pumps, the test is to start from zero capacity point (when the outlet pressure control valve is fully closed) to 120% of rated capacity. At least seven pressure points are selected as measuring points, evenly distributed on the entire characteristic curves; if it is not practical to select points according to capacity (e.g. the capacity is measured by volumetric method), points may be selected according to pressure, but to be evenly distributed on the entire characteristic curves;

(c) for mixed-flow pumps, axial flow pumps and regenerating pumps, the test is to start with the outlet pressure control valve being fully opened and end when 85% of the rated minimum capacity is reached. At least seven pressure points are selected as measuring points and evenly distributed on the entire characteristic curves; if it is not practical to select points according to capacity (e.g. the capacity is measured by volumetric method), points may be selected according to pressure, but to be evenly distributed on the entire characteristic curves;

(d) if the design pressure (capacity) range of pumps is narrow, the number of measuring points may be reduced as appropriate;

(e) each measuring point is to be stable for sufficient time in order to reach consistence and expected accuracy.

④ Test data

The following data are to be taken at each testing point:

(a) outlet pressure;

(b) inlet pressure;

(c) capacity;

(d) ambient temperature (measured only once if temperature variation is not obvious);

(e) medium temperature (to be taken at each measuring point);

(f) temperature of bearings (for assessing normal operating condition of pumps only, and measured only once at each measuring point);

(g) speed;

(h) shaft power.

⑤ Conversion of test data

When the deviation of test speed from required one falls within the range as specified in 1.9.3(6) ② , the test data may be converted into related data for rated speed/viscosity according to the following methods.

(a) Displacement pumps

For the displacement pump, if its speed and viscosity of medium do not meet the requirements due to test conditions, the manufacturer is to provide the formula so as to convert the actual measured data to the value at rated speed and required viscosity. Such formula is to be marked in the test report.

(b) Centrifugal pumps, axial flow pumps and mixed-flow pumps

When the difference between test speed and rated speed is within the range mentioned in 1.9.3(6) ② , the test data may be converted to the corresponding values at rated speed in accordance with the following formulae:

$$Q_{in} = Q_i \frac{n}{n_i} \tag{1}$$

$$H_{in} = H_i \left(\frac{n}{n_i} \right)^2 \tag{3}$$

$$Pa_{in} = Pa_i \left(\frac{n}{n_i} \right)^3 \tag{4}$$

where: Q_{in} – capacity at measuring point at rated speed, in m^3/h;

Q_i – capacity measured at measuring point, in m^3/h;

Q_0 – measured capacity at zero pressure point, in m^3/h; with the inlet and outlet control valves being fully opened and measured inlet and outlet pressures being approximately zero, the capacity at rated speed may be converted according to the positive ratio of actual speed to rated speed;

H_{in} – lift at measuring point at rated speed, in m;

H_i – lift measured at measuring point, in m;

Pa_{in} – shaft power at measuring point at rated speed, in kW;

Pa_i – shaft power measured at measuring point, in kW;

n/n_i – rated speed/measured speed, in r/min.

⑥ Analysis of test data

Measured data are to be compared with characteristic curves submitted by the manufacturer (the applicant for approval). The measured data are to be basically consistent with such characteristic curves within the allowable operating range given by the manufacturer (the applicant for approval) and the tolerances for rated conditions are to be as required below:

(a) capacity tolerance of displacement pumps is not to exceed that given in Table 1.9.3(2);

Capacity Tolerance of Displacement Pumps Table 1.9.3(2)

Rated capacity range (m^3/h)	Capacity tolerance (%)
≤ 0.1	–10 ~ +20
> 0.1 ~ 10	+10
> 10	–5 ~ +10

(b) lift tolerance of centrifugal pumps and regenerating pumps is not to exceed ±10%;

(c) shaft power tolerance is not to exceed that given in Table 1.9.3(3).

Shaft Power Tolerance Table 1.9.3(3)

Rated shaft power range (kW)	Shaft power tolerance (%)
≤ 5	+25
> 5 ~ 10	+20
> 10 ~ 50	+15
> 50	+10

(5) Safety valve test

① All displacement pumps designed to be fitted with safety valves are to be subjected to safety valve test.

② The opening pressure of the safety valve is first to be measured, which is to be 1.1 ~ 1.15 times the rated discharge pressure.

③ The outlet control valve is then to be gradually closed until fully closed to measure the total backflow pressure of the safety valve; the total backflow pressure of the safety valve is not to exceed 1.5 times the rated discharge pressure; when the rated discharge pressure is less or equal to 0.5 MPa, the total backflow pressure of the safety valve is not to exceed the rated discharge pressure plus 0.25 MPa.

④ When the outlet control valve is reopened and the condition of the pump returns from full backflow of the safety valve to rated pressure point, the capacity is not to be less than that measured at the point during full performance test.

(6) Cavitation test

The cavitation test may be carried out by either of the following test methods:

① when the cavitation parameter in performance data submitted by the manufacturer is the allowable suction vacuum lift H_S, the inlet control valve may be closed gradually at the required point to reach that allowable suction vacuum lift H_S at the inlet. The pump capacity may be measured only when the difference between outlet and inlet pressures remains unchanged. When the capacity reduction is less than 3% of that at the required point during the performance test, H_S provided by the manufacturer is acceptable;

② when cavitation parameter in performance data submitted by the manufacturer is the necessary net positive suction head (NPSH)r, the critical net positive suction head (NPSH)c is to be measured by testing and compared with that necessary net positive suction head (NPSH)r. In case of (NPSH)r $\geq$ (NPSH)c + 0.3 mH_2O, the necessary net positive suction head (NPSH)r provided by the manufacturer is acceptable.

(7) Self-priming performance test

① The medium in the test pipeline is to be evacuated by practical and reliable means before the test.

② During the test, the vertical height of inlet piping is not to be less than the self-priming height given by the manufacturer, the diameter of piping connected in way of inlet of pump and the distance from the inlet of pump to liquid surface are to be recorded in the test report.

③ During the test, the speed allowance is ±5%, and the test is to be repeated for at least three times, and the time from starting to the moment when water discharge commences is to be measured in each test cycle, which is to be not more than the time given by the manufacturer in approved technical documents.

(8) Self-induced vibration test

① Self-induced vibration test may be carried out in the rated operating condition in conjunction with the operation test or the full performance test.

② Self-induced vibration test points may be selected as follows:

(a) the inlet bearing end cover and outlet flange of the pump may be selected as main measuring points;

(b) the pump pedestal or pump case may be selected as an auxiliary measuring point;

(c) the vibration severity V_{rms} (in mm/s) in directions X, Y and Z are to be measured at each measuring point.

③ The maximum vibration severity V_{rms} measured is to comply with the requirements of 1.7.3 of this Chapter.

(9) Fixed inclination test (only applicable to pumps required for self-priming performance, such as emergency fire pump, etc.)

① The test is to be carried out at the required point for at least 60 min.

② One pump is to be selected for each pump type, for which approval is sought, and tested to verify the compliance of the pump design with the requirements for service in conditions of inclination and heeling of the ship.

③ The inclination angle in the test is to be as follows:

(a) the shaft axis is at an angle of 20° to the horizontal plane for horizontal pumps, and 25° for pumps to be used as emergency fire pumps;

(b) the shaft axis is at an angle of 70° to the horizontal plane for vertical pumps, and 65° for pumps to be used as emergency fire pumps.

(10) Dismantling after test

Each pump which has been subjected to type test is to be dismantled to examine the wear of operating components, the surface of which is to be free from obvious locking together or excessive wear. The structural dimensions and fit clearance of components are to be within required limits.

1.10 Unit/batch inspection

CCS inspection may be requested only for those pumps which have been satisfactorily inspected/tested by the manufacturer and are ready for delivery.

1.10.1 The unit/batch inspection items for manufacturers with CCS type approval B are as follows:

(1) Tests are to be carried out according to the approved inspection plan (related provisions in quality control plans), including at least the performance test at required points (operation test), self-priming performance test (if required), safety valve test (if any) and cavitation performance test (if cavitation performance required).

(2) The above tests may be carried out by the manufacturer independently and a complete test report is to be submitted to the Surveyor for review.

(3) At least 3% or one unit is to be selected randomly from each batch/for each structural type and re-tested by the Surveyor according to the above test items in (1) or the test of which is to be witnessed at the manufacturer.

(4) The raw material quality certificates of main components and parts and the hydraulic strength test records of pressure parts for each unit/batch are to be submitted to CCS Surveyor for review when applying for unit/batch inspection.

(5) If the purchased pressure parts such as casings, covers, safety valves are made of castings or forgings, they are to hold the CCS product certificates or test/retest of physical or chemical properties is witnessed by CCS surveyor when the manufacturers apply for product inspection.

(6) Special requirements of pumps intended for conveying liquefied gases (IACS UR_G3 Rev.4 2011)

① water pressure test of casing and performance test at rated pressure for each pump are to be witnessed by CCS surveyor at site;

② for submerged pumps (both the prime motor and pump are submerged in medium), the performance test at rated pressure is to be carried out by adoption of low-temperature medium designed for the pumps or other medium with temperature lower than the design value; for the shaft driven deep well pumps, the capacity test may be carried out with water.1.10.2 Unit/batch inspection for manufacturers with CCS type approval A

(1) For the pumps intended for conveying liquefied gas medium, the inspection requirements are the same as those in 1.10.1(6);

(2) For the pumps intended for conveying medium other than liquefied gas, the inspection is basically to review reports and all test items are to be completed by the manufacturer independently. The inspection application is to be submitted before product delivery, together with reports/records/documents covering all test/inspection items specified in 1.10.1(1) and (4) of this Chapter for review by CCS Surveyor.

(3) Periodical audits are to be requested in time by manufacturers with CCS type approval A according to the requirements in Section 4, Chapter 3, PART ONE of CCS Rules for Classification of Sea-Going Steel Ships

1.10.3 Unit/batch inspection for manufacturers without CCS approval

(1) The inspections are to include drawing examination and type test.

(2) Plan approval

Drawings/technical documents are to be prepared by the manufacturer according to 1.4.1 and 1.4.2 of this Chapter and submitted to CCS for approval/information.

(3) Type test

For pumps to be inspected, at least one unit is to be selected randomly for each type and tested for all type test items required in 1.9 of this Chapter.

(4) Pumps, which have not been selected as samples, are to be inspected and tested at least according to 1.10.1 of this Chapter.

Appendix A Arrangement of Test Apparatus

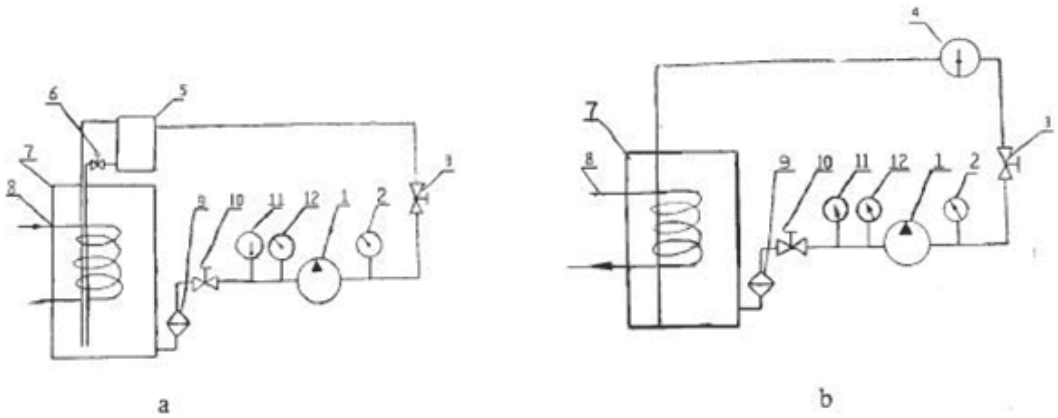


Figure 1 Test Apparatus of Screw Pumps and Gear Pumps

1 – Test pump; 2 – Outlet pressure gauge; 3 – Outlet pressure control valve; 4 – Flowmeter;
5 – Metering container; 6 – Valve; 7 – Storage tank; 8 – Heat exchanger; 9 – Filter;
10 – Inlet pressure control valve; 11 – Temperature meter; 12 – Vacuum gauge

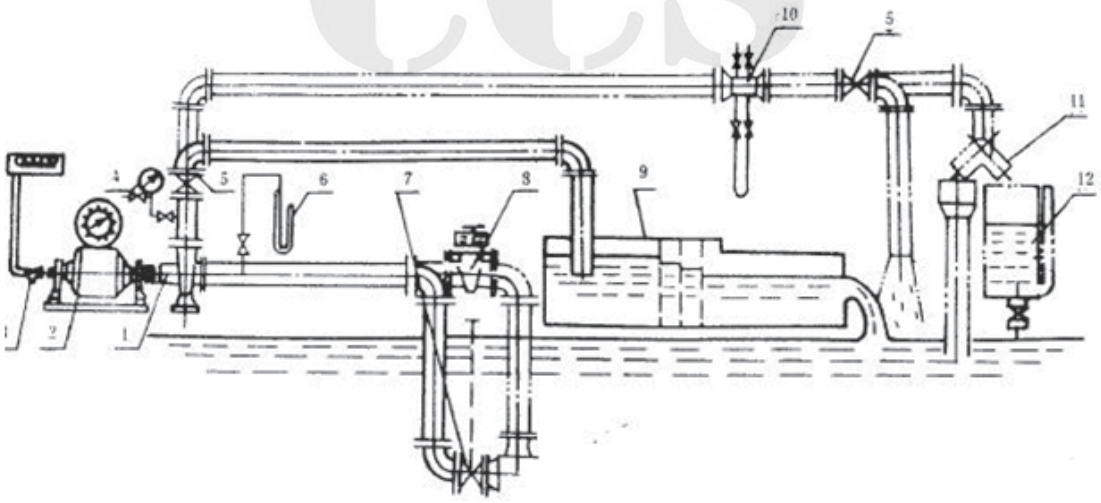


Figure 2 Open Test Basin for Centrifugal Pumps and Regenerating Pumps

1 – Test pump; 2 – Dynamometer; 3 – Velometer; 4 – Manometer; 5 – Flow control valve; 6 – Vacuum gauge;
7 – Inlet throttle; 8 – Water seal throttle; 9 – Water weir; 10 – Flowmeter; 11 – Reverser; 12 – Measuring vessel

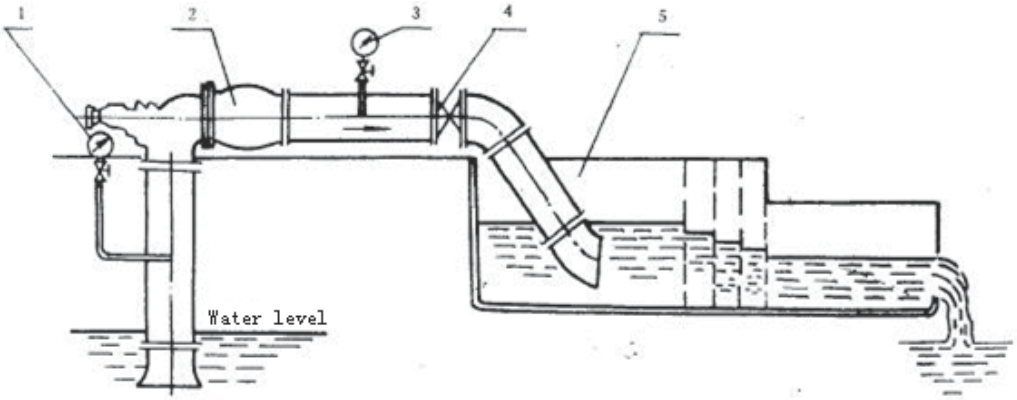


Figure 3 Open Test Basin for Centrifugal Pumps and Regenerating Pumps

1 – Vacuum gauge; 2 – Test pump; 3 – Manometer; 4 – Flow control valve; 5 – Water weir

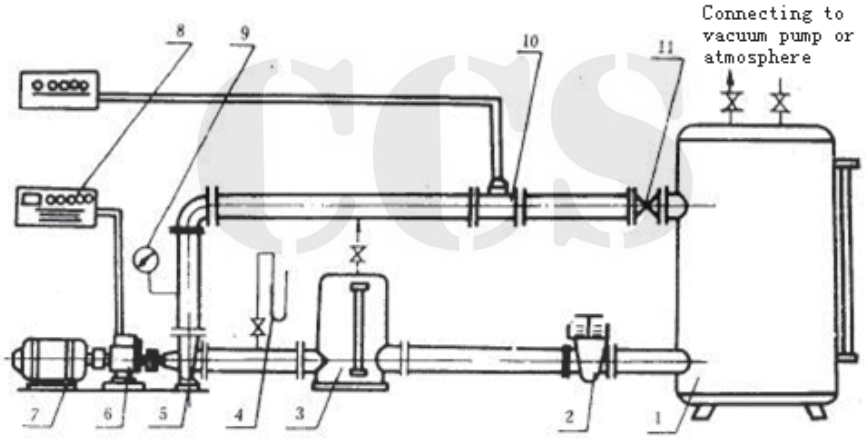


Figure 4 Closed-Circuit Test Apparatus for Centrifugal Pumps and Regenerating Pumps

1 – Cavitation tank; 2 – Water-seal gate valve; 3 – Stabilizer; 4 – Vacuum gauge; 5 – Test pump;
6 – Torque sensor; 7 – Motor; 8 – Torque tachometer; 9 – Manometer; 10 – Flowmeter; 11 – Flow control valve

CHAPTER 2 VALVES OF PIPING SYSTEMS

2.1 Application

2.1.1 This Chapter applies to type approval and inspection of valves and fittings in marine piping systems.

2.1.2 This Chapter specifies general requirements for valves and fittings in marine piping systems. The type approval and inspection of valves and fittings in chemical cargo piping, chemical processing piping, liquefied gas cargo piping and liquefied gas processing piping are also to comply with the relevant special requirements and recognized standards acceptable to CCS.

2.1.3 The applicable design pressure and design temperature ranges are those used for valves of Class I, Class II and Class III marine piping systems. The piping system classes are specified in 2.1.5, Section 1, Chapter 2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

2.1.4 This Chapter applies to type approval and products inspections of gate valves, stop valves, check valves, plug valves, ball valves, butterfly valves, diaphragm valves, reducing valves and adjusting valves in marine piping systems. Filters and other piping fittings are to be referred to in this Chapter.

2.1.5 Generally valves and fittings in marine piping systems are to be subject to CCS Type Approval B; if the manufacturer has special requirements and the conditions permit, CCS Type Approval A or works approval may be requested.

2.2 Basis for approval and inspection

2.2.1 The approval and inspection in this Chapter are to be based on the following documents:

(1) CCS Rules for Classification of Sea-Going Steel Ships;

(2) CCS Rules for Materials and Welding;

(3) IACS UR_G3 (Rev.4 2011).

2.3 Terms and definitions

2.3.1 For the purpose of this Chapter:

(1) Design pressure and design temperature are the design pressure and design temperature as defined respectively in 2.1.3 and 2.1.4, Section 1, Chapter 2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

(2) Test pressure means the gauge pressure (manometer pressure) to which the internal chamber of the valve is subjected during testing.

(3) Valve body test means the pressure test of the whole valve housing which consists of valve body and valve cover. The test is to examine the compactness of valve body and valve cover and the pressure tightness of connection between valve body and valve cover.

(4) Seal test means the test to examine sealing of seal pair of discs and valve body.

(5) Upper seal test means the test to examine sealing seal pair of valve rod and valve cover.

(6) Duration of test means the duration the test at the test pressure.

2.4 Plans and documents

2.4.1 The valves are to designed and manufactured in accordance with the accepted standards and their structure, scantling, material, intended purposes, service conditions and inspection and test items are to meet the accepted criterion and also to be in compliance with the relevant requirements of CCS Rules for Classification of Sea-going Steel Ships and this Guidelines. For the valves with novel structures or non-standard valves, the following drawings and technical documents are to be submitted to CCS when applying for approval:

(1) Main performance specifications (including the design pressure, design temperature, applicable medium, performance and purposes of the entire series of products to be approved; for valves to be delivered with associated hydraulically, electrically or pneumatically controlled devices, models and parameters of associated devices also to be included);

(2) General assembly;

(3) Drawings of main components and parts: Valve body and coupling flange, valve disc and rod, valve seat, spring (if any), servo mechanism (if any);

(4) Physicochemical performance schedule of main components and parts;

(5) Type test programme.

2.4.2 The following plans and documents are to be submitted to CCS for information:

(1) Main procedure documents, including welding procedures and heat treatment, build-up welding and spray welding procedures, if applicable;

(2) Specimens of product instructions, product nameplates and manufacturer's certificate.

2.4.3 Other documents to be submitted:

(1) Documents to be submitted as required in 3.2.1, PART ONE of the Guidelines.

2.5 Main components and parts

2.5.1 Main components and parts mean the valve bodies and coupling flanges, valve discs, valve plates, valve rods, valve seats, springs (if any), servo mechanism (if any), etc.

2.5.2 The valve bodies, valve covers and other pressure parts are to be tested to 100% hydraulic pressure. The pressure parts are to be subjected to 100% seal test after assembling with valve discs, valve plates, valve rods and valve seats.

The pressure test reports are to be reviewed and confirmed by CCS Surveyor or the tests are to be carried out in the presence of CCS Surveyor.

2.5.3 If the above-mentioned main components and parts are purchased, the applicant must establish perfect means to control subcontractors for ensuring the quality of such parts and materials used are to comply with the requirements of Chapter 2, PART THREE in CCS Rules for Classification of Sea-Going Steel Ships.

2.5.4 If the purchased pressure parts such as valves, valve covers, etc. are made of castings or forgings, they are to hold CCS product certificates or the test/retest of physical and chemical properties is to be witnessed by CCS surveyor when the manufacturers apply for product inspection.

2.6 Evaluation of welding procedures

2.6.1 If the main components and parts are of welded construction, the welding procedure is to be evaluated and approved according to the relevant requirements of CCS Rules for Materials and Welding.

2.7 Design and technical requirements

2.7.1 Marine ambient conditions

(1) The design and type selection of valves in marine piping systems are to comply with the requirements in Section 2, Chapter 1, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships so as to ensure their normal operation.

2.7.2 Applicability of valves in marine piping systems

(1) The design and technical characteristics of valves in marine piping systems are to comply with the requirements of marine ambient conditions and applicable medium.

(2) The valves intended to use for low-temperature liquefied gas piping system, chemical cargo and dangerous cargo are also to meet the relevant requirements of IGC Code, IBC Code, IMDG Code, etc.

2.7.3 Technical requirements

(1) General requirements for valves and fittings in marine piping systems

① For through type valves and fittings, the inlet and outlet sealing surfaces are to be parallel to each other. For rectangular valves and fittings, the inlet and outlet sealing surfaces are to be vertical to each other. The parallelism or verticality is to comply with requirements of approved plans.

② The structural length tolerances of valves and fittings are to comply with requirements of approved plans.

③ Where the valve body and valve cover are connected by bolts and the periphery of such connection is not machined, the misalignment as shown in Table 2.7.3(1) is allowed.

Table 2.7.3(1) (in mm)

Non-nominal diameter (DN)	Allowable misalignment
≤ 100	< 3.0
125 ~ 250	< 4.0
300 ~ 600	< 6.0
650 ~ 800	< 8.0

④ The valves and fittings assembled are to comply with the following requirements:

(a) flexible on-off operation, without any blocking;

(b) lifting check valves and stop check valves are to have the following functions: When the valve rod is hoisted, the valve is to be capable of being opened or closed freely at an inclination angel of 16° to the vertical. Special requirements for valves and fittings are to be additionally specified in product standards;

(c) when the gate valve is closed, the sealing surface center of the valve core is to be above that of the valve seat.

⑤ Technical specifications for castings and forgings are to comply with requirements of CCS Rules for Materials and Welding or recognized material standards, the designated classes and surface quality are to be indicated in construction drawings.

⑥ The grinding-in sealing surface of valves must be free from harmful pores or other scars.

⑦ The fluid passage is to be carefully cleaned and processed, without mould sand or impurities.

⑧ The exterior surfaces of steel and iron valves and fittings are to be coated with anticorrosive paint, without any holiday, draining or silting.

⑨ The dimensions of parts are to comply with requirements of plans approved by CCS.

⑩ The positive mass deviation of valves and fittings is not to exceed 4% of required mass.

(2) Technical requirements for flanges and wafer butterfly valves (PN 0.25 ~ 2.5 MPa; DN 40 ~ 2000 mm)

① When a fluid medium is used, the peak flow rate at the butterfly valve inlet is to be 3 m/s or 5 m/s.

② The butterfly valves are randomly applicable to the following conditions, excluding the condition of free evacuation:

(a) stopping and sealing;

(b) stopping and low leakage (allowable maximum percolation rate of fluid: 0.1 DN mm^3/s);

(c) adjusting flow within required range.

③ Pressure-temperature class

The maximum working pressure and temperature are to be determined by the manufacturer according to construction and material of butterfly valves, other factors and related recognized standards and to be marked on nameplates of products. However, butterfly valves of all types are to operate continuously at the indicated working pressure and at -10 ~ 65℃ .

④ Valve bodies

(a) The connection dimensions and sealing surface types of flanges are to comply with the requirements of plans approved by CCS.

(b) The sealing surface of flanges is to be perpendicular to the axis of the butterfly valve opening, the flange is to be coaxial with the butterfly valve.

(c) Both end faces of double flanges and wafer flanges are to be parallel to each other.

(d) Threaded bolt holes are allowable for double flanges and wafer flanges, if required for constructional reasons.

(e) The position tolerance of the axis of diameter d_o of flange bolt holes at both ends relative to that of flange holes is to comply with the accepted criterion or requirements of drawings approved by CCS.

(f) The structural length of wafer butterfly valves is to comply with requirements of plans approved by CCS.

(g) The minimum diameter of valve seats is not to be less than that required in Table 2.7.3(3).

Table 2.7.3(3) (in mm)

Nominal diameter DN	Minimum diameter of valve seats	Nominal diameter DN	Minimum diameter of valve seats
40	34	450	425
50	44	500	475
65	59	600	575
80	74	700	670
100	94	800	770
125	119	900	870
150	144	1000	970
200	190	1200	1160
250	230	1400	1360
300	280	1600	1560
350	325	1800	1760
400	375	2000	1960

(h) The valve body gasket ring (valve seat) and valve body are to be so connected that no loosening or leakage will occur in valve operation.

(i) Where material of valve body is HT 200, the minimum thickness of valve body is to be according to Table 2.7.3(4).

Table 2.7.3(4) (in mm)

Nominal diameter DN	Nominal pressure PN Mpa			Nominal diameter DN	Nominal pressure PN Mpa		
	0.25	0.6	1.0		0.25	0.6	1.0
	Minimum wall thickness t				Minimum wall thickness t		
40	7	7.5	8	450	12	15	16
50				500	13	16	17
65	8	8.5	9	600	14	17	18
80				700	15	18	19
100				800	16	19	20
125	9	9.5	10	900	18	20	22
150				1000	20	21	23
200	10	11	12	1200	21	23	26
250				1400	22	25	30
300	11	12	14	1600	24	28	34
250		13	15	1800	26	31	38
400	12	14		2000	28	34	42

(j) The valve body may be of welded construction, the welding procedure and requirements for welders are to comply with CCS Rules for Materials and Welding.

(k) The edge forms of butt-welded joints are to comply with CCS Rules for Materials and Welding or recognized standards.

(l) For butterfly valves with nominal diameter DN not less than 800 mm, the valve body is to be suitably stiffened to enhance shell rigidness and footing support and fixing bolt holes are to be provided.

⑤ Valve plates and rods

(a) Valve plates and rods are to be so designed as to withstand the load 1.5 times the maximum differential pressure imposed on the butterfly plate by the medium when the medium flows in any direction.

(b) The valve rod may be designed as an integral shaft or two separate short ones, whose embedded length in the shaft hole is to be not less than 1.5 times the shaft diameter.

(c) The strength of connection of valve rod with butterfly plate is to be designed for delivering the maximum torque the valve rod can withstand. Shaft and butterfly plate may be connected by any means, provided that no loosening will occur in normal operation and that the valve rod will not be released automatically due to medium pressure.

⑥ Bearings and shaft seals

(a) The bearings are to be capable of withstanding the maximum load delivered by the valve rod during testing and operation of the butterfly valve.

(b) For butterfly valves with nominal diameter of not less than 350 mm, suitable bearings are to be selected to withstand axial thrust and spring collars are not to be used for stopping the thrust.

(c) A reliable shaft seal is to be arranged to avoid leakage at the valve rod.

⑦ Operation

(a) The butterfly valves may be operated manually, electrically, hydraulically or pneumatically.

(b) The driving devices for butterfly valves are to be so arranged as to ensure normal operation of butterfly valves in non-free-evacuating pipelines where the maximum differential pressure does not exceed the maximum working pressure of the valves.

(c) The dimensions of driving devices and coupling flanges of butterfly valves are to comply with requirements of design plans approved by CCS.

(d) For butterfly valves operated by handwheel (including handwheel of driving device) or wrench, the valve is to be closed by turning handwheel or wrench clockwise towards the operator, unless otherwise specified in the contract for delivery.

(e) An arrow indicating the closing direction is to be clearly marked at the handwheel rim together with the word "OFF" before the arrow or alternatively, two arrows respectively indicating the opening and closing directions together with the word "ON" or "OFF" may be marked.

(f) When the butterfly valve operated by wrench is fully open, the wrench is to be parallel with piping axis. The wrench or tag is to be marked with the words "ON" and "OFF".

(g) All butterfly valves are to be fitted with a means of indicating butterfly plate position and a limiter for securing full opening and full closing positions of the valve.

(h) Butterfly valves operated by wrench are to be fitted with a means for locking more than three opening conditions.

2.7.4 Materials

(1) Materials of main components and parts of valves in marine piping systems are to be selected for types, temperatures and pressures of medium to be conveyed. In the case of conveying dangerous chemicals, the manufacturer is to provide sufficient evidence for compliance of the material selected with operational requirements.

(2) If the valve is fitted on piping connecting with cargo tank onboard ship carrying liquefied gases in bulk, the melting point of valve material is not to be lower than 925℃. (IACS UR_G3 Rev.4 2011)

2.7.5 All valve structures are to be capable of preventing the possible release or loosening of valve cover and compressing cover during the operation, Rotary valve cover is not to be used for valve with the nominal diameter greater than 40mm in Grade I and II piping system, sea valve and side valve with the nominal diameter greater than 40mm and valve fitted in flammable liquid system.

2.7.6 The marine valves are to be closed by turning the hand wheel in clockwise direction and opened conversely.

2.7.7 The welded neck on valve body is to be longer sufficient to ensure that the valve will not deform due to welding at joints or postweld heat treatment.

2.8 Type test

2.8.1 Selection of typical samples

(1) When applying for approval at the first time, the selected typical samples are to cover the manufacturer's production level, processing and testing capabilities. Usually the valves with maximum design pressure and maximum design diameter in each product series are selected, depending on structure, purpose, design pressure and temperature of valves of different materials. Type test is to be carried out for each type and specification of valves intended to use for the low-temperature liquefied gas medium below -55 ℃ (IACS UR-G3 Rev.4 2011). The manufacturer's marketing and stocks as well as testing equipment in the selected test location may be taken into account when selecting typical samples.

(2) When renewing the approval, only one type which is the most representative or the most demanded in market may be selected for inspection and test from approved product series.

2.8.2 Type test items are to include:

(1) test of physical and chemical properties of raw materials of main components and parts;

(2) dimensional and visual examination;

(3) back seal test (if applicable);

(4) hydraulic strength test of main pressure parts;

(5) seal test;

(6) test of physical properties of rubber valve seat (if applicable);

(7) functional test (for valves fitted with electrically, pneumatically or hydraulically controlled actuators);

(8) other test items with special requirements.

2.8.3 The following test methods and technical requirements are to be complied with.

(1) Test of physical and chemical properties of raw materials of main components and parts: Technical specifications for castings and forgings are to comply with the relevant recognized material standards, and designated classes and surface quality are to be indicated in construction drawings. The casting methods and dimensions of test bars, processed shapes and dimensions of test samples, and their chemical composition, mechanical properties and heat treatment procedures are to comply with the relevant requirements of CCS Rules for Materials and Welding. For materials not listed in CCS Rules for Materials and Welding, other relevant recognized standards may apply.

Material test is to be carried out for the valves intended to use for low-temperature medium below -55℃ in accordance with the minimum design temperature.

(2) Dimensional and visual examination is to comply with the relevant technical requirements in 2.7.3 of this Chapter.

(3) Assembly check is to comply with the relevant technical requirements in 2.7.3 of this Chapter.

(4) Hydraulic strength test of valve bodies

① The hydraulic test pressure P_s is 1.5 times the nominal pressure or 1.5 times the maximum allowable working pressure; but not more than design pressure plus 7 MPa. Special requirements are to be additionally specified in product standards.

② Test time is specified in Table 2.8.3(1).

Table 2.8.3(1)

Nominal diameter DN, in mm	Minimum duration of maintaining pressure in testing, in s
< 250	120
≥ 250	180

③ The valve body or other stressed parts are to be knocked with a copper hammer (of 0.1 kg in mass and 300 mm in handle length) during testing, no leakage or percolation are to be visible by naked eyes on surface of valve body and stuffing box while maintaining pressure.

(5) Test of sealing surfaces

① The seal or back seal test pressure P_m is to be 1.1 times the nominal pressure or 1.1 times the maximum allowable working pressure. Special requirements are to be additionally specified in product standards.

② Test time is specified in Table 2.8.3(2).

Table 2.8.3(2)

Nominal diameter DN, in mm	Minimum duration of maintaining pressure in testing, in s
≤ 200	60
≥ 250	120

③ The seal pair of valve disc and valve seat is to be checked during testing, the maximum allowable leakage is specified in Table 2.8.3(3).

Table 2.8.3(3)

Type of valves	Maximum allowable leakage, in mm^3/s
Soft seal valves and fittings, valves and fittings closed by handwheel and lifting check valves	0
Swing check valves and plug valves	0.01 DN

(6) General requirements of hydraulic test

① Air in the valve chamber is to be fully evacuated in hydraulic tests.

② The sealing surface of valves and fittings is not to be greased in seal tests.

③ The pressure is to be increased gradually to required value and abrupt increase is not allowed in tests.

④ In general, test medium is fluid or gas.

(7) Tests requirements for valves and fittings

① Strength test and seal test of stop valves and diaphragm valves

Seal the outlet port and fill the chamber with water and apply the hydraulic test pressure P_s to inlet port (lower side of valve disc) to carry out hydraulic strength test on valve body. Upon satisfactory examination, reduce the pressure to seal test pressure P_m, close the valve and open the blank flange on the outlet port. Check the tightness of sealing surface after removing all water.

② Strength test and seal test of stop check valves

First carry out the strength test and seal test of valve body according to 2.8.3(7) ① above. Upon satisfactory examination, release the pressure and hoist the valve rod. Apply the seal test pressure P_m (pressure of 0.3 MPa for valves and fittings with maximum working pressure more than 0.3 MPa) to outlet port (upper side of valve disc) and check the tightness of sealing surface on the lower side of valve disc.

③ Strength test and seal test of lifting check valves and swing check valves

First carry out the hydraulic strength test of valve body according to 2.8.3(7) ① above. Upon satisfactory examination, carry out the seal test of sealing surface according to 2.8.3(7) ② .

④ Strength test and seal test of butterfly valves

(a) First carry out the hydraulic strength test and seal test of valve body according to 2.8.3(7) ① above. For two-way seal butterfly valves, carry out the seal test in the other direction.

(b) Physical property test of rubber valve seats, the test results are to meet the requirements of accepted criteria.

⑤ Tests of gate valves, ball valves and cocks

Seal one port and fill the chamber with water. Apply the hydraulic test pressure P_s on one port and carry out the hydraulic strength test of valve body. Upon satisfactory examination, reduce the pressure to seal test pressure P_m and close the valve, open the blank flanges on both ports. Check the tightness of two sealing surfaces after removing all water.

For seal tests of gate valves, ball valves and cocks with one-way seals, apply the pressure on inlet port only and check the outlet port; for valves and fittings without designed medium flow directions, apply on one port and check the other port; carry out the seal test in the other direction upon satisfactory examination.

For three-way valves and fittings, check the tightness of outlet ports.

⑥ Reducing valves and pneumatic control valves

Carry out the pressure strength (P_s) test according to design requirements. Upon satisfactory examination, carry out the seal performance (P_m) test (the internal leakage of pneumatic control valve is not to be more than 1.5% of maximum output pressure, without external leakage at connections). Upon satisfactory examination, carry out pressure control function test. When the inlet pressure reaches nominal pressure, the outlet pressure is to change evenly within the nominal range without phase steps.

⑦ Besides the above-mentioned test items, for the valves intended to use at the working temperature below -55 ℃, tightness test is to be carried out for each structural type and specification of valves with the pressure not less than its design value at its minimum design temperature or below, and the valves are to be verified to have good operational performances during the test. (IACS UR_G3 Rev.4 2011).

2.8.4 Exemption from test items

(1) Normally all test items applicable in 2.8.2 above are to be carried out when the applicant applies for approval at the first time. The manufacturer may apply for exemption from some of the test items in writing, and CCS Surveyor will consider the application according to the manufacturer's production, history of production and usage record of his products and will fax the manufacturer's written application together with comments to the Classed Newbuildings Department/Product Management Department of the Headquarters, and can grant an exemption from some test items only upon approval by the Classed Newbuildings Department/Product Management Department, provided that the following conditions are met:

① the applicant is to be able to provide a test report of corresponding test items issued by an authoritative technical organization (e.g. General Administration of Quality Supervision, or a national defense laboratory) recently;

② the applicant is to be able to provide a test report of corresponding test items signed by an IACS member society recently;

③ if the products are manufactured upon technology transfer or authorization from another manufacturer whose products are type approved by CCS, some test items as specified in 2.8.2 above may be dispensed with after the manufacturing capability and processing/assembling level are assessed.

(2) For re-approval at renewal of approval certificate, if there is no change to the design, the type test may be omitted. However, CCS still reserves the right to require type test again.

2.9 Unit/batch inspection

2.9.1 The inspections for issuing marine products certificates may be carried out only for those valves which have been satisfactorily inspected/tested by the manufacturer as required and are ready for delivery.

2.9.2 The unit/batch inspection items for manufacturers with CCS type approval B

(1) Tests are to be carried out according to the approved inspection plan (related provisions in quality control plans), including at least the related items such as strength test, back seal test and seal test for valve body.

(2) The above tests may be carried out by the manufacturer independently and a complete test report is to be submitted to the Surveyor for review.

(3) 3% or at least one unit is to be selected randomly from each batch/for each structural type and re-tested by the Surveyor according to the above test items or the test of which is to be witnessed at the manufacturer. For the valves intended to use at the working temperature below -55 ℃, the strength test and seal test for all valves are to be witnessed by the surveyor at site. At least 10% of tightness test for each type/specification of valves with the pressure not less than its design value at its minimum design temperature or below is to be sampled to witness by surveyor, and the valves are to be verified to have good operational performances during the test. (IACS UR_G3 Rev.4 2011).

(4) The raw material quality certificates of main components and parts and the records of hydraulic strength test, seal test and function test of valve bodies for each unit/batch are to be submitted to CCS Surveyor for review when applying for unit/batch inspection.

(5) If the purchased pressure parts such as valves, valve covers, etc. are made of castings or forgings, they are to hold CCS product certificates or the test/retest of physical and chemical properties is to be witnessed by CCS surveyor when the manufacturers apply for product inspection.

2.9.3 Unit/batch inspection for manufacturers with CCS type approval A

(1) The inspection is basically to review reports and all test items are to be completed by the manufacturer independently. The inspection application is to be submitted before product delivery, together with reports/records/documents covering all test/inspection items specified in 2.9.2 of this Chapter for review by CCS Surveyor.

(2) Periodical audits are to be requested in time by manufacturers with CCS type approval A according to the requirements in Section 4, Chapter 3, PART ONE of CCS Rules for Classification of Sea-Going Steel Ships.

(3) For the valves intended to use at the working temperature below -55℃, the strength test and seal test for all valves are to be witnessed by the surveyor at site. At least 10% of tightness test for each type/specification of valves with the pressure not less than its design value at its minimum design temperature or below is to be sampled to witness by surveyor, and the valves are to be verified to have good operational performances during the test. (IACS UR_G3 Rev.4 2011).

2.9.4 Unit/batch inspection for manufacturers without CCS approval

(1) Drawings/technical documents are to be prepared by the manufacturer according to 2.4.1 and 2.4.2 of this Chapter and submitted to CCS for approval/information.

(2) For valves to be inspected, at least one unit is to be selected randomly for each type and tested for all type test items required in 2.8.2 of this Chapter.

(3) Valves, which have not been selected as samples, are to be inspected and tested at least according to the related items as specified in 2.9.2 of this Chapter.

CHAPTER 3 AIR PIPE AUTOMATIC CLOSING DEVICES

3.1 Application

3.1.1 This Chapter applies to approval and inspection of air pipe automatic closing devices in oil tanks (excluding cargo oil tanks) and water tanks of ships. For other types of air pipe closing devices, reference may be made to in this Chapter.

3.2 Basis for approval and inspection

(1) CCS Rules for Classification of Sea-Going Steel Ships;

(2) CCS Rules for Materials and Welding;

(3) IACS UI LL49 (1980 Rev.1 2008.7), Interpretation to Reg. 20, Annex I of 1966 ICLL Convention.

The paragraphs in the above mentioned basis for approval and inspection quoted are part of this Chapter. For quoted documents marked with the date, their subsequent amendments (except corrigenda) or revisions will be inapplicable, hence, it is to meet the requirements of the latest edition of these documents during the product design, manufacture and inspection. However, for those quoted documents without any date marked, the latest edition applies to this Chapter.

3.3 Definitions

The definitions as specified in CCS Rules for Classification of Sea-Going Steel Ships are applicable to this Chapter.

3.4 Plans and documents

3.4.1 The following plans and documents are to be submitted to CCS for approval:

(1) Main performance specifications (including type/specification, nominal diameter, lift of floats and purpose);

(2) General assembly;

(3) Drawing of main components and parts, such as bodies, floats and guide pillars;

(4) Calculations of minimum circulation section;

(5) List of physical and chemical properties of main components and parts;

(6) Type test programme.

3.4.2 The following plans and documents are to be submitted to CCS for information:

(1) Volume flow-pressure drop characteristic curves, if applicable;

(2) Main technological documents, such as welding and casting procedures, if applicable;

(3) Operation instructions for the products.

3.5 Main components and parts

3.5.1 The manufacturer is to control the quality of purchased bodies, floats, guide pillars and other main components and parts of air pipe heads.

3.6 Design and technical requirements

3.6.1 Technical requirements

(1) The general design requirements are to comply with the requirements as specified in 1.2 of Appendix 4, Chapter 2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

(2) The strength of air pipe closing devices located within the forward 0.25 L on ships of 80 m or over in length, where the height of the exposed deck is less than 0.1 L or 22 m above the summer load waterline, whichever is less, is to be sufficient to withstand the loads as required in 1.7.1.3 and 1.7.1.4, Section 7, Chapter 1, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships.

(3) Air pipe closing devices are to be fitted with flame screens or fly nets made of anticorrosive material in suitable positions. The number of meshes of flame screens is to be not less than 30 for single-layer ones and not less than 20 for two-layer ones (12.7 mm space between two layers); that of fly nets is to be not less than 8.

(4) Closing device of air pipe is to be weathertightly.

3.6.2 Material requirements

(1) The materials are to comply with the requirements as specified in 1.3, Appendix 4, Chapter 2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

(2) The body material of air pipe closing devices located within the forward 0.25 L on ships of 80 m or over in length, where the height of the exposed deck is less than 0.1 L or 22 m above the summer load waterline, whichever is less, is to be made of ductile metal.

3.6.3 Welding requirements

(1) In the case of main components of welded construction, all welds are to be continuous closed.

3.7 Type test

3.7.1 Selection of typical samples

(1) Air pipe automatic closing devices of each type and size are to be type tested.

(2) If the test of closing devices of air pipes with large diameter is impracticable due to restriction of test equipment, proportionally reduced test samples may be used in flow characteristics test upon approval by CCS.

(3) Where the construction types and specifications of air pipe closing devices are the same and flame screens and fly nets are to be fitted for the purpose of oil tanks and water tanks, the closing devices with large circulation resistance are to be selected for type test.

(4) For the closing device of air pipe with matured or standardized structure, if it is examined that the structure could ensure the weathertightness or other equivalent test is verified the weathertightness of closing device. Manufacturer may be exempted from weathertightness test according to the methods as specified in this Guidelines with the approval by CCS.

3.7.2 Type test items are to include:

(1) test of physical and chemical properties of raw materials;

(2) dimension check;

(3) performance test;

(4) flow characteristics test;

(5) pressure test and immersion/emerging tightness test;

(6) impact test and compression loading test of non-metallic balls/floats;

(7) impact test of metallic balls/floats;

(8) weathertightness test.

3.7.3 Requirements for type test apparatus/instrumentation

(1) CCS Surveyor is to check the manufacturer's test laboratory/test bench used as approval test location and confirm compliance with the requirements of 3.7.3(2), (3) and (4) below. Otherwise, all tests are to be carried out at certification and test organizations recognized by CCS.

(2) Measuring instruments used in the tests are to have valid calibration certificates, and the accuracy of test instruments is not to be lower than that required by Table 3.7.3.

Table 3.7.3

Measured value	Allowable system error of test instrument (%)
Pressure	±1.0
Flow	±2.5

(3) Water is generally used as test medium. Where air is used in special cases, means are to be available for converting the test graphs into equivalent graphs for water used as test medium to the satisfaction of CCS.

(4) Test apparatus

① The arrangement of test apparatus is shown in figures below:

(a) the typical arrangement of flow characteristics test apparatus is referred to Figure 1;

(b) the typical arrangement of immersion/emerging test apparatus is referred to Figure 2;

(c) the typical arrangement of impact test apparatus is referred to Figure 3;

(d) the typical arrangement of compression loading test apparatus is referred to Figure 4.

② In respect to flow characteristics test apparatus, effective measures are to be taken so that the fluid passing the measuring section will have the following characteristics:

(a) speed distribution with axial symmetry;

(b) isostatic pressure distribution;

(c) whirl due to lack of control.

③ The following basic measures are to ensure the above conditions for flow characteristics test apparatus:

(a) the capacity of test medium is to be sufficient for ensuring static pressure during testing;

(b) straight pipe section is to be used in inlet and outlet circuits of the pump to be tested; and

(c) the length of straight pipe section is to be not less than:

12*D* for inlet pipeline;

4*D* for outlet pipeline;

D – outlet diameter of the pump; and

no pressure control valve is to be fitted at the straight pipe section.

(5) Measurement of test parameters is to include:

① flow measurement: the flow measurement is to comply with recognized standards and may be conducted by the turbine flowmeter, tube flowmeter, electromagnetic flowmeter, gravimetric method or volumetric method;

② pressure measurement: the pressure may be measured by the liquid column gauge, or other types of pressure gauges complying with recognized standards;

③ volume measurement: the volume may be measured by the measuring glass.

3.7.4 Methods and requirements for type test

(1) Test of physical and chemical properties of raw materials

① Scope: The body castings produced by the manufacturer are to be subjected to test of physical and chemical properties; if castings are to be purchased, they are to be purchased from such manufacturers approved or accepted by CCS and their furnace samples are to be subjected to test of physical and chemical properties.

② Sampling: The test samples of castings are to be taken and sealed up on site according to CCS Rules for Materials and Welding.

③ The test methods and technical requirements are to be referred to the related chapters in CCS Rules for Materials and Welding.

(2) Dimension check

① Scope:

Finished assembly dimensions, wall thicknesses of internal and external chambers of the body, and finished ball/float shapes and wall thicknesses.

② Test methods:

(a) Lift measurement of balls/floats – measure by length measuring tool and record the rising height.

(b) Dimensional measurement of air venting passage – measure relative shape dimensions at the nominal diameter of the flange in the body, at the minimum passage in mid-body, at the lift of ball/float and at the outlet (filter screen), and record and calculate the effective circulation area.

(c) Measurement of wall thickness of the body – measure and record wall thickness at the mid-body and at the flange passage throat.

(d) Measurement of float dimensions and wall thickness – the measured and recorded diameter and height of floats are to comply with requirements of plans; split the ball/float from the middle and measure the maximum and minimum thickness of float material (steel plate).

③ Technical requirements:

The tolerance of wall thickness of ball/float is not to exceed ±10% , and other test results are to comply with plans approved by CCS.

(3) Performance test

① Test method:

The air pipe closing device is to be connected to the test apparatus as shown in Figure 1 and subjected to the performance test for withstanding water for 30 min with pressure drop measured at the inlet being not less than 0.05 MPa.

② Technical requirement:

After the test, the ball/float, seal receptacle, filter screen of the closing device is free from any damage.

(4) Flow characteristics test

① Test method:

Fill the pipe with water, keep the inlet pressure drop of the air pipe closing device within the range of 0 ~ 0.05 MPa and measure evenly 10 times, record the flow, pressure drop data and the pressure drop of the orifice meter, orifice flow constant and Reynolds number.

② Technical requirement:

Calculate the local resistance coefficient of the air pipe closing device and prepare the resistance characteristics curves (See Figure 5) according to measured volume flow and pressure drop. The coefficient may be calculated according to the following formula:

$$\zeta = \frac{2 \cdot \Delta P_v}{W^2 \cdot \rho}$$

$$W = \frac{V}{A}$$

where: ζ – local resistance coefficient;

ΔP_v – pressure drop of closing device, in mbar;

W – flow rate of test medium, in m/s;

V – volume flow of test medium, in m^3/h;

A – sectional area of measured pipe section, in m^2;

ρ – specific gravity of test medium, in kg/m^3.

(5) Pressure test and immersion/emerging tightness test

① Pressure test:

(a) Test method: remove the exit cover of the closing device and fit the blind plate. Fill the body with water and when the float is fully immersed in water, check whether bubbles bust out of the float; then apply a pressure of not less than 0.03 MPa twice for at least 5 min to the flange and exit blind plate respectively.

(b) Technical requirements: the body is free from leakage; open the upper cover and observe the surfaces of ball/float that contact the valve seat and the sealing surface is free from any linear leakage.

② Methods and technical requirements for immersion/emerging tightness test are specified in 1.4.1(2), Appendix 4, Chapter 2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

(6) Impact test and compression loading test of non-metallic balls/floats

Methods and technical requirements for such test are specified in 1.4.2, Appendix 4, Chapter 2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

(7) Impact test of metallic balls/floats

Methods and technical requirements for such test are specified in 1.4.3, Appendix 4, Chapter 2, PARTTHREE of CCS Rules for Classification of Sea-Going Steel Ships.

(8) Weathertightness test

① Inspection/test methods:

Hose testing is required to verify the tightness of the closing device, as defined in the minimum pressure in the hose, at least equal to 0.2MPa is to be applied at a maximum distance of 1.5m. The nozzle diameter is not to be less than 12mm;

② Technical requirements:

No leakage will be found for the closing device after the test.

3.8 Unit/batch inspection

3.8.1 The inspections for issuing CCS marine products certificates are to be carried out only for those products which have been satisfactorily inspected/tested by the manufacturer and are ready for delivery.

3.8.2 The unit/batch inspection items for manufacturers with CCS type approval are as follows.

(1) Tests are to be witnessed according to the approved inspection plan, covering at least:

① visual inspection;

② dimension check;

③ pressure test and immersion/emerging tightness test.

(2) The following documents are to be submitted to CCS Surveyor for review when applying for unit/batch inspection:

① raw material quality certificates of main components and parts or report of reexamination of their physical and chemical properties – body, floats and guide pillars;

② pressure/tightness test records of the body and float;

③ dimension check records – diameter, lift, float diameter and height;

④ routine performance inspection/test reports or records;

⑤ copies of calibration certificates of test instruments and meters, or a list of their calibration.

(3) At least 5% or one unit is to be selected randomly from each batch/for each specification and re-tested by the surveyor according to the above test items.

(4) The test report is to include product or sample type, specification, serial number, test location and date, test environment, test items, test data, problems revealed in the test and examination and description of how the problems are handled, and test conclusions.

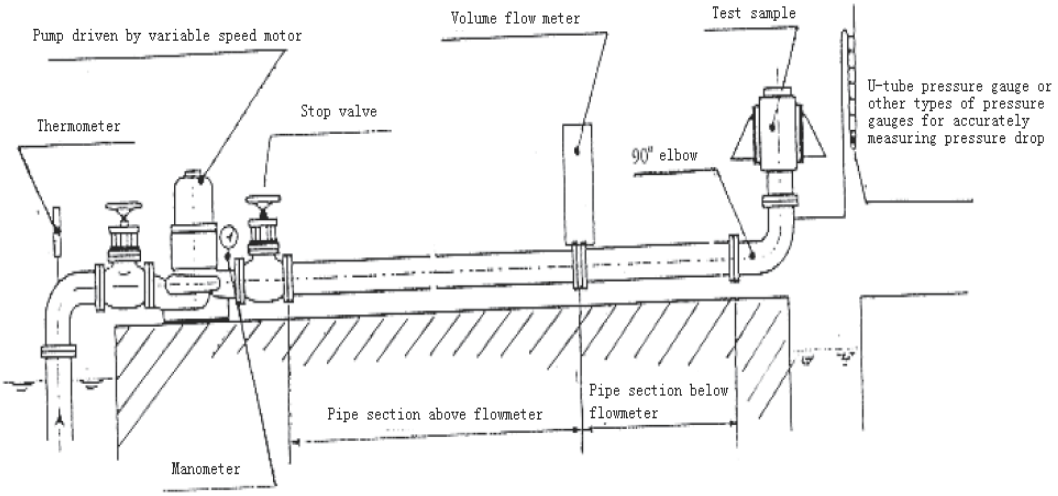

Pump driven by variable speed motor
Volume flow meter
Test sample
U-tube pressure gauge or other types of pressure gauges for accurately measuring pressure drop
Thermometer
Stop valve
90° elbow
Pipe section above flowmeter
Pipe section below flowmeter
Manometer

Figure 1

CCS

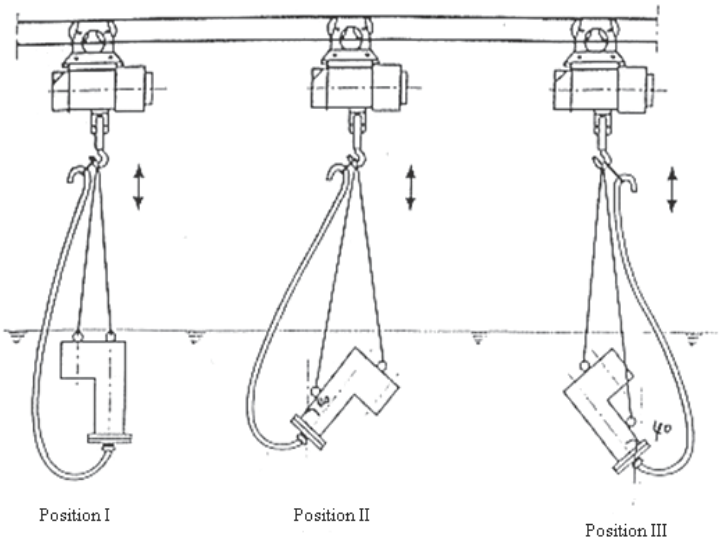


Figure 2

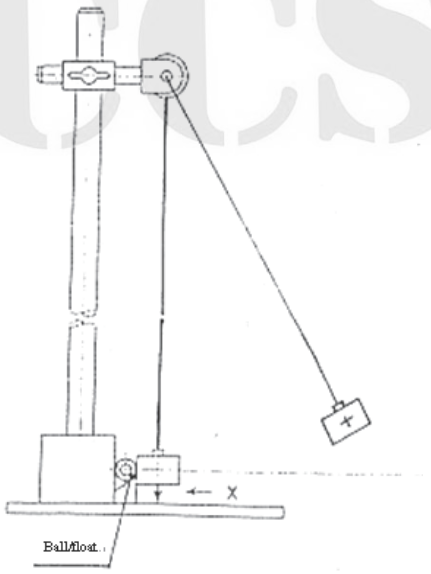


Figure 3

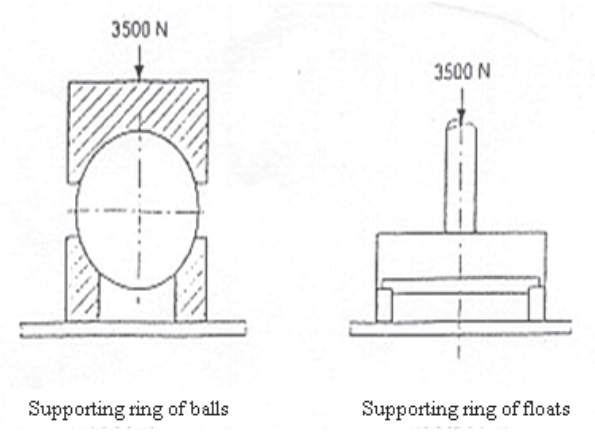
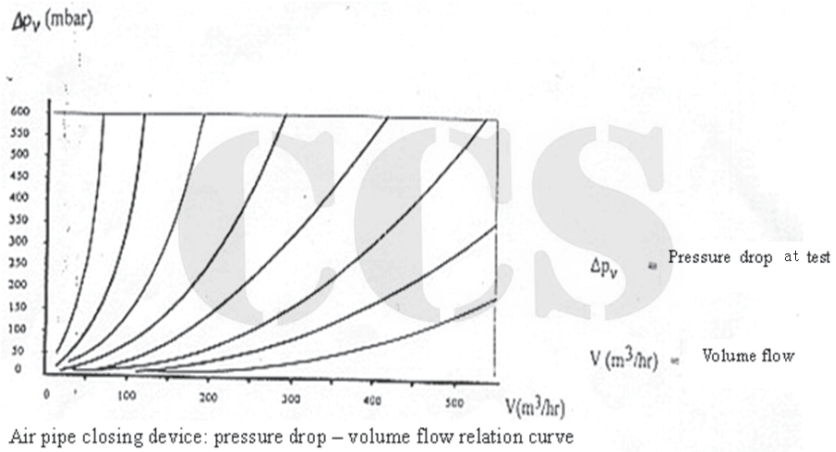


Figure 4



Air pipe closing device: pressure drop – volume flow relation curve

Figure 5

PART NINE BOILERS AND PRESSURE VESSELS

CHAPTER 1 BOILERS

1.1 Application

1.1 This Chapter applies to boilers of welded construction with water or steam as medium.

1.2 Basis for approval and inspection

1.2.1 The approval and inspection in this Chapter are to be based on the following documents:

(1) CCS Rules for Classification of Sea-Going Steel Ships ;

(2) CCS Rules for Materials and Welding;

1.2.2 The paragraphs in the above mentioned basis for approval and inspection quoted are part of this Chapter. For quoted documents marked with the date, their subsequent amendments (except corrigenda) or revisions will be inapplicable, hence, it is to meet the requirements of the latest edition of these documents during the product design, manufacture and inspection. However, for those quoted documents without any date marked, the latest edition applies to this Chapter.

1.3 Definitions

1.3.1 Relevant definitions specified in CCS Rules for Classification of Sea-Going Steel Ships are applicable to this Chapter.

1.4 Plans and documents

1.4.1 The following plans and documents are to be submitted to CCS for approval:

(1) General arrangement;

(2) Body construction (including details of welded connections, attachments and supports);

(3) Construction of pressure parts (boiler shell, steam and water drum, headers, combustion chamber, furnace, superheater, desuperheater, economizer, etc.);

(4) Arrangement of mountings and fittings;

(5) Diameter calculations for safety valves;

(6) Strength calculations;

(7) Heat treatment procedures for welded connections;

(8) Type test programme (for approval).

1.5 Main components and parts

1.5.1 If produced at the manufacturer, the following boiler parts (if any) are to be inspected by CCS Surveyor and if purchased, to be furnished with products certificates or equivalent documents and meet their intended purposes:

(1) burner;

(2) inlet valve;

(3) electric control box;

(4) feed pump;

(5) safety valve;

(6) economizer;

(7) superheater;

(8) steel plates, steel pipes and welding consumables used in manufacturing of boilers.

1.6 Evaluation of welding procedures

1.6.1 When applying for approval at the first time, the welding procedures are to be evaluated according to the relevant requirements of Chapter 3, PART THREE of CCS Rules for Materials and Welding.

1.7 Technical requirements for design

1.7.1 Selection of materials

(1) The steel plates, steel pipes used in construction of pressure parts of marine boilers are to comply with the relevant requirements of Chapter 3 and Chapter 4, PART ONE of CCS Rules for Materials and Welding. The welding consumables used in welding of marine boilers are to comply with the relevant requirements of Chapter 2, PART THREE of CCS Rules for Materials and Welding.

1.7.2 Structural design requirements for boilers

(1) The structural design of marine boilers is to comply with the relevant requirements of Chapter 6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships and of CCS Rules for Materials and Welding. Mainly butt welds are to be used for boilers, and double continuous fillet welds are to be used generally for spools, flanges and bedplates. If T-shaped fillet welds are to be used for boiler shell and tube plate, the following conditions are to be met, subject to approval by CCS:

① welded joints of full penetration type are to be used and edge bevels are to be machined;

② edges are to be beveled on tube plates;

③ the weld thickness at connection of T-shaped joints is to be not less than wall thickness of tube plates and back sealing runs are to be made where this is practical, and if back sealing runs are impracticable, argon-arc welding may be applied for the first run and full penetration is to be ensured.

(2) Intersection of more than two welds is to be avoided. Butt welds are not to be intersected with acute angles. Welds of non-pressure parts are not to penetrate main welds or welds of pipes and tubes. The distance between weld edges of non-pressure parts and main welds or joint weld edges is not to be less than twice the plate thickness of pressure parts or 40 mm (whichever is the lesser). If this is not practical, welds of non-pressure parts are to penetrate main welds and to be arranged symmetrically and not to be terminated in the vicinity of main welds or pipe joint welds. Perforation in or near welds is to be avoided. Where the distance between the weld centerline and the edge of a perforation is less than 60 mm or four times the thickness of the perforated plate (whichever is the greater), the perforation is to penetrate the weld so that the weld centerline and the perforation will coincide as much as possible. The welds on both sides of the perforated weld are to be subjected to radiographic testing, and a length of at least 60 mm or four times the thickness of the perforated plate (whichever is the greater) at each side is to be examined.

(3) Boilers are to be provided with manholes to facilitate internal examination. In case components of a boiler are too small to permit entry, sufficient number of sight holes is to be provided for facilitating internal examination and cleaning.

(4) Splice welding of end covers or tube plates: End covers and tube plates are to be made of a whole steel plate so far as practicable. Where slicing is necessary, the end cover welds are not to pass through any plate edge hole or be completely arranged in plate edge arc. The distance between weld and plate edge is not to be less than 100 mm, and that between weld and centerline is not to be more than 0.3 times the nominal internal diameter. Welds of tube plates are to be clear of steam-water boundaries and lines of tube holes.

(5) Longitudinal welds of boiler shell: The number of longitudinal welds for each section of the boiler shell is not to be more than two and the length of the external circular arc between centerlines of both welds is not to be less than 300 mm. The splice welds of end covers, tube plates and the longitudinal welds of adjacent portions of the boiler shell are to be staggered. The arc length between two weld centerlines is to be not less than three times the thicker steel plate and not less than 100 mm. The distance between circumferential welds of the boiler shell is to be not less than 300 mm.

(6) Arrangement of boiler tube holes in tube plates

① Welded tube holes are to be clear of welds so far as practicable and coincidence of heat-affected zones of tube hole welds and adjacent welds is to be avoided. If unavoidable, the following conditions are to be met: the welds within 1.5 times the tube hole diameter d (if the diameter is less than 60 mm, 0.5d + 60 mm is to be taken) around the tube hole center are to be tested satisfactorily without edge defects (except defects which can be rectified by cutting holes).

② The distance between expansion tube hole center and weld edge and that between tube hole center and starting point of tube plate edge arc are not to be less than 0.8 times the tube hole diameter d, and not to be less than 0.5d + 12 mm.

(7) Main welds of pressure parts and their heat-affected zones are to be clear of welded parts. If unavoidable, the welds of such parts may pass through main welds and are not to terminate in welds and their heat-affected areas so as to avoid stress concentration in these areas.

(8) Structural members and their connection are to comply with the relevant requirements in Section 2, Chapter 6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

(9) Number, specification and arrangement of boiler mountings and fittings are to comply with the relevant requirements in Section 3, Chapter 6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

(10) Diameter of safety valve: The diameter of safety valve for boilers is to be calculated according to the relevant requirements in Section 3, Chapter 6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

(11) Boilers are to be provided with means indicating highest part of the heating surfaces according to the relevant requirements in Section 3, Chapter 6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships.

(12) The post-welding heat treatment is to be carried out after completion of welding and prior to hydraulic test according to requirements of CCS Rules for Materials and Welding.

1.7.3 Strength requirements

(1) The design strength of pressure parts for marine boilers is to comply with relative provisions as specified in Chapter 6, PART THREE of CCS Rules for Classification of Sea-going Steel Ships and CCS Rules for Materials and Welding.

1.8 Type test

1.8.1 Selection of typical samples

(1) The marine boiler used for works approval test is to be, in respect of performance, characteristics and manufacturing quality, capable of representing or covering the products for which approval is sought. In general, a boiler with large design pressure and thick boiler shell is to be selected.

1.8.2 Type test items and requirements

(1) Type test items are to include non-destructive testing of welds, mechanical test of welded test plates, and visual examination, hydraulic strength test of the boiler body and tightness test.

(2) Test methods and related technical criteria for type test are to comply with the following requirements:

① Non-destructive testing of welds: The extent, methods and requirements of non-destructive testing are to comply with plans approved by CCS as well as requirements as specified in Chapter 7, PART THREE of CCS Rules for Materials and Welding. The quality of welds which are subject to non-destructive testing is to be evaluated according to standards acceptable to CCS.

② Mechanical test of welded test plates: Preparation of test plates, test items and results are to comply with the relevant requirements in Section 2, Chapter 7, PART THREE of CCS Rules for Materials and Welding.

③ Visual examination is to comply with the following requirements:

(a) surfaces of butt welds and essential fillet welds are to be uniform and sound, and free from cracks, overlaps, undercuts, porosities, slag inclusions, craters and unfilled cavities;

(b) internal examination after completion: Examine the internal welds of boilers and external quality of tunnel wall and defects such as craters, depressions, overlaps, splashes, undercuts and mechanical damages are not allowed;

(c) examination of welding and expanding quality: the weld sizes for smoke tubes, stay tubes and stays as well as the projected length of tube ends are to comply with the requirements as specified in 4, 5 and 6, Annex 2, Chapter 6, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships. Defects such as deep undercuts, overlaps, cracks or unfilled cavities are not allowed in the tube ends after welding. The quality of expanding tubes is to comply with the requirements as specified in 6.2.11, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships;

(d) examination of heat treatment quality: Examination for burnt or deformed parts. Any burnt part is to be ground and subjected to metallographic examination for widmanstatten structure exists (in case of any widmanstatten structure, re-austenitization may be achieved by annealing, normalizing or multiple high-temperature tempering so as to refine the grains). Check for cracks in welds and their heat-affected zones. If necessary, the welds of high strength alloy steels and complex welds are to be subjected to radiographic testing or ultrasonic retesting.

④ Hydraulic strength test for boiler body: After completion of assembling and satisfactory non-destructive testing, the boiler body is to be subjected to hydraulic strength test when it is not painted and not fitted with insulation. When heat treatment is required, the hydraulic strength test is to be carried out after heat treatment. The test pressure is to be 1.5 times the design pressure and kept for at least 20 min. The test results are satisfactory when:

(a) no leakage is found on welds or boiler shell;

(b) no abnormal noise or obvious deformation occurs; and

(c) no leakage is found in expanding holes or at connection of fittings and attachments when the pressure is reduced to working pressure.

⑤ Tightness test: The boiler is to be subjected to tightness test after completion of assembly of its mountings and fittings. Heat insulation may be provided in test and when necessary, part or whole of the insulation may be removed. The test pressure is to be 1.25 times the design pressure. The inspection requirements are the same as those for strength test.

⑥ Performance test (only carried out for new product approval): The automatic and manual control and safety protection test, safety valve test, value effectiveness test, furnace inspection, etc. are to be carried out in order to verify the performances of boiler. (For those boilers without conditions to carry out performance test in manufacturers, such as exhaust gas boiler and oil-fired auxiliary and exhaust gas composite boiler, interim approval certificates and type test certificates for product may be issued by manufacturers based on the thermodynamic calculations, the performance tests are to be carried out after the boilers are installed onboard ships, the work approval certificates will be renewed after all type test reports are received and reported.)

1.9 Unit/batch inspection

1.9.1 Unit/batch inspection for issuing marine products certificates is to include the following items:

(1) raw material inspection;

(2) inspection of pressure parts;

(3) assembly inspection prior to welding and welding inspection, and review of report of non-destructive testing of welds;

(4) inspection of completed body;

(5) test of welded test plates;

(6) inspection after assembly of mountings and fittings.

1.9.2 Inspection requirements

(1) Raw material inspection: Steel plates, steel pipes and welding consumables used in manufacturing of marine boilers are to be furnished with products certificates issued by CCS or equivalent documents. Their types and specifications are to comply with the plans approved by CCS and to be consistent with delivered products, shown by a complete quality assurance document. The material marks are to comply with certificates, including steel grade, type, cast no., specification, manufacturer's inspectors stamp and CCS stamp. The steel plates and steel pipes not certified by CCS are to be fabricated by manufacturers accepted by CCS and subject to CCS inspection. The steels used in manufacturing of boilers are to be of a uniform quality and the surface is to be free from cracks, blisters, scabs, laps or slag inclusions. Steel plates are to be free from laminations. The internal and external surfaces of seamless steel pipes and tubes are to be free from defects such as cracks, laps, laminations, scabs, pinches, hair-line cracks. The dimensions of steel plates and steel pipes are to comply with plans approved by CCS.

After completion of the above-mentioned inspection, the materials from which pressure parts will be made or suitable positions of intended welded test plates are to be marked by the Surveyor with CCS stamp, for confirmation in subsequent inspections so as to ensure proper use of materials.

(2) Inspection of pressure parts: For the finished pressure parts, the Surveyor is to confirm the stamp affixed in the raw material inspection for ensuring that the materials used have been inspected. In addition, visual examination and dimension examination are to be carried out.

(3) Inspection prior to welding: included angles and butt gaps are to comply with the plans and welding procedure specifications approved by CCS as well as the requirements as specified in Section 3, Chapter 7, PART THREE of CCS Rules for Materials and Welding.

(4) Welding inspection is to include the following:

① Welding process inspection: Welding of boilers is to be carried out under supervision of the manufacturer's inspector, and the Surveyor is to make spot checks at the welding site on regular basis, mainly covering the following:

(a) In the case of any of the following ambient conditions and in the absence of effective protective measures, welding is prohibited:

a. the wind speed is more than 10 m/s for manual welding, or more than 2 m/s for gas shielded arc welding;

b. relative humidity is more than 90%; or

c. outdoor operation in rain or snow.

(b) When the temperature of weldment is below 0℃, preheating till about 15℃ is necessary within 100 mm from both sides of the welding.

② Welders engaged in welding of marine boilers are to hold Qualification Certificate of Welder issued or accepted by CCS, which enables them to be engaged in the certified range of work only.

③ Welding equipment is to comply with the following requirements:

(a) the equipment is to be fitted in a sheltered place and reliably earthed; and

(b) the required welding quality is to be ensured, an effective working condition maintained and suitable facilities are to be provided to measure current and voltage. The ammeter and voltmeter are to be within the valid calibration period.

④ Welding consumables: All welding wires, electrodes and fluxes are to be furnished with CCS products certificates or equivalent documents. Their types and specifications are to comply with approved welding procedures. The electrodes are to be baked and stored prior to welding according to the instructions. The welding wires are to be free from water, rust and oil.

⑤ Welding methods and welding positions are to comply with approved welding procedures.

⑥ Inspection of tack welding: The tack welding procedure (welding methods, welding consumables and preheating temperature) is to be consistent with the first run. The slags of tack welds are to be thoroughly removed prior to completion of welding and a careful examination for cracks is to be carried out. If any crack is found, it is to be removed by grinding and re-welding is to be carried out and repairing by welding is not to be used to obscure the crack. The tack welds where no cracks are found may remain. The welding consumables of tack welds are to be the same as that for the finished welds.

(5) Welding quality inspection: Butt welds and essential fillet welds are to be visually examined by the Surveyor prior to heat treatment. The surface of welds is to be uniform and sound and free from cracks, overlaps, undercuts, porosities, slag inclusions, craters and unfilled cavities.

(6) Non-destructive testing of welds is to be carried out according to 1.8.2(2) ① of this Chapter. Generally the Surveyor may check the manufacturer's testing reports and note that personnel engaged in non-destructive testing of marine boilers and their parts are to be well trained and to hold the "Qualification Certificate of NDT Personnel" issued or accepted by CCS and that they can only be engaged in the non-destructive testing appropriate to the certified range of work and are to assume related technical responsibilities.

(7) Mechanical test of welded test plates is to be carried out according to 1.8.2(2) ② of this Chapter.

(8) Visual examination of the completed body is to be carried out according to 1.8.2(2) ③ of this Chapter.

(9) Hydraulic test is to be carried out after completion of body manufacturing process, including repairing, grinding, heat treatment and other internal cleaning work and prior to heat insulation according to 1.8.2(2) ④ of this Chapter.

(10) Inspection after assembly of mountings and fittings: Examination for completeness of assembled fittings and mountings of the boiler and for their correct and secure assembly. The tightness test is to be carried out according to 1.8.2 (2) ⑤ of this Chapter, after completion of such assembly. If only the boiler body is fabricated by the manufacturer and the boiler mountings and fittings are assembled in the manufacturer after delivery by assembling suppliers directly, when the test could not be carried out, the certificate is to be marked: This certificate will be valid after the following inspection and verification are carried out:

1. to check the consistency of inspection marks between certificate and the boiler.
2. to check the boiler fittings type, installation position and quantities etc. which are to be in compliance with the requirements of approved drawings and the comments provided by the unit issued the certificate, according to the approved arrangement drawings or boiler general drawings or the part lists.
3. to check the burner suitable furnace volume could be suitable for the boiler's furnace according to the boiler body certificate and burner approval certificate.
4. to check the safety valve could meet the parameters listed in the boiler body certificate according to the boiler body certificate and safety valves approval certificate.
5. to verify that the automation condition which recorded in the boiler control box certificate could meet the requirement of CCS's Automation Notation.
6. the hydraulic test (watertightness test) is to be witnessed and record is to be signed according to the requirements of Section 5, Chapter 6, PART Three in CCS Rules for Classification of Sea-going Steel Ships after completion installation of fittings.
7. the safety valve is to be tested to comply with the requirement of item 6.3.5.3 of Chapter 6, PART Three of CCS Rules for Classification of Sea-going Steel Ships at sea trial test.

PART ELEVEN ELECTRICAL INSTALLATIONS

CHAPTER 1 SHIPBOARD ELECTRIC WIRES AND CABLES

1.1 General provisions

1.1.1 Application

1.1.1.1 This Chapter applies to approval and inspection of cables which are permanently fixed and used on ships and offshore installations.

1.1.1.2 Shipboard electric cables are to include:

(1) power cables;

(2) cables for control and instrumentation circuits, etc.

1.1.2 Basis for approval and inspection

1.1.2.1 The approval and inspection of shipboard cables in this Chapter are to be based on the following documents:

1.1.2.2 Products and performance standards

	Section 5, Chapter 3 of PART FOUR of CCS Rules for Classification of Sea-going Steel Ships
IEC 60092-350(2008-02)	Electrical installations in ships - Part 350: Shipboard power cables - General construction and test requirements
IEC 60092-351(2004-04)	Electrical installations in ships - Part 351: Insulating materials for shipboard and offshore units, power, control, instrumentation, telecommunication and data cables
IEC 60092-353(2011-08)	Electrical installations in ships - Part 353: Power cables for rated voltages 1 kV and 3 kV
IEC 60092-354(2003-06)	Electrical installations in ships - Part 354: Single- and three-core power cables with extruded solid insulation for rated voltages 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)
IEC 60092-359(1999-08)	Electrical installations in ships - Part 359: Sheathing materials for shipboard power and telecommunication cables
IEC 60092-376(2003-05)	Electrical installations in ships - Part 376: Cables for control and instrumentation circuits 150/250 V (300 V)
IEC 60228(2004-11)	Conductors of insulated cables

1.1.2.3 Test methods and standards

IEC 60331-1(2009-05)	Tests for electric cables under fire conditions - Circuit integrity - Part 1: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0.6/1.0 kV and with an overall diameter exceeding 20 mm

IEC 60331-2(2009-05)	Tests for electric cables under fire conditions - Circuit integrity - Part 2: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0.6/1.0 kV and with an overall diameter not exceeding 20 mm
IEC 60331-11(2009-07)	Tests for electric cables under fire conditions - Circuit integrity - Part 11: Apparatus - Fire alone at a flame temperature of at least 750 °C
IEC 60331-21(1999-04)	Tests for electric cables under fire conditions - Circuit integrity - Part 21: Procedures and requirements - Cables of rated voltage up to and including 0.6/1.0 kV
IEC 60331-23(1999-04)	Tests for electric cables under fire conditions - Circuit integrity - Part 23: Procedures and requirements - Electric data cables
IEC 60331-25(1999-04)	Tests for electric cables under fire conditions - Circuit integrity - Part 25: Procedures and requirements - Optical fibre cables
IEC 60332-1-1(2004-07)	Tests on electric and optical fibre cables under fire conditions - Part 1-1: Test for vertical flame propagation for a single insulated wire or cable – Apparatus
IEC 60332-1-2(2004-07)	Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame
IEC 60332-1-3(2004-07)	Tests on electric and optical fibre cables under fire conditions - Part 1-3: Test for vertical flame propagation for a single insulated wire or cable - Procedure for determination of flaming droplets/particles
IEC 60332-3-10(2009-02)	Tests on electric and optical fibre cables under fire conditions - Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables - Apparatus
IEC 60332-3-21(2000-10)	Tests on electric cables under fire conditions - Part 3-21: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category A F/R
IEC 60332-3-22(2009-02)	Tests on electric and optical fibre cables under fire conditions - Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category A
IEC 60754-1(2011-11)	Test on gases evolved during combustion of materials from cables - Part 1: Determination of the halogen acid gas content
IEC 60754-2(2011-11)	Test on gases evolved during combustion of materials from cables - Part 2: Determination of acidity pH measurement) and conductivity
IEC 61034-1(2005-04)	Measurement of smoke density of cables burning under defined conditions - Part 1: Test apparatus
IEC 61034-2(2005-04)	Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements
IEC60811-201ed1.0(2012-03)	Electric and optical fibre cables – Test methods for non-metal materials – Part 201: General tests – Measurement of insulation thickness
IEC60811-202ed1.0(2012-03)	Electric and optical fibre cables – Test methods for non-metallic materials – Part 202: General tests – Measurement of thickness of non-metallic sheath

IEC60811-203ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 203：General tests – Measurement of overall dimensions

IEC60811-401ed1.0(2012-03) Electric and optical fibre caboes – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven

IEC60811-412ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 412: Miscellaneous tests – Thermal ageing methods – Ageing in an air bomb

IEC60811-402ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 402: Miscellaneous tests – Water absorption tests

IEC60811-502ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 502: Mechanical tests – Shrinkage test for insulations

IEC60811-503ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 503: Mechanical tests – Shrinkage test for sheaths

IEC60811-606ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 606: Physical tests – Methods for determining the density

IEC60811-403ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 403: Miscellaneous tests – Ozone resistance test on cross-linked compounds

IEC60811-404ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 404: Miscellaneous tests – Mineral oil immersion tests for sheaths

IEC60811-507ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 507: Mechanical tests – Hot set test for cross-linked materials

IEC60811-508ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 508: Mechanical tests – Pressure test at high temperature for insulation and sheaths

IEC60811-509ed1.0(2012-03) Electric and optical fibre caboes – Test methods for non-metallic materials – Part 509: Mechanical tests – Test for resistance of insulations and sheaths to cracking (heat shock test)

IEC60811-405ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 405: Miscellaneous tests – Thermal stability test for PVC insulation and PVC sheaths

IEC60811-409ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 409: Miscellaneous tests – Loss of mass test for thermoplastic insulations and sheaths

IEC60811-406ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 406: Miscellaneous tests – Resistance to stress cracking of polyethylene and polypropylene compounds

IEC60811-511ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 511: Mechanical tests – Measurement of the melt flow index of polyethylene compounds

IEC60811-605ed1.0(2012-03) Electric and optical fibre cables – Test methods for non-metallic materials – Part 605: Physical tests – Measurement of carbon black and/or mineral filter in polyethylene compounds

IEC60811-607ed1.0(2012-03)	Electric and optical fibre cables – Test methods for non-metallic materials – Part 607: Physical tests – Test for the assessment of carbon black dispersion in polyethylene and polypropylene
IEC60811-407ed1.0(2012-03)	Electric and optical fibre cables – Test methods for non-metallic materials – Part 407: Miscellaneous tests – Measurement of mass increase of polyethylene and polypropylene compounds
IEC60811-408ed1.0(2012-03)	Electric and optical fibre cables – Test methods for non-metallic materials – Part 408: Miscellaneous tests – Long-term stability test of polyethylene and polypropylene compounds
IEC60811-410ed1.0(2012-03)	Electric and optical fibre cables – Test methods for non-metallic materials – Part 410: Miscellaneous tests – Test method for copper-catalyzed oxidative degradation of polyolefin insulated conductors
IEC60811-510ed1.0(2012-03)	Electric and optical fibre cables – Test method for non-metallic materials – Part 510: Mechanical tests – Methods specific to polyethylene and polypropylene compounds – Wrapping test after thermal ageing in air
IEC60811-512ed1.0(2012-03)	Electric and optical fibre cables – Test methods for non-metallic materials – Part 512: Mechanical tests – Methods specific to polyethylene and polypropylene compounds – Tensile strength and elongation at break after conditioning at elevated temperature
IEC60811-513ed1.0(2012-03)	Electric and optical fibre cables – Test methods for non-metallic materials – Part 513: Mechanical tests – Methods specific to polyethylene and polypropylene compounds – Wrapping test after conditioning
IEC60811-501ed1.0(2012-03)	Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds
IEC 60189-1(2007-05)	Low-frequency cables and wires with PVC insulation and PVC sheath - Part 1: General test and measuring methods
IEC 60189-2(2007-05)	Low-frequency cables and wires with PVC insulation and PVC sheath - Part 2: Cables in pairs, triples, quads and quintuples for inside installations
IEC 60189-3(2007-05)	Low-frequency cables and wires with PVC insulation and PVC sheath - Part 3: Equipment wires with solid or stranded conductor wires, PVC insulated, in singles, pairs and triples
IEC 60684-2(2011-08)	Flexible insulating sleeving - Part 2: Methods of test
IEC 60885-2(1987-03)	Electrical test methods for electric cables. Part 2: Partial discharge tests

1.1.2.4 Other standards

IEC 60050-461(2008-06)	International Electrotechnical Vocabulary - Part 461: Electric cables

1.1.3 Definitions

1.1.3.1 Terms and definitions in this Chapter are the same as those of IEC 60050-461(2008-06).

1.2 Plans and documents

1.2.1 General requirements for plans and documents to be submitted to CCS for examination and approval are specified in PART ONE of the Guidelines.

1.2.2 The following plans and documents are to be submitted to CCS for approval:

(1) Structural drawing of cables;

(2) Technical specifications of cables or equivalent documents.

1.2.3 The following plans and documents are to be submitted to CCS for information:

(1) Designation of cable types and specifications;

(2) Table of cable construction data or equivalent documents;

(3) Production process flow chart indicating quality control points;

(4) List of production technology;

(5) List of production equipment;

(6) List of test equipment;

(7) List of trademarks and suppliers of main raw materials;

(8) Specimen of quality certificate;

(9) Asbestos free statement;

(10) Routine inspection programme or equivalent documents;

(11) Format of routine inspection report;

(12) Operation instructions for the products;

(13) Other documents to be submitted as required for approval.

1.3 Technical requirements

1.3.1 Shipboard electric cables are to comply with the following standards:

(1) Shipboard electric cables are to comply with the requirements of IEC60092-350(2008-02).

(2) Power cables for rated voltages 1 kV and 3 kV are to comply with the requirements of IEC60092-353(2011-08).

(3) Power cables for rated voltages 6 kV up to 30 kV are to comply with the requirements of IEC 60092-354(2003-06).

(4) Cables for control and instrumentation circuits are to comply with the requirements of IEC 60092-376(2003-05).

1.3.2 Non-metallic compounds such as insulation, non-metallic coverings and sheaths, fillers and binders of cables are not to contain asbestos.

1.3.3 Single-core cables or cores rated in excess of 20A are to be either non-armoured or armoured and covered with non-magnetic material.

1.3.4 Screens for power cables are to comply with the requirements in paragraph 5.5 of IEC60092-353. The metallic screen is to cover outside the cores at least consisting of two cores laid up. The individual insulating core of pair unit, triple unit and multi unit shipboard power cables is to be without metallic screen or cover (i.e. sub-screened cable is not permitted).

1.3.5 In case of a braid armour of galvanized steel wires in which case the inner covering is to be extruded for pair unit, triple unit and multi unit shipboard power cables.

1.3.6 The insulating compounds and their designation for shipboard power cables are to be as given in IEC60092-351. For cables having rated voltage of 0.6/1(1.2)kV and below, types EPR、HEPR、XLPE、HF 90 or S 95 are to be used. For cables having rated voltage of 1.8/3(3.6)kV and below, types EPR、HEPR、XLPE are to be used.

1.3.7 The inner, outer sheathing compounds are to be one of those given in IEC60092-359 except that PVC type ST1 is not permitted.

1.4 Approval and tests

1.4.1 Cables used in ships classed with CCS are to be subjected to CCS works approval, covering examination and approval of plans and technical documents, type approval tests and on-site audit.

1.4.2 Shipboard electric cables are to be subjected to type test according to 1.4.2.1 to 1.4.2.4.

1.4.2.1 Unless otherwise specified, all tests are to be carried out in the following atmospheric conditions:

(1) ambient temperature: 15℃ to 35℃ ;

(2) relative humidity: 30%RH to 90%RH;

(3) atmospheric pressure: 86 to 106 kPa.

1.4.2.2 Power cables for rated voltages 1 kV and 3 kV are to be type tested according to Table 1.4.2.2.

1.4.2.3 Power cables for rated voltages 6 kV up to 30 kV are to be type tested according to Table 1.4.2.3.

1.4.2.4 Cables for control and instrumentation circuits are to be type tested according to Table 1.4.2.4.

Type test of power cables for rated voltages 1 kV and 3 kV Table 1.4.2.2

No.	Test	Requirement	Testing method
1	**Electrical**		
1.1	Insulation resistance test at 20℃	IEC60092-351:2004 Table 2	IEC60092-350:2008 para.7.2.1
1.2	Insulation resistance measurement at maximum rated temperature (90℃)	IEC60092-351:2004 Table 2	IEC60092-350:2008 para.7.2.2
1.3	Increase in a.c. capacitance after immersion in water	IEC60092-350:2008 para.7.3	IEC60092-350:2008 para.7.3
1.4	High-voltage test for 4 h	IEC60092-350:2008 para.7.4	IEC60092-350:2008 para.7.4
2	**Non-electrical**		
2.1	Conductor examination	IEC60092-353:2011 para.5.2 IEC60228:2004 Tables II、III	IEC60092-350:2008 para.6.4
2.2	Check of cable dimensions . Thickness of insulation . Thickness of non metallic sheaths (excluding inner coverings) . External diameter	 IEC60092-353:2011 para.5.3.3 IEC60092-353:2011 para.5.5.2 IEC60092-353:2011 para.5.7.3	 IEC60092-353:2011 para.8.1 IEC60092-353:2011 para.8.2 IEC60092-353:2011 para.6.7
2.3	Hot set test (HEPR, EPR, XLPE, HF 90, S 95 insulations and SE1, SHF2 sheaths)	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table II	IEC60092-350:2008 para.6.8
2.4	Coverage density of braid (Braid armoured Cables)	IEC60092-353:2011 para.5.8	IEC60092-350:2008 para.4.8.2
2.5	Mechanical properties of insulation before and after ageing	IEC60092-351:2004 Table 3	IEC60092-350:2008 para.8.3
2.6	Mechanical properties of sheath before and after ageing	IEC60092-359:1999 Table II	IEC60092-350:2008 para.8.4
2.7	Additional ageing compatibility test	IEC60092-351:2004 Table 3	IEC60092-350:2008 para.8.5
2.8	Loss of mass test (ST2 sheath)	IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.6
2.9	Behaviour at high temperature (ST2 and SHF1 Sheaths)	IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.7
2.10	Behaviour at low temperatures (ST2, SHF1 and SHF2 sheaths)	IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.8

No.	Test	Requirement	Testing method
2.11	Test for coating of copper wires	IEC60092-350:2008 para.8.10	IEC60092-350:2008 para.8.10
2.12	Galvanizing test	IEC60092-350:2008 para.8.11 ISO 7989-2:2007 para.5.3	IEC60092-350:2008 para.8.11 ISO 7989-2:2007 para.5.3
2.13	Resistance to cracking heat shock (ST2 and SHF1 sheaths)	IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.12
2.14	Ozone resistance (Insulations and sheaths)	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.13
2.15	Hot oil immersion (SE1, SH and SHF2 sheaths)	IEC60092-359:1999 Table II	IEC60092-350:2008 para.8.14.1
2.16	Flame-spread tests: IEC 60332-1-2 and IEC 60332-3-22	IEC60092-350:2008 para.8.16.1 IEC60332-1-2:2004 IEC60092-350:2008 para.8.16.2 IEC60332-3-22:2009	IEC60092-350:2008 para.8.16.1 IEC60332-1-2:2004 IEC60092-350:2008 para.8.16.2 IEC60332-3-22:2009 in which case cables are to be installed in touching configuration on the front of the ladder
2.17	Determination of hardness (HEPR insulation)	IEC60092-351:2004 Table 4	IEC60092-350:2008 para.8.17
2.18	Determination of modulus of elasticity (HEPR insulation)	IEC60092-351:2004 Table 4	IEC60092-350:2008 para.8.18
2.19	Durability of marking	IEC60092-350:2008 para.8.19 IEC60092-353:2011 para.4.2	IEC60092-350:2008 para.8.19 IEC60092-353:2011 para.4.2
3	**Additional tests required for halogen-free cables**		
3.1	Acid gas emission	IEC60092-350:2008 para.4.1.4	IEC60092-350:2008 para.8.16.4 IEC60754-1:2011
3.2	pH and conductivity	IEC60092-350:2008 para.4.1.4	IEC60092-350:2008 para.8.16.5 IEC60754-2:2011
3.3	Fluorine content test	IEC60092-350:2008 para.4.1.4	IEC60092-350:2008 para.8.16.6 IEC60684-2:2011
4	**Additional test required for low smoke cables**		
4.1	Smoke emission test for cables insulated and sheathed with halogenfree materials. When tested according to IEC 61034-1 and IEC 61034-2	IEC60092-350:2008 para.8.16.3 IEC61034-1:2005 IEC61034-2:2005 The test is satisfactory for the finished cables if the levels of light transmittance exceeds 60% throughout the test	IEC60092-350:2008 para.8.16.3 IEC61034-1:2005 IEC61034-2:2005

No.	Test	Requirement	Testing method
5	**Additional tests required for fire resistant cables**		
5.1	Test for fire resistance (limited circuit integrity), The test is to be carried out in accordance with IEC 60331-21 or IEC 60331-1 or IEC 60331-2 and the minimum time to failure is to be 90 min	IEC60092-350:2008 para.8.16.7 IEC60331-1:2009(Overall diameter exceeding 20mm) IEC60331-2:2009(Overall diameter not exceeding 20mm) IEC60331-21:1999	IEC60092-350:2008 para.8.16.7 IEC60331-1:2009(Overall diameter exceeding 20mm) IEC60331-2:2009(Overall diameter not exceeding 20mm) IEC60331-21:1999
6	**Additional tests required for specific performances**		
6.1	Special test for low temperature behaviour	IEC60092-350:2008 para.8.9	IEC60092-350:2008 para.8.9
6.2	Enhanced hot oil immersion	IEC60092-359:1999 Table II	IEC60092-350:2008 para.8.14.2
6.3	Mud fluid drilling test	IEC60092-350:2008 para.8.15	IEC60092-350:2008 para.8.15

Type test of single and three-core power cables with extruded solid insulation for rated voltages 6 kV up to 30 kV Table 1.4.2.3

No.	Test item	Technical requirement	Test method
1	**Test, electrical**		
1.1	Partial discharge test	IEC60092-354:2003 para.18.3.3	IEC60092-354:2003 para.18.3.3 IEC60885-2:1987
1.2	Bending test	IEC60092-354:2003 para.18.3.4	IEC60092-354:2003 para.18.3.4
1.3	Tan δ measurement as a function of voltage	IEC60092-354:2003 para.18.3.5	IEC60092-354:2003 para.18.3.5
1.4	Tan δ measurement as a function of temperature	IEC60092-354:2003 para.18.3.6	IEC60092-354:2003 para.18.3.6
1.5	Heating cycle plus partial discharge test	IEC60092-354:2003 para.18.3.7	IEC60092-354:2003 para.18.3.7
1.6	Impulse withstand test, followed by a power-frequency voltage test	IEC60092-354:2003 para.18.3.8	IEC60092-354:2003 para.18.3.8
1.7	Voltage test for 4h	IEC60092-354:2003 Table 5	IEC60092-354:2003 para.18.2 f)
2	**Test, non-electrical**		
2.1	Measurement of thickness of insulation	IEC60092-354:2003 Table 1 IEC60092-350:2008 para.4.3.3	IEC60092-350:2008 para.8.1
2.2	Measurement of thickness of non-metallic sheaths	IEC60092-354:2003 para.14.2 and 15.2 IEC60092-350:2008 para.4.7.3 and 4.9.3	IEC60092-350:2008 para.8.2
2.3	Test for determining the mechanical properties of insulation before and after ageing in air bomb	IEC60092-351:2004 Table 3	IEC60092-350:2008 para.8.3
2.4	Test for determining the mechanical properties of sheaths before and after ageing in air bomb	IEC60092-359:1999 Table II	IEC60092-350:2008 para.8.4
2.5	Additional ageing test on pieces of completed cables (compatibility test)	IEC60092-351:2004 Table 3	IEC60092-350:2008 para.8.5

No.	Test item	Technical requirement	Test method
2.6	Loss of mass test on PVC insulation and ST1 and ST2 sheaths	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.6
2.7	Test for behavior at high temperature of PVC insulation and PVC and ST1, ST2 and SHF1 sheaths (pressure test)	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.7
2.8	Test for behavior at low temperature of PVC insulation and PVC and ST1, ST2, SHF1and SHF2 sheaths	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.8
2.9	Special test for low temperature behaviour	IEC60092-350:2008 para.8.9	IEC60092-350:2008 para.8.9
2.10	Test of the metal coating of copper wires	IEC60228:2004 Tables II、III	IEC60092-350:2008 para.8.10
2.11	Galvanizing test	IEC60092-350:2008 para.8.11	IEC60092-350:2008 para.8.11
2.12	Test for resistance to cracking of PVC insulation, ST1, ST2 and SHF1 sheaths (heat shock test)	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.12
2.13	Hot-set test for insulations and for sheaths	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table II	IEC60092-350:2008 para.6.8
2.14	Ozone resistance test for EPR, HEPR, HF EPR, HFHEPR, HF 90 insulation and for SE1, SH and SHF2 sheaths	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.13
2.15	Oil immersion test for elastomeric oversheaths	IEC60092-359:1999 Table II	IEC60092-350:2008 para.8.14
2.16	Flame-retardant test of a single wire or cable	IEC60092-350:2008 para.8.16.1 IEC60332-1-2:2004	IEC60092-350:2008 para.8.16.1 IEC60332-1-2:2004
2.17	Flame-retardant test of bunched wires or cables	IEC60092-350:2008 para.8.16.2 IEC60332-3-22:2000	IEC60092-350:2008 para.8.16.2 IEC60332-3-22:2009
2.18	Fire test of cables	IEC60092-350:2008 para.8.16.7 IEC60331-1:2009 IEC60331-21:1999	IEC60092-350:2008 para.8.16.7 IEC60331-1:2009 IEC60331-21:1999
2.19	Smoke emission test of completed cables	IEC60092-350:2008 para.8.16.3 IEC61034-1:2005 IEC61034-2:2005	IEC60092-350:2008 para.8.16.3 IEC61034-1:2005 IEC61034-2:2005
2.20	Determination of degree of acidity of halogen gas in insulating, sheathing, fillers and other non-metallic materials	IEC60092-350:2008 para.4.1.4	IEC60092-350:2008 para.8.16.5
2.21	Determination of amount of halogen gas in insulating, sheathing, fillers and other non-metallic materials	IEC60092-350:2008 para.4.1.4	IEC60092-350:2008 para.8.16.4
2.22	Determination of fluorine content in insulating, sheathing, fillers and other non-metallic materials	IEC60092-350:2008 para.4.1.4	IEC60092-350:2008 para.8.16.6
2.23	Determination of hardness for HEPR and HF HEPR insulations	IEC60092-351:2004 Table 4	IEC60092-350:2008 para.8.17
2.24	Determination of elastic modulus for HEPR and HF HEPR insulations	IEC60092-351:2004 Table 4	IEC60092-350:2008 para.8.18
2.25	Visual examination of cables	IEC60092-354:2003 para.7	IEC60092-350:2008 para.8.19 IEC60092-354:2003 para.17.1

Note: Electrical test is to be carried out in the sequence from 1.1 to 1.7.

Type test of cables for control and instrumentation circuits Table 1.4.2.4

No.	Test	Requirement	Testing Method
1	**Electrical**		
1.1	Insulation resistance test at 20℃	IEC60092-351:2004 Table 2	IEC60092-350:2008 para.7.2.1
1.2	Insulation resistance measurement at maximum rated temperature(90℃)	IEC60092-351:2004 Table 2	IEC60092-350:2008 para.7.2.2
1.3	Mutual capacitance	NIL	IEC60092-350:2008 para.7.5 IEC60092-376:2003 para.17.4 a)
1.4	Inductance to resistance ratio (L/R ratio)	NIL	IEC60092-350:2008 para.7.6 IEC60092-376:2003 para.17.4 b)
2	**Non-electrical**		
2.1	Conductor examination	IEC60092-376:2003 Table 6 IEC60228:2004 Tables II、III	IEC60092-350:2008 para.6.4
2.2	Check of cable dimensions . Thickness of insulation . Thickness of non metallic sheaths (excluding inner coverings) . External diameter	IEC60092-376:2003 para.10.4 IEC60092-376:2003 para.13.2 IEC60092-376:2003 para.14.1	IEC60092-353:2011 para.8.1 IEC60092-353:2011 para.8.2 IEC60092-353:2011 para.6.7
2.3	Hot set test (HEPR, EPR, XLPE, HF 90, S 95 insulations and SE1, SHF2 sheaths)	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table II	IEC60092-350:2008 para.6.8
2.4	Electrostatic screen (Screened Cables)	IEC60092-376:2003 para.12	IEC60092-350:2008 para.4.8.2
2.5	Coverage density of braid (Braid armoured Cables)	IEC60092-376:2003 para.15	IEC60092-350:2008 para.4.8.2
2.6	Mechanical properties of insulation before and after ageing	IEC60092-351:2004 Table 3	IEC60092-350:2008 para.8.3
2.7	Mechanical properties of sheath before and after ageing	IEC60092-359:1999 Table II	IEC60092-350:2008 para.8.4
2.8	Additional ageing compatibility test	IEC60092-351:2004 Table 3	IEC60092-350:2008 para.8.5
2.9	Loss of mass test (ST2 sheath)	IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.6
2.10	Behaviour at high temperature (ST2 and SHF1 Sheaths)	IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.7
2.11	Behaviour at low temperatures (ST2, SHF1 and SHF2 sheaths)	IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.8
2.12	Test for coating of copper wires	IEC60092-350:2008 para.8.10	IEC60092-350:2008 para.8.10

No.	Test	Requirement	Testing Method
2.13	Galvanizing test	IEC60092-350:2008 para.8.11 ISO 7989-2:2007 para.5.3	IEC60092-350:2008 para.8.11 ISO 7989-2:2007 para.5.3
2.14	Resistance to cracking heat shock (ST2 and SHF1 sheaths)	IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.12
2.15	Ozone resistance (Insulations and sheaths)	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.13
2.16	Hot oil immersion (SE1, SH and SHF2 sheaths)	IEC60092-359:1999 Table II	IEC60092-350:2008 para.8.14.1
2.17	Flame-spread tests: IEC 60332-1-2 and IEC 60332-3-22	IEC60092-350:2008 para.8.16.1 IEC60332-1-2:2004 IEC60092-350:2008 para.8.16.2 IEC60332-3-22:2009	IEC60092-350:2008 para.8.16.1 IEC60332-1-2:2004 IEC60092-350:2008 para.8.16.2 IEC60332-3-22:2009 in which case cables are to be installed in touching configuration on the front of the ladder
2.18	Determination of hardness (HEPR insulation)	IEC60092-351:2004 Table 4	IEC60092-350:2008 para.8.17
2.19	Determination of modulus of elasticity (HEPR insulation)	IEC60092-351:2004 Table 4	IEC60092-350:2008 para.8.18
2.20	Durability of marking	IEC60092-350:2008 para.8.19 IEC60092-376:2003 para.7.3	IEC60092-350:2008 para.8.19 IEC60092-376:2003 para.16.2
3	**Additional tests required for halogen-free cables**		
3.1	Acid gas emission	IEC60092-350:2008 para.4.1.4	IEC60092-350:2008 para.8.16.4 IEC60754-1:2011
3.2	pH and conductivity	IEC60092-350:2008 para.4.1.4	IEC60092-350:2008 para.8.16.5 IEC60754-2:2011
3.3	Fluorine content test	IEC60092-350:2008 para.4.1.4	IEC60092-350:2008 para.8.16.6 IEC60684-2:2011
4	**Additional test required for low smoke cables**		
4.1	Smoke emission test for cables insulated and sheathed with halogenfree materials. When tested according to IEC 61034-1 and IEC 61034-2	IEC60092-350:2008 para.8.16.3 IEC61034-1:2005 IEC61034-2:2005 The test is satisfactory for the finished cables if the levels of light transmittance exceeds 60% throughout the test	IEC60092-350:2008 para.8.16.3 IEC61034-1:2005 IEC61034-2:2005
5	**Additional tests required for fire resistant cables**		

No.	Test	Requirement	Testing Method
5.1	Test for fire resistance (limited circuit integrity), The test is to be carried out in accordance with IEC 60331-21 or IEC 60331-1 or IEC 60331-2 and the minimum time to failure is to be 90 min	IEC60092-350:2008 para.8.16.7 IEC60331-1:2009(Overall diameter exceeding 20mm) IEC60331-2:2009(Overall diameter not exceeding 20mm) IEC60331-21:1999	IEC60092-350:2008 para.8.16.7 IEC60331-1:2009(Overall diameter exceeding 20mm) IEC60331-2:2009(Overall diameter not exceeding 20mm) IEC60331-21:1999
6	**Additional tests required for specific performances**		
6.1	Special test for low temperature behaviour	IEC60092-350:2008 para.8.9	IEC60092-350:2008 para.8.9
6.2	Enhanced hot oil immersion	IEC60092-359:1999 Table II	IEC60092-350:2008 para.8.14.2
6.3	Mud fluid drilling test	IEC60092-350:2008 para.8.15	IEC60092-350:2008 para.8.15

1.4.4 Principles for selection of samples

1.4.4.1 Types and specifications of test samples are to cover the products for which works approval is sought. Generally samples are to be taken from each series of cable products.

1.4.4.2 Types and specifications of test samples are to be technically representative. In other words, it is difficult for test samples to pass approval type test.

1.4.4.3 Quantity (length) of test samples is to meet related standards.

1.4.4.4 Test samples are to be taken by CCS Surveyor at the applicant's factory.

1.4.5 Test organization

1.4.5.1 For initial works approval, tests are to be carried out by a test organization approved by CCS.

1.4.5.2 For renewal of works approval certificate, works approval type test may be carried out at the manufacturer's laboratory in the presence of CCS Surveyor, subject to agreement of CCS and provided that the manufacturer has required test environment and equipment as well as competent inspection and test personnel.

1.4.6 Approval certificate

1.4.6.1 The works approval certificate is to be issued, maintained, modified, renewed or cancelled according to Chapter 3 of PART ONE of Rules for Classification of Sea-going Ships.

1.5 Unit/batch inspection

1.5.1 The power cables for rated voltages 1 kV and 3 kV are at least to be subjected to the following inspections and tests at the manufacturer:

Test programme for unit/batch inspection of power cables for rated voltages 1 kV and 3 kV **Table 1.5.1**

No.	Test	Requirement	Testing method
1	**Routine Tests**		
1.1	Measurement of electrical resistance of conductors	IEC60228:2004 Tables II、III	IEC60092-350:2008 para.5.2.2
1.2	Voltage test	IEC60092-350:2008 para.5.2.3	IEC60092-350:2008 para.5.2.3
1.3	Voltage test on sheath (Armoured cables)	IEC60092-350:2008 para.5.2.3.4	IEC60092-350:2008 para.5.2.3.4
1.4	Insulation resistance test	IEC60092-351:2004 Table 2	IEC60092-350:2008 para.5.2.4
2	**Sample Tests**		
2.1	Insulation resistance test	IEC60092-350:2008 para.7.2.4	IEC60092-350:2008 para.5.2.4
2.2	Conductor examination	IEC60092-353:2011 para.5.2 IEC60228:2004 Tables II、III	IEC60092-350:2008 para.6.4
2.3	Check of cable dimensions . Thickness of insulation . Thickness of non metallic sheaths (excluding inner coverings) . External diameter	 IEC60092-353:2011 para.5.3.3 IEC60092-353:2011 para.5.5.2 IEC60092-353:2011 para.5.7.3	 IEC60092-353:2011 para.6.5 IEC60092-353:2011 para.6.5 IEC60092-353:2011 para.6.7
2.4	Hot set test (HEPR, EPR, XLPE, HF 90, S 95 insulations and SE1, SHF2 sheaths)	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table II	IEC60092-350:2008 para.6.8

Note: Routine tests are to be carried out in the full length for delivery. For frequency of sample tests and number of samples, see paragraph 6.2 of IEC60092-350:2008 for detail.

1.5.2 The power cables for rated voltages 6 kV and 30 kV are at least to be subjected to (all of) the following inspections and tests at the manufacturer:

(1) Measurement of conductor DC resistance (IEC60092-350:2008 para. 5.5.2);

(2) Partial discharge test (IEC60092-354:2003 para. 18.1 b));

(3) High voltage test (IEC60092-350:2008 para. 5.5.3);

(4) Conductor examination (IEC60092-350:2008 para. 6.4, for frequency of sample tests, see 60092-350:2008 para. 6.2);

(5) Construction examination (IEC60092-350:2008 para. 6.5 to 6.7, for frequency of sample tests, see 60092-350:2008 para. 6.2);

(6) Hot-set test for insulations and for sheaths (IEC60092-350:2008 para. 6.8, for frequency of sample tests, see 60092-350:2008 para. 6.2).

Test programme for unit/batch inspection of power cables for rated voltages 6 kV and 30 kV **Table 1.5.2**

No.	Test	Requirement	Testing method
1	**Routine Tests**		
1.1	Measurement of electrical resistance of conductors	IEC60092-354:2003 para.9 IEC60228:2004 Tables II、III	IEC60092-350:2008 para.5.2.2
1.2	Partial discharge test	IEC60092-354:2003 para.18.1b)	IEC60092-354:2003 para.18.1b)
1.3	Voltage test	IEC60092-354:2003 para.18.1c)	IEC60092-350:2008 para.5.2.3
2	**Special Tests**		
2.1	Conductor examination	IEC60092-354:2003 para.9 IEC60228:2004 Tables II、III	IEC60092-350:2008 para.6.4
2.2	Check of cable dimensions . Thickness of insulation . Thickness of non metallic sheaths (excluding inner coverings) . External diameter	IEC60092-354:2003 para.10.3 IEC60092-354:2003 para.14.2 IEC60092-354:2003 para.15.2	IEC60092-353:2011 para.6.5 IEC60092-353:2011 para.6.5 IEC60092-353:2011 para.6.7
2.3	Hot set test (HEPR, EPR, XLPE, HF 90, S 95 insulations and SE1, SHF2 sheaths)	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table II	IEC60092-350:2008 para.6.8
2.4	Behaviour at low temperatures (ST2, SHF1 and SHF2 sheaths)	IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.8
2.5	Coverage density of braid (Braid armoured Cables)	IEC60092-354:2003 para.16	IEC60092-350:2008 para.4.8.2
2.6	Power-frequency voltage of 4 Uo	IEC60092-354:2003 para.18.2f)	IEC60092-354:2003 para.18.2f)

Note: Routine tests are to be carried out in the full length for delivery. For frequency of special tests and number of samples, see paragraph 6.2 of IEC60092-350:2008 for detail.

1.5.3 The cables for control and instrumentation circuits are at least to be subjected to the following inspections and tests at the manufacturer:

Test programme for unit/batch inspection of cables for control and instrumentation circuits **Table 1.5.3**

No.	Test	Requirement	Testing method
1	**Routine Tests**		
1.1	Measurement of electrical resistance of conductors, including drain wires	IEC60092-376:2003 para.17.1.a)	IEC60092-350:2008 para.5.2.2
1.2	Voltage test	IEC60092-376:2003 para.17.1.b)	IEC60092-350:2008 para.5.2.3
1.3	Insulation resistance test	IEC60092-376:2003 para.17.1.c)	IEC60092-350:2008 para.5.2.4
1.4	Screen insulation resistance	IEC60092-376:2003 para.17.1.d)	IEC60092-350:2008 para.5.2.4
1.5	The insulation resistance between any screen and the armour for armoured cables	IEC60092-376:2003 para.17.1.e)	IEC60092-350:2008 para.5.2.4
2	**Special Tests**		
2.1	Conductor examination	IEC60092-376:2003 para.9	IEC60092-350:2008 para.6.4
2.2	Check of cable dimensions . Thickness of insulation . Thickness of non metallic sheaths (excluding inner coverings) . External diameter	 IEC60092-376:2003 para.10.4 IEC60092-376:2003 para.13.2 IEC60092-376:2003 para.14.1	 IEC60092-353:2011 para.6.5 IEC60092-353:2011 para.6.5 IEC60092-353:2011 para.6.7
2.3	Hot set test (HEPR, EPR, XLPE, HF 90, S 95 insulations and SE1, SHF2 sheaths)	IEC60092-351:2004 Table 4 IEC60092-359:1999 Table II	IEC60092-350:2008 para.6.8
2.4	Behaviour at low temperatures (ST2, SHF1 and SHF2 sheaths)	IEC60092-359:1999 Table III	IEC60092-350:2008 para.8.8
2.5	Electrostatic screen (Screened Cables)	IEC60092-376:2003 para.12	IEC60092-350:2008 para.4.8.2
2.6	Coverage density of braid (Braid armoured Cables)	IEC60092-376:2003 para.15	IEC60092-350:2008 para.4.8.2

Note: Routine tests are to be carried out in the full length for delivery. For frequency of special tests and number of samples, see paragraph 6.2 of IEC60092-350:2008 for detail.

CHAPTER 2 CIRCUIT-BREAKERS

2.1 Application

2.1.1 This Chapter applies to shipborne low-voltage air circuit-breakers operated at AC 50 Hz (or 60 Hz) for rated voltages up to 1 kV (herein after called as "circuit-breakers").

2.1.2 The Chapter is applicable to frame circuit-breakers and molded case circuit-breakers.

2.1.3 DC circuit-breakers may be referred to in this Chapter and related standards.

2.2 Utilization category

2.2.1 Category A (nonselective): Circuit-breakers not specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e without an intentional short-time delay provided for selectivity under short-circuit conditions. Such circuit-breakers are not required to have a short-time withstand current rating.

2.2.2 Category B (selective): Circuit-breakers specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. with an intentional short-time delay (which may be adjustable), provided for selectivity under short-circuit conditions. Such circuit-breakers are required to have rated short-time withstand current, characteristic of long-time, short-time and instantaneous protections as selective protection.

2.3 Basis for approval and inspection

2.3.1 The basis for approval and inspection of circuit breakers:

(1) CCS Rules for Classification of Sea-going Steel Ships (hereinafter referred as "Rules");

(2) IEC60947-1: 2004-03 Low-voltage switchgear and control gear - Part 1: General rules;

(3) IEC60947-2: 2006-05 Low-voltage switchgear and control gear - Part 2: Circuit-breakers.

2.4 Definitions

2.4.1 For the purpose of this Chapter:

(1) Circuit-breaker is a mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal conditions such as those of short circuit.

(2) Air circuit-breaker is a circuit-breaker in which the contacts open and close in air at the atmospheric pressure.

(3) Molded case circuit-breaker is a circuit-breaker having a supporting housing of molded insulating material forming an integral part of the circuit-breaker.

(4) Plug-in circuit-breaker is a circuit-breaker which, in addition to its interrupting contacts, has a set of contacts which enable the circuit-breaker to be removed.

(5) Withdrawable circuit-breaker is a circuit-breaker which, in addition to its interrupting contacts, has a set of isolating contacts which enable the circuit-breaker to be disconnected from the main circuit, in the withdrawn position, to achieve an isolating distance in accordance with specified requirements.

(6) Rated operational voltage ("Ue") is the voltage which together with rated operating current determines the purpose of a circuit-breaker, depending on appropriate test and utilization category.

(7) Rated current ("In") is specified in the standard of the product, taking into account rated voltage, rated frequency, rated duty, utilization category and type of enclosure protection (if any).

(8) Short-circuit breaking (or making) capacity is a breaking (or making) capacity for which the prescribed conditions include a short circuit.

(9) The rated ultimate short-circuit breaking capacity ("Icu") of a circuit-breaker is the value of ultimate short-circuit breaking capacity (see 2.15.1) assigned to that circuit-breaker by the manufacturer for the corresponding rated operational voltage, under the specified conditions. It is expressed as the value of the prospective breaking current, in kA (r.m.s. value of the a.c. component in the case of a.c.).

(10) The rated service short-circuit breaking capacity ("Ics") of a circuit-breaker is the value of service short-circuit breaking capacity assigned to that circuit-breaker by the manufacturer for the corresponding rated operational voltage, under the specified conditions. It is expressed as a value of prospective breaking current, in kA, corresponding to one of the specified percentages of the rated ultimate short-circuit breaking capacity and rounded up to the nearest whole number. It may be expressed as a % of Icu (for example Ics = 25 % Icu).

(11) Rated short-time withstand current ("Icw") is the current that a circuit or a circuit-breaker in the closed position can carry during a specified short time under prescribed conditions of use and behavior (the minimum rated short-time withstand current is specified in IEC 600947-2).

(12) Verification and verification test: The term "verification" referred to in this Chapter is to be interpreted as "test for the verification" and has been used where it is intended to verify the condition of the circuit-breaker following an earlier test in a test sequence whereby it may have been adversely affected. Satisfactory verification of a test item means completion of the item.

2.5 Plans and documents

2.5.1 The following plans and documents are to be submitted to CCS for approval:

(1) Drawing of general assembly;

(2) Electrical schematic diagram;

(3) Drawings of electrical wiring;

(4) Technical specifications;

(5) Type test programme.

2.5.2 The following plans and documents are to be submitted to CCS for information:

(1) Nameplates and marks;

(2) Detailed list of main components and parts and materials;

(3) Drawing of main components and parts (including contacts, arc-quenching chamber and operated mechanism etc.);

(4) Operation instructions for the products;

(5) Production process flow chart.

2.5.3 The plans and documents are also to comply with related requirements as specified in PART ONE of the Guidelines.

2.6 Selection of typical samples

2.6.1 Each test sequence is to be carried out on one (or one group of) new and clean circuit-breaker(s).

2.6.2 The number and test conditions of samples for each test sequence are listed according to parameters of the circuit-breaker in Table 2.6.2.

Number of Samples for Test **Table 2.6.2**

Test sequence	Terminals marked line/load		Sample quantity	Sample no.	Current setting 1)		Test voltage	Test current		Verification of temperature rise	Remark
	Yes	No			Min.	Max.		Corresponding	Max.		
I	×	×	1	1		×	Max. Ue	×		×	8), 9), 10)
II (Ics) and combined	×		2	1		×	Ue	×		×	8), 9),
				2	×		Ue	×			10), 2)
		×	3	1		×	Ue	×		×	8), 9),
				2	×		Ue	×			10), 2)
				3		×	Ue	×		×	3), 10)
III (Icu)	×		2	1		×	Ue	×			8), 9),
				2	×		Ue	×			10), 2), 4)
	×	×	3	1		×	Ue	×			8),
				2	×		Ue	×			2),
				3		×	Ue	×			3)
IV (Icw)	As for test sequence III										5)

Notes:

1) Min means the minimum In of a given frame size;. in the case of adjustable overload releases, it means the minimum setting of the minimum In. Max. means the maximum In of a given frame size.
2) For a circuit-breaker having a single non-adjustable current setting for a given frame size and for a circuit-breaker provided only with a shunt release (i.e. without an integral overcurrent release), the sample is omitted.
3) Connections reversed.
4) Connections revered wiring, if terminals unmarked.
5) Applicable to Category A and Category B circuit-breakers.
6) To be agreed between test station and manufacturer.
7) For terminals unmarked, an additional sample is to be tested with connections reversed.
8) In the case of one or more construction breaks within the frame size, a further sample is tested at the maximum rated current corresponding to each construction, under the conditions applicable to sample 1.
9) The requirements of note 8) apply to the combined test sequence only.
10) For circuit-breakers where the value In differs through external current-carrying parts (i.e. interchangeable terminals or draw-out cradle connections), the minimum and maximum ratings of this construction is to be subjected to the full sequence. At the end of the sequence, the maximum rating sample is then to be adapted to perform a verification of temperature rise on each variation of external current-carrying parts.

2.7 Design and technical requirements

2.7.1 Operating conditions of shipboard circuit-breakers are to comply with the requirements in Section 2, Chapter 1, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships.

2.7.2 Design and construction of shipboard circuit-breakers (including air clearance and creepage distance, insulating materials, conducting materials, earthing and protective enclosure, etc.) are to comply with IEC publication 60947-2 and Section 3, Chapter 1, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships.

(1) Shipboard circuit-breakers are to be trip-free so that they can be freely released at any position during switching-on. Each circuit-breaker is to be so arranged that it will not close the circuit by any inadvertent movement at the OFF position.

(2) The frame, skeleton and fixed components of the metallic enclosure of shipboard frame circuit-breakers are to be electrically connected to each other, to earthed terminals and reliably earthed.

2.7.3 Technical and performance requirements

(1) Protective properties of circuit-breakers are to comply with the requirements in Section 5, Chapter 2, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships.

(2) Power-operated closing is to comply with the following requirements:

① The power-operated closing mechanism is to be capable of securing the closing of the circuit-breaker in any condition between no-load and its rated making capacity, when the supply voltage, measured during the closing operation, remains between 85% and 110% of the rated control supply;

② At 110% of the rated control supply voltage, the closing operation performed on no-load is not to cause any damage to the circuit-breaker.

(3) Stored energy closing is to comply with the following requirements:

① When the stored energy is retained within the circuit-breaker, a device must be provided which indicates when the storing mechanism is fully charged;

② Means for charging the operating mechanism are to be capable of operating when the auxiliary supply voltage is between 85% and 110% of the rated control supply voltage;

③ When the energy storing mechanism is manually operated, the direction of operation is to be indicated.

(4) Opening is to comply with the following requirements:

① Circuit-breakers which open automatically are to be trip-free (i.e. capable of being released automatically at any operating position);

② A shunt release for opening is to cause tripping under all operation conditions of the circuit-breaker when the supply voltage of the shunt release measured during the tripping operation remains between 70% and 110% of the rated control supply voltage;

③ Opening by under-voltage releases:

(a) Performance not related to frequency

The operating performance of an under-voltage release is to remain effective in case of substantial reduction of power supply frequency and release the circuit-breaker easily;

(b) Operating voltage

An under-voltage release is to operate a delayed or instantaneous opening of the circuit-breaker on a falling supply voltage within the range between 70% and 35% of the rated voltage. The under-voltage release is to prevent the closing of the circuit-breaker when the supply voltage is below 35% of the rated voltage of the release, and it is to permit the closing of the circuit-breaker at supply voltages equal to or above 85% of its rated value.. Unless otherwise stated in the relevant product standard, the upper limit of the supply voltage is to be 110% of its rated value.

2.8 Type test

2.8.1 Type tests are grouped in a number of sequences and one circuit-breaker is to be used for each sequence.

2.8.2 The items, technical requirements and test methods for test sequences are given in Table 2.8.2.

Summary of Type Test **Table 2.8.2**

No.	Test item	Technical requirement	Test method
1	Construction examination	IEC 60947-2:2006 para. 8.2	IEC 60947-2:2006 para. 8.2
2	Dielectric test	IEC 60947-2:2006 para. 8.4.5	IEC 60947-2:2006 para. 8.4.5
3	Tripping limits and characteristics	IEC 60947-2:2006 para. 7.2.1.2.4	IEC60947-2:2006 para. 8.3.3.1
4	Mechanical operation and operational performance capability	IEC 60947-2:2006, 7.2.4.2, Table 8	IEC 60947-2:2006 para.8.3.3.3
5	Overload performance (if applicable)	IEC 60947-2:2006 para. 7.2.4.1	IEC 60947-2:2006 para. 8.3.3.4
6	Rated service short-circuit breaking capacity	IEC 60947-2:2006 para. 8.3.4.1	IEC 60947-2:2006 para. 8.3.4.1
7	Rated ultimate short-circuit breaking capacity	IEC 60947-2:2006 para. 8.3.5.2	IEC 60947-2:2006 para., 8.3.5.2
8	Rated short-time withstand current	IEC 60947-2:2006 para. 8.3.6.2	IEC 60947-2:2006 para. 8.3.6.2
9	Combined sequence test: Rated short-time withstand current	IEC 60947-2:2006 para. 8.3.8.2	IEC 60947-2:2006 para. 8.3.8.2
10	Combined sequence test: Rated service short-circuit breaking (delay) capacity	IEC 60947-2:2006 para. 8.3.8.3	IEC 60947-2:2006 para. 8.3.8.3
11	Damp heat test (55℃)	CCS GD01 – 2006, 2.10	CCS GD01 – 2006, 2.10
12	Tripping limits and characteristics in inclination conditions	CCS GD01 – 2006, 2.6	CCS GD01 – 2006, 2.6
13	Vibration test	CCS GD01 – 2006, 2.7	CCS GD01 – 2006, 2.7
14	Flame-retardant test*	CCS GD01 – 2006, 2.16	CCS GD01 – 2006, 2.16
15	Power supply variation test	CCS GD01 – 2006, 2.4	CCS GD01 – 2006, 2.4
16	Electromagnetic compatibility test	CCS GD01 – 2006, Chapter 3	CCS GD01 – 2006, Chapter 3

* The test item may be omitted if the manufacturer of plastic materials can prove the compliance with the requirements of GD01 – 2006 (CCS Guidelines for Type Approval Test of Electric and Electronic Products (2006)).

2.9 Unit/batch inspection

2.9.1 The number of products to be inspected is to be 10% of the total number of submitted circuit-breakers. In case of 2 circuit-breakers or less, a full inspection is to be carried out.

2.9.2 The inspection is to include:

(1) General examination and construction examination (IEC 60947-2:2006, 8.2);

(2) Examination of operating characteristics (IEC 60947-2:2006, 8.4.1 and 8.4.3);

(3) Characteristics of over-current release (IEC 60947-2:2006, 8.4.2), (as per the delivery order or technical documents);

(4) Dielectric test (IEC 60947-2:2006, 8.4.5).

CCS

PART THIRTEEN FIREPROOF STRUCTURE AND EQUIPMENT

CHAPTER 1 FIRE DECKS AND BULKHEADS

1.1 Application

1.1.1 This Chapter applies to the approval and inspection of fire decks and bulkheads of the following specifications, which are installed and applied onboard ships and offshore installations:

(1) A-60, A-30, A-15, A-0 of A class decks;

(2) A-60, A-30, A-15, A-0 of A class bulkheads;

(3) B-15, B-0 of B class bulkheads (including linings);

(4) H-120, H-60, H-30, H-0 of H class decks;

(5) H-120, H-60, H-30, H-0 of H class bulkheads;

(6) B-15, B-0 of B class ceilings.

1.2 Basis for approval and inspection

1.2.1 The approval and inspection of fire decks and bulkheads are to be based on the following documents and their subsequent amendments:

(1) Regulation 3, Chapter II-2 of the International Convention for the Safety of Life at Sea, 1974 (1974 SOLAS Convention) and the amendments thereof;

(2) IMO Resolution MSC.307(88) – the International Code for Application of Fire Test Procedures, 2010 (IMO 2010 FTP Code);

(3) Chapter 1, PART SEVEN of CCS Rules for the Construction and Classification of Mobile Offshore Units;

(4) ISO/TR 834-3:1994 “Fire-resisting Tests – Elements of Building Construction – Part 3: Commentary on Test Method and Test Data Application”.

1.3 Definition and classification

1.3.1 Definitions

(1) “A” class divisions are those divisions composed by bulkheads and decks which comply with the following criteria:

① they are constructed of steel or other equivalent material;

② they are suitably stiffened;

③ they are insulated with approved non-combustible materials such that the average temperature of the unexposed surface will not rise more than 140℃ above the initial temperature, nor will the temperature, at any one point, including any joint, rise more than 180℃ above the initial temperature within the period of time listed below:

Class "A-60" 60 min

Class "A-30" 30 min

Class "A-15" 15 min

Class "A-0" 0 min;

④ they are so constructed as to be capable of preventing the passage of smoke and flame to the end of the one-hour standard fire test; and

⑤ the Administration required a test of a prototype bulkhead or deck in accordance with the FTP Code to ensure that it meets the above requirements for integrity and temperature rise.

(2) "B" class divisions are those divisions composed by bulkheads, decks, ceilings or linings which comply with the following criteria:

① they are constructed of approved non-combustible materials and all materials used in the construction and erection of "B" class divisions are non-combustible, with the exception that combustible veneers may be permitted provided their low flame spread characteristics comply with Part 5 of IMO 2010 FTP Code, their smoke and toxicity comply with Part 2 of IMO 2010 FTP Code or Annex 2 of IMO 2010 FTP Code and their gross calorific value complies with ISO 1716:2010 or Annex 2 of IMO 2010 FTP Code;

② they have an insulation value such that the average temperature of the unexposed surface will not rise more than 140℃ above the initial temperature, nor will the temperature, at any one point, including any joint, rise more than 225℃ above the initial temperature, within the period of time listed below:

Class "B-15" 15 min

Class "B-0" 0 min;

③ they are so constructed as to be capable of preventing the passage of flame to the end of the first half hour of the standard fire test; and

④ the Administration required a test of a prototype division in accordance with the FTP Code to ensure that it meets the above requirements for integrity and temperature rise.

(3) "H" class divisions are those divisions composed by bulkheads and decks which comply with the following criteria:

① they are constructed of steel or other equivalent material;

② they are suitably stiffened;

③ they are insulated with approved non-combustible materials such that the average temperature of the unexposed surface will not rise more than 140℃ above the initial temperature, nor will the temperature, at any one point, including any joint, rise more than 180℃ above the initial temperature, within the period of time listed below:

Class "H-120"	120 min
Class "H-60"	60 min
Class "H-30"	30 min
Class "H-0"	0 min;

④ they are so constructed as to be capable of preventing the passage of flame to the end of the two-hour standard fire test; and

⑤ the Administration required a test of a prototype bulkhead or deck in accordance with ISO/TR 834-3 and Part 3 of IMO 2010 FTP Code to ensure that it meets the above requirements for integrity and temperature rise.

(4) The FTP Code is the International Code for Application of Fire Test Procedures defined in Chapter II-2 of 1974 SOLAS Convention, as amended, i.e., the International Code for Application of Fire Test Procedures, 2010 (IMO 2010 FTP Code) adopted by Resolution MSC.307(88) by the Maritime Safety Commission of the International Maritime Organization.

(5) Non-combustible material is a material which neither burns nor gives off flammable vapours in sufficient quantity for self-ignition when heated to approximately 750℃, this being determined in accordance with the FTP Code.

(6) Steel or other equivalent material means any non-combustible material which, by itself or due to insulation provided, has structural and integrity properties equivalent to steel at the end of the applicable exposure to the standard fire test (e.g., aluminium alloy with appropriate insulation).

(7) A standard fire test for A, B and F class divisions is a test in which specimens of the relevant bulkheads or decks are exposed in a test furnace to temperatures corresponding approximately to the standard time-temperature curve in accordance with the test method specified in the FTP Code. The standard time-temperature curve is to be obtained by the following time-temperature relationship:

$$T = 345 \log_{10}(8t + 1) + 20$$

Where: T - the average furnace temperature, in℃;

t - the time, in min.

(8) A standard fire test for H class divisions is a test in which specimens of the relevant bulkheads or decks are exposed in a test furnace to temperatures corresponding approximately to the standard time-temperature curve in accordance with the test method specified in ISO/TR834-3 and the FTP Code. The standard test furnace temperature curve is to be obtained by the following time-temperature relationship:

$$T = 1100\ (1 - 0.325e^{-0.1667t} - 0.204e^{-1.417t} - 0.471e^{-15.833t})$$

Where: T - the average furnace temperature, in℃;

t - the time, in min;

e - the constant (2.71828).

According to the above relationship, the temperature in the furnace at different times is determined as follows (The real temperature is 20℃ higher than the calculated temperature):

Time *t*, in min	Furnace temperature *T* , in degrees (℃)
3	880
5	945
10	1033
15	1071
30	1098
60	1100
120	1100
360	1100

(9) Divisions mean decks and bulkheads.

(10) Fire divisions are fire decks and bulkheads.

1.3.2 Classification

(1) On the basis of different fire class, fire decks are classified as A class decks, including A-60, A-30, A-15, A-0, and H class decks, including H-120, H-60, H-30, H-0.

(2) On the basis of different fire class, fire bulkheads are classified as A class bulkheads, including A-60, A-30, A-15, A-0 bulkheads, B class bulkheads, includingB-15, B-0 of bulkheads, B-15, B-0 of linings and B-15, B-0 of ceilings, and H class bulkheads, including H-120, H-60, H-30, H-0.

1.4 Design technical requirements

1.4.1 A class fire divisions (bulkheads and decks) are to comply with the relevant requirements in 1.2.1(1) and (2) in terms of structural design, integrity and insulation.

1.4.2 B class fire divisions (bulkheads, linings and ceilings) are to comply with the relevant requirements in 1.2.1(1) and (2) in terms of structural design, integrity and insulation.

1.4.3 H class fire divisions (bulkheads and decks) are to comply with the relevant requirements in 1.2.1(2), (3) and (4) in terms of structural design, integrity and insulation.

1.4.4 The main raw materials of fire-resisting structures are to meet the following requirements:

(1) Insulation materials (such as ceramic fiber, rock wool, fireproof deck covering, calcium silicate board and inorganic fireproof board): The non-combustibility is to comply with Part 1 of IMO 2010 FTP Code.

(2) Adhesives used in B class divisions: The low flame spread characteristics are to comply with Part 5 of IMO 2010 FTP Code.

(3) PVC films and veneers used in B class divisions: low flame spread characteristics are to comply with Part 5 of IMO 2010 FTP Code, smoke and toxicity are to comply with Part 2 of IMO 2010 FTP Code or Annex 2 of IMO 2010 FTP Code, and gross calorific value is to comply with the relevant requirements of ISO 1716:2010 or Annex 2 of IMO 2010 FTP Code.

(4) Non-metallic materials used for fire divisions are to be free of asbestos.

1.5 Plans and documents

1.5.1 The following plans and documents are to be submitted to CCS for approval:

(1) Structural drawings of products;

(2) Drawings of installation of fire test specimens (containing arrangement of temperature-measuring thermocouples on the unexposed surface);

(3) Type test program;

(4) List of qualified suppliers of main raw materials/components and parts;

(5) Product installation specifications.

1.6 Type test

1.6.1 Selection of typical samples

1.6.1.1 Sampling of insulation materials of fire divisions and sealing of samples

(1) Sampling of insulation material: For fibrous material, generally three pieces of such products in appropriate size are to be taken, and for bulk deck covering, test sample is to be made in a specified mould so as to verify the compliance of type, model and/or specification (density and thickness); additional pieces of about 10 m^2 (or more, as appropriate) are to be taken from the same batch of material as sample in type test (standard fire test) Such samples are to be marked and sealed.

(2) Where insulation material has not been approved by CCS, CCS surveyor is required to witness the preparation of non-combustible samples in accordance with the requirements in Part 1 of IMO 2010 FTP Code, and a non-combustible test is to be carried out by an entrusted organization which is recognized by CCS (laboratory is to establish the Quality Control System and be subject to audit and approval according to ISO/IEC 17025). Where insulation material has been approved by CCS, it is to check the term of validity for non-combustibility test report (24 months) or the valid approval certificate issued by CCS.

1.6.1.2 Preparation of standard fire test samples

(1) Appropriate standard fire test samples are to be prepared at a test organization recognized by CCS (laboratory is to establish the Quality Control System and be subjected to audit and approval according to ISO/IEC 17025) in accordance with the relevant requirements in Part 3 of IMO 2010 FTP Code,

(2) Where samples are to be made at the applicant or any other locations, CCS Surveyor is to witness the main process on site to ensure compliance with the drawings.

1.6.1.3 Maintenance of test samples

(1) The maintenance of test samples is to comply with the test standards for related items.

1.6.2 Standard fire test drawings

(1) Structure of products and installation of fire test specimens (containing arrangement of temperature-measuring thermocouples on the unexposed surface) are to be submitted.

(2) The CCS branch or office carrying out the approval is to send the examined standard fire test program and the drawings mentioned in (1) above, together with CCS "Product Test Notice" to the test organization recognized by CCS to carry out the standard fire test (laboratory is to establish the Quality Control System and be subjected to audit and approval according to ISO/IEC 17025).

1.6.3 Type test items

(1) The type test items and requirements are given in Table 1.6.3(1).

Table 1.6.3(1)

Product name		Item	Technical requirements	Test method
A class bulkhead A class deck	A-0	Integrity	60 min	Testing is not required (when Annex 2 of IMO 2010 FTP Code is complied with)
	A-15	Insulation	15 min	Part 3 of IMO 2010 FTP Code
		Integrity	60 min	
	A-30	Insulation	30 min	
		Integrity	60 min	
	A-60	Insulation	60 min	
		Integrity	60 min	
H class bulkhead H class deck	H-0	Integrity	120 min	ISO/TR834-3 Part 3 of IMO 2010 FTP Code
	H-30	Insulation	30 min	
		Integrity	120 min	
	H-60	Insulation	60 min	
		Integrity	120 min	
	H-120	Insulation	120 min	
		Integrity	120 min	
B class bulkhead	B-0	Integrity	30 min	Part 3 of IMO 2010 FTP Code
	B-15	Insulation	15 min	
		Integrity	30 min	
B class lining	B-0	Integrity	30 min	
	B-15	Insulation	15 min	
		Integrity	30 min	
B class ceiling	B-0	Integrity	30 min	
	B-15	Insulation	15 min	
		Integrity	30 min	

(2) The insulation is to comply with the temperature rise limits for unexposed surface of corresponding fire class specified in Part 3 of IMO 2010 FTP Code or CCS Rules for the Construction and Classification of Mobile Offshore Units, i.e.:

① A class divisions: During the period from test commencement to test end determined for corresponding fire class, the average temperature rise of thermocouples fitted as required on unexposed surface is not to be more than 140 ℃ and the highest temperature rise of any of such thermocouples fitted as required on unexposed surface is not to be more than 180℃ ;

② B class divisions: During the period from test commencement to test end determined for corresponding fire class, the average temperature rise of thermocouples fitted as required on unexposed surface is not to be more than 140℃ and the highest temperature of any of such thermocouples fitted as required on unexposed surface is not to be more than 225℃ ;

③ H Class divisions: During the period from test commencement to test end determined for corresponding fire class, the average temperature rise of thermocouples fitted as required on unexposed surface is not to be more than 140 ℃ and the highest temperature rise of any of such thermocouples fitted as required on unexposed surface is not to be more than 180℃ ;

④ For A class divisions, where the structural core is made of aluminum alloy, the average temperature of the five thermocouples fitted respectively as required on the unexposed surface of the center of the specimen and the center of each of the four quarters is not to rise more than 200 ℃ above the initial temperature during the periods specified for corresponding fire class.

(3) Integrity (preventing the passage of smoke and flame): The requirements for corresponding fire class in Part 3 of IMO 2010 FTP Code or CCS Rules for the Construction and Classification of Mobile Offshore Units are to be complied with, i.e. 60 min of test duration for A class divisions, 30 min of test duration for B class divisions, and 120 min of test duration for H class divisions.

① Flame: No flame is to occur on the unexposed surface;

② Cotton wool pads: Required pads are to be used and are not to be ignited, i.e. flame or flameless combustion occurs;

③ Gap gauges: Gap gauges are to be of a required size. The 6 mm gauge is not to be capable of penetrating specimen to enter furnace and moving about 150 mm along the opening or crack; or 25 mm gauge is not to be capable of penetrating specimen to enter furnace..

(4) B class continuous ceilings and linings: to be in compliance with the requirements in Part 3 of IMO 2010 FTP Code (Appendix 4).

(5) B class bulkheads, linings and ceilings (composite rock wool/metal honeycomb panels/calcium silicate/inorganic fire boards, etc.) are to comply with the manufacturer's technical standards in terms of appearance, size, geometric tolerance, resistance to impact/other physical properties.

(6) Where necessary, samples of insulation and other non-metallic materials may be taken, sealed and sent to a test organization recognized by CCS to carry out asbestos free test or approval.

1.6.4 Test report

(1) The non-combustibility test report for insulation materials is to comply with the requirements in Part 1 of IMO 2010 FTP Code. The term of validity of non-combustibility test report for insulation materials of A, B and H class decks and bulkheads is not to be beyond 24 months before the date of the fire test of decks and bulkheads, or valid CCS certificates for insulation materials are to be furnished with.

(2) The standard fire test report for fire divisions is to comply with Part 3 of IMO 2010 FTP Code or ISO/TR834-3 & Part 3 of IMO 2010 FTP Code.

(3) Adhesive used in B class divisions: The test report of low flame spread characteristics are to comply with Part 5 of IMO 2010 FTP Code.

(4) PVC films and veneers used in B class divisions: low flame spread characteristics are to comply with Part 5 of IMO 2010 FTP Code, smoke and toxicity are to comply with Part 2 of IMO 2010 FTP Code or Annex 2 of IMO 2010 FTP Code, and gross calorific value is to comply with ISO 1716:2010 or Annex 2 of IMO 2010 FTP Code.

(5) Test reports for application are not to be more than 5 years old. If the approval depends on several test reports with different dates, the date of the oldest report governs. However, a type approval certificate may be renewed without retesting provided that the test report is not more than 15 years old and that no alternation of components or construction has been made to the product.

(6) Prior to 1 July 2013, fire tests may still be carried out in accordance with the older edition of FTP Code (1996 FTP Code). The term of validity for test reports is not to exceed 15 years.

1.7 Unit/batch inspection

1.7.1 Approved A class and H class bulkheads/decks: According to Chapter 3, PART ONE of CCS Rules for Classification of Sea-Going Steel Ships, A class and H class bulkheads/decks after approval will not be inspected by CCS. However, CCS unit/batch inspection is to be requested for insulation materials (non-combustible materials) used in bulkheads/decks according to other relevant CCS requirements (such as relevant shipbuilding industry standards or appropriate standards determined in the approval), and such materials used on board are to be furnished with product certification/ equivalent documentation to verify and ensure the consistence between the actually applied insulation materials (density and thickness) as well as the installation method and the approved structure.

1.7.2 The unit/batch inspection scope of the approved B class bulkheads, linings and ceilings is as follows:

1.7.2.1 Sampling: A batch is to be of the same model and the same thickness specified for the same purchase order. Three pieces are to be taken for each type of bulkheads, linings and ceilings in each batch for visual examination and inspection of size and geometric tolerance, covering most of the specifications; for calcium silicate boards/inorganic fire boards, additional samples with physical properties of routine delivery inspection are to be kept by the manufacturer for on-site inspection by CCS Surveyor.

1.7.2.2 Inspection requirements

(1) Composite rock wool panels/metal honeycomb panels

① Plastic-covered steel plates: confirming the quality certificate for PVC films, compliance with requirements of Parts 2 and 5 of IMO 2010 FTP Code for low flame spread, smoke, toxicity and gross calorific value, furnished with CCS certification or test reports, as well as compliance of steel plate brand and thickness with the approval requirements, furnished with the quality certificate of the manufacturer.

② Insulation materials (core material): such materials are to be non-combustible materials approved by CCS and in compliance with Part 1 of IMO 2010 FTP Code, of which the model, density/size are to comply with the requirements of approved drawings and be kept consistent with the approval, furnished with CCS certification.

③ Adhesives: confirming the quality documentation at receiving deliveries and compliance with the low flame spread characteristics required in Part 5 of IMO 2010 FTP Code, furnished with CCS certification.

④ Product performance: visual examination, size (length, width and thickness) and geometric tolerance are to be in compliance with the approval requirements.

(2) Calcium silicate boards/inorganic fire boards

① Finish materials (veneers): such materials are to be in compliance with requirements of Parts 2 and 5 of IMO 2010 FTP Code for low flame spread, smoke, toxicity and gross calorific value, furnished with CCS certification.

② Product performance: appearance, size (length, width and thickness), geometric tolerance, density and rupture strength are to be in compliance with the requirements for approval.

(3) Products are to comply with the asbestos free requirement and provide asbestos free statement or approval certificate.

CHAPTER 2 FIRE DOORS

2.1 Application

2.1.1 This Chapter applies to the doors fitted in compartments and passages of ships and offshore installations according to the requirements for "A", "B" and "H" class fire divisions.

2.1.2 The types of fire doors are as follows: single leaf fire doors, double leaf fire doors, sliding fire doors (i.e. fire sliding doors), lift fire doors, shutter fire doors, etc.

2.2 Basis for approval and inspection

2.2.1 The approval and inspection of fire doors are to be based on the following documents and their subsequent amendments:

(1) Regulations 3 and 9, Chapter II-2 of International Convention for the Safety of Life at Sea, 1974 and the amendments thereof;

(2) IMO Resolution MSC.307(88)-the International Code for Application of Fire Test Procedures, 2010 (IMO 2010 FTP Code);

(3) Chapter 1, PART SEVEN of CCS Rules for the Construction and Classification of Mobile Offshore Units;

(4) ISO/TR 834-3:1994 "Fire-resisting Tests – Elements of Building Construction – Part 3: Commentary on Test Method and Test Data Application".

2.3 Plans and technical documents

2.3.1 To apply for the type approval of fire doors, the following drawings and technical documents are to be submitted in triplicate to CCS for approval or information:

(1) General arrangement of fire door;

(2) Drawing of door leaves (including vent, escape hatch grating or hose opening, as appropriate);

(3) Drawing of door frame;

(4) Fire test arrangement (including thermocouples);

(5) Technical specifications of fire doors (for information);

(6) Type test program;

(7) List of qualified suppliers of major raw materials/components and parts;

(8) Product installation specifications;

(9) Nameplate.

2.4 Materials

2.4.1 The door leaves and frame are to be made of steel or other equivalent materials, and CCS approved core materials (i.e. insulation materials, e.g. non-combustible materials such as rock wool, ceramic fiber and calcium silicate boards), and relevant approval certificates are to be provided. Door locks, automatic closing devices (if necessary) are to be approved by CCS.

2.5 Design and technical requirements

2.5.1 A and B class fire doors are to comply with the relevant requirements in 2.2.1(1) and (2) of this Chapter in terms of structural design, integrity and insulation.

2.5.2 H class fire doors are to comply with the relevant requirements in 2.2.1(2), (3) and (4) of this Chapter in terms of structural design, integrity and insulation.

2.5.3 Major raw materials of fire doors are to comply with the following requirements:

(1) Insulation materials (non-combustible materials such as ceramic fiber, rock wool and calcium silicate boards): the non-combustibility is to comply with Part 1 of IMO 2010 FTP Code.

(2) Adhesives: the low flame spread characteristics are to comply with Part 5 of IMO 2010 FTP Code.

(3) Non-metallic materials used in fire doors are to be free of asbestos.

2.6 Type test

2.6.1 Selection of typical samples: The standard fire test may be carried out to the largest fire door (with the largest opening size) constructed on the basis of approved drawings. Other tests may be carried out at the manufacturer.

2.6.2 The type test items are given in Table 2.6.2.

Table 2.6.2

No.	Test item	Type test	Routine test
1	Review of material quality certificates	√	√
2	Size examination	√	√
3	Surface quality examination	√	√
4	Strength test	√	—
5	Opening and closing test	√	√
6	Standard fire test	√	—

2.6.3 Test methods and requirements

(1) Review of material quality certificates: Main raw materials of fire doors are to be furnished with: the manufacturer's quality certificate for steel plates, CCS products/approval certificates for insulation materials, CCS products/approval certificates for fire door locks and automatic closing devices (if necessary).

(2) Size examination: External size and gap measurements are to comply with the approved drawings.

(3) Surface quality examination: The surface of samples is to be smooth and free from burrs and cuts, and the paint is to be applied evenly without drainage, wrinkling, and breakdown (if painted).

(4) Strength test (except shutter doors, sliding doors and lift fire doors): The door is to be dropped freely for three times with door leaf being opened to an angle of 60°, and the tested door leaf and frame are to be structurally intact and undamaged.

(5) Opening and closing test (except shutter doors, sliding doors and lift fire doors): The vertically installed door is to be inclined to an angle of 3.5° in the direction opposite to the vertical one and then opened and closed for three times, with the door leaf being opened flexibly without abnormal noise and the bolt being easily inserted into the lock latch when closing the door.

(6) The standard fire test is to be carried out in accordance with the requirements in Part 3 of IMO 2010 FTP Code or ISO/TR 834-3 & Part 3 of IMO 2010 FTP Code.

① Integrity requirements:

(a) A class (including A-60, A-30, A-15, A-0) fire doors are to be subjected to the standard fire test for one hour, at the end of which the doors are to be intact and capable of preventing the passage of smoke and flame;

(b) B class (including B-15, B-0) fire doors are to be subjected to the standard fire test for half an hour, at the end of which the doors are to be intact and capable of preventing the passage of flame;

(c) H class (including H-120, H-60, H-30, H-0) fire doors are to be subjected to the standard fire test for two hours, at the end of which the doors are to be intact and capable of preventing the passage of smoke and flame.

② Insulation requirements:

(a) A-0, B-0, H-0 class fire doors are to comply with the integrity requirements only;

(b) A-60, A-30, A-15, H-120, H-60 and H-30 class fire doors are to be fitted with thermocouples on the unexposed surface according to 7.6.3 of Appendix 1 of Part 3 of IMO 2010 FTP Code during the standard fire test, and the average temperature will not rise more than 140℃ above the initial temperature, nor will the temperature, at any one point, including any joint, rise more than 180℃ above the initial temperature, whereas for B-15 class fire doors the temperature at any one point will not rise more than 225 ℃ above the initial temperature, within the test period corresponding to the appropriate degrees of fire resistance.

(7) The connection of the door frame to the bulkhead: in a test, the method of fixing the door frame to the bulkhead is to be as used in practice. If the method of fixing the door frame in a test is made by bolts, welding may also accepted as a method of fixing the door frame without further tests. Where intermittent welding is used, reliable methods are to be used to fill the welding gap with non-combustible materials or appropriate fire-retardant materials (e.g. fire-resisting sealant).

(8) Non-metallic materials used in products are to be free of asbestos and are to provide asbestos free statement or approval certificate.

2.6.4 Test report

(1) The non-combustibility test report for insulation materials is to comply with the requirements in Part 1 of IMO 2010 FTP Code. The term of validity of non-combustibility test report for insulation materials of A, B and H class fire doors is not to be beyond 24 months before the date of the insulation test, or valid CCS certificates for insulation materials are to be furnished with.

(2) The standard fire test report is to comply with Part 3 of IMO 2010 FTP Code or ISO/TR834-3 & Part 3 of IMO 2010 FTP Code.

(3) Test reports for application are not to be more than 5 years old. If the approval depends on several test reports with different dates, the date of the oldest report governs. However, a type approval certificate may be renewed without retesting provided that the test report is not more than 15 years old and that no alternation of components or construction has been made to the product.

(4) Prior to 1 July 2013, fire tests may still be carried out in accordance with the older edition of FTP Code (1996 FTP Code). The term of validity for test reports is not to exceed 15 years.

2.7 Unit/batch inspection

2.7.1 10% of fire doors for each type/specification are to be taken as test samples.

2.7.2 The unit/batch inspection of fire doors is to be carried out upon type approval. The inspection scope is shown in column “Routine test” of Table 2.6.2.

2.7.3 Products are to comply with the asbestos free requirement and provide asbestos free statement or approval certificate.

CHAPTER 3 FIRE WINDOWS

3.1 Application

3.1.1 This Chapter applies to the windows and side scuttles fitted in bulkheads of ships and offshore installations according to the requirements of "A" and "H" class fire divisions.

3.2 Basis for approval and inspection

3.2.1 The approval and inspection of fire windows are to be based on the following documents and their subsequent amendments:

(1) Regulations 3 and 9, Chapter II-2 of the International Convention for the Safety of Life at Sea, 1974 and the amendments thereof;

(2) IMO Resolution MSC.307(88) - the International Code for Application of Fire Test Procedures, 2010 (IMO 2010 FTP Code);

(3) Chapter 1, PART SEVEN of CCS Rules for the Construction and Classification of Mobile Offshore Units;

(4) ISO/TR 834-3:1994 "Fire-resisting Tests – Elements of Building Construction – Part 3: Commentary on Test Method and Test Data Application".

3.3 Plans and technical documents

3.3.1 To apply for the type approval of fire windows, the following drawings and technical documents are to be submitted in triplicate to CCS for approval:

(1) General arrangement of fire window;

(2) Drawing of main window frame;

(3) Drawings of sash frame and clamp batten (if any);

(4) Fireproof glass and toughened glass;

(5) Fire test arrangement (including thermocouples);

(6) Type test program;

(7) List of qualified suppliers of major raw materials/components and parts;

(8) Product installation specifications.

3.4 Materials

3.4.1 The window frame is to be made of approved steel or other equivalent materials, furnished with the quality certificate of the manufacturer; the insulation materials are to be of approved non-combustible materials like rock wool, ceramic fiber and calcium silicate boards; glass is to be fireproof or be made into fireproof glass unit by grouting the toughened glass with fire-resistant fluid, and relevant CCS products/approval certificates are to be provided.

3.5 Design technical requirements

3.5.1 A class fire windows are to comply with the relevant requirements in 3.2.1(1) and (2) of this Chapter in terms of structural design, integrity and insulation.

3.5.2 H class fire windows are to comply with the relevant requirements in 3.2.1(2), (3) and (4) of this Chapter in terms of structural design, integrity and insulation.

3.5.3 Major raw materials of fire windows are to comply with the following requirements:

(1) Insulation materials (non-combustible materials such as ceramic fiber, rock wool and calcium silicate boards): the non-combustibility is to comply with Part 1 of IMO 2010 FTP Code.

(2) Fireproof glass is to comply with the relevant national or international standards.

(3) Toughened glass is to comply with the relevant national or international standards.

(4) Non-metallic materials used in fire windows are to be free of asbestos.

3.6 Type test

3.6.1 Selection of typical samples: The standard fire test may be conducted on a window of the maximum size (with the largest pane size) and the type of the glass pane and/or the minimum thickness of the glass pane or panes and gaps (i.e. the minimum thickness and gap of each type of the glass), constructed on the basis of approved drawings.

3.6.2 The type test items are given in Table 3.6.2.

Table 3.6.2

No.	Test item		Type test	Routine test
1	Review of material quality certificates		√	√
2	Examination of external size and manufacturing tolerance		√	√
3	Surface quality examination		√	√
4	Tightness test	Hose test	√	√
		Hydraulic test	√	√
5	Standard fire test (Note: additional thermal radiation test is to be carried out for A-0 class windows)		√	—
6	Strength test		√	—

3.6.3 Test methods and requirements

(1) Review of material quality certificates: Main raw materials of fire windows are to be furnished with: the manufacturer's quality certificate for steel/copper/stainless steel, CCS products certificates for insulation materials and fireproof glass.

(2) Size examination: The external size is to comply with the approved drawings.

(3) Surface quality examination: The surface of samples is to be smooth and free from burrs and cracks, and the paint is to be applied evenly without drainage, wrinkling, and breakdown (if painted).

(4) Tightness test

① Hose test: The manufacturer is to carry out 100% hose test for the products to be delivered. No water trace is to be detected on the inspected areas after 3 to 5 min of test with a nozzle of not less than 12.5 mm in diameter, to a pressure not less than 250 KPa and from a distance not exceeding 1.5 m. In addition to the confirmation of the test report, CCS Surveyor will randomly take 10% of the tested windows as the samples for unit/batch hose test.

② Hydraulic test: 10% of the products are to be taken randomly for hydraulic test during unit/batch inspection. The test pressure is 25 KPa for rectangular fire windows, 150 KPa for A class fire side scuttles, 75 KPa for B class ones and 35 KPa for C class ones (all with glass being fitted and deadlight opened). No water trace is to be detected on the inspected areas after 1 min of test.

(5) The standard fire test is to be carried out in accordance with the relevant requirements in Part 3 of IMO 2010 FTP Code or ISO/TR834-3 & Part 3 of IMO 2010 FTP Code; the thermal radiation test for A-0 Class fire windows is to be carried out in accordance with the requirements in Part 3 of IMO 2010 FTP Code.

(6) Strength test: The window is to be placed on the test platform and a load (test pressure being 75 KPa for type E, 35 KPa for type F, 240 KPa for type A and 120 KPa for type B) applied on the batten of the window frame, and the glass is to be examined for integrity and damage and the frame for deformation when the load is removed after 5 min.

(7) Non-metallic materials used in products are to be free of asbestos and are to provide asbestos free statement or approval certificate.

3.6.4 Test report

(1) The non-combustibility test report for insulation materials is to comply with the requirements in Part 1 of IMO 2010 FTP Code. The term of validity of non-combustibility test report for insulation materials of A and H class fire windows is not to be beyond 24 months before the date of the insulation test, or valid CCS certificates for insulation materials are to be furnished with.

(2) The standard fire test report is to comply with Part 3 of IMO 2010 FTP Code or ISO/TR834-3 & Part 3 of IMO 2010 FTP Code.

(3) Test reports for application are not to be more than 5 years old. If the approval depends on several test reports with different dates, the date of the oldest report governs. However, a type approval certificate may be renewed without retesting provided that the test report is not more than 15 years old and that no alternation of components or construction has been made to the product.

(4) Prior to 1 July 2013, fire tests may still be carried out in accordance with the older edition of FTP Code (1996 FTP Code). The term of validity period of test reports is not to exceed 15 years.

3.7 Unit/batch inspection

3.7.1 The unit/batch inspection of fire windows is to be carried out upon type approval. The inspection scope is shown in column "Routine test" of Table 3.6.2.

3.7.2 The product certificate is to be issued to fire windows which are found to be in compliance with the relevant requirements upon inspection and test.

3.7.3 Products are to comply with the asbestos free requirement and provide asbestos free statement or approval certificate.

CCS

PART FOURTEEN FIRE-EXTINGUISHING APPLIANCES

CHAPTER 2 FIXED WATER-BASED LOCAL APPLICATION FIRE-EXTINGUISHING SYSTEM

2.1 Application

2.1.1 This Chapter applies to the fixed local application fire-extinguishing systems as required in Regulation II-2/10.5.6 of SOLAS.

2.1.2 Fixed local application fire-extinguishing systems applies to passenger ships of 500 gross tonnages and upwards, cargo ships of 2,000 gross tonnage and above and machinery spaces of category A with more than 500 m^3 in volume.

2.1.3 Fixed local application fire-extinguishing systems are to protect areas such as the following without the necessity of engine shutdown, personnel evacuation, or sealing of the spaces:

(1) the fire hazard portions of internal combustion machinery used for the ship's main propulsion and power generation;

(2) boiler fronts;

(3) the fire hazard portions of incinerators;

(4) heated fuel oil separators;

(5) oil fired inert gas generators; and

(6) oil heaters.

2.2 Basis for approval and inspection

2.2.1 Regulation II-2/10.5.6 of the International Convention for the Safety of Life at Sea, 1974 (1974 SOLAS Convention) and the amendments thereof.

2.2.2 Chapter 7 of the International Code for Fire Safety Systems.

2.2.3 MSC.1/Circ.1387 Revised Guidelines for the Approval of Fixed Water-based Local Application Fire-fighting Systems for Use in Category A Machinery Spaces.

2.3 Terms and definitions

2.3.1 This Chapter adopts the following terms and definitions as given in MSC.1/Circ.1387 and MSC/Circ.1082.

2.3.1.1 Fire suppression means a reduction in heat output from the fire and control of the fire to restrict its spread from its seat and reduce the flame area.

2.3.1.2 Protected space is a machinery space where a local application fire-fighting system is installed.

2.3.1.3 Protected area is an area (an installation or a part of installation) within a protected space which is required to be protected by the system.

2.3.1.4 The effective nozzle coverage is determined by the results of fire-extinguishing test.

.1 For a 3 × 3 nozzle grid, the fire-extinguishing test is to comply with the requirements in 3.3.2.1 to 3.3.2.3 of Appendix of MSC/Circ.1387. See Figure 1 for the effective nozzle coverage area.

.2 For a 3 × 3 or 2 × 2 nozzle grid, the fire-extinguishing test is to comply with the requirements in 3.3.2.3 to 3.3.2.5 of Appendix of MSC/Circ.1387. See Figure 2-1 or 2-2 for the effective nozzle coverage area.

.3 For a single row of nozzles, the fire-extinguishing test is to comply with the requirements in 3.3.2.1 to 3.3.2.3 of Appendix of MSC/Circ.1387. See Figure 3 for the effective nozzle coverage area.

.4 For a single row of nozzles, the fire-extinguishing test is to comply with the requirements in 3.3.2.3 to 3.3.2.5 of Appendix of MSC/Circ.1387. See Figure 4 for the effective nozzle coverage area.

.5 For individual nozzles, the effective nozzle coverage (width and length) is defined as 1/2 the maximum nozzle spacing. See Figure 5.

Note: the fuel spray nozzle locations shown in Figures 3 to 5 are shown for information only.

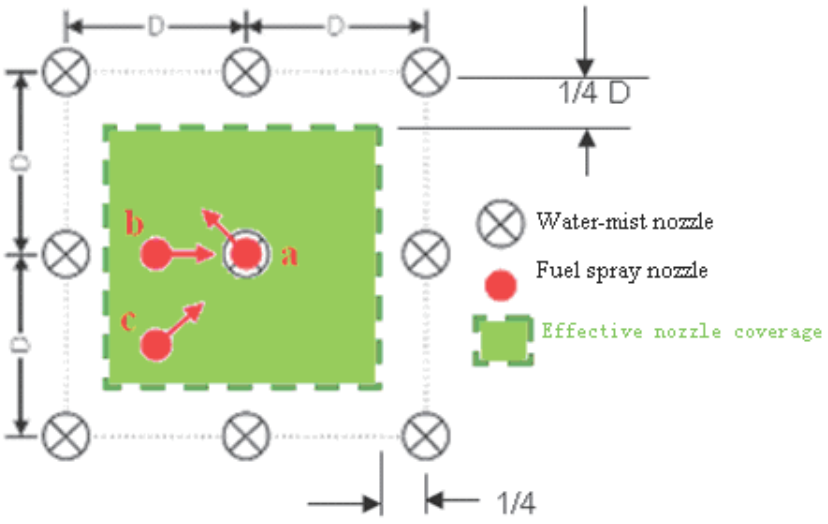


Figure 1

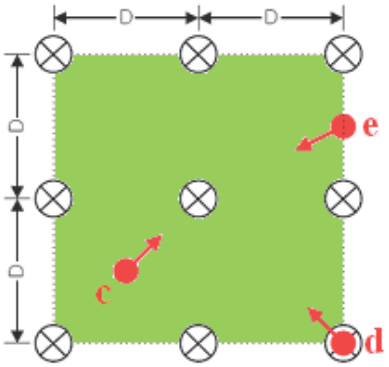


Figure 2-1

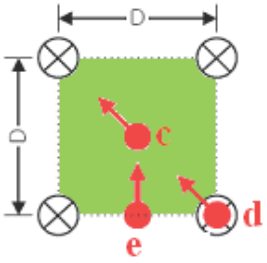


Figure 2-2

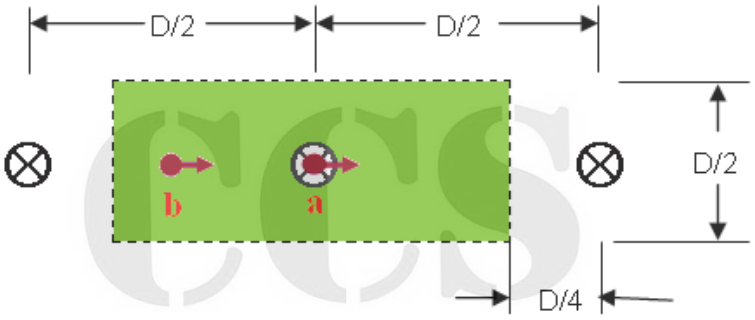


Figure 3

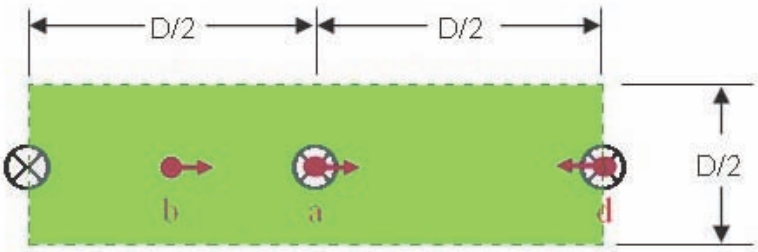


Figure 4

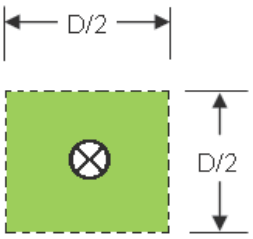


Figure 5

2.4 Plans and documents

2.4.1 The following documents are to be submitted to CCS for approval when applying for products approval:

(1) system design principles;

(2) specification of product primary performance;

(3) general assembly drawing;

(4) main components and parts;

(5) schematic diagram of the system;

(6) calculations;

(7) a list of physicochemical properties of main parts materials;

(8) technical specification of delivery and acceptance;

(9) the type test program.

2.4.2 The following documents are to be submitted to CCS for information when applying for products approval:

(1) product instruction;

(2) maintenance manual.

2.4.3 The applicant is to submit to CCS the following approved plans and technical documents when applying for products inspection by CCS:

(1) schematic diagram of the fixed water-based local application fire-extinguishing system;

(2) piping arrangement of full-scale ship, including nozzles arrangement, protection areas, release station and pump group;

(3) piping hydraulic calculations;

(4) arrangement of fire detection and fire alarm system.

2.5 Main components and parts

2.5.1 The following parts of fixed water-based local application fire-extinguishing system, where purchased, are to be furnished with CCS certificate:

(1) water-mist nozzle, selector valves, pressure switch;

(2) water pump and motor;

(3) electrical control box;

(4) fire detection and fire alarm system (fire detector, alarm controls, displays, etc.).

2.6 Design and technical requirements

2.6.1 Arrangement

2.6.1.1 Water-mist nozzles are to be vertically arranged. Where the installation with an inclination away from the vertical direction is adopted, the protected section is to be verified and defined by fire-extinguishing test. The joints used in piping system are to comply with the requirements provided in 2.5.3 “Mechanical Joints”, PART THREE of Rules for Classification of Sea-going Steel Ships.

2.6.1.2 The fire-extinguishing system operation controls are to be available at easily accessible positions both in and outside the spaces to be protected and are not to be liable to be cut off by a fire in the protected spaces.

2.6.1.3 Pressure source components of the system are to be located outside the protected area.

2.6.1.4 The identification of effective coverage within the protected areas:

(1) The length of effective coverage for diesel engines used for main propulsion and power generation is the distance between two cylinders at the top two ends of diesel engine. In case an exhaust gas turbine supercharger is fitted on one end, it is to be considered in the protected length. The width of the protected area is measured from the outer surface of the high-pressure oil pump to the outlet outer edge of the exhaust gas turbine supercharger. Where the fuel oil nozzle is arranged with an inclination from the vertical, the protected section are to cover to the direction of height, which indicates the distance from high-pressure oil pump outlet to the top of diesel engine cylinders. The arrangement for multi-engines is required for at least two sections.

(2) The effective coverage for boiler, incinerator and oil fired inert gas generator refers to the entire burner.

(3) The effective coverage for heated fuel oil separator refers to the entire oil separator but not necessarily including the heater.

2.6.2 Function

2.6.2.1 The system is to be capable of manual release.

2.6.2.2 The activation of the fire-fighting system is not to result in loss of electrical power or reduction of the maneuverability of the ship.

2.6.2.3 The system is to be available for immediate use and capable of continuously supplying water-based medium for at least 20 min in order to suppress or extinguish the fire and to prepare for the discharge of the main fixed fire-extinguishing system within that period of time.

2.6.2.4 The system is to be capable of fire suppression with forced ventilation fans running and supplying air to the protected area, or a method of automatically shutting air supply fans upon release of the system is to be provided to ensure that the fire-fighting medium is not dispersed.

2.6.2.5 The system and its components are to be suitably designed to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging and corrosion normally encountered in machinery spaces.

2.6.2.6 The electrical elements of the pressure source for the system are to have a minimum rating of IP× 4. Systems requiring an external power source need only be supplied by the main power source.

× means the characteristic numeral used to mark the degree of protection against access to hazardous parts and ingress of solid foreign objects, which could be 0 to 6.

2.6.2.7 The piping system is to be sized in accordance with a hydraulic calculation technique to ensure availability of flows and pressures required for correct performance of the system.

2.6.2.8 The water supply for local application systems may be fed from the supply to a water-based main fire-extinguishing system providing that adequate water quantity and pressure are available to operate both systems for the required period of time. Local application systems may form a section(s) of a water-based main fire-extinguishing system provided that all requirements of SOLAS regulation II-2/10, MSC/Circ.1387, and MSC/Circ.1165 and its amendments, as amended by MSC.1/Circ.1237 and MSC.1/Circ.1269 are met, and the systems are capable of being isolated from the main system.

2.6.2.9 The capacity and design of the system are to be based on the protected area demanding the greatest volume of water.

2.6.2.10 Components within the protected spaces are to be designed to withstand the elevated temperatures which could occur during a fire. Components are to be tested in accordance with the relevant sections of Appendix A of MSC/Circ.1165, as amended by MSC/Circ.1269.

2.6.2.11 A means for testing the operation of the system for assuring the required pressure and flow are to be provided.

2.6.2.12 A fitting is to be installed on the discharge piping of open head systems to permit blowing air through the system during testing to check for possible obstructions.

2.6.3 Fire detection and alarm

2.6.3.1 Activation of any local water-based fire-extinguishing system is to give a visual and distinct audible alarm in the protected space and at continuously manned stations. The alarm is to indicate the specific system activated.

2.6.3.2 Irrespective of the detection system of either conventional type (multi-wire system) or zone address coding type (main wire system), the detection system of the local water-based fire-extinguishing system are usually to be independent of the ship's fire detection and alarm system. In particular, special attention is to be paid to the system of conventional type that each area to be protected by local water-based fire-extinguishing system is to have an independent detection branch.

2.6.3.3 Where the detection system of zone address coding type complies with 2.1.4, Chapter 9 of International Code for Fire Safety Systems, the detection system of local water-based fire-extinguishing system will be allowed to share with the detection part of the ship's fire detection and alarm system, namely, the detector of "fire detection and alarm system" may replace that of "local water-based fire-extinguishing system", whose corresponding requirements, however, are to be compliable with by the detectors in terms of types and arrangements. In addition, such combination is not to impact the original functions of the ship's fire detection and alarm system and local water-based fire-extinguishing system. Any alarm released by the local water-based fire-extinguishing system is to be distinct from that of the ship's fire detection and alarm system.

2.6.3.4 Fire detectors are to be positioned adjacent to the protected areas. The detection system of any type to be used is to be functioned to identify fire in the protected areas and the detection units in one area are not to actuate the action of those in other areas.

2.6.3.5 In periodically unattended or unmanned machinery spaces of category A, the fixed pressure water-spraying and water mist fire-extinguishing system are to be able to automatically release and alarm in addition to manual release. To avoid false release, a combination of smoke detection and flame detection is recommended. The smoke detector is to give out alarm signal first when detecting smoke in the protected area to notify the crew to go on patrol as necessary. While the flame detector starts, the relief valves in the protected area will be released to discharge pressure water-spraying and to alarm. The manufacturer is to provide the instructions for detector performance, operation and arrangement.

2.6.4 Miscellaneous

2.6.4.1 Where automatic starting local water-based fire-extinguishing system is fitted, a notice indicating the medium type adopting and the possibility of automatic release is to be displayed at the entrance of the protected spaces.

2.6.4.2 Operating instructions for the system are to be displayed at each operating position. Spare parts and operating and maintenance instructions for the system are to be provided as recommended by the manufacturer.

2.7 Selection of typical samples

2.7.1 In a type approval, a type test is to be carried out for each model of system. For different types of water-mist nozzles, each water-mist nozzle is to be type tested. For different types of water-mist nozzles made of the same material, only one type of nozzle may be selected for corrosion test. The samples are to be randomly selected on site.

2.7.2 In a re-approval, one type is to be selected from the water-mist nozzles of which type tests have been completed for type test again.

2.7.3 In product inspection, 10% or at least 2 water-mist nozzles of the same batch are to be randomly selected for water flow measurement.

2.8 Type test

2.8.1 The type test items and requirements for open water-mist nozzle are given in Table 1.

Open water-mist nozzle test item **Table 1**

Serial No.	Test item	Test requirements	Remark
1	Visual examination	4.2	
2	Functional test	4.5	
3	Water flow test	4.10	
4	Corrosion test	4.11	Sulfur dioxide corrosion test: 3.14.2 is inapplicable Salt mist corrosion test: 3.14.2 and 4.11.4.2 are inapplicable
5	Heat-resistance test	4.13	
6	Vibration test	4.15	For open water-mist nozzle, the vibration test period may be reduced to 8 h; 3.5 and 3.8 are inapplicable
7	Impact test	4.16	
8	Clogging test	4.20	It is considered that for open spray nozzle without strainer or filter, serving for a local water-spraying system applying fresh water as medium or a high-pressure plunger pump to supply water may be exempt from the clogging test
9	Water-mist nozzle markings	5.1	

Note: The numbers in the test requirements column correspond to the paragraphs in Appendix A of MSC/Circ.1165, as amended by MSC.1/Circ.1269.

2.8.2 Fire-extinguishing test

2.8.2.1 Test objective

2.8.2.1.1 These tests are intended to evaluate the fire-extinguishing capabilities of individual water-mist nozzles and grids of water-mist nozzles used as local application fire-fighting systems on light diesel oil fuel spray fires.

2.8.2.1.2 The tests also define the following design and installation criteria:

(1) the maximum spacing between water-mist nozzles;

(2) the minimum and maximum distance between the water-mist nozzles and the protected hazard;

(3) the need for water-mist nozzles to be positioned outside of the protected hazard; and

(4) the minimum and maximum operating pressure of water-mist nozzles.

2.8.2.2 Test conditions

2.8.2.2.1 The test enclosure, if any, is to be at least 100 m^2 in area, and the height of the test enclosure is to be at least 5 m., above which a canopy is fitted and the casing wall around need not be enclosed.

2.8.2.2.2 The test enclosure, if any, is to be sufficiently large and provided with adequate natural or forced ventilation during the fire test to ensure that the oxygen concentration at 500 mm after and 100 mm below the fuel oil nozzle during the fire test (5 min after ignition) remains above 20% (by volume) without activation of the local application fire-fighting system.

2.8.2.2.3 Fire scenarios

(1) The fire scenarios are to consist of nominal 1 MW and 6 MW spray fires. These fires are to be produced using light diesel oil as the fuel as described in Table 2.

(2) The fuel spray nozzles are to be installed horizontally and directed toward the centre of the nozzle glide.

(3) The fuel spray nozzle is to be located 1 m above the floor and at least 4 m away from the walls of the enclosure, if any.

Table 2

Spray nozzle	**Wide spray angle (120° to 125°) full cone type**	**Wide spray angle (80°) full cone type**
Nominal oil pressure	8.0 Bar	8.5 Bar
0il flow	0.16± 0.01 kg/s	0.03± 0.005 kg/s
0il temperature	20 ± 5℃	20 ±5℃
Nominal heat release rate	6MW	1MW

2.8.2.2.4 Installation of water-mist nozzles

(1) The local application system is to consist of uniformly spaced nozzles directed vertically downward or to the side, or installed at an inclined angle, if any, and tested in accordance with 2.8.2.3 and 2.8.2.6.

(2) The maximum spacing of the nozzles is to be in accordance with the manufacturer's system design and installation manual.

(3) The nozzles are to be installed at least 1 m below the ceiling of the enclosure, if any.

(4) The system is to consist of either a 2 ×2 or 3 × 3 nozzle grid, as required.

(5) Additional nozzles may be installed at the test in accordance with manufacturer's instruction. In this case, details for additional nozzles should be included in the test report and reflected in the individual ship's design.

2.8.2.3 Test items

2.8.2.3.1 The fire-extinguishing capabilities of the system are to be evaluated for the minimum and maximum separation distances (the distance between the nozzle grid and the fuel spray nozzle). These distances are to be as defined in the manufacturer's system design and installation manual.

2.8.2.3.2 The fire-extinguishing capabilities of the system are to be evaluated for the working conditions with the lowest pressures. These working pressures are to be as defined in the manufacturer's system design and installation manual.

2.8.2.3.3 Each separation distance is to be evaluated against the two fire scenarios (1 MW and 6 MW spray fires). Tests are to be conducted with the fuel spray nozzles horizontally positioned in the following locations:

(1) under one nozzle in the centre of the grid;

(2) between two nozzles in the centre of the grid;

(3) between four nozzles;

(4) under one nozzle at the edge of the grid (comer); and

(5) between two nozzles at the edge of the grid.

2.8.2.4 Test procedure

(1) Pre-burn. Each fuel oil spray is to be ignited and allowed to bum for 10 to 15 seconds prior to system operation.

(2) The water spray system is to be activated within the pre-bum time, and to extinguish fires in 5 min.

(3) The fuel oil spray is to be operated for at least 15 seconds after fire extinguishments.

(4) The water spray system is to be operated for a minimum of 1 min after fire extinguishments.

2.8.2.5 Test measurements and records

2.8.2.5.1 The following data are to be measured and recorded before test:

(1) the type, number, flow coefficient of the water-mist nozzles;

(2) the installation height of and horizontal space between the water-mist nozzles;

(3) the installation height, flow rate, working pressure and spray atomizing angle of the fuel spray nozzles.

2.8.2.5.2 During the test, the following observations are to be recorded:

(1) start of the ignition procedure;

(2) ignition of fuel oil nozzle;

(3) time when the extinguishing system is activated;

(4) time when the fire is extinguished;

(5) time when the extinguishing system is shut off;

(6) time of re-ignition;

(7) time when the fuel supply to the nozzle is stopped;

(8) time when the test is terminated.

2.8.2.6 Test results and interpretation

2.8.2.6.1 The local application fire-extinguishing system is required to extinguish the test fires within 5 min from the start of water discharge. If the fire re-ignites after this five minute water discharge period the test is considered to be a failure.

2.8.2.6.2 The results of the tests are to be interpreted as follows:

(1) Systems (utilizing a 3 × 3 nozzle grid) that extinguish fires referred to in 2.8.2.3.3(1) to 2.8.2.3.3(3) are considered to have successfully completed the protocol with the condition that the outer nozzles are to be installed outside of the protected area a distance of at least 1/4 of the maximum nozzle spacing.

(2) Systems (utilizing either a 2 × 2 or 3 × 3 nozzle grid) that extinguish fires referred to in 2.8.2.3.3(3) to 2.8.2.3.3(5) are considered to have successfully completed the protocol and can be designed with the outer nozzles located at the edge of the protected area. This does not prohibit the location of the nozzles outside of the protected area.

(3) For installations which may be adequately protected using individual nozzles or a single row of nozzles, the effective nozzle coverage (width and length) is defined as 1/2 the maximum nozzle spacing.

(4) For installations where the protected area is next to a bulkhead or similar vertical obstruction, the first row of nozzles is to be located at 1/2 the maximum nozzle spacing away from the bulkhead for either of the conditions.

2.9 Unit/batch inspection

2.9.1 For main components: marine certificates of water-mist nozzle, selector valve, pressure switch, water pump, motor, electric control box, fire detection and alarm system (fire detector, alarm controls, displays, etc.).

2.9.2 Piping hydraulic pressure test: the test pressure is not to be less than 1.5 times the maximum working pressure.

2.9.3 The water-mist nozzle water flow rate test: 10% or at least 2 water-mist nozzles of the same batch are to be randomly selected for water flow measurement. The results are to be within the ±5% range of the specified value.

2.9.4 The exterior appearance of the water-mist nozzle: no appearance defect is visible for the water-mist nozzles. The manufacturer, water-mist nozzle type and number are to be permanently marked on the nozzles.

2.9.5 Water-mist nozzle function test: 3 water-mist nozzles of the same batch are to be randomly select for hydraulic pressure strength test under the pressure 1.25 times the rated working pressure for 15 min.

2.9.6 System operation test:

(1) test on system starting or stopping automatically and manually;

(2) test on alarms and displays;

(3) at least one protected area to be selected for test, operating for not less than 30 seconds. It is recommended that a protected area further away from water supply pump be chosen for the test.

2.10 After installation onboard ship, in addition to testing the operation (pumping and closing) of the system as required in 3.3.6 of Annex of MSC/Circ.1387, at least two protected areas are to be selected for a 30-second effectiveness test, to inspect the flow condition of the system and observe the operation performance of the nozzle, which at this time are to be covered with a transparent plastic shroud to collect the spraying water. Alarm and automatic activation tests are to be conducted for the automatic water-spraying system.

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CHAPTER 3 FIXED FIRE DETECTION AND FIRE ALARM SYSTEM

3.1 General

3.1.1 Application

3.1.1.1 This Chapter applies to the type approval and unit/batch inspection of the fixed fire detection and fire alarm system installed onboard ships engaged on international voyages and off-shore installations after 1 July 2012, as required by Chapter 9 of the International Code for Fire Safety Systems, as revised by MSC.311(88).

For products that are type approved according GB4717 after 1 July 2012, the certificate is to state "applicable only to ships engaged on domestic voyages."

3.1.1.2 For the fixed fire detection and fire alarm system ①, this chapter applies to the followings:

(1) control and indicating equipment;

(2) power supply equipment;

(3) heat detectors – point detectors;

(4) smoke detectors – point detectors using scattered light, transmitted light or ionization;

(5) flame detectors – point detectors;

(6) manual call points.

Note ①: See figure 1 of EN54-1 for the composition of the fixed fire detection and fire alarm system.

3.1.2 Basis for approval and inspection

3.1.2.1 For the purpose of this Chapter, the following documents apply:

IMO Res.MSC.311(88)	The revised Chapter 9 of the International Code for Fire Safety Systems (FSS Code) — Fixed fire detection and fire alarm system
IMO MSC.1/Circ.1242	Guidelines for the Approval of Fixed Fire Detection and Fire Alarm Systems for Cabin Balconies
IMO A. 1021(26)	Code on Alerts and Indicators, 2009
EN54-1(1996)	Fire Detection and Alarm Systems – Part 1: Introduction
EN 54-2(1997) including AC(1999) and A1(2006)	Fire Detection and Alarm Systems- Part 2: Control and Indicating Equipment

EN 54-4(1997) including AC(1999), A1(2002) and A2(2006)	Fire Detection and Alarm Systems- Part 4: Power Supply Equipment
EN 54-5(2000) including A1(2002)	Fire Detection and Alarm Systems – Part 5:Heat Detectors - Point Detectors
EN 54-7(2000) including A1(2002) and A2(2006)	Fire Detection and Alarm Systems- Part 7: Smoke Detectors - Point Detectors Using Scattered Light, Transmitted Light or Ionization
EN 54-10(2002) including A1(2005)	Fire Detection and Alarm Systems – Part 10: Flame Detectors - Point Detectors
EN 54-11(2001) including A1(2005)	Fire Detection and Alarm Systems - Part 11: Manual Call Points
IEC60092-504(2001-03)	Electrical Installations in Ships – Part 504: Special Features - Control and Instrumentation
IEC60533(1999-11)	Electrical and Electronic Installations in Ships - Electromagnetic Compatibility
CCS GD01-2006	CCS Guidelines for Type Approval Test of Electric and Electronic Products and the revisions thereof

3.1.3 Definitions

The terms and definitions of the standards listed in 3.1.2 apply to this Chapter. To facilitate the compilation of the Chapter and the understanding of relevant requirements, the following items and definitions are added or quoted:

(1) Section means a group of fire detectors and manually operated call points as reported in the indicating unit(s).

(2) Section identification capability means a system with the capability of identifying the section in which a detector and/or manually operated call point has activated.

(3) Individually identifiable means a system with the capability to identify the exact location and type of detector or manually activated call point which has activated, and which can differentiate the signal of that device from all others.

The capability to identify means individually showing and editing relevant data on the control and indicating equipment. Individual identification is achieved by the controller together with the detector. Information of the location of the detector is generally to be prepared by technicians of the manufacturer during the equipment commissioning at site and can be modified afterwards by operator with appropriate authority.

(4) Power supply equipment (component) of fixed fire detection and fire alarm system means an equipment or component is used for power supply to the control and indicating equipment, which is powered by main/emergency power sources of the ship and is also called as power supply unit. Power supply unit is generally integrated an part of the controller of alarm or is an independent equipment.

3.2 Plans and documents

3.2.1 The general principle:

The scope and detail of plans and documents to be submitted are such that the product can be checked for the compliance with this Guidelines and relevant standards, and that mechanical and electrical design of the product can be checked generally.

3.2.2 The following documents are to be submitted to CCS:

(1) General descriptions of the product (product specifications)

Product specifications are to specify the general performance and design requirements of the product, including at least the following:

- provisions for the product environmental conditions;

- provisions for power supply to the product;

- consisting of the system (product);

- detailed descriptions of product functions and performance.

(2) Hardware and interface

Documents for hardware and interface are to include at least the followings:

- specifications for hardware configuration of the major parts of the product;

- mechanical drawings (structure and outline), electrical drawings (schematic diagram, wiring diagrams and functional block diagram) and explanatory documents necessary for describing the functions, mechanical and electric characteristics of the product and its components;

- detailed description of interfaces between the main units of the equipment as well as between other equipment (or systems), including physical and electric characteristics, data protocol, format or protocol converters I/O configuration, etc.;

- schematic diagram or block diagram of power supply unit arrangement of power supply;

- wiring connection diagram of system describing the maximum application (the maximum number of sections and circuits, the maximum number and type of detectors connected, the maximum number and type of other external equipment connected).

(3) Software

The technical documentation submitted is to comply with the requirements of PART SEVEN of the Rules for the Classification of Sea-going Steel Ships of CCS for computer system of category II as well as the following requirements for products: EN54-2(13.2), EN54-5(4.11), EN54-7(4.11), EN54-10(4.11) and EN54-11(4.8).

(4) User interface

To include at least the followings:

- function allocation of each working station operation station as well as description of switching control of each station (if applicable);

- description of user interface, menu and illustrative pictures (if necessary).

(5) Type test program and delivery inspection program

At least the following descriptions are to be included: sampling principles of type tests or batch sampling principles of delivery inspection, requirements for test equipment, test methods, and acceptance criteria.

(6) Description of product identification and photos.

(7) Installation, operation and maintenance manuals of the product.

The above is the common requirements for the submission of technical documents, which can be added or deleted according to different products. The contents under each item do not mean that they should be submitted individually.

3.3 Design and technical requirements

3.3.1 General requirements

(1) The fixed fire detection and fire alarm system and equipment are to be suitably designed to withstand supply voltage variation and transients, ambient temperature changes, vibration, humidity, shock, impact and corrosion normally encountered in ships. The equipment is to be tested for electromagnetic compatibility specified in GD01-2006. Degree of protection of the enclosure of the equipment is to be suitable for the intended installation environment.

(2) All detectors are to be of a type such that they can be tested for correct operation and restored to normal surveillance without the renewal of any component.

(3) The maximum spacing of detectors is to comply with Table 9.1 of Chapter 9 of the International Code for Fire Safety Systems (FSS Code). If the installation spacing recommended by the manufacturer exceeds those specified by the table, relevant test data is to be submitted.

(4) In principle, detectors of which the response behavior can be adjusted on site as specified in EN54-5 (4.8), EN54-7 (4.6) and EN54-10 (4.7) are not recommended. If such detectors need to be approved, detailed adjustment methods are to be given in the documentation submitted and means are to be provided to guarantee effective control of the on-site adjustment by users. For such types of detectors, associated type test is to be carried out for each operating characteristic obtained by adjustment which is stated by manufacturer.

(5) The manufacturer is to provide suitable instructions and component spares for testing and maintenance of detectors. Detectors are to be periodically tested using equipment suitable for the types of fires to which the detector is designed to respond.

(6) Detectors fitted in hazardous areas are to be tested and approved for such service. All fire detectors fitted in vehicle spaces, special category spaces and ro-ro spaces, dangerous goods spaces of ships carrying dangerous goods are to comply with relevant requirements in Chapter 2, PART FOUR of the Rules for the Classification of Sea-going Steel Ships of CCS, taking into account of applicable requirements of the International Maritime Dangerous Goods (IMDG) Code and the International Maritime Solid Bulk Cargoes (IMSBC) Code.

(7) In passenger ships, the fixed fire detection and fire alarm system is to have individual identification capability. Once activated, fire detectors installed in the cabins of passenger ships are to initiate a visual and audible alarm through visual and audible alarms or other external systems in the installation space. The characteristics and sound pressure levels of alarm are to comply with relevant requirements of A.1021(26).

In cargo ships and on passenger cabin balconies, the fixed fire detection and fire alarm system is, as a minimum, to have section identification capability.

3.3.2 Control and indicating equipment

Control and indicating equipment is to be designed, manufactured and tested in compliance with the following requirements in addition to the provisions of EN54-2:

(1) The fixed fire detection and fire alarm system is to be capable of immediate operation.

(2) If detectors installed in particular spaces can be disconnected by design, the means for disconnecting the detectors is to be designed to automatically restore the system to normal surveillance after a predetermined time that is appropriate for the operation in question. Disconnection of one detector is not to affect the normal operation of other detectors connected.

(3) The control and indicating equipment is to be so designed as to provide output signals to other alarm systems (e.g. general alarm system, public address system, etc.) and other fire safety systems.

(4) The control and indicating equipment is to be capable of providing information about system status to VDR.

(5) The fire detection system may be connected to other compatible systems (e.g. decision management system), provided that other systems can be disconnected without losing any of the functions of the fire detection system, and that any malfunction of the interfaced and connected equipment is not to propagate under any circumstance to the fire detection system.

(6) Control and indicating equipment with individually identifiable fire detectors is to be so arranged that: means are provided to ensure that any fault (e.g., power break, short circuit, earth, etc.) occurring in the section will not prevent the continued individual identification of the remainder of the connected detectors in the section; all arrangements are made to enable the initial configuration of the system to be restored in the event of failure (e.g., electrical, electronic, informatics, etc.);

(7) The activation of any detector or manually operated call point is to initiate a visual and audible fire detection alarm signal at the control panel and indicating units (if any). The sound pressure levels of alarm are to comply with relevant requirements of A.1021(26). If the signals have not been acknowledged within 2 min, an audible fire alarm is to be automatically sounded throughout the crew accommodation and service spaces, control stations and machinery spaces of category A. This alarm sounder system need not be an integral part of the fixed fire detection and fire alarm system.

(8) When the fixed fire detection and fire alarm system is designed to sound a local audible alarm within the cabins where the detectors are located (e.g. as required by 3.3.1(6)), a means to silence the local audible alarms from the control panel is not to be permitted.

(9) To satisfy the provisional requirements of the ship, the fixed fire detection and fire alarm system may be provided with indicating units in addition to the control and indicating equipment. The function of such unit(s) is for indicating and no other function of the control and indicating equipment are permitted. Any special arrangements, if used, are to be approved by CCS.

(10) The fixed fire detection and fire alarm system is to be divided into several physical sections by the control and indicating equipment so as to comply with the specific requirements for ships and offshore installations.

(11) The control and indicating equipment is to monitor power supplies and electric circuits necessary for the operation of the system for loss of power and fault conditions and initiate a visual and audible fault signal distinct from a fire signal at the occurrence of a fault condition, including:

① a single open or power break fault caused by a broken wire;

② a single ground fault caused by the contact of a wiring conductor to a metal component; and

③ a single wire to wire fault caused by the contact of two or more wiring conductors.

3.3.3 Power supply equipment (component) of fixed fire detection and fire alarm system

Power supply unit is to be designed, manufactured and tested in compliance with the following requirements in addition to the provisions of EN54-4:

(1) Power supply unit may be independent equipment or integrated in the control and indicating equipment as a component.

(2) The design of the power supply unit is to be such that there are at least two sources of power supply, one of which is to be main source and the other is an emergency source. The emergency source of power may be that of the ship or the batteries carried by the power supply unit. The change-over between the two sources is to be done by the power supply unit automatically. Means are to be provided to ensure that the performance of the detection system will not be reduced during and after the change-over.

(3) The main source of power is to be sufficient to permit the continued operation of the system with all detectors activated, but not more than 100 if the total exceeds this figure.

(4) The emergency source of power (including batteries, if applicable) is to be sufficient to maintain the operation of the fire detection and fire alarm system for the periods required under regulations II-1/42 and 43 of the SOLAS Convention, and at the end of that period, is to be capable of operating all connected visual and audible fire alarm signals for a period of at least 30 min.

(5) When used as an emergency source of power, the batteries carried by power supply unit are to be sufficient to meet the requirements of 3.3.3(3) and be able to be recharged to the capacity required by 3.3.3(4) within ten hours from a complete discharge state.

(6) Batteries are to meet the requirements of Chapter 2, PART FOUR of the Rules for Classification of Sea-going Steel Ships of CCS.

3.3.4 Point-type heat detectors

Point-type heat detectors are to be designed, manufactured and tested in compliance with the following requirements in addition to the provisions of EN54-5:

(1) Heat detectors are to be certified to operate before the temperature exceeds 78ºC but not until the temperature exceeds 54ºC, when the temperature is raised to those limits at a rate less than 1ºC per min, when tested according to standards EN 54-5:2001. In general, class A1 or A2 detectors specified in EN54-5 are to be used.

(2) The operation temperature of heat detectors in drying rooms and similar spaces of a normal high ambient temperature may be up to 130ºC, and up to 140ºC in saunas. Class E or F detectors specified in EN54-5 may be used and detailed description is to be given in the documentation submitted.

3.3.5 Point-type smoke detectors

Point-type smoke detectors are to be designed, manufactured and tested in compliance with the following requirements in addition to the provisions of EN54-7:

Smoke detectors are to be certified to operate before the smoke density exceeds 12.5% obscuration per metre, but not until the smoke density exceeds 2% obscuration per metre, when tested according to standards EN 54-7:2001.

3.3.6 Point-type flame detectors are to be designed, manufactured and tested in compliance with the requirements of EN54-10.

3.3.7 Manual call points are to be designed, manufactured and tested in compliance with the requirements of EN54-11.

3.4 Type approval and unit/batch inspection

3.4.1 General

(1) The fixed fire detection and fire alarm system is to be type approved by CCS. The issue, maintenance, change, renewal and cancellation of the type approval certificate are to be in compliance with the relevant requirements in Chapter 3, PART ONE of the Rules.

(2) Although EN54 specifies some of the environmental tests and electromagnetic compatibility tests, the requirements of some items of EN54 are lower than the those of the Guidelines for Type Approval Test of Electric and Electronic Product of CCS (GD01). Consequently, these items are to be carried out in accordance with GD01.

(3) For some test items, if the manufacturer has already carried out tests in authoritative and impartial test organizations accepted by CCS, and products have not undergone any changes after tests, these items may be exempted with upon the application of the manufacturer after the CCS surveyor has checked relevant technical documents and test reports.

3.4.2 Sampling of typical specimens and test arrangements

The types and specifications of test specimens are to be technically representative and cover the product ranges applying for type approval. Test specimens are to be taken on site of the manufacturer by the CCS surveyor.

(1) Control and indicating equipment and power supply unit

For control and indicating equipment of the same type, one may be chosen to be tested according to the maximum configuration of the system which includes, but is not limited to the following: the maximum section number, the maximum number arrangement of the detectors, the maximum type arrangement of the detectors, the maximum power supply capacity, etc.

The detectors and manual call points are to be verified for compatibility with the control and indicating equipment through type tests and vice versa.

For detectors with different installation types, considerations are to be given to the impacts of different enclosures and electromagnetic compatibility.

(2) Sampling of and test arrangements for point-type heat detectors are to be carried out according to 5.1.6 and 5.1.7 of EN54-5.

(3) Sampling of and test arrangements for point-type smoke detectors are to be carried out according to 5.1.6 and 5.1.7 of EN54-7.

(4) Sampling of and test arrangements for point-type flame detectors are to be carried out according to 5.1.8 and 5.1.9 of EN54-10.

(5) Sampling of and test arrangements for manual call points are to be carried out according to 5.1.6 and 5.1.7 of EN54-11.

3.4.3 Test organizations

Type approval tests are to be carried out in authoritative and impartial test organizations accepted by CCS. Such organizations are to be subject to international or domestic certification. Where the product manufacturer has the test conditions, some functional test items may be carried out in the manufacturer, subject to agreement and witness of the CCS surveyor.

3.4.4 Items and requirement for type approval tests

(1) Refer to Table 3.4.4.1 for control and indicating equipment and power supply unit.

(2) Refer to Table 3.4.4.2 for point-type heat detectors.

(3) Refer to Table 3.4.4.3 for point-type smoke detectors.

(4) Refer to Table 3.4.4.4 for point-type flame detectors.

(5) Refer to Table 3.4.4.5 for manual call points.

3.4.5 Unit/batch inspection

Before delivery of the equipment, unit/batch inspection is required by CCS and the certificate of marine products is to be issued after inspection.

(1) After type approved, the manufacturer is to control the manufacturing and testing processes according to the quality control documents submitted for approval, and carry out tests specified in the procedures of delivery tests in 3.2.2(5).

(2) Control and indicating equipment and power supply unit

The manufacturer is to carry out delivery test for each marine product and provide the delivery test report. The CCS surveyor is to inspect the product according to the product inspection plan. The unit/batch inspection is to include at least the following tests:

- check of documentation of main components (parts); confirmation of software edition;

- visual inspection and internal winding inspection;

- measurement of insulation resistance;

- high voltage tests;

- confirmation of function tests.

The surveyor may add test items and the number of specimens as deemed necessary.

(3) Fire detectors and manual call points

According to the widely adopted sampling inspection standards (e.g. GB/T 2828 and ISO 2859 series standards), based on the process features and controlled quality level, the manufacturer is to develop the sampling inspection plan and submit it to CCS for review. The sampling arrangement is to be listed in the product inspection plan. The surveyor is to check the implementation record of the sampling inspection plan when carrying out unit/batch inspection. Verification of product performance may be carried out if deemed necessary.

Type test items of control and indicating equipment and power supply unit **Table 3.4.4.1**

No.	**Test items**	**Technical requirements and test methods**
1	Fire alarm condition	Paragraph 7 of EN 54-2
2	Fault warning condition	Paragraph 8 of EN 54-2
3	Disabled condition	Paragraph 9 of EN 54-2
4	Insulation resistance	Paragraph 2.3 of GD01
5	High voltage	Paragraph 2.14 of GD01
6	Power variation	Paragraph 2.4 of GD01
7	Power supply performance	Paragraph 3.3.3 of these Guidelines
8	Impact	Paragraph 15.6 of EN 54-2; IEC 60068-2-75
9	Vibration	Paragraph 2.7 of GD01; IEC60068-2-6
10	Dry heat	Paragraph 2.8 of GD01; IEC60068-2-2
11	Cold	Paragraph 2.9 of GD01; IEC60068-2-1
12	Damp heat, cyclic	Paragraph 2.10 of GD01; IEC60068-2-30
13	Enclosure	IEC60529
14	Flame retardant test	IEC60092-101; IEC60695-11-5
15	Conducted transmission	Paragraph 3.2 of GD01-2006; CISPR16-1, CISPR16-2
16	Radiated emissions from enclosure port	Paragraph 3.3 of GD01-2006; CISPR16-1, CISPR16-2
17	Electrostatic discharge	Paragraph 3.4 of GD01-2006; IEC61000-4-2
18	Radiated electromagnetic fields	Paragraph 3.5 of GD01-2006; IEC61000-4-3
19	Fast transient bursts	Paragraph 3.6 of GD01-2006; IEC61000-4-4
20	Slow high-energy voltage surge	Paragraph 3.7 of GD01-2006; IEC61000-4-5
21	Low frequency conductive immunity	Paragraph 3.8 of GD01-2006; IEC60533
22	Immunity test to conducted disturbances induced by radio-frequency fields	Paragraph 3.9 of GD01-2006; IEC61000-4-6

Type test items of point-type heat detectors Table 3.4.4.2

Test procedure		
No.	**Test items**	**Technical requirements and test method**
1	Directional dependence	Paragraph 5.2 of EN 54-5
2	Static response temperature	Paragraph 5.3 of EN 54-5
3	Response times from typical application temperature	Paragraph 5.4 of EN 54-5
4	Response times from 25℃	Paragraph 5.5 of EN 54-5
5	Response times from high ambient temperature	Paragraph 5.6 of EN 54-5
6	Variation in supply parameters	Paragraph 5.7 of EN 54-5
7	Reproducibility	Paragraph 5.8 of EN 54-5
8	Cold (operational)	Paragraph 5.9 of EN 54-5
9	Dry heat (endurance)	Paragraph 5.10 of EN 54-5
10	Damp heat, cyclic (operational)	Paragraph 2.10 of GD01; IEC60068-2-30
11	Damp heat, steady state (endurance)	Paragraph 5.12 of EN 54-5
12	SO_2 corrosion (endurance)	Paragraph 5.13 of EN 54-5
13	Shock (operational)	Paragraph 5.14 of EN 54-5
14	Impact (operational)	Paragraph 5.15 of EN 54-5
15	Vibration, sinusoidal, (operational)	Paragraph 2.7 of GD01; IEC60068-2-6
16	Vibration, sinusoidal, (endurance)	Paragraph 5.17 of EN 54-5
17	Radiated emissions from enclosure port	Paragraph 3.3 of GD01-2006; CISPR16-1, CISPR16-2
18	Electrostatic discharge	Paragraph 3.4 of GD01-2006; IEC61000-4-2
19	Radiated electromagnetic fields	Paragraph 3.5 of GD01-2006; IEC61000-4-3
20	Fast transient bursts	Paragraph 3.6 of GD01-2006; IEC61000-4-4
21	Slow high-energy voltage surge	Paragraph 3.7 of GD01-2006; IEC61000-4-5
22	Immunity to conducted disturbances induced by radio-frequency fields	Paragraph 3.9 of GD01-2006; IEC61000-4-6
23	Additional test for S-type detectors	Paragraph 6.1 of EN 54-5
24	Additional test for R-type detectors	Paragraph 6.2 of EN 54-5
25	Enclosure	IEC60529
26	Flame retardant	IEC60092-101; IEC60695-11-5

Type test items of point-type smoke detectors Table 3.4.4.3

No.	Test items	Technical requirements and test method
1	Repeatability	Paragraph 5.2 of EN 54-7
2	Directional dependence	Paragraph 5.3 of EN 54-7
3	Reproducibility	Paragraph 5.4 of EN 54-7
4	Variation of supply parameters	Paragraph 5.5 of EN 54-7
5	Air movement	Paragraph 5.6 of EN 54-7
6	Dazzling (applicable to detector using a scattered or transmitted light principle of operation)	Paragraph 5.7 of EN 54-7
7	Dry heat (operational)	Paragraph 5.8 of EN 54-7
8	Cold (operational)	Paragraph 5.9 of EN 54-7
9	Damp heat , steady state (operational)	Paragraph 2.10 of GD01; IEC60068-2-30
10	Damp heat, steady state (endurance)	Paragraph 5.11 of EN 54-7
11	SO_2 corrosion (endurance)	Paragraph 5.12 of EN 54-7
12	Shock (operational)	Paragraph 5.13 of EN 54-7
13	Impact (operational)	Paragraph 5.14 of EN 54-7
14	Vibration, sinusoidal, (operational)	Paragraph 2.7 of GD01; IEC60068-2-6
15	Vibration, sinusoidal, (endurance)	Paragraph 5.16 of EN 54-7
16	Radiated emissions from enclosure port	Paragraph 3.3 of GD01-2006; CISPR16-1, CISPR16-2
17	Electrostatic discharge	Paragraph 3.4 of GD01-2006; IEC61000-4-2
18	Radiated electromagnetic fields	Paragraph 3.5 of GD01-2006; IEC61000-4-3
19	Fast transient bursts	Paragraph 3.6 of GD01-2006; IEC61000-4-4
20	Slow high-energy voltage surge	Paragraph 3.7 of GD01-2006; IEC61000-4-5
21	Immunity to conducted disturbances induced by radio-frequency fields	Paragraph 3.9 of GD01-2006; IEC61000-4-6
22	Fire sensitivity	Paragraph 5.18 of EN 54-7
23	Enclosure	IEC60529
24	Flame retardant	IEC60092-101; IEC60695-11-5

Type test items of point-type flame detectors Table 3.4.4.4

No.	Test items	Technical requirements and test method
1	Reproducibility	Paragraph 5.2 of EN 54-10
2	Repeatability	Paragraph 5.3 of EN 54-10
3	Directional dependence	Paragraph 5.4 of EN 54-10
4	Fire sensitivity	Paragraph 5.5 of EN 54-10
5	Dazzling (operational)	Paragraph 5.6 of EN 54-10
6	Dry heat (operational)	Paragraph 5.7 of EN 54-10

7	Cold (operational)	Paragraph 5.8 of EN 54-10
8	Damp heat, cyclic (operational)	Paragraph 2.10 of GD01; IEC60068-2-30
9	Damp heat, steady state (endurance)	Paragraph 5.10 of EN 54-10
10	SO_2 corrosion (endurance)	Paragraph 5.11 of EN 54-10
11	Shock (operational)	Paragraph 5.12 of EN 54-10
12	Impact (operational)	Paragraph 5.13 of EN 54-10
13	Vibration, sinusoidal, (operational)	Paragraph 5.14 of EN 54-10
14	Vibration, sinusoidal, (endurance)	Paragraph 5.15 of EN 54-10
15	Variation in supply parameters (operational)	Paragraph 5.16 of EN 54-10
16	Radiated emissions from enclosure port	Paragraph 3.3 of GD01-2006; CISPR16-1, CISPR16-2
17	Electrostatic discharge	Paragraph 3.4 of GD01-2006; IEC61000-4-2
18	Radiated electromagnetic fields	Paragraph 3.5 of GD01-2006; IEC61000-4-3
19	Fast transient bursts	Paragraph 3.6 of GD01-2006; IEC61000-4-4
20	Slow high-energy voltage surge	Paragraph 3.7 of GD01-2006; IEC61000-4-5
21	Immunity to conducted disturbances induced by radio-frequency fields	Paragraph 3.9 of GD01-2006; IEC61000-4-6
22	Enclosure	IEC60529
23	Flame retardant	IEC60092-101; IEC60695-11-5

Type test items of manual call points **Table 3.4.4.5**

No.	Test items	Technical requirements and test method
1	Operational performance test	Paragraph 5.2 of EN 54-11
2	Function test	Paragraph 5.3 of EN 54-11
3	Test facility test (operational)	Paragraph 5.4 of EN 54-11
4	Reliability test (endure)	Paragraph 5.5 of EN 54-11
5	Variation in supply parameters	Paragraph 5.6 of EN 54-11
6	Dry heat (operational)	Paragraph 5.7 of EN 54-11
7	Dry heat (endurance)	Paragraph 5.8 of EN 54-11
8	Cold (operational)	Paragraph 5.9 of EN 54-11
9	Damp heat, cyclic (operational)	Paragraph 2.10 of GD01; IEC60068-2-30
10	Damp heat, cyclic (endurance)	Paragraph 5.11 of EN 54-11
11	Damp heat, steady state (endurance)	Paragraph 5.12 of EN 54-11
12	SO_2 corrosion (endurance)	Paragraph 5.13 of EN 54-11
13	Shock (operational)	Paragraph 5.14 of EN 54-11
14	Impact (operational)	Paragraph 5.15 of EN 54-11
15	Vibration, sinusoidal (operational)	Paragraph 2.7 of GD01; IEC60068-2-6
16	Vibration, sinusoidal (endurance)	Paragraph 5.17 of EN 54-11
17	Radiated emissions from enclosure port	Paragraph 3.3 of GD01-2006; CISPR16-1, CISPR16-2
18	Electrostatic discharge	Paragraph 3.4 of GD01-2006; IEC61000-4-2
19	Radiated electromagnetic fields	Paragraph 3.5 of GD01-2006; IEC61000-4-3
20	Fast transient bursts	Paragraph 3.6 of GD01-2006; IEC61000-4-4
21	Slow high-energy voltage surge	Paragraph 3.7 of GD01-2006; IEC61000-4-5
22	Immunity to conducted disturbances induced by radio-frequency fields	Paragraph 3.9 of GD01-2006; IEC61000-4-6
23	Enclosure	IEC60529
24	Flame retardant	IEC60092-101; IEC60695-11-5

PART FIFTEEN LIFE-SAVING APPLIANCES

CHAPTER 1 LIFEJACKETS

1.1 Application

1.1.1 This Chapter applies to the approval and inspection of the lifejackets provided onboard ships engaged on international voyages.

1.2 Basis for approval and inspection

1.2.1 For the purpose of this Chapter, the following documents apply:

(1) Chapter III of the International Convention for the Safety of Life at Sea, 1974, and MSC.201(81);

(2) MSC.48(66), Chapters I and II of the International Life-saving Appliances Code (LSA Code), and MSC.207(81), MSC218(82);

(3) MSC.81(70), Recommendation on Testing of Life-saving Appliances, and MSC.200(80), MSC.226(82), MSC.323(89);

(4) IMO Resolution A.658(16), Recommendation on the Use and Fitting of Retro-reflective Material on Life-saving Appliances, and its amendments;

(5) IMO Resolution A.760(18), Symbols Related to Life-saving Appliances and Arrangements, and its amendments.

1.3 Definitions

1.3.1 For the purpose of this Chapter:

(1) Lifejacket means a lifejacket (including infant and children's lifejacket) using inherent buoyancy material as core material.

(2) Inflatable lifejacket means a lifejacket (including infant and children's lifejacket) which depend upon inflating for buoyancy and which has at least two independent inflatable bladders.

1.4 Plans and documents

1.4.1 The following documents are to be submitted to CCS for approval when applying for products approval:

(1) products structural plan;

(2) fabric prototype plan;

(3) buoyant material measurements;

(4) type test program.

1.4.2 The following documents are to be submitted to CCS for information when applying for products approval:

(1) a list of materials and attachments;

(2) molding technique documents;

(3) instruction manual;

(4) product identification.

1.5 Main components and parts

1.5.1 The following main components and raw materials of the lifejackets are to be furnished with CCS certificates:

(1) retro-reflective tape;

(2) lifejacket lights.

1.6 Design and technical requirements

1.6.1 The design and manufacturing of the lifejackets are to at least comply with the applicable requirements of 1.2.1(1), (2) and (3) of this Chapter.

1.6.2 If a lifejacket is manufactured and designed to fit persons weighing up to 140 kg and with a chest girth of up to 1,750 mm, suitable accessories are to be specified.

1.7 Type test

1.7.1 Selection of samples

Each type and model of the lifejacket is to be selected for type test.

1.7.1.1 Lifejackets

(1) The lifejackets produced are to be randomly selected from the products warehouse of the manufacturer applying for type approval. Six lifejackets of each model are to be sampled and the sampling base is not to be less than 100 pieces per model.

(2) The following quantity of materials from each model of lifejackets are to be taken for test, with the exception that different types/models of products applying the same material and furnished with a written declaration provided by the manufacturer may be exempt from the repetition of sampling:

① fabric: 3 m;

② webbing: woven belt 20 m; the webbing attached by fabric in a total length of not less than 4 m, is to be taken from the lifejackets;

③ thread: 1 roll;

④ buckle: 75;

⑤ core material: 16 pieces, 300 mm Í 300 mm Í 25 mm in size; 4 pieces, 300 mm Í 300 mm Í 10 mm in size.

1.7.1.2 Inflatable lifejackets

(1) The lifejackets produced are to be randomly selected from the products warehouse of the manufacturer applying for type approval. Four lifejackets of each model are to be sampled and the sampling base is not to be less than 100 pieces per model. In addition, 60 gas cylinders, 10 sets each of automatic inflation devices and manual inflation devices, and 30 expendable start components of the automatic inflation devices are to be provided.

(2) The following quantity of materials from each model of lifejackets are to be taken for test, with the exception that different types/models of products applying the same material and furnished with a written declaration provided by the manufacturer may be exempt from the repetition of sampling:

① coated fabrics of inflatable buoyancy chambers: $3m^2$;

② 20 pieces, 300 mm Í 70 mm in size;

③ 40 pieces, 300 mm Í 50 mm in size, of which 20 in the warp direction and 20 in the weft direction; coated surface to coated surface, to be connected by means of the connecting inflatable lifejackets method, to form 10 pieces, 300 mm Í 50 mm in size, each in the warp direction and in the weft direction.

1.7.2 Type test items

(1) The test items of lifejackets (inherent buoyancy materials) and the corresponding technical requirements and test methods are given in Table 1.7.2(1).

Table 1.7.2(1)

No.	Test items	Technical requirements and test methods
1	Visual examination	The color to be orange, and the retro-reflective tape to comply with A.658(16)
2	Temperature cycling test	Paragraph 2.1, PART 1 of MSC.200(80) and Paragraph 1.2.2.2, Chapter I of MSC.207(81)
3	Buoyancy test	Paragraph 2.2, PART 1 of MSC.200(80) and Paragraph 2.2.1.11, Chapter II of MSC.207(81)
4	Fire test	Paragraph 2.3, PART 1 of MSC.200(80) and Paragraph 2.2.1.1, Chapter II of MSC.207(81)
5	Tests of components other than buoyancy materials	Paragraph 2.4, PART 1 of MSC.200(80)
6	Strength test	Paragraph 2.5, PART 1 of MSC.200(80)
7	Tests for lifejacket buoyancy material	Paragraph 2.6, PART 1 of MSC.200(80)

8	Donning test	Paragraph 2.7, PART 1 of MSC.200(80) and Paragraph 2.2.1.5, Chapter II of MSC.207(81)
9	Water performance test	Paragraph 2.8, PART 1 of MSC.200(80) and Paragraph 2.2.1.6, Chapter II of MSC.207(81)
9.1	Righting test	Paragraph 2.8.5, PART 1 of MSC.200(80) and Paragraph 2.2.1.6, Chapter II of MSC.207(81)
9.2	Static balance test	Paragraph 2.8.6, PART 1 of MSC.200(80) and Paragraph 2.2.1.6, Chapter II of MSC.207(81)
9.3	Jump and drop tests	Paragraph 2.8.8, PART 1 of MSC.200(80) and Paragraph 2.2.1.5, Chapter II of MSC.207(81)
9.4	Stability test	Paragraph 2.8.10, PART 1 of MSC.200(80)
9.5	Swimming and water emergence test	Paragraph 2.8.11, PART 1 of MSC.200(80)

(2) Infant and children's lifejackets (inherent buoyancy materials) and the corresponding test methods are given in Table 1.7.2(2).

Table 1.7.2(2)

No.	Test items	Test methods
1	Visual examination	The color to be orange, and the retro-reflective tape to comply with A.658(16); symbols to comply with Paragraph 2.2.1.6.2, Chapter I of MSC.48(66)
2	Temperature cycling test	Paragraph 2.1, PART 1 of MSC.200(80) and Paragraph 1.2.2.2, Chapter I of MSC.207(81)
3	Buoyancy test	Paragraph 2.2, PART 1 of MSC.200(80) and Paragraph 2.2.1.11, Chapter II of MSC.207(81)
4	Fire test	Paragraph 2.3, PART 1 of MSC.200(80) and Paragraph 2.2.1.1, Chapter II of MSC.207(81)
5	Tests of components other than buoyancy materials	Paragraph 2.4, PART 1 of MSC.200(80)
6	Strength test	Paragraph 2.5, PART 1 of MSC.200(80)
7	Tests for lifejacket buoyancy material	Paragraph 2.6, PART 1 of MSC.200(80)
8	Donning test	Paragraph 2.7, PART 1 of MSC.200(80) and Paragraph 2.2.1.8, Chapter II of MSC.207(81)
9	Water performance test	Paragraphs 2.8, 2.9.2, 2.9.3, PART 1 of MSC.200(80) and Paragraphs 2.2.1.8, 2.2.1.9, Chapter II of MSC.207(81)

(3) Inflatable lifejackets and the corresponding test methods are given in Table 1.7.2(3).

Table 1.7.2(3)

No.	Test items	Test methods
1	Visual examination	The color to be orange, and the retro-reflective tape to comply with A.658(16)
2	Temperature cycling test	Paragraph 2.1, PART 1 of MSC.200(80) and Paragraph 1.2.2.2, Chapter I of MSC.207(81)
3	Inflation test	Paragraph 2.10.1, PART 1 of MSC.200(80)
4	Buoyancy test	Paragraph 2.2, PART 1 of MSC.200(80) and Paragraph 2.2.1.11 Chapter II of MSC.207(81)
5	Fire test	Paragraph 2.3, PART 1 of MSC.200(80) and Paragraph 2.2.1.1, Chapter II of MSC.207(81)

6	Tests of components other than buoyancy materials	Paragraph 2.4, PART 1 of MSC.200(80)
7	Strength test	Paragraph 2.5, PART 1 of MSC.200(80)
8	Donning test	Paragraphs 2.7, 2.10.2, PART 1 of MSC.200(80) and Paragraph 2.2.1.5, Chapter II of MSC.207(81)
9	Water performance test	Paragraphs 2.8, 2.10.3, PART 1 of MSC.200(80) and Paragraph 2.2.1.6, Chapter II of MSC.207(81)
10	Tests of materials for inflatable bladders, inflation systems and components	Paragraph 2.10.4, PART 1 of MSC.200(80), MSC.323(89)
10.1	Material test	Paragraphs 2.10.4.1, PART 1 of MSC.200(80)
10.2	Coated fabrics	Paragraph 2.10.4.2, PART 1 of MSC.200(80)
10.3	Operating head load test	Paragraph 2.10.4.3, PART 1 of MSC.200(80)
10.4	Pressure test	Paragraph 2.10.4.4, PART 1 of MSC.200(80)
10.5	Compression test	Paragraph 2.10.4.5, PART 1 of MSC.200(80)
10.6	Test of metallic components	Paragraph 2.10.4.6, PART 1 of MSC.200(80)
10.7	Inadvertent inflation test	Paragraph 2.10.4.7, PART 1 of MSC.200(80)

1.8 Unit/batch inspection

1.8.1 Ratio of sampling

(1) Each type and model is regarded as a sampling unit and each unit not more than 6,000 pieces a batch, from which 2 pieces are taken as samples.

1.8.2 Inspection and test items

(1) Lifejackets are subject to the following inspection:

① visual examination;

② buoyancy test;

③ strength test.

(2) Additional test items may be required where deemed necessary by the Surveyor.

(3) The certificates of each batch of lifejacket materials and components as specified in 1.5 are to be examined.

(4) The markings of lifejackets are to be inspected to ensure they comply with the 1.2.2.9 and 2.2.1.6 of LSA Code.

CHAPTER 2 LIFEBUOYS

2.1 Application

2.1.1 This Chapter applies to the approval and inspection of the lifebuoys provided onboard ships engaged on international voyages.

2.2 Basis for approval and inspection

2.2.1 For the purpose of this Chapter, the following documents apply:

(1) Chapter III of the International Convention for the Safety of Life at Sea, 1974;

(2) MSC.48(66), Chapters I and II of the International Life-saving Appliances Code (LSA Code), and MSC.207(81);

(3) MSC.81(70), Recommendation on Testing of Life-saving Appliances, and MSC.200(80), MSC.226(82);

(4) IMO Resolution A.658(16), Recommendation on the Use and Fitting of Retro-reflective Material on Life-saving Appliances, and its amendments;

(5) IMO Resolution A.760(18), Symbols Related to Life-saving Appliances and Arrangements, and its amendments.

2.3 Definitions

(1) Lifebuoy means a lifebuoy have a mass of not less than 2.5 kg.

(2) Lifebuoy with the quick release arrangement means a lifebuoy that have a mass sufficient to operate the quick release arrangement and that has a mass of not less than 4 kg.

2.4 Plans and documents

2.4.1 The following documents are to be submitted to CCS for approval when applying for products approval:

(1) products structural plan;

(2) type test program.

2.4.2 The following documents are to be submitted to CCS for information when applying for products approval:

(1) a list of materials and attachments;

(2) molding technique documents;

(3) instruction manual.

2.5 Main components and parts

2.5.1 The following main components and raw materials of the lifebuoys are to be furnished with CCS certificates:

(1) retro-reflective tape.

2.6 Design and technical requirements

2.6.1 The design and manufacturing of the lifebuoys are to at least comply with the applicable requirements of 2.2.1(1), (2) and (3) of this Chapter.

2.7 Type test

2.7.1 Selection of samples

(1) In type approval, each model of the lifebuoy is to be selected for type test.

2.7.2 Type test items

(1) The test items of lifebuoys and the corresponding test methods are given in Table 2.7.2(1).

Table 2.7.2(1)

No.	Test items	Test methods
1	Visual examination	The color to be orange, and the retro-reflective tape to comply with A.658(16), Paragraph 2.1.1.2, Chapter II of MSC.48(66), and Paragraph 1.1, PART 1 of MSC.81(70)
2	Temperature cycling test	Paragraph 1.2, PART 1 of MSC.81(70) and Paragraph 1.2.2.2, Chapter I of MSC.48(66)
3	Drop test	Paragraph 1.3, PART 1 of MSC.81(70) and Paragraph 2.1.1.6, Chapter II of MSC.48(66)
4	Oil resistance test	Paragraph 1.4, PART 1 of MSC.81(70)
5	Fire test	Paragraph 1.5, PART 1 of MSC.81(70) and Paragraph 2.1.1.15, Chapter II of MSC.48(66)
6	Flotation test	Paragraph 1.6, PART 1 of MSC.81(70) and Paragraph 2.1.1.3, Chapter II of MSC.48(66)
7	Strength test	Paragraph 1.7, PART 1 of MSC.81(70)
8	Test for operation with a light and smoke signal	Paragraph 1.8, PART 1 of MSC.81(70)

2.8 Unit/batch inspection

2.8.1 Ratio of sampling

(1) The lifebuoys are not to be more than 5,000 pieces a batch and at least two samples are to be taken from each batch.

2.8.2 Inspection and test items

(1) Lifebuoys are subject to the following inspection:

① visual examination;

② buoyancy test;

③ strength test.

(2) Additional test items may be required where deemed necessary by the Surveyor.

(3) The certificates of each batch of lifebuoy materials as specified in 2.5 are to be examined.

(4) The markings of lifebuoys are to be inspected to ensure they comply with the 1.2.2.9 of LSA Code.

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CHAPTER 3 INFLATABLE LIFERAFTS

3.1 Application

3.1.1 This Chapter applies to the approval and inspection of the liferafts provided onboard ships engaged on international voyages and as required in the International Code of Safety for High-speed Craft, 2000.

3.2 Basis for approval and inspection

3.2.1 For the purpose of this Chapter, the following documents apply:

(1) Chapter III of the International Convention for the Safety of Life at Sea, 1974;

(2) MSC.48(66), Chapters I and IV of the International Life-saving Appliances Code (LSA Code), and MSC.218(82), MSC.293(87);

(3) MSC.97(73), Annex 11 of the International Code of Safety for High-speed Craft, (2000);

(4) MSC.81(70), Recommendation on Testing of Life-saving Appliances, and MSC.226(82), MSC.295(87), MSC.323(89);

(5) IMO Resolution A.658(16), Recommendation on the Use and Fitting of Retro-reflective Material on Life-saving Appliances, and any subsequent amendments;

(6) IMO Resolution A.760(18), Symbols Related to Life-saving Appliances and Arrangements, and any subsequent amendments.

3.3 Definitions

(1) Open reversible inflatable liferaft means an inflatable liferaft as required in Annex 11 of the International Code of Safety for High-speed Craft, 2000, which is not a SOLAS liferaft.

(2) Canopied reversible inflatable liferaft means a canopied reversible liferaft which is substitutable for a self-righting inflatable liferaft complying with the International Convention for the Safety of Life at Sea, 1974 and its amendments as well as the International Life-saving Appliances Code.

3.4 Plans and documents

3.4.1 The following documents are to be submitted to CCS for approval when applying for products approval:

(1) structural plan;

(2) arrangement plan;

(3) inflation system plan;

(4) construction plan of main valves (relief valves, inlet valves, safety valves, platform non-return valves, canopy pillar non-return valves, exhaust valves);

(5) technical specifications (or manufacturer's standards) of the product

(6) calculations: volume of main buoyancy tubes, raft bottom area, water pockets capacity, freeboard, stability, inflation system volume, lifting system strength;

(7) type test program.

3.4.2 The following documents are to be submitted to CCS for information when applying for products approval:

(1) structural plan of vessels and technical requirements (or to submit approval certificate);

(2) material technical requirements and acceptance or test methods;

(3) manufacturing techniques;

(4) acceptance procedures of and requirements for product survey (relevant tables of records);

(5) a list of attachments;

(6) instruction manual;

(7) a list of suppliers.

3.5 Main components and parts

3.5.1 The following main components, raw materials and attachments of the liferafts are to be furnished with CCS certificates:

(1) retro-reflective tape;

(2) gas cylinders;

(3) raft lamps;

(4) relief valves;

(5) vessels (purchased);

(6) fresh water or manually powered reverse osmosis desalinator;

(7) ration;

(8) rocket parachute flares;

(9) hand flares;

(10) buoyant smoke signals;

(11) first-aid outfit;

(12) daylight signaling mirror;

(13) radar reflector;

(14) survival craft radar transponder (if fitted);

(15) thermal protective aids;

(16) painters (purchased);

(17) hydrostatic release units.

3.6 Design and technical requirements

3.6.1 The design and manufacturing of the liferafts are to at least comply with the applicable requirements of 3.2.1(1), (2), (3), (4) and (5) of this Chapter.

3.7 Type test

3.7.1 Selection of samples

(1) In type approval, each type and model of the liferafts is to be selected for type test.

3.7.2 Type test items

(1) The test items of inflatable liferaft, davit-launched liferaft, self-righting liferaft and canopied reversible liferaft, and the corresponding technical requirements and test methods are given in Table 3.7.2(1).

Table 3.7.2(1)

No.	Test items	Technical requirements and test methods
1	Drop test	Paragraph 5.1, PART 1 of MSC.81(70) and Paragraph 4.1.5.1.5, Chapter IV, Annex of MSC.48(66)
2	Jump test	Paragraph 5.2, PART 1 of MSC.81(70), and MSC.295(87)
3	Weight test	Paragraph 5.3, PART 1 of MSC.81(70)
4	Towing test	Paragraph 5.4, PART 1 of MSC.81(70) and Paragraph 4.1.5.1.5, Chapter IV, Annex of MSC.48(66), and MSC.295(87)
5	Mooring test	Paragraph 5.5, PART 1 of MSC.81(70) and Paragraph 4.1.1.1, Chapter IV, Annex of MSC.48(66), and MSC.295(87)
6	Liferaft painter system test	Paragraph 5.6, PART 1 of MSC.81(70)
7	Loading and seating test	Paragraph 5.7, PART 1 of MSC.81(70), and MSC.295(87)
8	Boarding and closing arrangement test	Paragraph 5.8, PART 1 of MSC.81(70)
9	Stability test	Paragraph 5.9, PART 1 of MSC.81(70), and MSC.295(87)
10	Maneuverability test	Paragraph 5.10, PART 1 of MSC.81(70), and MSC.295(87)
11	Swamp test	Paragraph 5.11, PART 1 of MSC.81(70), MSC.295(87) and MSC.323(89)
12	Canopy closure test	Paragraph 5.12, PART 1 of MSC.81(70), and MSC.226(82)
13	Buoyancy of float-free liferafts	Paragraph 5.13, PART 1 of MSC.81(70)
14	Detailed inspection	Paragraph 5.14, PART 1 of MSC.81(70)
15	Weak link test	Paragraph 5.15, PART 1 of MSC.81(70) and Paragraph 4.1.6.2, Chapter IV, Annex of MSC.48(66)
16.1	● Lifting component strength test	Paragraph 5.16.1, PART 1 of Resolution MSC.81(70), and MSC.295(87)
16.2	● Impact test	Paragraph 5.16.2, PART 1 of MSC.81(70), and MSC.295(87)
16.3	● Drop test	Paragraph 5.16.3, PART 1 of MSC.81(70), and MSC.295(87)
16.4	●Davit-launched liferaft boarding test	Paragraph 5.16.4, PART 1 of MSC.81(70), and MSC.295(87)
17	Additional tests	
17.1	Damage test	Paragraph 5.17.1, PART 1 of MSC.81(70), and MSC.295(87)
17.2	*Righting test	Paragraph 5.17.2, PART 1 of MSC.81(70), and MSC.295(87)
17.3	Inflation test	
17.3.1	*Normal temperature inflation test	Paragraphs 5.17.3 and 5.17.4, PART 1; Paragraph 5.1.2, PART 2 of MSC.81(70)
17.3.2	Low temperature inflation test	Paragraphs 5.17.3 and 5.17.5, PART 1 of MSC.81(70)
17.3.3	High temperature inflation test	Paragraphs 5.17.3 and 5.17.6, PART 1 of MSC.81(70)
17.3.4	Test of three times working pressure	Paragraphs 5.17.7, 5.17.8, PART 1 of MSC.81(70), and paragraph 15 of MSC.226(82)
17.3.5	Seam strength test	Paragraphs 5.17.9.1 and 5.17.9.2, PART 1 of MSC.81(70), and MSC.323(89)
17.4	● Overload suspension test	Paragraph 5.17.10, PART 1 of MSC.81(70), and MSC.295(87)
17.5	● Low temperature suspension test	Paragraph 5.17.11, PART 1 of MSC.81(70), and MSC.295(87)
17.6	● Simulated lowering test	Paragraph 5.17.12, PART 1 of MSC.81(70), and MSC.295(87)
17.7	Material test	Paragraph 5.17.13, PART 1 of MSC.81(70), paragraph 16 and 17 of MSC.226(82), MSC.323(89)

18	*Righting tests (additional tests applicable to automatically self-righting liferafts only)	Paragraph 5.18.2, PART 1 of MSC.81(70) (not applicable to canopied reversible liferaft)
19	*Submergence test (additional tests for automatically self-righting and canopied reversible liferafts)	Paragraph 5.19, PART 1 of MSC.81(70)
20	Wind velocity test	Paragraph 5.20, PART 1 of MSC.81(70)
21	*Self-draining test (additional tests for automatically self-righting and canopied reversible liferafts)	Paragraph 5.21, PART 1 of MSC.81(70)
22	Dimension inspection	Paragraph 5.1.3, PART 2 of MSC.81(70)
23	Test of twice working pressure and relief valve sensitivity	Paragraphs 5.1.4 and 5.1.7, PART 2 of MSC.81(70)
24	Gas-tightness inspection	Paragraphs 5.1.5 and 5.1.6, PART 2 of MSC.81(70)
25	● Normal temperature suspension test	Paragraph 5.2, PART 2 of MSC.81(70), and MSC.295(87)
26	Boarding ramp strength test	Paragraph 4.2.4.1, Chapter IV of MSC.48(66), and paragraph 11 of MSC.218(82)
27	Water pockets test	Paragraph 4.2.5.4, Chapter IV of MSC.48(66)
28	Inflation system test	Paragraph 4.2.2.3, Chapter IV of MSC.48(66) and paragraph 10 of MSC.218(82)
29	Visual inspection	Paragraph 4.2, Chapter IV of MSC.48(66) and paragraphs 9, 12 of MSC.218(82)

Note: "●" indicates additional tests for davit-launched liferafts;
"*" indicates additional tests for automatically self-righting liferafts (or inclusive).

(2) The test items of open reversible inflatable liferafts, and the corresponding technical requirements and test methods are given in Table 3.7.2(2).

Table 3.7.2(2)

No.	Test items	Technical requirements and test methods
1	Drop test	Paragraph 5.1, PART 1 of MSC.81(70); Paragraph 2.1, Annex 10 of Resolution MSC.36(63)
2	Jump test	Paragraph 5.2, PART 1 of MSC.81(70); Paragraph 2.2, Annex 10 of Resolution MSC.36(63)
3	Weight test	Paragraph 5.3, PART 1 of MSC.81(70)
4	Towing test	Paragraph 5.3, PART 1 of MSC.81(70); Paragraph 2.3, Annex 10 of Resolution MSC.36(63); MSC.295(87)
5	Liferaft painter system test	Paragraph 5.6, PART 1 of MSC.81(70); Paragraph 3.3, Annex 10, Resolution MSC.36(63)
6	Loading and seating test	Paragraph 5.7, PART 1 of MSC.81(70); MSC.295(87)
7	Boarding test	Paragraph 5.8, PART 1 of MSC.81(70); Paragraphs 2.4 and 3.4, Annex 10 of MSC.36(63)
8	Stability test	Paragraph 5.9, PART 1 of MSC.81(70); MSC.295(87)
9	Maneuverability test	Paragraph 5.10, PART 1 of MSC.81(70); MSC.295(87)
10	Swamp test	Paragraph 5.11, PART 1 of MSC.81(70); MSC.295(87) and MSC.323(89)
11	Buoyancy of float-free liferafts	Paragraph 5.13, PART 1 of MSC.81(70)

12	Detailed inspection Visual and dimensional inspection	Paragraph 5.14, PART 1 of MSC.81(70); Paragraphs 2.9 and 2.10, Annex 10 of Resolution MSC.36(63)
13	Weak link test	Paragraph 5.15, PART 1 of MSC.81(70); Paragraph 4.1.6.2, Chapter IV of MSC.48(66)
14	Damage test	Paragraph 5.17.1, PART 1 of MSC.81(70); MSC.295(87); Paragraph 2.5, Annex 10 of Resolution MSC.36(63)
15	Normal temperature inflation test	Paragraphs 5.17.3 and 5.17.4, PART 1 of MSC.81(70); Paragraph 2.7, Annex 10 of Resolution MSC.36(63)
16	Low temperature inflation test	Paragraphs 5.17.3 and 5.17.5, PART 1 of MSC.81(70); Paragraph 2.7, Annex 10 of Resolution MSC.36(63)
17	High temperature inflation test	Paragraphs 5.17.3 and 5.17.6, PART 1 of MSC.81(70); Paragraphs 1.1.3 and 2.8, Annex 10 of Resolution MSC.36(63)
18	Test of 3 times working pressure	Paragraphs 5.17.7 and 5.17.8, PART 1 of MSC.81(70); Paragraph 15 of MSC.226(82); Paragraph 2.8, Annex 10 of Resolution MSC.36(63)
19	Seam strength test	Paragraphs 5.17.9.1 and 5.17.9.2, PART 1 of MSC.81(70); MSC.323(89)
20	Material test	Paragraph 5.17.13, PART 1 of MSC.81(70); Paragraphs 16 and 17 of MSC.226(82); MSC.323(89)
21	Water-proof test of liferaft floor	Paragraph 2.6, Annex 10 of Resolution MSC.36(63)
22	Self-draining test	Paragraph 5.21, PART 1 of MSC.81(70); Paragraph 3.7, Annex 10 of Resolution MSC.36(63)
23	Water pockets test	Paragraph 3.5, Annex 10 of Resolution MSC.36(63)
24	Floating test of attachments	Paragraph 3.10, Annex 10 of Resolution MSC.36(63)
25	Boarding ramp strength test	Paragraph 4.2.4.1, Chapter IV of MSC.48(66); Paragraph 3.4, Annex 10 of Resolution MSC.36(63); Paragraph 11 of MSC.218(82)

3.8 Unit/batch inspection

3.8.1 Ratio of sampling

(1) One sample from each type and model of liferafts is to be taken among the satisfactorily inspected products of the manufacturer.

3.8.2 Inspection and test items

(1) Each batch of liferafts is subject to visual examination, normal temperature inflation test, twice working pressure test, inspection and test for tightness and relief valves commissioning.

(2) Additional test items may be required where deemed necessary by the Surveyor.

(3) The certificates of materials and components as specified in 3.5 are to be examined.

(4) The identifications of liferafts are to be inspected in accordance with 1.2.2.9, 4.1.5.2, 4.2.6.3, 4.2.7.1 and 4.2.7.2 of LSA Code.

CHAPTER 4 INSPECTION FOR APPROVAL OF RESCUE BOATS

4.1 Application

This Chapter applies to the approval and inspection of the rescue boats provided onboard ships engaged on international voyages.

4.2 Basis for approval and inspection

For the purpose of this Chapter, the following documents apply:

(1) MSC.47(66), 1996 Amendments to the International Convention for the Safety of Life at Sea, 1974, and MSC.216(82), MSC.317(89);

(2) MSC.48(66), the International Life-saving Appliances Code (LSA Code), and MSC.218(82), MSC.272(85), MSC.320(89);

(3) MSC.81(70), Recommendation on Testing of Life-saving Appliances, and MSC.226(82), MSC.274(85), MSC.321(89), MSC.323(89) ;

(4) IMO Resolution A.658(16), Recommendation on the Use and Fitting of Retro-reflective Material on Life-saving Appliances, and its amendments;

(5) IMO Resolution A.760(18), Symbols Related to Life-saving Appliances and Arrangements, and its amendments.

(6) MSC/Circ.1006, Guidelines on Fire Test Procedures for Acceptance of Fire-retardant Materials for the Construction of Lifeboats.

4.3 Terms and definitions

(1) Length means a horizontal distance measured between the fore and aft outer hull plates of a rescue boat.

(2) Overall length means a length of boat plus the outboard motor where a motor is attached outboard.

(3) Breadth means a horizontal distance measured between the widest outer hull plates of a rescue boat.

(4) Depth means a vertical distance measured at the mid-boat from the lower edge of keel to the upper edge of the gunwale angle.

(5) Freeboard means a distance measured at the mid-boat from the full-load waterline to the upper edge of the side.

4.4 Plans and documents

4.4.1 The following documents are to be submitted to CCS for approval:

(1) general arrangement;

(2) hydrostatic curves;

(3) lines and offsets;

(4) cross-sectional area;

(5) stability calculations (light loading, full loading, open to sea and capsizing (for self-righting boats) conditions to be calculated respectively);

(6) arrangement of reserve buoyancy;

(7) calculation of reserve buoyancy volume;

(8) hull construction strength calculation;

(9) strength calculations of boat-hooks fixed base (where applicable);

(10) arrangement and installation plans of engine, shafting and propeller (where applicable);

(11) arrangement and installation plans of steering system;

(12) arrangement and installation plans of releasing system (where applicable);

(13) arrangement and installation plans of painter release mechanism;

(14) arrangement and installation of vessels and tanks;

(15) arrangement and installation of draining valves (where applicable);

(16) arrangement and installation of electrical system;

(17) molding technical documents;

(18) type test program.

4.4.2 The following documents are to be submitted to CCS for information:

(1) a list of raw materials and accessories (names, models, performance parameters and suppliers);

(2) a list of attachments and spares;

(3) instruction manual;

(4) maintenance and repair manual.

4.5 Main components and parts

4.5.1 The following materials of the rescue boats are to be furnished with CCS approval certificates

(1) buoyant material;

(2) resin;

(3) fibre reinforced material;

(4) retro-reflective tape.

4.5.2 The following components and fittings installed on rescue boats are to be furnished with CCS products certificates:

(1) engine;

(2) position-indicating lights;

(3) lifting hooks;

(4) batteries;

(5) battery charger (where applicable).

4.5.3 The following attachments provided onboard rescue boats is to be furnished with CCS products certificates:

(1) operational compass;

(2) sea-anchor;

(3) first-aid outfit;

(4) manual pump (where applicable);

(5) portable fire-extinguisher;

(6) searchlight;

(7) radar reflector;

(8) thermal protective aids.

4.6 Procedure approval

In the initial approval for a manufacturer, the molding procedure of glass fiber reinforced plastic is to be approved in accordance with the requirements in Chapter 3, PART TWO of CCS Rules for Materials and Welding (2009).

4.7 Design and technical requirements

The design and manufacturing of the rescue boats are to at least comply with the applicable requirements of 4.2(1), (2) and (3) of this Chapter.

4.8 Type test

4.8.1 Selection of samples

In type approval, each model of the rescue boat as specified in this Chapter is to be selected for type test.

4.8.2 Type test items and requirements

The rescue boats for type test are subject to tests, as appropriate, given in Table 4.8.1, 4.8.2, 4.8.3 and 4.8.4.

Rescue boat type test items – visual examination Table 4.8.1

No.	Test items		Test methods and requirements
1	Persons and seats	Seat size	Paragraphs 4.4.2.2.2 and 5.1.1.3.2 of LSA Code
		Indication	Paragraph 4.4.2.3 of LSA Code
2	Power units	Engine, battery casing (where applicable)	Paragraphs 4.4.6.2, 4.4.6.9 of LSA Code
		Exhaust pipeline protection (where applicable)	Paragraph 4.4.6.6 of LSA Code
		Propulsion system safety protection	Paragraph 4.4.6.7 of LSA Code
3	Release mechanism (where applicable)	Reset indication	Paragraph 4.4.7.6.3 of MSC.218(82); Paragraph 4.4.7.6.8 of MSC.320(89)
		Operation instruction and warning indication	Paragraph 4.4.7.6.5 of MSC.218(82); Paragraph 4.4.7.6.11 of MSC.320(89)
		Operational handle	Paragraph 4.4.7.6.6 of MSC.218(82); Paragraph 4.4.7.6.12 of MSC.320(89)
		Maintenance equipment	Paragraph 4.4.7.6.7 of MSC.218(82); Paragraph 4.4.7.6.13 of MSC.320(89)
4	Retro-reflective material		Paragraph 1.2.7 of LSA Code; IMO A.658(16)
5	Fittings	Ladder	Paragraph 4.4.3.3 of LSA Code
		Draining valve	Paragraph 4.4.7.1 of LSA Code
		Rudder (where applicable)	Paragraph 4.4.7.2 of LSA Code
		Lifeline	Paragraph 4.4.7.3 of LSA Code
		Handholds on hull underside (for not a self-righting boat)	Paragraph 4.4.7.4 of LSA Code
		Fitting of antenna (where applicable)	Paragraph 4.4.7.10 of LSA Code and MSC.218(82)
		Position-indicating light	Paragraph 4.4.7.11 of LSA Code and MSC.218(82)
		Illumination light	Paragraph 4.4.7.11 of LSA Code
		Non-skid finish	Paragraph 4.4.3.5 of LSA Code

Rigid rescue boat type test items **Table 4.8.2**

No.	Test items		Rigid rescue boat	Rigid fast rescue boat	Test methods and requirements
1	Rescue boat material test	Material fire-retardant performance	X	X	Paragraph 6.2, PART 1 of MSC.81(70); MSC/Circ.1006
2	Rescue boat overload test	Davit-launched rescue boat	X	X	Paragraph 7.1.4, PART 1 of MSC.81(70)
3	Impact test, drop test of davit-launched rescue boat		X	X	Paragraph 6.4.1, 6.4.3, 6.4.4, PART 1 of MSC81(70); Paragraph 4.4.1.5.2 of LSA Code
4	Inspection after impact and drop tests		X	X	Paragraph 6.4.7, PART 1 of MSC.81(70)
5	Rescue boat seating strength test	Davit-launched rescue boat	X	X	Paragraph 6.6.1, PART 1 of MSC.81(70)
6	Rescue boat seating test		X	X	Paragraph 7.1.3, PART 1 of MSC.81(70); MSC.226(82)
7	Rescue boat freeboard and stability tests	Flooded stability test	X	X	Paragraphs 6.8.1 to 6.8.3, PART 1 of MSC.81(70); MSC.226(82); Paragraph 4.6.3.3 of LSA Code
		Freeboard test	X	-----	Paragraphs 6.8.4, 6.8.5, PART 1 of MSC.81(70); Paragraph 4.4.5.2 of LSA Code
		Freeboard test	-----	X	Paragraphs 6.8.4, 6.8.5, 7.2.4.2, PART 1 of MSC.81(70); Paragraph 4.4.5.2 of LSA Code
8	Release mechanism test (where applicable)	Davit-launched rescue boat	X	X	Paragraphs 6.9.1 to 6.9.3, 6.9.6, PART 1 of MSC.81(70); Paragraph 6.9.4, PART 1 of MSC.226(82); Paragraphs 4.4.7.6.2, 4.4.7.6.5 of LSA Code; Paragraphs 6.9.1 to 6.9.5, PART 1 of MSC.321(89)
9	Rescue boat operation test	Speed and fuel consumption tests	X	-----	Paragraphs 7.1.5, 7.1.6, PART 1 of MSC.81(70); Paragraph 5.1.1.6 of MSC.218(82)
		Speed and fuel consumption tests	-----	X	Paragraphs 7.1.6, 7.4.2, PART 1 of MSC.81(70); Paragraph 5.1.4.4 of MSC.218(82)
		Engine-out-of-water test	X	X	Paragraphs 6.10.5 and 7.7.10, PART 1 of MSC.81(70)
		Compass performance test	X	X	Paragraph 6.10.7, PART 1 of MSC.81(70)
		Survival recovery test	X	X	Paragraph 6.10.8, PART 1 of MSC.81(70); Paragraph 4.4.3.4 of LSA Code
10	Rescue boat towing and painter release test		X	X	Paragraph 6.11, PART 1 of MSC.81(70)
11	Righting test	Righting the inverted rescue boat	X	X	Paragraph 7.1.7, PART 1 of MSC.81(70); MSC.226(82)
				X	Paragraph 5.1.4.5 of MSC.218(82)
12	Rowing test		X	X	Paragraph 7.1.8, PART 1 of MSC.81(70)
13	Towing liferaft test		X	X	Paragraph 7.1.2, PART 1 of MSC.226(82)
14	Self-righting test	Self-righting in the light condition	-----	X	Paragraphs 6.14.1 and 7.4.1, PART 1 of MSC.81(70); MSC.226(82); Paragraph 5.1.4.5 of MSC.218(82)
15	Additional requirements for fast rescue boats			X	Paragraph 5.1.4 of MSC.218(82)

Rigidity + inflatable rescue boat type test items Table 4.8.3

No.	Test items		Rigidity + inflatable rescue boat	Rigidity + inflatable fast rescue boat	Test methods and requirements
1	Rescue boat material test	Material fire-retardant performance	X	X	MSC/Circ.1006; Paragraph 7.2.14, PART 1 of MSC.81(70)
2	Rescue boat overload test	Davit-launched rescue boat	X	X	Paragraph 7.1.4, PART 1 of MSC.81(70)
3	Rescue boat i mpact test		X	X	Paragraph 6.4.1, PART 1 of MSC.81(70); Paragraph 4.4.1.5.2 of LSA Code
	Drop test		X		Paragraphs 7.2.2 and 7.2.3, PART 1 of MSC.81(70); Paragraph 4.4.1.5.2 of LSA Code
4	Inspection after impact and drop tests		X	X	Paragraph 6.4.7, PART 1 of MSC.81(70)
5	Rescue boat seating strength test	Davit-launched rescue boat	X	X	Paragraph 6.6.1, PART 1 of MSC.81(70)
6	Rescue boat seating test		X	X	Paragraph 7.1.3, PART 1 of MSC.81(70); MSC.226(82)
7	Rescue boat freeboard and stability tests	Flooded stability test	X	X	Paragraphs 7.2.6 and 7.2.7, PART 1 of MSC.81(70); Paragraph 4.6.3.3 of LSA Code
		Freeboard test	X	X	Paragraphs 7.2.4, 7.2.5, PART 1 of MSC.81(70); Paragraph 4.4.5.2 of LSA Code
8	Release mechanism test (where applicable)	Davit-launched rescue boat	X	X	Paragraphs 6.9.1 to 6.9.4, 6.9.6, PART 1 of MSC.81(70); Paragraphs 4.4.7.6.2, 4.4.7.6.5 of LSA Code
9	Rescue boat operation test	Speed and fuel consumption tests	X	-----	Paragraphs 7.1.5, 7.1.6, PART 1 of MSC.81(70); Paragraph 4.4.6.8 of LSA Code
		Speed and fuel consumption tests	-----	X	Paragraphs 7.1.6, 7.4.2, PART 1 of MSC.81(70); Paragraph 4.4.6.8 of LSA Code
		Engine-out-of-water test	X	X	Paragraph 6.10.5, PART 1 of MSC.81(70)
		Compass performance test	X	X	Paragraph 6.10.7, PART 1 of MSC.81(70)
		Survival recovery test	X	X	Paragraph 6.10.8, PART 1 of MSC.81(70); Paragraph 4.4.3.4 of LSA Code
10	Rescue boat towing and painter release test		X	X	Paragraph 6.11, PART 1 of MSC.81(70)
11	Righting test	Righting the inverted rescue boat	X	X	Paragraph 7.1.7, PART 1 of MSC.81(70)
12	Rowing test		X	X	Paragraph 7.1.8, PART 1 of MSC.81(70)
13	Towing liferaft test		X	X	Paragraph 7.1.2, PART 1 of MSC.81(70); MSC.266(82)
14	Self-righting test		-----	X	Paragraph 6.14, PART 1 of MSC.81(70)
15	Flooded capsizing test		-----	X	Paragraph 6.14, PART 1 of MSC.81(70)
16	Damage test	The test is not applicable where the boat has its waterline below the lower side of the inflated tube	X	X	Paragraphs 7.2.8, 7.2.9, 7.3.2, PART 1 of MSC.81(70)
17	Simulated heavy weather test		X	X	Paragraph 7.2.10, PART 1 of MSC.81(70)
18	Swamp test		X	X	Paragraph 7.2.11, PART 1 of MSC.81(70); MSC.323(89)
19	Mooring test	The test is not applicable where the boat has its waterline below the lower side of the inflated tube	X	X	Paragraph 7.2.15, PART 1 of MSC.81(70)
20	Additional requirements for fast rescue boats			X	Paragraph 5.1.4 of MSC.218(82)

Inflatable rescue boat type test items **Table 4.8.4**

No.	Test items		Inflatable rescue boat	Inflatable fast rescue boat	Test methods and requirements
1	Rescue boat material test	Material fire-retardant performance	X	X	Paragraphs 6.2 and 7.1.14, PART 1 of MSC.81(70)
2	Rescue boat overload test	Davit-launched rescue boat	X	X	Paragraphs 7.2.12, 7.2.13, PART 1 of MSC.81(70); Paragraph 4.4.1.6 of LSA Code
3	Rescue boat impact test		X	X	Paragraph 6.4.1, PART 1 of MSC.81(70); Paragraph 4.4.1.5.2 of LSA Code
	Drop test		X	X	Paragraphs 7.2.2 and 7.2.3, PART 1 of MSC.81(70); Paragraph 4.4.1.5.2 of LSA Code
4	Inspection after impact and drop tests		X	X	Paragraph 6.4.7, PART 1 of MSC.81(70)
5	Rescue boat seating strength test	Davit-launched rescue boat	X	X	Paragraph 6.6.1, PART 1 of MSC.81(70)
6	Rescue boat seating test		X	X	Paragraph 7.1.3, PART 1 of MSC.81(70)
7	Rescue boat freeboard and stability tests	Flooded stability test	X	X	Paragraphs 7.2.6, 7.2.7, PART 1 of MSC.81(70); Paragraph 4.6.3.3 of LSA Code
		Freeboard test	X	X	Paragraphs 7.2.4, 7.2.5, PART 1 of MSC.81(70); Paragraph 4.4.5.2 of LSA Code
8	Release mechanism test (where applicable)	Davit-launched rescue boat	X	X	Paragraphs 6.9.1 to 6.9.4, 6.9.6, PART 1 of MSC.81(70); Paragraphs 4.4.7.6.2, 4.4.7.6.5 of LSA Code
9	Rescue boat operation test	Speed and fuel consumption tests	X	-----	Paragraphs 7.1.5, 7.1.6, PART 1 of MSC.81(70); Paragraph 4.4.6.8 of LSA Code
		Speed and fuel consumption tests	-----	X	Paragraphs 7.1.6, 7.4.2, PART 1 of MSC.81(70); Paragraph 4.4.6.8 of LSA Code
		Engine-out-of-water test	X	X	Paragraphs 6.10.5, 7.7.10, PART 1 of MSC.81(70);
		Compass performance test	X	X	Paragraph 6.10.7, PART 1 of MSC.81(70)
		Survival recovery test	X	X	Paragraph 6.10.8, PART 1 of MSC.81(70); Paragraph 4.4.3.4 of LSA Code
10	Rescue boat towing and painter release test		X	X	Paragraph 6.11, PART 1 of MSC.81(70)
11	Righting test	Righting the inverted rescue boat	X	X	Paragraph 7.1.7, PART 1 of MSC.81(70)
12	Rowing test		X	X	Paragraph 7.1.8, PART 1 of MSC.81(70)
13	Towing liferaft test		X	X	Paragraph 7.1.2, PART 1 of MSC.81(70)
14	Self-righting test		-----	X	Paragraph 6.14, PART 1 of MSC.81(70)
15	Flooded capsizing test		-----	X	Paragraph 6.14, PART 1 of MSC.81(70)
16	Damage test	The test is not applicable where the boat has its waterline below the lower side of the inflated tube	X	X	Paragraphs 7.2.8, 7.2.9, 7.3.2, PART 1 of MSC.81(70)
17	Simulated heavy weather test		X	X	Paragraph 7.2.10, PART 1 of MSC.81(70)
18	Swamp test		X	X	Paragraph 7.2.11, PART 1 of MSC.81(70)
19	Mooring test	The test is not applicable where the boat has its waterline below the lower side of the inflated tube	X	X	Paragraph 7.2.15, PART 1 of MSC.81(70)

4.9 Delivery test items of products

4.9.1 Each rescue boat is subject to a unit/batch inspection as required by Table 4.9.1.

Rescue boat delivery test items **Table 4.9.1**

No.	Test items		Test requirements
1	Visual examination	Hull appearance, identification	IMO A.760(18); Paragraphs 4.4.6.12, 4.4.7.6.2.2 of LSA Code; Approved procedure
		Retro-reflective material	Paragraph 1.2.7 of LSA Code; IMO A.658(16)
2	Rescue boat release test	1.1 times its related load and suspended from its release mechanism(where applicable)	Paragraph 5.3.1, PART 2 of MSC.81(70); Paragraph 4.4.7.6 of LSA Code; MSC.218(82)
		Release when fully waterborne in the light condition	Paragraph 5.3.1, PART 2 of MSC.81(70); Paragraph 4.4.7.6 of LSA Code; MSC.218(82)
		Release when fully waterborne in a 10% overload condition(where applicable)	Paragraph 5.3.1, PART 2 of MSC.81(70); Paragraph 4.4.7.6 of LSA Code; MSC.218(82)
3	Operation test	All transmission gears, ahead and astern	Paragraph 5.3.3, PART 2 of MSC.81(70)
		Hand steering test	Paragraph 5.3.3, PART 2 of MSC.81(70)
		Inspection of electrical system	Paragraph 5.3.3, PART 2 of MSC.81(70)
		Speed measurement	Paragraph 5.3.3, PART 2 of MSC.81(70); Paragraph 5.1.4.4 of MSC.218(82) (fast rescue boats)
4	Load test	Strength test of the connection of the release gear fixed to the boat	Paragraph 5.3.4, Part 2 of MSC.226(82)

① According to the requirements of MSC.272(85) and MSC.274(85), the average body weight of passenger on the rescue boats above is assumed to be 82.5 kg instead of 75 kg.

4.9.2 Additional test items may be required where deemed necessary by the Surveyor.

4.9.3 The certificates of materials, components and attachments are to be examined as required in 4.5 of this Chapter.

4.10 Miscellaneous

Upon installation onboard, the rescue boat is to be tested in accordance with Paragraph 5.4, Part 2 of MSC.81(70) – Recommendation on Testing of Life-saving Appliances (where applicable), to confirm it is fully equipped and the attachments are valid, and the boat identification is to be examined in accordance with 4.4.9 of LSA Code.

CHAPTER 5 LAUNCHING AND EMBARKATION APPLIANCES

5.1 Application

5.1.1 This Chapter applies to the launching and embarkation appliances of the following survival craft provided onboard ships engaged on international voyages, with the configurations as specified in 5.1.2:

(1) davit-launched lifeboats;

(2) davit-launched rescue boats, davit-launched life-saving and rescue boats;

(3) davit-launched liferafts;

(4) free-fall lifeboats;

(5) fast rescue boats.

5.1.2 The launching appliances applicable to this Chapter have the following configurations:

(1) luffing arm davit appliance;

(2) sliding arm davit appliance;

(3) telescopic arm davit appliance;

(4) slewing arm launching appliance;

(5) free-fall lifeboat launching appliance;

(6) fast rescue boat launching appliance.

5.2 Basis for approval and inspection

5.2.1 For the purpose of this Chapter, the following documents apply:

(1) MSC.47(66), Chapter III of International Convention for the Safety of Life at Sea, 1974, and MSC.216(82);

(2) MSC.48(66), Chapter VI/6.1, International Life-saving Appliances Code (LSA Code), and MSC.218(82);

(3) MSC.81(70), PART 1/8 and PART 2/6, Recommendation on Testing of Life-saving Appliances, and MSC.226(82);

(4) ISO 15516-2006, Ships and Marine Technology — Launching Appliances for Davit-launched Lifeboats;

(5) CCS Rules for Materials and Welding and its amendments.

5.3 Definitions

5.3.1 The definitions given in Chapter III of the International Convention for the Safety of Life at Sea, the International Life-saving Appliances Code and ISO 15516 apply to this Chapter.

5.3.2 For the purpose of this Chapter:

(1) Hanging-off pendants mean an appliance, provided onboard a lifeboat as required in Regulation III/16.2 of SOLAS, for hanging-off the lifeboat to free the release gear for maintenance.

(2) Foul weather recovery strops mean an appliance, provided onboard a lifeboat for use in foul weathers as required in Regulation III/17.5 of SOLAS, for safety if heavy fall blocks constitute a danger to boarding persons.

5.4 Plans and documents

5.4.1 The following documents are to be submitted to CCS for approval when applying for products approval or inspection:

(1) main performance and specifications;

(2) general assembly;

(3) main components plan;

(4) schematic diagram and safety alarms of main systems;

(5) calculations;

(6) a list of physicochemical properties of main part materials;

(7) type test program.

5.4.2 The following documents are to be submitted to CCS for information when applying for products approval or inspection:

(1) main relevant acceptance criteria;

(2) technical conditions of products delivery acceptance;

(3) instruction manual (including maintenance manual).

5.5 Main components

5.5.1 The following purchased products used for launching appliances are to be furnished with CCS product certificates and to satisfy the intended use:

(1) davit hooks;

(2) wire ropes;

(3) loose gears;

(4) motors (50 kW and over);

(5) hydraulic pumps;

(6) winches;

(7) electrical control box;

(8) accumulator.

5.5.2 The following purchased products used for launching appliances are to be furnished with manufacturer's certification documents and to satisfy the intended use:

(1) motors (below 50 kW);

(2) electromagnetic (hydraulic) reversal valves;

(3) hydraulic motors;

(4) hydraulic cylinders;

(5) relief valves.

5.5.3 The design of automatic release hook used for davit liferaft launching appliances is to comply with the requirements in 6.1.5, Chapter VI of LSA Code and be subject to related tests in accordance with 8.2 of PART 1 and 6.2 of PART 2 of MSC.81(70).

5.6 Qualification of welding procedures

5.6.1 The welding procedures of the essential welding structural members, such as davit arms, frames, rotating supports, ramps, guide sheaves for launching appliances, are to be approved by CCS prior to manufacture.

5.7 Design and technical requirements

5.7.1 The technical requirements for launching appliances are given in Table 5.7.1.

Table 5.7.1

No.	Content	Paragraphs for approval and inspection	Remarks
1	Performance and arrangement	Paragraph 6.1.1.1 of LSA Code	The combination of trim, list and lightest load line may cause the over-length of embarkation ladders (III/11.7) and of falls (III/16.6), due to the increase of a ship's size. IACS has provided a reasonable less length, which is measured under the conditions of lightest load line, a list of 20°, and a trim that the highest point of bow is in water or the No.1 hold hatch coamings are flooded (whichever is the larger, but not more than 10°).
		Paragraph 6.1.1.2 of LSA Code	
		Paragraph 6.1.1.3 of LSA Code	Except for free-fall secondary launching appliances
		Paragraph 6.1.1.4 of LSA Code	
		Paragraph 6.1.1.7 of LSA Code	
		Paragraph 6.1.1.8 of LSA Code	
		Paragraph 6.1.1.10 of LSA Code	
		Paragraph 6.1.2.2 of LSA Code	The launching appliances using falls and winches; except for free-fall secondary launching appliances
		Reg.III/16.3 of SOLAS	
		Reg.III/17.1 of SOLAS	
		Paragraph 6.1.4 of LSA Code	Free-fall
		Paragraph 6.1.5 of LSA Code	Liferafts
		Reg.III/23 of SOLAS	Additional requirements for passenger ships
		Reg.III/33.1 of SOLAS	Additional requirements for cargo ships
		Reg.III/26.3 of SOLAS	Additional requirements for ro-ro passenger ship
2	Launching speed	Paragraph 6.1.2.8 of LSA Code	The launching appliances using falls and winches; except for free-fall secondary launching appliances
		Paragraph 6.1.2.9 of LSA Code	The launching appliances using falls and winches; except for free-fall secondary launching appliances
		Paragraph 6.1.2.10 of LSA Code	The launching appliances using falls and winches; except for free-fall secondary launching appliances; MSA required that for sea-going ships engaged on international voyages the maximum lowering speed ≤1.3 m/s
		Paragraph 5.1.1.4 of ISO 15516	
3	Recovery time and speed	Reg.III/17.4 of SOLAS	Rescue boats
		Paragraph 6.1.1.9 of LSA Code	
		Paragraph 5.1.2.2 of ISO 15516	
4	Strength and safety factor of design	Paragraphs 6.1.1.5, 6.1.1.6, 6.1.2.5 of LSA Code	The launching appliances using falls and winches
5	Materials	Paragraph 5.2.1 of ISO 15516	
6	Davit arms and frames	Paragraph 5.2.3 of ISO 15516	
7	Loose gears	Paragraph 5.2.4.1 of ISO 15516	

No.	Content	Paragraphs for approval and inspection	Remarks
8	Falls and drums	Paragraphs 6.1.2.3, 6.1.2.4 of LSA Code; Reg.III/16.6 of SOLAS; Paragraph 5.2.4.3 of ISO 15516; Paragraph 5.2.4.4 of ISO 15516; Paragraph 5.2.8 of ISO 15516	The launching appliances using falls and winches
9	Blocks and guide sheaves	Paragraph 5.2.5 of ISO 15516	
10	Safety means	Paragraph 6.1.2.7 of LSA Code; Paragraph 5.3, ISO 15516	The launching appliances using falls and winches
11	Brake	Paragraphs 6.1.2.5, 6.1.2.11, 6.1.2.12 of LSA Code	The launching appliances using falls and winches
12	Hand gears and operating device	Paragraph 6.1.2.6 of LSA Code	The launching appliances using falls and winches; except for free-fall secondary launching appliances
		Paragraph 5.2.12 of ISO 15516	
		Paragraph 5.2.15 of ISO 15516	
13	Bowsing gears and lifeline gears	Reg.III/11.8 of SOLAS; Reg.III/16.10 of SOLAS; Paragraph 5.2.7 of ISO 15516	
14	Launching controlled from a position within boats	Paragraph 5.2.14 of ISO 15516	
15	Hanging-off pendant units	Reg.III/16.2 of SOLAS	
16	Recovery strops units	Reg.III/17.5 of SOLAS	Rescue boats
17	Winches for fast rescue boats	Paragraph 5.2.13 of ISO 15516	Fast rescue boats
18	Maintenance	Reg.III/20 of SOLAS; Reg.III/36 of SOLAS; Paragraph 5.4 of ISO 15516	
19	Test and approval	Reg.III/4 of SOLAS; MSC.81(70)1/8.1 and 2/6.1	

5.7.2 Additional technical requirements

(1) The safe working load of the hanging-off pendants and recovery strops as required by Regulation III/16.2 and 17.5 of SOLAS is not to be less than the design lifting load of launching appliances, and the test load is to be 2.2 times its safe working load.

(2) The materials containing asbestos are prohibited in the brake-block and clutch disk for the winches of the launching appliances so as to meet the requirement of Regulation II-1/3.5 of SOLAS.

(3) The hydraulic system of the launching appliances is subject to the tightness test under 1.25 times the design pressure (but not to exceed the design pressure plus 7 MPa). The piping of hydraulic system is subject to the pressure test under 1.5 times the design pressure (but not to exceed the design pressure plus 7 MPa). And the relief valves of the hydraulic system are subject to performance test.

5.8 Type test

5.8.1 Selection of typical samples is to comply with the following requirements.

(1) When applying for type approval of single type of product, the applicant may randomly select one for type test.

(2) When applying for type approval of different types of the same model of products, the applicant may select one of representative or with maximum size for type test.

(3) In renewal test, at least one sample of the same structure and configuration is to be selected.

5.8.2 Type test items

(1) The type test items for launching appliances are given in Table 5.8.2(1).

Table 5.8.2(1)

No.	Test items	Test loads	Simulated shipboard condition	Paragraphs for approval and inspection to be complied with	Remarks
1	Loose gear test	/	/	See Table 5.8.2(2) of this Chapter	
2	Hydraulic system test	/	/	See Table 5.8.2(3) of this Chapter	
3	Winch test	/	/	See Table 5.8.2(4) of this Chapter	
4	Launching test	Lightest launching load	List of 0°, Trim of 0°	Items 1, 2, Table 7, paragraph 6.3.1 of ISO 15516; MSC.81(70)1/8.1.2	For free-fall secondary launching appliances, the test is in the condition of list 2°, and trim 5°
			Inboard list of 20°,Trim of 10°		
5	Recovery test	Maximum recovery load	List of 0°, Trim of 0°	Item 3, Table 7, paragraph 6.3.1 of ISO 15516; MSC.81(70)1/8.1.3; MSC.81(70)2/6.1.9 and 2/6.1.10	
		Maximum working load		MSC.218(82) 6.1.7.5	Fast rescue boat
6	Dynamic load test	1.1 times maximum working load	List of 0°, Trim of 0°	Items 4-6, Table 7, paragraph 6.3.1 of ISO 15516; MSC.81(70)1/8.1.2; MSC.81(70)1/8.1.3; paragraph 6.1.4.7 of LSA Code	For free-fall secondary launching appliances, the test is in the condition of list 2°, and trim 5°
			Inboard list of 20°, Trim of 10°		
7	Static load test	2.2 times maximum working load	List of 0°, Trim of 0°	Items 7-9, Table 7, paragraph 6.3.1 of ISO 15516; MSC.81(70)1/8.1.1	Free-fall secondary launching appliances
			Inboard list of 20°, Trim of 10°		
			Outboard list of 20°, Trim of 10°		
8	Operation in a sea state	Maximum working load	Foul sea state	MSC.81(70)1/8.1.8	Fast rescue boats

(2) The type test items for loose gears of launching appliances are given in Table 5.8.2(2).

Table 5.8.2(2)

No.	Test items	Test loads	Paragraphs for approval and inspection to be complied with	Remarks
1	Static load test	2.2 times maximum working load	Table 4, paragraph 6.1 of ISO 15516; paragraph 6.1.1.5 of LSA Code	

(3) The type test items for hydraulic systems of launching appliances are given in Table 5.8.2(3).

Table 5.8.2(3)

No.	Test items	Test pressure	Test methods	Requirements	Remarks
1	Pressure/tightness test	1.5/1.25 times design pressure	Piping/hydraulic system to keep test pressure for at least 5 min	No leaking	
2	Relief valve performance test	Set pressure of relief valve	Increase the pressure of hydraulic system to the relief valve set pressure	Satisfactory operation of the relief valve	

(4) The type test items for winches of launching appliances are given in Table 5.8.2(4).

Table 5.8.2(4)

No.	Test items	Test loads	Paragraphs for approval and inspection to be complied with	Remarks
1	No load test	No load	Item 1, Table 5, paragraph 6.2.1 of ISO 15516	
2	Powered hoisting test	Hoisting load of winch	Item 2, Table 5, paragraph 6.2.1 of ISO 15516	
			Paragraph 6.1.1.9 of LSA Code; MSC.81(70)1/8.1.5	Rescue boats
3	Lowing test	Maximum setting load of winch	Item 3, Table 5, paragraph 6.2.1 of ISO 15516; paragraph 6.1.2.8 of LSA Code; paragraph 6.1.2.9 of LSA Code; paragraph 6.1.2.11 of LSA Code	Except for free-fall
			MSC.81(70)1/8.1.8	Fast rescue boats
4	Dynamic load launching test	1.1 times maximum working load of winch	Item 4, Table 5, paragraph 6.2.1 of ISO 15516; paragraph 6.1.2.5.2 of LSA Code; MSC.81(70)1/8.1.4	
5	Static load test	1.5 times maximum working load of winch	Item 5, Table 5, paragraph 6.2.1 of ISO 15516; paragraph 6.1.2.5.1 of LSA Code; MSC.81(70)1/8.1.4	
6	Manually hoisting test	Hoisting load of winch	Item 6, Table 5, paragraph 6.2.1 of ISO 15516; paragraph 6.1.2.6 of LSA Code; MSC.81(70)1/8.1.6	
		1.5 times the weight of all loose gears	Item 7, Table 5, paragraph 6.2.1 of ISO15516; MSC.81(70)1/8.1.6	If the winch is designed for quick recovery by hand with no load
7	Overhauling of winch after test		MSC.81(70)1/8.1.7	

5.9 Unit/batch inspection

5.9.1 Inspection items

(1) The inspection of launching appliances is to be carried out after type approval, which includes information examination, manufacturing process inspection and function tests.

(2) The inspection of manufacturing process mainly includes material test, main parts and welds tests (if required), inspection of components manufacturing and assembly quality, etc.

(3) The main materials of launching appliances, such as transmission shaft, gears, guide sheaves, sheave shaft, suspension chains, main strength steel plate, etc. are subject to mechanical performance test.

(4) The launching appliances are classified in terms of configurations and specifications. The first product is subject to type test according to 5.8 of this Chapter, while the subsequent products are to be tested according to the approved product test items.

5.9.2 The records or reports to be submitted by the manufacturer are to contain at least:

(1) the material quality warranty and/or physicochemical review report of the main product parts processed in the manufacturer;

(2) the qualification documents and relevant certificates of main purchased or outsourced products;

(3) the manufacturer's inspection, measuring and test conditions, and a list of test and inspection equipment for use and copies of their valid calibration certificates;

(4) the manufacturer's test report, which is to include the products or samples models, specifications, serial numbers., test place and date, test environment, test items and all test data, as well as the issues found in tests and inspection together with explanation for countermeasures, and test conclusions.

5.9.3 Test items of approved unit/batch inspection

(1) The test items for launching appliances are given in Table 5.9.3(1).

Table 5.9.3(1)

No.	Test items	Test loads	Simulated shipboard condition	Paragraphs for approval and inspection to be complied with	Remarks
1	Loose gear test	/	/	See Table 5.9.3(2) of this Chapter	
2	Hydraulic system test	/	/	See Table 5.9.3(3) of this Chapter	
3	Winch test	/	/	See Table 5.9.3(4) of this Chapter	
4	Launching test	Lightest launching load	List of 0°, Trim of 0°	Item 1, Table 7, paragraph 6.3.1 of ISO 15516; MSC.81(70)2/6.1.3	
5	Recovery test	Maximum recovery load	List of 0°, Trim of 0°	Item 3, Table 7, paragraph 6.3.1 of ISO 15516; MSC.81(70)1/8.1.3; MSC.81(70)2/6.1.9 and 2/6.1.10	
6	Dynamic load test	1.1 times maximum working load	List of 0°, Trim of 0°	Item 4, Table 7, paragraph 6.3.1 of ISO 15516; MSC.81(70)2/6.1.5	
7	Static load test	2.2 times maximum working load	List of 0°, Trim of 0°	Item 4, Table 8, paragraph 6.3.1 of ISO15516; MSC.81(70)2/6.1.1	

(2) The test items for loose gears of launching appliances are given in Table 5.9.3(2).

Table 5.9.3(2)

No.	Test items	Test loads	Paragraphs for approval and inspection to be complied with	Remarks
1	Static load test	2.2 times maximum working load	Table 4, paragraph 6.1 of ISO 15516; paragraph 6.1.1.5 of LSA Code	Exempt from the test when solely having a CCS product certificate.

(3) The test items for hydraulic systems of launching appliances are given in Table 5.9.3(3).

Table 5.9.3(3)

No.	Test items	Test pressure	Test methods	Requirements	Remarks
1	Pressure/tightness test	1.5/1.25 times design pressure	Piping/hydraulic system to keep test pressure for at least 5 min	No leaking	

(4) The test items for winches of launching appliances are given in Table 5.9.3(4).

Table 5.9.3(4)

No.	Test items	Test loads	Paragraphs for approval and inspection to be complied with	Remark
1	No load test	No load	Item 1, Table 5, paragraph 6.2.1 of ISO 15516	
2	Powered hoisting test	Hoisting load of winch	Item 2, Table 5, paragraph 6.2.1 of ISO 15516	
			Paragraph 6.1.1.9 of LSA Code; MSC.81(70)1/8.1.5 and 2/6.1.11;	Rescue boat
3	Lowering test	The load held by falls at the winch drum when loading a fully-loaded boat	Item 3, Table 6, paragraph 6.2.1 of ISO 15516; Paragraphs 6.1.2.8, 6.1.2.9, 6.1.2.11 of LSA Code; MSC.81(70)2/6.1.2; MSC.81(70)2/6.1.3; MSC.81(70)2/6.1.7;	Except for free-fall
		The load held by falls at the winch drum when loading a non-loaded boat		
4	Dynamic load test	1.1 times the calculated load of the winch when loading a fully-loaded boat	Item 4, Table 6, paragraph 6.2.1 of ISO 15516; MSC.81(70)2/6.1.5	
5	Static load test	1.5 times maximum working load of winch	Item 5, Table 5, paragraph 6.2.1 of ISO 15516; paragraph 6.1.2.5.1 of LSA Code; MSC.81(70)1/8.1.4 and 2/6.1.1	

CHAPTER 6 LIFEBOATS

6.1 Application

6.1.1 This Chapter applies to the lifeboats and lifeboats combined as rescue boats provided onboard ships engaged on international voyages.

6.2 Basis for approval and inspection

6.2.1 The approval and inspection of lifeboats are based on the following documents:

(1) Chapter III of International Convention for the Safety of Life at Sea, 1974, and MSC.216(82), MSC.317(89);

(2) MSC.48(66), Chapters I and IV, International Life-saving Appliances Code (LSA Code), and MSC.207(81) , MSC.218(82), MSC.272(85), MSC.320(89);

(3) MSC.81(70), Recommendation on Testing of Life-saving Appliances, and MSC.226(82), MSC.274(85), MSC.321(89), MSC.323(89);

(4) CCS Rules for Materials and Welding and its amendments;

(5) IMO Resolution A.658(16), Recommendation on the Use and Fitting of Retro-reflective Material on Life-saving Appliances, and its amendments;

(6) IMO Resolution A.760(18), Symbols Related to Life-saving Appliances and Arrangements, and its amendments.

(7) IMO Resolution A.657(16) Instructions for Action in Survival Craft, and its amendments;

(8) MSC/Circ.1006, Guidelines on Fire Test Procedures for Acceptance of Fire-retardant Materials for the Construction of Lifeboats, and its amendments.

Note: MSC.317(89), MSC.320(89) and MSC.321(89) will enter into force on 1 Jan 2013.

6.3 Definitions

6.3.1 For the purpose of this Chapter:

(1) Length means a horizontal distance measured between the fore and aft outer hull plates of a rescue boat.

(2) Breadth of boat means a horizontal distance measured between the widest outer hull plates of a rescue boat.

(3) Depth of boat means a vertical distance measured at the mid-boat from the lower edge of keel to the upper edge of the gunwale angle.

(4) Freeboard of an open boat means a distance measured at the mid-boat from the full-load waterline to the upper edge of the side opening.

(5) Freeboard of an enclosed boat means a distance measured at the mid-boat from the full-load waterline to the canopy or to the upper edge of the lowest opening of enclosed cover.

(6) Gross weight means a total weight of a fully equipped lifeboat (including engines, fully-loaded fuel, spare parts and attachments, etc.) and the rated number of persons.

6.4 Plans and documents

6.4.1 The following documents are to be submitted to CCS for approval:

(1) internal and external general arrangement;

(2) hydrostatic curves;

(3) cross-sectional drawing;

(4) lines and offsets ;

(5) stability calculations (light loading, full loading, open to sea and capsizing (for self-righting boats) conditions to be calculated respectively);

(6) arrangement of reserve buoyancy;

(7) calculation of reserve buoyancy volume;

(8) hull construction and strength calculation;

(9) strength calculations of boat-hooks fixed base;

(10) arrangement and installation of engine, shafting and propeller;

(11) arrangement and installation of steering system;

(12) arrangement and installation of releasing system;

(13) arrangement and installation of painter release mechanism;

(14) arrangement and installation of spraying system (for fire-protected lifeboats);

(15) arrangement and installation of air-supply system for engines and persons (for lifeboats with a self-contained air support system);

(16) arrangement and installation of seats and safety belts (safety harness - for free-fall lifeboats);

(17) arrangement and installation of vessels and tanks;

(18) arrangement and installation of doors, windows and openings (for partially enclosed and totally enclosed lifeboats);

(19) arrangement and installation of draining valves (not applicable for free-fall lifeboats);

(20) arrangement and installation of electrical system;

(21) molding technical documents;

(22) type test program;

(23) name plate.

6.4.2 The following documents are to be submitted to CCS for information:

(1) a list of raw materials and accessories (names, models, performance parameters and suppliers);

(2) a list of attachments;

(3) instruction manual;

(4) maintenance and repair manual (including the release system).

6.5 Main components and parts

6.5.1 The following materials of the lifeboats are to be furnished with CCS approval certificates

(1) buoyant material;

(2) resin;

(3) glass fabric;

(4) retro-reflective tape.

6.5.2 The following components and fittings installed on lifeboats are to be furnished with CCS products certificates:

(1) engine;

(2) gas cylinder;

(3) position-indicating lights;

(4) lifting hooks;

(5) batteries and battery charger.

6.5.3 The following attachments provided onboard lifeboats are to be furnished with CCS products certificates:

(1) operational compass;

(2) sea-anchor;

(3) fresh water or manually powered reverse osmosis desalinator;

(4) ration;

(5) rocket parachute flares, hand flares, buoyant smoke signals;

(6) first-aid outfit;

(7) manual pump;

(8) portable fire-extinguisher;

(9) searchlight;

(10) radar reflector or survival craft radar transponder;

(11) thermal protective aids.

6.6 Procedure approval

6.6.1 The procedure approval is to be carried out in accordance with the requirements in Chapter 3, PART TWO of CCS Rules for Materials and Welding.

6.7 Design and technical requirements

6.7.1 The design and manufacturing of the products are to comply with the applicable requirements in Chapter III of International Convention for the Safety of Life at Sea, 1974, and its amendments, MSC.48(66), Chapters I and IV, International Life-saving Appliances Code (LSA Code) and its amendments, MSC.81(70), Recommendation on Testing of Life-saving Appliances, as amended, and its amendments.

6.7.2 The hull and rigid top cover (internal and external) must be made of alkali-free glass fiber materials; the hull and rigid top cover (internal and external) and engine hood are to be made of flame retardant materials.

6.8 Type test

6.8.1 Selection of samples

In type approval, each model of the lifeboat as specified in this Chapter is to be selected for type test.

6.8.2 Type test items and requirements

The test items for lifeboats include visual examination, general tests and additional tests, to be given respectively Tables 6.8.2(1), 6.8.2(2) and 6.8.2(3).

Lifeboat type test items – visual examination Table 6.8.2(1)

No.	Test items		Test methods and requirements
1	Verification of basic parameters		Parameter tolerance: gross weight ±5%; boat length ±0.5%; breadth ±1.0%; depth ±1.0%
2	Vertical distance of the boat		Paragraph 4.4.1.8 of LSA Code
3	Identification	Marks for start engine, secure hatches, etc.	IMO A.760(18)
4	Persons and seats	Seat size (for davit boat)	Paragraph 4.4.2.2.2 of LSA Code
		Seat size (for free-fall boat)	Paragraph 4.7.2 of MSC.272 (85)
		Indication	Paragraph 4.4.2.3 of LSA Code
		Arrangement (for totally enclosed boat)	Paragraph 4.6.2.10 of LSA Code
		Safety belts (for totally enclosed boat) Safety harness (for free-fall boat)	Paragraph 4.6.3.1 of LSA Code
5	Power units	Engine, battery casing	Paragraphs 4.4.6.2, 4.4.6.9 of LSA Code
		Exhaust pipeline protection	Paragraph 4.4.6.6 of LSA Code
		Propulsion system safety	Paragraph 4.4.6.7 of LSA Code
		Operation instruction	Paragraph 4.4.6.12 of LSA Code
6	Release mechanism	Reset indication	Paragraph 4.4.7.6.3 of MSC.218(82); Paragraph 4.4.7.6.8 of MSC.320(89)
		Maintenance equipment	Paragraph 4.4.7.6.7 of MSC.218(82); Paragraph 4.4.7.6.13 of MSC.320(89)
		Operational handle	Paragraph 4.4.7.6.6 of MSC.218(82); Paragraph 4.4.7.6.12 of MSC.320(89)
		Operation instruction and warning indication	Paragraph 4.4.7.6.5 of MSC.218(82); Paragraph 4.4.7.6.11 of MSC.320(89)
		Colour (for free-fall boat)	Paragraph 4.7.6.1 of LSA Code
7	View for boat operator		Paragraph 4.4.7.12 of LSA Code
8	Colour of lifeboat	Partially enclosed boat	Paragraphs 4.5.2.4, 4.5.3 of LSA Code
		Totally enclosed boat	Paragraph 4.6.2.8 of LSA Code
9	Retro-reflective material		Paragraph 1.2.7 of LSA Code; IMO A.658(16)

No.	Test items		Test methods and requirements
10	Fittings and attachments	Boarding ladder	Paragraph 4.4.3.3 of LSA Code
		Draining valve	Paragraph 4.4.7.1 of LSA Code
		Rudder	Paragraph 4.4.7.2 of LSA Code
		Lifeline	Paragraph 4.4.7.3 of LSA Code
		Handholds on hull floor (for not a self-righting boat)	Paragraph 4.4.7.4 of LSA Code
		Hatches (for totally enclosed boat)	Paragraphs 4.6.2.3, 4.6.2.4 of LSA Code
		Windows (for totally enclosed boat)	Paragraph4.6.2.7 of LSA Code
		Handrails (for totally enclosed boat)	Paragraph 4.6.2.9 of LSA Code
		Fitting of antenna (where applicable)	Paragraph 4.4.7.8 of LSA Code
		Position-indicating light	Paragraph 4.4.7.10 of LSA Code and MSC.218(82)
		Illumination light	Paragraph 4.4.7.11 of LSA Code and MSC.218(82)
		Attachments	Paragraph 4.4.8 of LSA Code; Paragraph 5.1.2.2.4/6 (combined as rescue boat) of LSA Code

Lifeboat type test items – general tests Table 6.8.2(2)

No.	Test items		Test methods and requirements
1	Lifeboat material test	Material fire-retardant performance	Paragraph 6.2, PART 1 of MSC.81(70); MSC/Circ.1006
2	Lifeboat overload test	Davit-launching lifeboat	Paragraphs 6.3.1-6.3.6, PART 1 of MSC.81(70)
		Free-fall lifeboat	Paragraphs 6.3.7-6.3.9, PART 1 of MSC.81(70)
3	Impact test, drop test of davit-launched lifeboat		Paragraph 6.4, PART 1 of MSC81(70); Paragraph 4.4.1.5.2 of LSA Code
4	Free-fall launching test of free-fall lifeboat		Paragraph 6.5, PART 1 of MSC.81(70); Paragraphs 4.7.3.1-4.7.3.2 and 4.7.5 of LSA Code
5	Lifeboat seating strength test	Davit-launched lifeboat	Paragraph 6.6.1, PART 1 of MSC.81(70)
		Free-fall lifeboat	Paragraph 6.6.2, PART 1 of MSC.81(70)
6	Lifeboat seating space test		Paragraph 6.7, PART 1 of MSC.81(70); Paragraphs 4.4.3.1 and 4.4.3.2, PART 1 of MSC.218(82);
7	Lifeboat freeboard and stability tests	Flooded stability test	Paragraphs 6.8.1-6.8.3, PART 1 of MSC.81(70); MSC.226(82); Paragraph 4.6.3.3 of LSA Code
		Freeboard test	Paragraphs 6.8.4, 6.8.5, PART 1 of MSC.81(70) Paragraph 4.4.5.2 of LSA Code
8	Release mechanism test	Davit-launched lifeboat	Paragraphs 6.9.1-6.9.3 and 6.9.6, PART 1 of MSC.81(70); Paragraph 6.9.4, PART 1 of MSC.226(82); Paragraphs 4.4.7.6.2, 4.4.7.6.5 of LSA Code; Paragraphs 6.9.1-6.9.5, PART 1 of MSC.321(89)
		Free-fall lifeboat	Paragraphs 6.9.5-6.9.6, PART 1 of MSC.81(70); Paragraphs 4.7.6.2-4.7.6.4 of LSA Code
9	Lifeboat operation test	Speed and fuel consumption tests	Paragraph 6.10.1, PART 1 of MSC.81(70); MSC.226(82); Paragraph 4.4.6.8 of LSA Code
		Engine-out-of-water test	Paragraph 6.10.5, PART 1 of MSC.81(70)
		Compass performance test	Paragraph 6.10.7, PART 1 of MSC.81(70)
		Survival recovery test	Paragraph 6.10.8, PART 1 of MSC.81(70); Paragraph 4.4.3.4 of LSA Code
		Rowing test	Paragraph 4.6.2.5 of LSA Code
10	Lifeboat towing and painter release test		Paragraph 6.11, PART 1 of MSC.81(70)

Lifeboat type test items – additional tests Table 6.8.2(3)

No.	Test items		Test methods and requirements
1	Partially enclosed lifeboat	Cover and canopy	Paragraphs 4.5.2and 4.5.3 of LSA Code
		Canopy erection test	Paragraph 6.13, PART 1 of MSC.81(70)
		Two-way VHF radiotelephone apparatus (where applicable)	Paragraph 4.5.4 of LSA Code
2	Totally enclosed lifeboat	Self-righting test	Paragraphs 6.14.1, 6.14.2, PART 1 of MSC.81(70); Paragraph 4.6.3.1 of LSA Code
		Flooded capsizing test	Paragraphs 6.14.3-6.14.5, PART 1 of MSC.81(70) Paragraph 4.6.3.3 of LSA Code
		Rowing test	Paragraph 4.6.2.5 of LSA Code
		Pressure test	Paragraph 4.6.2.11 of LSA Code
		Watertight test	Paragraph 4.6.2.2 of LSA Code
3	Self-contained air support lifeboat	Pressure test	Paragraph 6.15, PART 1 of MSC.81(70); MSC.226(82)
4	Fire-protected lifeboat	Fire test	Paragraphs 6.16.1-6.16.7, PART 1 of MSC.81(70)
		Water spray test	Paragraphs 6.16.8-6.16.10, PART 1 of MSC.81(70)
5	combined as rescue boat	Towing test	Paragraph 7.1.2, PART 1 of MSC.81(70); MSC.226(82)
		Seating test	Paragraph 7.1.3, PART 1 of MSC.81(70); MSC.226(82)
		Overload test	Paragraph 7.1.4, PART 1 of MSC.81(70)
		Righting test	Paragraph 7.1.7, PART 1 of MSC.81(70); MSC.226(82)
		Manoeuvrability test	Paragraph 7.1.8, PART 1 of MSC.81(70)

Notes: ① All closed entrances and seams of a lifeboat are to be hose tested, directed at the entrances or seams through a 16 mm hose from a point 3 m away under a pressure of 0.1 Mpa, to demonstrate that no obvious leakage is found on the reverse side (or equivalent method may be used);

② The specimen of the hull for material test is to be made in the same condition, with the same material, same layer structure and same techniques as those for the hull;

③ According to the requirements of MSC.272(85) and MSC.274(85), the average body weight of passengers on the above lifeboats for cargo ships is assumed to be 75 kg instead of 82.5 kg.

6.9 Unit/batch inspection

6.9.1 Each new-built lifeboat applying for a marine product certificate of lifeboat is subject to inspection and test in accordance with Table 6.9.1.

6.9.2 Additional test items may be required where deemed necessary by the Surveyor.

6.9.3 The certificates for materials, components and fittings, attachments for use onboard lifeboats are to comply with 6.5 of this Chapter.

Lifeboat delivery test items **Table 6.9.1**

No.	Test items		Test methods and requirements
1	Visual examination	Hull appearance, identification	IMO A.760(18); Paragraphs 4.4.6.12, 4.4.7.6.2.2 of LSA Code; MSC.218(82); Approved procedure
		Verification of basic parameters	Table 9.1
		Retro-reflective material	Paragraph 1.2.7 of LSA Code; IMO A.658(16)
2	Davit lifeboat release test	1.1 times its related load and suspended from its release mechanism	Paragraph 5.3.1, PART 2 of MSC.81(70); Paragraph 4.4.7.6.2 of LSA Code; MSC.218(82)
		Release when fully waterborne in the light condition	Paragraph 5.3.1, PART 2 of MSC.81(70) Paragraph 4.4.7.6.2 of LSA Code; MSC.218(82)
		Release when fully waterborne in a 10% overload condition	Paragraph 5.3.1, PART 2 of MSC.81(70) Paragraph 4.4.7.6.2 of LSA Code; MSC.218(82)
3	Free-fall launching test of free-fall lifeboat	As for required launching height, ramp length and angle	Paragraph 5.3.2, PART 2 of MSC.81(70)
4	Operation test	All transmission gears, ahead and astern	Paragraph 5.3.3, PART 2 of MSC.81(70)
		Hand steering test	Paragraph 5.3.3, PART 2 of MSC.81(70)
		Inspection of electrical system	Paragraph 5.3.3, PART 2 of MSC.81(70)
		Speed measurement	Paragraph 5.3.3, PART 2 of MSC.81(70)
		Air-supply test	Paragraph 5.3.3, PART 2 of MSC.81(70)
		Water spray test	Paragraph 5.3.3, PART 2 of MSC.81(70)
5	Watertight test (for totally enclosed lifeboat)		Paragraph 4.6.2.2 of LSA Code Table 6.8.2(3)
6	Load test	Strength test of the connection of the release gear fixed to the boat	Paragraph 5.3.4, PART 2 of MSC.226(82)

6.10 Miscellaneous

Upon installation onboard, the lifeboat is to be tested, where applicable, in accordance with Paragraph 5.4, PART 2 of MSC.81(70) – Recommendation on Testing of Life-saving Appliances, and examined to confirm it is fully equipped and the attachments are valid, and the boat identification is to be examined in accordance with Paragraph 4.4.9 of LSA Code.

PART SIXTEEN POLLUTION PREVENTION EQUIPMENT

CHAPTER 5 MARINE SEWAGE TREATMENT PLANTS

5.1 Application

5.1.1 This Chapter applies to the type approval and inspection of marine sewage treatment plants.

5.2 Basis for approval and inspection

5.2.1 The approval and inspection of marine sewage treatment systems in this Chapter are to be based on the following documents:

(1) Annex IV – Regulations for the Prevention of Pollution by Sewage from Ships of MARPOL 73/78;

(2) IMO MEPC.159(55) – Revised Guidelines on Implementation of Effluent Standards and Performance Tests for Sewage Treatment Plants;

(3) PART 3 "Specifications for Environmental Testing for Type Approval of Pollution Prevention Equipment", Annex of IMO MEPC.107(49) – Revised Guidelines and Specifications for Pollution Prevention Equipment for Machinery Space Bilges of Ships;

5.2.2 The paragraphs in the above mentioned basis for approval and inspection quoted are part of this Chapter. For quoted documents marked with the date, their subsequent amendments (except corrigenda) or revisions will be inapplicable, hence, it is to meet the requirements of the latest edition of these documents during the product design, manufacture and inspection. However, for those quoted documents without any date marked, the latest edition applies to this Chapter.

5.3 Terms and definitions

5.3.1 For the purpose of this Chapter:

(1) Grey water is drainage from dishwater, shower, laundry, bath and washbasin drains.

(2) Sewage means:

① drainage and other wastes from any form of toilets and urinals;

② drainage from medical premises (dispensary, sick bay, etc) via wash basins, wash tubs and scuppers located in such premises;

③ drainage from spaces containing living animals; or

④ other waste waters when mixed with the drainages defined above.

(3) Sewage treatment plant means a plant which is applied to reduce the index of thermotolerant coliforms, suspended solids and biochemical oxygen demand in sewage by means of biochemical, electrolysis methods in addition to dilution.

(4) Chemical oxygen demand (COD) means the amount of oxidant consumed during the treatment of the water sample under specific conditions. This index is to reflect the reducing substances in water and also the index to measure the content of organic substances in water, in mg/l.

(5) Total suspended solidity (TSS) means solidity which is in a suspension state in water. Method of testing is to be by filtration of representative sample through a 0.45 ìm filter membrane, drying at 105°C and weighing; or centrifuging of a representative sample (for at least five minutes with mean acceleration of 2,800-3,200 g), drying at least 105°C and weighing; or other internationally accepted equivalent test standard, in mg/l.

(6) 5-day biochemical oxygen demand (BOD5): biochemical oxygen demand means the difference of the dissolved oxygen of the water samples before and after storage for incubation. BOD5 means a mass concentration of dissolved oxygen consumed under specified conditions by the biological oxidation (organic matter in particular) in water at a temperature of 20±1℃, where the incubation time is 5 days, in mg/l.

(7) Thermotolerant coliforms means the group of coliform bacteria which produce gas from lactose within 48 hours at the temperature of 44.5ºC, in quantity (geometric mean)/100 ml.

(8) Testing onboard means testing carried out on a sewage treatment plant that has been installed upon a ship.

(9) Testing ashore means testing carried out on a sewage treatment plant prior to installation e.g. in the factory.

5.4 Plans and documents

5.4.1 Unless specified otherwise by CCS, the following plans and technical documents are to be submitted by the applicant to CCS when applying for approval of marine sewage treatment plants.

5.4.2 The following plans and documents are to be submitted to CCS for approval:

(1) Product performance specifications, including at least the following:

① designed treatment capability: hydraulic loading and organic loading, etc.;

② working temperature, range of salinity;

③ emission standard: thermotolerant coliforms, total suspended solids (TSS), chemical oxygen demand (COD), 5-day biochemical oxygen demand (BOD5), residual chlorine (if chlorine is used for disinfection), pH value, etc.;

④ if the sewage treatment plant is marked with “number of persons in use”, the following values are to be contained in the type approval certificate issued by CCS: BOD5 flowing into the raw sewage during the type test, in mg/l; hydraulic loading for each person per day, in l/p.d; organic loading for each person per day, in gBOD5. For sewage treatment plant equipped onboard ships flying the flag of China, the designed hydraulic loading is not to be less than 70 l/p.d., while the designed organic loading is not to be less than 35gBOD.

(2) General assembly plan, tank plan;

(3) Schematic diagram or flow chart of main systems and safety alarm plan;

(4) electrical diagram;

(5) Type test program (when applying for type approval by CCS);

(6) Routine test/inspection program.

5.4.3 The following plans and documents are to be submitted to CCS for information:

(1) Products instruction manual including at least:

① number of persons in use advised by the manufacturer;

② types of sewage for treatment: clearly indicating the types of sewage whether black water (as defined in 5.3.1(2) of this Chapter) or grey water. If the sewage is black water, requirements for the hydraulic loading and organic loading of the greywater added into the sewage treatment plant, proportion of the greywater/black water added, deoiling before adding are to be specified;

③ types of flushing and backflushing water (fresh/sea water, including range of salinity, compressed air, steam, etc.);

④ capacity of the plant: average, maximum and minimum hydraulic loading;

⑤ working principles and steps of operation (flowchart included), malfunction and handling measures, maintenance and specifications for main equipment /parts; Where a disinfectant is used by the equipment, the concentration and dose used are to be clearly specified;

⑥ discharged water pressure.

(2) Calculations: including sewage retaining time, organic loading, air-supply amount (applicable to sewage treatment plant by means of biochemistry), type selection calculation for membrane, ultra-violet sterilizer and ozone generator, the rolling strength of large sewage treatment plant under service conditions of the ship, etc.;

(3) list, types and technical parameters of main accessories (if any): such as comminuting pump, air pump, circulating pump, discharge pump, vacuum drencher pump, dosing pump, ultra-violet sterilizer, ozone generator, film and electrolyzer;

(4) Drawing of nameplate.

5.5 Main components and parts

5.5.1 Main components:

(1) discharge pump;

(2) comminuting pump, circulating pump;

(3) air pump;

(4) electrical control box;

(5) disinfectant equipment and parts: membrane , ultra-violet sterilizer, ozone generator;

(6) vacuum collector (vacuum drencher pump);

(7) electrolyzer.

5.5.2 The following components are to be provided with CCS Marine Product Certificate:

(1) electrical control box: to be tested to verify compliance with PART 3 “Specifications for Environmental Testing for Type Approval of Pollution Prevention Equipment”, Annex of IMO MEPC.107(49) – Revised Guidelines and Specifications for Pollution Prevention Equipment for Machinery Space Bilges of Ships;

(2) ultra-violet sterilizer.

5.5.3 The following components are to be provided with the qualification certificates by the manufacturer:

(1) disinfectant equipment and components: membrane, ozone generator;

(2) motor, electrolyzer;

(3) Special consideration is to be given where the pumps are only provided with the qualification certificates by the manufacturer.

5.6 Design and technical requirements

5.6.1 Environmental condition:

(1) Sewage treatment plant is to be capable of operating normally when:

① the ship has a $\pm 15^{o}$ heel, or $\pm 22.5^{o}$ roll, or $\pm 5^{o}$ trim or $\pm 7.5^{o}$ pitch;

② ambient temperature is under 0 ～ 55℃ ;

③ relative humidity is ≤ 90%;

④ the sewage treatment plant is at angles of inclination of 22.5° in any plane from the normal operating position.

5.6.2 Standards for effluents

(1) Thermotolerant Coliform Standard: The geometric mean of the thermotolerant coliform count of the samples of effluent is not exceed 100 thermotolerant coliforms/100 ml as determined by membrane filter, multiple tube fermentation or an equivalent analytical procedure.

(2) Total Suspended Solids (TSS) Standard (see 4.1 of Resolution MEPC.159(55) for detail):

① Where the sewage treatment plant is tested ashore, the geometric mean of the total suspended solids content of the samples of effluent taken during the test period is not to exceed 35 mg/l.

② Where the sewage treatment plant is tested onboard ship, the geometric mean of the maximum allowed TSS is not to be greater than the TSS content of the flushing water plus 35 mg/l (see 4.2 of MEPC.159(55) for detail).

(3) Biochemical Oxygen Demand: the geometric mean of 5-day Biochemical Oxygen Demand (BOD5) of the samples of effluent taken during the test period is not to exceed 25 mg/l.

(4) Chemical Oxygen Demand: the Chemical Oxygen Demand (COD) of the samples of effluent taken during the test period is not to exceed 125 mg/l.

(5) pH : the pH of the samples of effluent taken during the test period is to be between 6 and 8.5.

(6) Residual chlorine: when chlorine is used as a disinfectant, the residual chlorine in the samples of effluent taken during the test period is to be below 0.5 mg/l.

5.6.3 Requirements for structure and attachments

(1) Proper holes are to be fitted for the purpose of draining, cleaning, inspection and maintenance.

(2) Venting pipe connection led to atmosphere is to be fitted. For the sewage treatment plant probably generating explosive gas, a spark arrestor is to be fitted at the end of the venting pipe.

(3) Emergency overflow hole is to be fitted, normally in disinfection room, and above the high alarm level.

(4) Plant or equipment is to be so arranged that it easily to take samples of influent and effluent of sewage.

(5) Plant or equipment is to be arranged with effective means of corrosion prevention, etc.

5.7 Type test

5.7.1 The type test may be performed ashore in the simulation shipboard condition or onboard a ship in actual operating condition.

5.7.2 Selection of typical samples

(1) The test sample is to be full-scale sewage treatment plant.

(2) It can be confirmed according to calculations that the plants with various specifications of the same series are the same or similar in the working principle and manufacturing technique (the same series means the plants have the same sewage treatment principle and their sewage retaining time and unit BOD air-supply amount are basically consistent). The types with the worst designed conditions (factors such as inclination conditions, structural stability of large products under swaying motion conditions are to be considered) are to be selected (scaling is to be fully taken into account) from the series as the test sample to represent the whole series of sewage treatment plant by the unit conducting type approval of CCS according to the specific situations. The potential restrictions on the performance of sewage treatment plant due to the increasing and reducing of its size are to be fully considered. Sewage treatment plants with very large or very small size or with specific conditions may be approved by prototype test. If it is impossible to provide calculations to determine whether the sewage treatment plants with various specifications and types are the same series products, type test is to be carried out for each specification.

5.7.3 Type test items and requirements

(1) Inspection of appearance, size and assembly quality

① To inspect the appearance, size, quality of welding and inner and outer wall coatings of sewage treatment plant for confirming compliance with design requirements.

② To inspect the installation of pump, disinfectant equipment and components, pipeline valves, electrical control box and instruments for confirming compliance with design requirements.

(2) Water tightness test: each tank is subject to hydraulic test by a water column with 2.1 m pressure and it is to be confirmed that no leakage or deformation is to be found between the tanks or in the whole tank.

(3) Performance test:

① Raw sewage quality: For equipment tested ashore, the influent is to be fresh sewage consisting of fecal matter, urine, toilet paper and flushing water to which, for testing purposes, primary sewage sludge has been added as necessary to attain a minimum concentration of 500 mg/l of suspended solids. For equipment tested onboard - the influent may consist of the sewage generated under normal operational conditions. In any case the average influent concentration of total suspended solids is not to be less than 500 mg/l. The BOD5 index of the influent is to be measured and recorded. During the type test, calculation is to be carried out based on the average BOD concentration of influent (raw sewage) and effluent (treated water) and the average hydraulic loading so as to determine the capacity. The test result is not to be lower than the design requirements. For adding of grey water and vacuum collecting of sewage, refer to the corresponding standards.

② Duration of test: The duration of the test period is to be 10 days after steady-state conditions have been reached by the equipment under test. A minimum of 40 effluent samples after treatment are to be collected.

③ Loading factors: During the test period, the sewage treatment plant is to be tested under conditions of minimum, average and maximum volumetric loadings. For loading factors and sampling timings, refer to Figure 1. For different requirements for testing ashore and testing onboard, see 5.4 of MEPC.159(55) for detail.

④ Sampling methods and frequency: An influent sample is to be taken and analyzed for every effluent sample taken and the results recorded. If possible, additional influent and effluent samples are to be taken to allow for a margin of error. See 5.5.2 of MEPC.159(55) for detail.

⑤ Salinity and temperature: Tests are to be carried out within the range of temperature and salinity specified by the manufacturer, which is worst than the actual conditions under which the sewage treatment plant operates. Any restrictions on operational conditions are to be recorded on the certificate. Consideration is to be given to carry out tests respectively under the minimum and maximum temperatures specified by the manufacturer.

⑥ Inclination test (included in the 10-day type test): When the sewage treatment system is tested ashore, a performance test is to be carried out in a steady inclination of 22.5° and it takes at least two days. The inclination direction of the sample plant is to be determined according to the most unfavorable condition such as fluid level control reliability, electrical reliability and intact stability of equipment. The effluent quality is to comply with the design requirements.

⑦ Analysis and test of effluent: For sewage treatment plant, consideration is to be given to recording of other indexes in addition to those required for thermotolerant coliforms, total suspended solids, COD, BOD5, pH and residual chlorine (when chlorine is used as a disinfectant or electrolyzer). Indexes which might be considered include turbidity, total phosphorus. It is encouraged that the use of ozone, ultra-violet irradiation or any other disinfectant, which minimizes the adverse environmental effects. When chlorine is used as a disinfectant, the disinfectant residual in the effluent is to be below 0.5 mg/l. The test standards for effluent are to be in compliance with the requirements of IMO MEPC.159(55).

⑧ Zero load test: For biochemical sewage treatment plant, a zero load test is to be carried out. The plant is to re-operated after a 2-day operation stop and the plant is to be expected to return to a normal operation within one or two days after restart. The zero load test may be arranged after completion of the above mentioned test items.

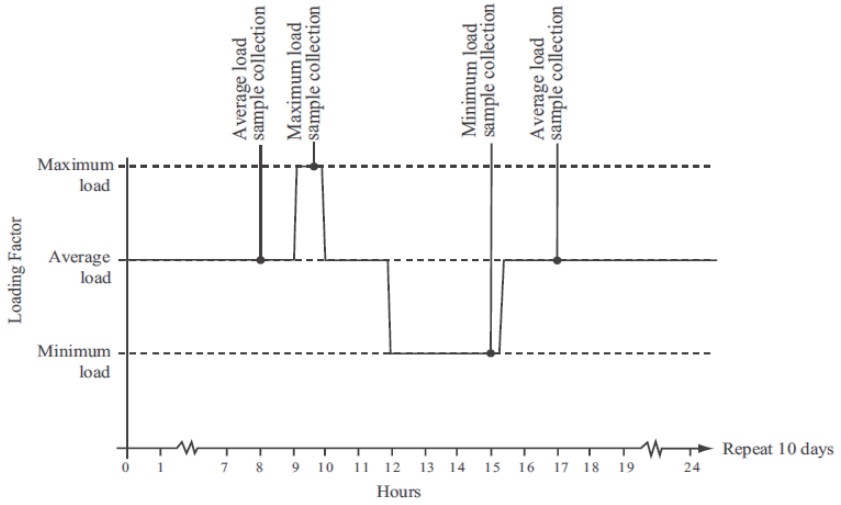


Figure 1: Suggested hydraulic loading factors and sampling frequency for testing sewage treatment plants. May be modified as necessary to take account of characteristics of individual sewage treatment plants

(4) Stripping: After type test, the sample plant is to be stripped, internal corrosion, spray painting quality, etc. are to comply with the design requirements.

5.7.4 Unit for testing sample water is to be an acceptable and nationally approved authoritative organization with the appropriate qualification.

5.8 Routine inspection

5.8.1 Inspection items

(1) check of CCS Marine Product Certificate and qualification certificates issued by the manufacturer;

(2) check of records or reports and conditions for inspection and tests: including the check of quality certificates and/or reports of physical and chemical properties of materials of main parts processed at the manufacturer; the check of inspection, measurement and test conditions of the manufacturer, together with a list of test and inspection equipment used and valid calibration certificates; the check of test report of the manufacturer, covering sample type, specification, serial number, test place and date, test environment, test items, test data, conclusions of inspection and test, etc. as well as the check of issues found during test and handling measures, etc.

5.8.2 The test items for unit/batch inspection after approval:

(1) inspection of appearance, size and assembly quality;

(2) watertightness test;

(3) operation test of equipment: to check whether the operation tests of equipment such as air pump, discharge pump, comminuting pump, dosing pump, ozone generator, ultra-violet sterilizer and electrolyzer are in normal order;

(4) fresh water operation test: tested with fresh water flushing to inspect all components and parts are working normally;

(5) backflow performance test (applicable to biochemical sewage treatment plant): open the return valves for lifting backflow sludge and scumming to check it is in normal condition.

5.8.3 Attention is to be paid to the latest development of MEPC.159(55), such as the requirements for the equipped sewage treatment plants of passenger ships and the testing requirements for indexes of phosphorus and ammonia nitrogen.

PART EIGHTEEN LIFTING APPLIANCES

CHAPTER 1 CRANES

1.1 Application

1.1.1 This Chapter applies to the following types of cranes:

(1) Deck cranes mounted on ships for handling cargo or containers in harbour conditions;

(2) Floating cranes or grab cranes mounted on barges or pontoons for operating in harbour conditions;

(3) Engine room cranes and provision cranes etc. mounted on ships (including floating docks) for handling equipment and stores in harbour conditions;

(4) Cranes mounted on fixed or mobile offshore installations for transferring equipment and stores.

1.1.2 This Chapter applies to the cranes of the following structural configurations:

(1) Jib type cranes;

(2) Gantry cranes;

(3) Traveling cranes in engine room.

1.2 Basis for approval and inspection

The approval and inspection in this Chapter are to be based on the following documents:

(1) Technical Regulations for the Statutory Surveys of Lifting Appliances of the Register of Shipping of the People's Republic of China (only for ships flying the flag of China only);

(2) CCS Rules for Lifting Appliances of Ships and Offshore Installations;

(3) CCS Rules for Classification of Sea-Going Steel Ships;

(4) CCS Rules for Materials and Welding and subsequent amendments thereto.

1.3 Terms and definitions

The following terms and definitions given in the above rules and standards apply to this Chapter:

1.3.1 Standard service conditions are the conditions under which the SWL of a lifting appliance is ascertained. It is to include all of the following conditions:

(1) the angle of heel not exceeding 5° and a trim of 2° during the operation of the appliance;

(2) the appliance being operated in harbour;

(3) the appliance being operated at a wind speed not exceeding 20 m/s and a corresponding wind pressure not exceeding 250 Pa;

(4) the motion of lifting load being free from any external conditions;

(5) the nature of the lifting operations in terms of their frequency and dynamic characteristics being compatible with the load of factor permitted in this PART for the appliances concerned.

1.3.2 Safe working load (SWL)

(1) Safe working load of a lifting appliance means the maximum static load the appliance is certified to be capable of sustaining whilst correctly rigged under the design operation.

(2) Safe working load of loose gear means the maximum load for which the gear has been designed and tested. This load is not to be less than the maximum load to which the gear will be subjected when the lifting appliance is operating at its SWL.

1.3.3 Nominal hoisting speed means the average speed of the hook when only the lifting mechanism is used to lift the safe working load.

1.3.4 Nominal luffing time means the time required for using luffing mechanism only to change the maximum operation radius to the minimum one at the safe working load.

1.3.5 Nominal slewing speed means the speed of the crane slewing with lifted safe wording load in maximum operation radius, with the ship having a 5° heel and a 2° trim.

1.3.6 Loose gear means the gear which is not permanently attached to the lifting appliances, such as chains, triangle eyeplates, hooks, blocks, shackles, swivels, sockets, preventer guys with patent clips and rigging screws, etc. Lifting beams, spreaders, frames and similar items of equipment are also considered as loose gear.

1.3.7 Fittings mean fittings which are permanently attached to the derrick booms, masts or derrick posts, decks, superstructures or other structures such as eyeplates, derrick heel assemblies, gooseneck bearings including gooseneck pipes, derrick bands and built-in sheaves, etc.

1.3.8 Factor load means the loads (excluding wind load) to be considered in designing a lifting appliance, expressed as follows:

$$\text{Factor load} = \text{live load} \times \text{duty factor} \times \text{dynamic factor}$$

1.3.9 Live load is the sum of the safe working load (SWL) of an appliance and the static weight of any component of the appliance which is directly connected to, and undergoes the same motion as, the safe working load during the lifting operation.

1.3.10 Duty factor is a factor which makes allowances for the frequency and state of loading for which a lifting appliance is to be considered in design.

1.3.11 Dynamic factor is a factor which takes account of all the dynamic effects of the appliance arising from its lifting operation, and by which the live load is multiplied to represent the load for all dynamic effects on the system.

1.3.12 Dead load is the self-weight of any component of the lifting appliance which is not included in the live load.

1.3.13 Design stress is the maximum stress permitted in this PART to which any component part of a lifting appliance may be subjected when the appliance is lifting its safe working load (SWL), that is, when the appliance is subjected to the factor load plus the specified lateral and wind loads.

1.3.14 General examination is to take the form of a visual inspection of the lifting appliances, which is to be supported by other means as necessary and carried out so far as practical to achieve a sound view on components in question. For this purpose, components or parts are to be dismantled for more thorough examination where considered necessary.

1.3.15 Visual examination is to take the form of a visual inspection of the lifting appliances by checking for deformation or other defects of components, such as chafe or excessive wear and corrosion.

1.4 Plans and documents

1.4.1 The applicant is to submit the following plans and documents for crane systems to CCS for approval:

(1) General arrangement of crane, including specification of principal operational parameters;

(2) Force analysis for the crane system;

(3) Layout of lifting, luffing, slewing and travelling mechanisms, including the arrangement and functions of overload protection, overmoment protection and various limit switches;

(4) Strength calculations of main items, clearly indicating the design basis, operating criteria, rated capacity, weights and centers of gravity of the crane parts and relevant national standards;

(5) Stability calculation of crane, as applicable;

(6) Structural plans of all main components comprising the crane including jib, tower, platform, gantry, logies, slewing ring, pedestals, rails, stowage arrangement, indicating their structures, scantlings and grades of steel, welding consumables, type and size of welds;

(7) Standards/technical specifications for welding, castings and forgings.

1.4.2 The applicant is to submit the following plans and documents for crane systems for information:

(1) Details of sheaves, axles, pivot pins, wheels, spreader beams, slewing ring, slewing ring bolts and similar items and the specification of the grade of steel to be used;

(2) Details of blocks, hooks, swivels, lifting beams, spreaders, frames and other items of loose gear, indicating material, safe working load (SWL), proof load and the standard to which they have been manufactured;

(3) Size, construction, finish and certified breaking loads of and normal tensile strength for wire ropes to be used;

(4) Instructions for operation and maintenance.

1.5 Main components and parts

1.5.1 The following purchased parts and components, if any, are usually to be furnished with CCS certificate of marine products or equivalent documents and fit for their intended purposes:

(1) main structural materials for pedestal, frame, jib, etc.;

(2) winches, loose gears, riggings, wire ropes, slewing rings and luffing cylinders;

(3) electrical motors (50 kW and above), electrical control boxes

1.5.2 Electrical motors below 50 kW are to be furnished with type approval certificate of product and manufacturer's quality certificate.

1.6 Evaluation of welding procedures

1.6.1 The welding procedures for main structures such as pedestal, frame and jib are to be evaluated prior to manufacturing by CCS according to CCS Rules for Materials and Welding.

1.7 Design and technical requirements

1.7.1 The calculation of structural strength is to be in accordance with CCS Rules for Lifting Appliances of Ships and Offshore Installations or the standards or publications recognized by CCS.

1.7.2 Design angles for normal operation of cranes onboard conventional ships, 5° is for heel and 2° for trim. For other ships see the requirements of 3.2.10.1 in CCS Rules for Lifting Appliances of Ships and Offshore Installations for details.

1.7.3 The materials used for construction of cranes are to comply with the requirements of Chapter 6 of CCS Rules for Lifting Appliances of Ships and Offshore Installations.

1.7.4 The slewing ring bearings are to be tight to prevent entry of rainwater or dust. The connection bolts are to be arranged evenly along the circumference. Where the lateral load analysis and the specific bolt connection are submitted, suitable scallop arrangement may be considered for the connection between the upper part of slewing bearings and the bolt.

1.7.5 Loose gear such as hooks, lifting eyes, swivels and shackles are not to be made of cast iron or cast steel.

1.7.6 Sheaves for steel wire rope are to be made of steel, and the use of cast iron sheaves is to be specially agreed by CCS.

1.7.7 The safety factor n of wire ropes for both running and standing application are not to be less than the value given by the following expression, but need not be greater than 5 or less than 3:

$$n = \frac{10^4}{0.9SWL + 1910}$$

where: SWL —— safe working load of crane, in kN.

1.7.8 The minimum breaking load Q_b is given by the following expression:

$$Q_b = nW \quad \text{kN}$$

where: n —— safety factor of wire rope required, obtained from (6);

W —— the static load in the wire rope taking due account of the friction in the sheaves over which the wire rope passes, in kN.

1.7.9 For running rope of crane, the ratio of sheave diameter measured at the bottom of rope groove to wire rope diameter is not to be less than 19:1.

1.7.10 The pedestal flange in way of the slewing ring bearing is to be of rigid and levelled construction. Where the flange is stiffened with brackets, the spacing of the brackets is not to be greater than that of two connecting bolts.

1.7.11 On or near each control, the function of which is to be identified, there is to be affixed a written notice or symbols which clearly show the directions of movement of the lifting appliances and the neutral position of the controller. The direction of movement of the control lever or wheel for the operation of the lifting appliances is to relate logically to the direction of motion controlled with the convention that, if there is a lever type controller, the movement towards the driver corresponds to the upward movement of the load or the jib and the movement towards the right of the driver corresponds to the crane slewing to the right; if there is a wheel type controller, the clockwise movement corresponds to the upward movement of the load or the jib or the crane slewing to the right, and so on.

1.7.12 Means are to be provided for the control of hoisting, luffing, slewing and the positioning of traveling cranes, as applicable.

1.7.13 Cranes are to be provided with limit switches for the following:

(1) Upper limit of hoisting travel;

(2) Luffing angles for upper and lower limits;

(3) Slewing angles, applicable to cranes with restricted slewing angle;

(4) Travel of crane, applicable to travelling cranes and to the crab of bridge crane.

The above limit switches are to operate alarms, automatically cut off operating power and hold crane and load in position in the event of the activation of any of these limit switches. Auxiliary cranes, such as food lifts, are excepted.

1.7.14 If the mechanism of a crane is required to have a function to run over a present limit, e.g. a jib is to be lowered down, an override switch may be provided to prevent the action of the limit switch. The switch is to be suitably protected to prevent inadvertent operation.

1.7.15 Buffers and buffered stops are to be provided for the travelling cranes and crabs and they are to be located behind limit switches.

1.7.16 Cranes are to be provided with overload protective devices or load indicator. The overload protective device is to be set to operate at a load not exceeding 110 per cent of the SWL.

1.7.17 For variable load/radius cranes a load indicator which automatically displays a maximum safe load at a given radius is to be fitted. An alarm is to operate when the load reaches 95 per cent of the SWL and at 110 per cent of the SWL the operating power is to be automatically cut off.

1.7.18 All running mechanisms of the cranes are to be fitted with brakes, for hoisting and luffing mechanisms they are to be of "locked on" type and be fitted with releasing gear to enable the load to be lowered down in position. The safety factor of the brake, i.e. the ratio of brake torque to rated torque, is not to be less than 1.5.

1.7.19 Travelling cranes are to be fitted with rail clamping devices so as to prevent the crane from slipping due to wind load or due to the inclination of ship.

1.7.20 Travelling cranes are to be provided with anchoring device for fixing the crane when it is out of service.

1.7.21 Cranes are to be provided with audible and visual signal alarms. In the case of travelling cranes a continuous audible and visual warning is to be given when the crane is to move/is moving along its track.

1.7.22 For variable load/radius cranes a jib radius indicator is to be fitted.

1.7.23 In the case of floating cranes the following is to be provided:

(1) a wind speed indicator and alarm when wind speed exceeds a predetermined limit for a given time;

(2) crane level indication with operating limits as specified in design;

(3) means of communication between the crane operator and the signalman;

(4) a hook load indicator.

1.7.24 Rope is to be capable of reeling onto the drum evenly and if necessary, coiler or other device may be fitted. The length of the rope drum is to be such that the rope will, in general, reel up onto the drum in not more than three layers, but it is recommended that where practicable the rope should reel onto the drum in a single layer. The rope may reel up onto the drum in more than three layers if either one of the following requirements is met:

(1) the coiler is fitted; or

(2) the drum has rope groove; or

(3) the reeling angle is restricted up to 2°.

1.7.25 The length of rope reeling up onto the drum is to be appropriate to any operating positions within the design working range of the lifting appliances and in any case not less than three turns of rope remaining on the drum.

1.7.26 Under all operation conditions the distance between the top layer of the wire rope when evenly reeling up onto the drum and the outer edge of the drum flange is to be greater than 2.5 times the diameter of the wire rope.

1.8 Testing of cranes

1.8.1 Each crane is to be tested with a test load in accordance with the following Table and the test procedure is to be subject to agreement. The jib is to be placed at the maximum jib radius as specified in the approved plan and the test is to be carried out using certified weight suspended from the cargo hook or lifting attachment for a duration not less than 5 min after lifting up the test weights.

Safe working load (SWL), in kN	Test load, in kN
SWL ≤ 196	1.25 × SWL
196 < SWL ≤ 490	SWL + 49
SWL > 490	1.1 × SWL

1.8.2 During the test, the crane is to hoist, slew and luff the test load at slow speed and braking tests are also to be carried out to the hoisting, slewing and luffing mechanisms for their effectiveness. Gantry and traveling cranes together with their travelling trolleys, where appropriate, are to be travelled slowly over the full length of their track with the test load suspended from hook.

1.8.3 In case of a variable load-radius crane the tests are, in general, to be carried out for the appropriate safe working loads at their respective jib radius. Alternative proposals will be specially considered.

1.8.4 Overload protection devices and overmoment protection devices, if any, are to be verified for their operation.

1.8.5 Where it is not practicable for the crane to raise the full test load, as may be the case for hydraulic cranes, a reduced test load may be accepted but in no case is this to be less than 1.1 times SWL.

1.8.6 For cranes on floating docks, the vertical projection of boom is to form a specific included angle when testing considering the need of anti-capsizing, and the angle is to be proved and approved.

1.8.7 After the overload test, the crane is to be loaded with its safe working load and operated over its full range of speeds in order to demonstrate satisfactory operation of crane, efficiency of overload and weightload indicators, effectiveness of limit switches, etc.

1.8.8 After testing, the crane is to be thoroughly examined for deformation or other defects.

1.9 Test Items

1.9.1 The test items of cranes are given in the following Table.

No.	Test items	Test load	General content	Basis	Remarks
1	Limit switch	No	Checking the ranges of hoisting, luffing, slewing and traveling	4.3.2.2 of CCS Rules for Lifting Appliances of Ships and Offshore Installations	Limit switches are to operate alarms, cut off operating power and hold crane and load in position. Auxiliary cranes are excepted.
2	Weight suspending	See 1.8.1 of this Chapter	Suspended for 5 min at the maximum jib radius	6.4.2.1 of CCS Rules for Lifting Appliances of Ships and Offshore Installations	For cranes with SWL section, each section is to be tested. The item 3, if tested at this point, may be deemed as an alternative
3	Dynamic load	See 1.8.1 and 1.8.5 of this Chapter	Various movements at slow speed	6.4.2.2 of CCS Rules for Lifting Appliances of Ships and Offshore Installations	Slow travel over the full length of their track
4	SWL	SWL	Various movements, all ranges, check of performance parameters	6.4.2.7 of CCS Rules for Lifting Appliances of Ships and Offshore Installations	Travel over the full length for 3 times, check of linkage/ interlock according to technical requirements
5	Overload protection	1.1 times SWL	See 1.7.16 and 1.7.17 of this Chapter	4.3.2.4 and 4.3.2.5 of CCS Rules for Lifting Appliances of Ships and Offshore Installations	Hoisting is malfunctioned, but could be lowered
6	Emergency stop	SWL	Cutting off operating power	4.3.1.3 of CCS Rules for Lifting Appliances of Ships and Offshore Installations	The emergency stop is to be independent of the controls. The manufacturer is to start from small load
7	Manual releasing	SWL	Using gravity and manual assistance to lower down the load	4.3.2.6 of CCS Rules for Lifting Appliances of Ships and Offshore Installations	This means hoisting and luffing mechanisms in principle
8	Measurement of insulation resistance	At the end of test	The resistance of main circuit and control circuit	4.1.3.2 of CCS Rules for Lifting Appliances of Ships and Offshore Installations	See relevant requirements in PART FOUR of CCS Rules for Classification of Sea-Going Steel Ships

PART NINETEEN MARINE NAVIGATIONAL EQUIPMENT

CHAPTER 3 STEERING CONTROL SYSTEMS

3.1 Application

3.1.1 This Chapter applies to type approval and unit/batch inspection of steering gear control system including heading control system and follow-up steering control system fitted on sea-going ships (high speed crafts excluded). On-off steering (non follow-up) may take reference for implementation.

3.1.2 Steering gear control system means the equipment by which orders are transmitted from the navigating bridge to the steering gear power units. Steering gear control systems comprise transmitters, receivers, hydraulic control pumps and their associated motors, motor controllers, piping and cables.

(1) This Chapter does not apply to hydraulic control pumps and their associated motors, piping and cables (equipment excluded) of the above mentioned steering control system.

(2) This Chapter does not apply to track control systems.

3.2 Basis for approval and inspection

3.2.1 The approval and inspection in this Chapter are to be based on the following documents:

(1) SOLAS (1974) Reg. II-1/29 and the amendments thereto;

(2) Chapter 13 of PART 3 of CCS Rules for Classification of Sea-going Steel Ships;

(3) Annex 3 of Resolution MSC. 64(67) on Performance Standards for Automatic Pilots;

(4) ISO 11674(2006-09) Ships and Marine Technology - Heading Control Systems;

(5) IACS UI SC94 Mechanical, Hydraulic and Electrical Independency and Failure Detection and Response of Steering Control Systems;

(6) IEC 60945-2002 Maritime Navigation and Radio Communication Equipment and Systems – General Requirements – Methods of Testing and Required Test Results;

(7) IEC 61162 series;

(8) IEC 62288 Ed. 1.0(2008) Maritime Navigation and Radio Communication Equipment and Systems – Presentation of Navigation-Related Information on Shipborne Navigational Displays – General Requirements, Methods of Testing and Required Test Results.

3.3 Definitions and terms

Definitions in Chapter 13 of PART 3 of CCS Rules for Classification of Sea-going Steel Ships and ISO 11674 (2006-09) apply to this Chapter. For the convenience of compilation and application, the following definitions are added or quoted:

(1) Manual mode

Method of controlling steering gear manually is contrast with automatic steering mode (heading control mode). Both follow-up and non follow-up modes may be considered as manual steering mode.

(2) Automatic mode

Method of controlling steering gear automatically is to enable a ship to keep a preset heading. Both heading control mode and track control mode belong to automatic steering mode. The Guidelines applies to heading control mode only.

(3) Follow-up mode (FU mode)

A kind of closed loop control mode. In this mode, the operator gives command of rudder angle manually and the steering gear will move the rudder according to the given rudder angle command.

(4) Non follow-up mode (NFU mode)

A kind of open loop control mode. In this mode, the operator manually controls the direction of rudder motion.

(5) Ship motion simulator

Ship motion simulation device used for the functional test for heading control system as specified in Annex A of ISO 11674-2006.

(6) Steering error (FU mode)

Within the specified range of rudder angle, the deviation between the actual position of rudder blades and the given rudder angle command.

(7) Steering sensitivity (FU mode)

It means the minimum given rudder angle which enables the final element of the steering gear to act during the operation of steering gear.

(8) Insensitivity of steering gear (FU mode)

It means the range of rudder angle for the inaction of the final element of the steering gear during the operation of steering gear (adjustable range of steering sensitivity).

(9) Heading stability (heading control mode)

Deviation between the actual heading and preset heading of the ship under the given sea conditions is expressed by the mean and maximum values of the deviation.

(10) Operational device

Components used for operating heading control system, such as switch, button, key, handle, etc.

3.4 Plans and documents

3.4.1 The following plans and documents are to be submitted to CCS for approval:

(1) Technical specifications (including the version No. of the major software);

(2) System schematic diagram;

(3) Schematic diagram of main units of the system (e.g. control unit, steering gear startup box, change-over device, alarm box (unit), feedback unit, etc.);

(4) Outline and panel arrangement;

(5) Type test program.

3.4.2 The following plans and documents are to be submitted to CCS for information:

(1) Operation instructions for the products;

(2) Block diagram of system configuration;

(3) Wiring connection diagrams of subsystems or units;

(4) Routine test record (sample);

(5) List of major components and parts;

(6) Product mark or nameplate, quality certificate/statement (sample).

3.5 Design and technical requirements

3.5.1 Electrical safety, adaptability to power supply conditions and environmental conditions and electromagnetic compatibility of the equipment are to be adaptable to the ambient environment of the ship and to comply with the test requirements for the “protected equipment” specified in IEC60945.

3.5.2 Function and performance requirements

3.5.2.1 Steering position and change-over

(1) Steering from the steering gear compartment

The selector switch is to be fitted in the steering gear compartment for changing the steering position. When control position “steering gear compartment” selects the control of power unit of the steering gear and the steering control are to be achieved by the control box/console of steering gear compartment. The navigation bridge is not to have any influence on the control from steering gear compartment.

(2) Control from navigation bridge

When control position “navigation bridge” selects the control of power unit of the steering gear and the steering control are to be achieved by the control unit/console of navigation bridge.

(3) Remote control (if available)

Remote control mode may be selected by the change-over switch in the navigation bridge. Remote steering may be conducted through remote control console/box. In any case, the navigation bridge may take over the control.

3.5.2.2 Steering mode and change-over

(1) Steering mode change-over switch or dedicated button is to be fitted on the control unit/console of navigation bridge. Change-over among automatic mode (heading control), follow-up mode, non follow-up mode and remote steering mode ① is to be possible through single operation (if applicable). Such change-over switch or dedicated button is to be located in such a position that it is readily accessible and easy to operate.

Note ① : Except for non follow-up mode, other steering modes are optional.

(2) Change-over from automatic to manual steering and vice versa is to be possible at any position of the rudder blade and is to be activated by the above mentioned switch or dedicated button within 3 seconds. Change-over from automatic to manual steering is to be possible under any conditions including any failure in the automatic steering control unit.

(3) Change-over from follow-up to non follow-up steering is to be possible under any conditions including any failure in the follow-up steering control unit.

(4) When changing-over from manual to automatic steering, if there is no new safe input of command, the heading control system is to take over the actual heading of this time as the preset heading.

(5) The indicator is to be fitted on the change-over switch. Adequate illumination is to be provided at the main steering console to show which mode of steering is in operation at a particular moment.

3.5.2.3 Functional and performance requirements for heading control unit

(1) The design of the operational controls of heading control unit is to comply with the principles of ergonomics as specified in 6.1 of IEC60945. The display of the navigation information is to comply with the applicable requirements of IEC62288.

(2) All operational controls are to be facilitate for normal working and to be easy to identify from the position at which the equipment is normally operated. Controls not required for normal operation are not to be readily accessible. The number and arrangement of operational controls are to be such that simple, safe and easy operation can be achieved.

(3) Adequate illumination is to be provided in the control unit to enable identification of controls and facilitate reading of indicators at all times. Means are to be provided for dimming the output of the light source which is capable of interfering with navigation.

(4) Unless features for automatic adjustment are incorporated in the installation, the heading control system is to be provided with adequate controls to adjust its performance to effects due to weather and the ship's steering performance.

(5) Preset heading

Any alteration of the preset heading is not to be possible without intended action of the ship' s personnel. Requirements are to be made to preclude unintended alteration of heading such as the confirmation by the steering operator. The heading control system is to be so designed to ensure altering the preset heading to starboard by turning the heading setting control clockwise or tilting it to the right-hand side. Turning the control counterclockwise or tilting it to the left is to effect a similar alteration to port.

(6) When the heading is changed in automatic mode, the ship's turning direction is to be in consistent with the heading change direction as the heading is preset (i.e. if the heading is preset to change towards starboard, the ship's actual heading is also to be changed towards starboard, and vice versa). Other controls are not to cause significant change to ship's heading, except preset heading control.

(7) Rudder angle limitation

Means are to be provided to enable adjustable rudder angle limitation in the automatic mode. Means are also to be available to indicate when the angle of limitation has been commanded or reached. When other means of directional control are used in the heading control unit, the rudder angel limitation may not be provided by the unit or be incorporated with other functions.

(8) Allowable yaw

Means are to be incorporated to prevent unnecessary activation of the rudder due to normal yaw motion.

(9) Heading indication accuracy

The deviation between the heading shown by heading indicator of steering gear system and the heading sensor is not to be more than 0.5°.

(10) Preset rate of turn (if applicable)

If the heading control unit is provided with the function to control the ship's turning at a preset rate of turn, the accuracy of the rate of turn when the ship is in a stable state is to be of ±10% of its preset value or 3°/min, whichever is the greater, under the ship's normal load condition and in a calm sea with sufficient breadth and depth, which will not influence the ship's manoeuvrability. ②

Note ② : There are some cases where it is not possible to turn at the preset rate (turning radius), even if steered at the maximum ruder angle, due to the effect of weather, sea state or ship's maneuverability.

(11) Preset turning radius (if applicable)

If the heading control unit is provided with the function to control the ship's turning with a preset turning radius, the accuracy of the radius when the ship is in a stable state is to be calculated by the data of the above-mentioned (10). ③

Note ③ : It is possible that the ship could not turn at the preset radius even at the maximum rudder angle due to the influences of weather, sea condition or ship's manoeuvrability in certain cases.

(12) Limiting of overshoot

The heading control unit is to include a counter rudder-angle adjustment control or similar system to allow the change to a preset heading without significant overshoot.

(13) Heading stability

Under the conditions of no disturbance, the average value of the difference between the preset and actual headings is within ±1° and the maximum single amplitude is within 1.5°.

3.5.2.4 Functional and performance requirements for follow-up control unit

(1) Steering error

The steering error is not to exceed 1° and not to exceed 0.5° at zero position within the specified steering range in the follow-up mode.

(2) Steering sensitivity

It is not to be more than 1° for follow-up steering.

(3) Rudder angle limitation'

±35° (adjustable)

(4) Insensitivity

Sensitivity adjustment is to be provided and the adjustable range of insensitivity is from the range of 0.5° to 2°. Rudder blades are not to vibrate within the steering range.

3.5.2.5 Power supply

(1) The control unit is to be supplied by the corresponding power unit.

(2) The steering control solenoid valve is to be supplied by the corresponding power unit.

(3) Indication is to be provided for the power supply to the alarm device (unit).It is to be ensured that the alarms as specified in 3.5.2.7 of this Chapter are given in the event of loss of power or failure of the controls (unit) of steering control system.

3.5.2.6 Independency of system components

(1) Two independent power and control systems are to be provided for the steering control system (except that the steering wheel and steering lever may be shared). The two systems are to be automatically changed over and standby each other. The change-over from one system to the other within 3 seconds is to be achieved in the event of failure in any one of the two systems. The change-over is also to be achieved manually through the selector switch. The system is to be restarted automatically after the restoration of the power supply.

(2) The two systems are to be separated electrically and mechanically and the failure in one of them will not render the other inoperative except the shared steering wheel /steering lever and steering mode selector switch. If a steering mode selector switch is employed for both steering gear control systems, the connections for the circuits of the control systems are to be separated from each other by an isolating plate or by air gap.

(3) The rudder angle feed-back units is to be designed as the mechanically parts may be shared and electrically separated in order to comply with the independence requirements.

(4) Wires, terminals and the components for duplicated steering gear control systems installed in units, control boxes, switchboards or bridge consoles are to be separated as far as practicable. Where physical separation is not practicable, separation may be achieved by means of a fire retardant plate.

3.5.2.7 Alarms and indication

(1) The steering control system is to comply with the requirements for alarms and monitoring as specified in 13.1.9.1 of Chapter 13 of PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

(2) In addition to (1) above, the heading control system is to be fitted with off-heading alarm, heading monitor (if applicable), indication of heading source (if applicable) and sensor status.

3.5.2.8 Interfaces and others

(1) The heading control system is to be connected to a heading sensor with appropriate interfaces.

(2) The heading control system is to be connected to a speed sensor with appropriate interfaces when it is used in a turning radius mode or when any control parameters are automatically adapted to speed.

(3) If required, appropriate interfaces are to be provided to connect the system with other navigation related systems of the ship.

(4) The interfaces mentioned above are recommended to adopt the standards of IEC61162 series.

(5) The display of navigation information is to comply with the applicable requirements of IEC62288.

3.6 Type approval and unit/batch test

3.6.1 The steering control system is to be type approved by CCS. The type approval certificate is to be issued, maintained, modified, renewed or cancelled according to the requirements of Chapter 3 of PART ONE of Rules for Classification of Sea-going Steel Ships.

3.6.2 Selection of typical samples and arrangement of test

Types and specifications of test samples are to be technically representative and are to cover the products for which type approval is sought. Products with most steering modes and functions are to be selected to compose the steering control system. The test samples are to be taken by CCS surveyor at the manufacturer on site.

3.6.3 Test organization

The type approval test is to be carried out in a competent test organization acceptable to CCS. The test organization is to be subject to the international/domestic laboratory certification. Some functional tests items may be carried out at the manufacturer under supervision of CCS Surveyor on site if the manufacturer is qualified to carry out the test and examined and approved by CCS surveyor. The ship model used for the functional test of heading control system is to comply with the requirements of Annex A of ISO11674-2006 and confirmed by CCS surveyor.

3.6.4 Type approval test items and requirements

For type approval test items, see the table below. The electromagnetic compatibility test and ambient conditions test only apply to the main instrument consisting of various steering control units.

3.6.5 Unit/batch inspection

The unit/batch inspection is to be carried out as required by CCS upon the delivery of products and the product certificate is to be issued.

After type approval, the manufacturer is to implement the control of the manufacturing and test progresses and to carry out the specified routine test for each product and issue the routine test report according to the quality control documentation submitted. CCS surveyor is to carry out the inspection according to the product inspection plan on the basis of the examination of the routine test report. The unit/batch inspection is to include at least the following tests:

— check of information of main components (parts), confirmation of the software version;

— visual examination and examination of internal wiring;

— measurement of insulation resistance;

— withstand voltage test;

— functional verification test.

The test items and number of samples may be added where deemed necessary by the surveyor.

No.	Test items	Technical requirements and test method
1.	Visual examination, examination of structure and enclosure, conductor and internal wiring, earthing, identification	
2.	Steering position and functional change-over	3.5.2.1 of this Chapter
3.	Steering mode and change-over	3.5.2.2 of this Chapter
4.	Functional test of heading controller	3.5.2.3 of this Chapter, 5.5 of ISO11674
5.	Functional test of follow-up control unit	3.5.2.3 of this Chapter
6.	Functional test of alarms and indication	3.5.2.7 of this Chapter
7.	Examination of interfaces and tests	3.5.2.8 of this Chapter
8.	Withstand voltage test	regulation 2.14 of GD01 ④
9.	Measurement of insulation resistance	regulation 2.3 of GD01 ④
10.	Extreme power supply condition test	IEC600945 7.1，5.2.2
	Immunity to power supply short-term variation	IEC600945 7.3，10.7
	Immunity to power supply failure	IEC600945 7.4，10.8
11.	Dry test	IEC600945 8.2
12.	Damp heat test (cyclic)	IEC600945 8.3
13.	Low temperature test	IEC600945 8.4
14.	Vibration test	IEC600945 8.7
15.	Protective enclosure test	IEC60533
16.	Salt mist test	IEC600945 8.12
17.	Acoustic noise and alarm signals	IEC600945 11.1
18.	Test of compass safe distance	IEC600945 11.2
19.	Conducted emissions	IEC600945 9.2
20.	Radiated emissions from enclosure port	IEC600945 9.3
21.	Immunity to conducted radio frequency disturbance	IEC600945 10.3
22.	Immunity to radiated radio frequencies	IEC600945 10.4
23.	Immunity to fast transients on electrical lines	IEC600945 10.5
24.	Immunity to surge (impact)	IEC600945 10.6
25.	Immunity to electrostatic discharge	IEC600945 10.9

Note ④ : CCS Guidance Note GD 01-2006 Guidelines for Type Approval Test of Electric and Electronic Products and the amendments thereto.

CHAPTER 4 VOYAGE DATA RECORDER

4.1 Application

4.1.1 The Guidelines applies to the type approval and unit/batch inspection of voyage data recorders (VDR) fitted and used on ships and offshore installations.

4.1.2 Voyage data recorder (VDR) is to include:

(1) Shipborne Voyage Data Recorder (VDR) as required by Reg. 18 and Reg. 20 of Chapter 5 of Amendments to 1974 SOLAS (2000);

(2) Shipborne Simplified Voyage Data Recorders (S-VDRs) as required by Amendments to 1974 SOLAS (2004) (MSC 170(79)); and

(3) The requirements for S-VDR may be implemented with reference to the cross-references between VDR and S-VDR as specified in 4.6.6.

4.2 Approval and inspection basis

4.2.1 Technical requirements

4.2.1.1 IMO Resolution A.861(20) Performance Standards for Shipborne Voyage Data Recorders (VDRs);

4.2.1.2 IMO Resolution MSC.163(78) Performance Standards for Shipborne Simplified Voyage Data Recorders (S-VDRs);

4.2.1.3 IMO Resolution MSC.214(81) Adoption of Amendments to the Performance Standards for Shipborne Voyage Data Recorders (VDRs) (Resolution A.861(20)) and Performance Standards for Shipborne Simplified Voyage Data Recorders (S-VDRs) (Resolution MSC.163(78));

4.2.1.4 IEC61996-1 ed1.0 2007-11 (Maritime Navigation and Radio Communication Equipment and Systems-Ship Borne Voyage Data Recorder (VDR)-Part 1: Voyage Data Recorder (VDR)-Performance Requirements, Methods of Testing and Required Test Results);

4.2.1.5 IEC61996-2 ed2.0 2007-11 (Maritime Navigation and Radio Communication Equipment and Systems-Ship Borne Voyage Data Recorder (VDR)-Part 2: Simplified Voyage Data Recorder (S-VDR)-Performance Requirements, Methods of Testing and Required Test Results);

4.2.1.6 IEC60945 ed4.0 2002-08 (Maritime Navigation and Radio Communication Equipment and Systems-General Requirements-Methods of Testing and Required Test Results);

4.2.1.7 IEC61162 Series (Maritime Navigation and Radio Communication Equipment and Systems-Digital Interfaces);

4.2.1.8 CCS: GUIDANCE NOTES GD01-2002 Guidelines for the Inspection of Shipborne Voyage Data Recorders.

4.3 Terms and definitions

The definitions in IEC61996-1 ed1.0 2007-11 apply to the Guidelines. For the convenience of developing and use, the Guidelines directly quotes or supplements the following definitions:

(1) Main unit: server of VDR system mainly including the following parts: data processing unit, data transformation unit, hybrid speech unit, video switching unit, power unit, input storage unit and USB interface for downloading the data. The main unit consists of both hardware and software. The hardware includes: mainboard, power supply, hard disc drive, sound card, high resolution image acquisition card, processor, internal storage, adaptive network card, video card. The software includes: operating system, data acquisition programs and various board drivers.

(2) Network exchanging unit: the network server used for the communications between all the internal units and external networks.

(3) Power unit: UPS power box consisting of storage battery, power switching unit and control system, which may be used for the power supply of 110/220V AC and/or 24V DC. The standby battery is used as the backup power supply for the system for 2 hours in the case of failure of both AC power supply and DC emergency power supply.

(4) Alarm and control unit: the equipment used for the processing and indicating of the alarm and for the operating of VDR system.

(5) Indoor microphone: the equipment installed in the bridge for the acquisition of the audio of bridge working station.

(6) Outdoor microphone: the equipment installed at the wings of the bridge for the acquisition of the audio of the bridge wings.

(7) Data acquisition unit: the unit used for processing all analog and digital signals received from the onboard sensors and communicates with the main unit. The unit supports the following data acquisition boards: DC digital signal input board, AC digital signal input board, current analog signal input board (4-20 mA), voltage analog signal input board (+/- 10V), synchronizing signal input board, dry contact signal input board. These modules are used to realize data switching and provide photoelectric isolation. Therefore, the failure of VDR system will not affect the normal operation of other equipment.

(8) Data protection unit: the storage module and its protective capsule used for extracting VDR data by the maritime investigation organization after the ship incidents. Circulating storage of data of the last 12 hours may be achieved and the latest data is to replace the old data when the capacity is full. The data may be downloaded from the capsule to USB disk, external notebook or other onboard external computers connected with permanent network.

(9) Radio acoustic beacon: the radio acoustic alarm bounded with the data protection unit for the purpose of searching the data protection unit. When the ship sank, the beacon is to start by connecting with the circuit through sea water so as to continuously send radio wave for at least 30 days for searching and locating.

(10) Sunken data protection unit: the data protection unit may be used by both VDR and SVDR. The unit is resistant to fire, vibration, penetration and may be maintained under the sea for a long time. The medium may be salvaged from the deck of the sunken ship. The unit is capable of indicating the location.

(11) Floating data protection unit: one of the data protection units used by SVDR. The unit can float freely after entering of water and the unit is capable of indicating the location.

4.4 Plans and documents

In addition to the review in accordance with CCS procedural documents and CCS Guidelines for the Inspection of Shipborne Voyage Data Recorders (GD01-2002), attention is also to be paid to Reg. 5.5 of IEC61996-1 2007 on the requirements for documentation supplied by manufacturer.

4.4.1 The following documents are to be submitted to CCS for approval:

(1) Technical specifications (software version number of major firmware is to be included);

(2) Schematic diagram of the system;

(3) Schematic diagram of major units of the system: main unit, power unit, alarm and control unit, data acquisition unit, data protection unit;

(4) Configuration drawing and panel arrangement;

(5) Type test program.

4.4.2 The following documents are to be submitted to CCS for information:

(1) Installation manual, operation manual and service manual;

(2) Block diagram of system configuration;

(3) Wiring diagrams of components;

(4) Routine test record (sample);

(5) List of main components and parts;

(6) Identification or nameplate, sample of products quality certificate;

(7) Simulation software used for test;

(8) Playback software used for recovery of data.

4.4.3 In addition to the review of the plans and technical documents of the hardware equipment for shipborne voyage data recorders, the information on the reliability and stability of the software are also to be reviewed.

4.4.4 If necessary, other plans and documents which required for review by CCS are to be submitted.

4.5 Design and technical requirements

4.5.1 The function and performance of the product are to comply with the ambient environment and test requirements in IEC61996-1 ed1.0 2007-11 (VDR) or IEC61996-2 ed2.0 2007-11 (SVDR).

4.5.2 Electrical safety, power supply conditions adaptability, environmental adaptability and electromagnetic compatibility of the product are to comply with the ambient environment and test requirements in IEC60945 ed4.0 2002-08.

4.5.3 Data format and interfaces are to comply with the ambient environment and test requirements in IEC61162, including:

(1) IEC 61162-1 Edition 4.0 2010-11 Maritime Navigation and Radio Communication Equipment and Systems – Digital Interfaces – Part 1: Single Talker and Multiple Listeners;

(2) IEC61162-2 First edition 1998-09 Maritime Navigation and Radio Communication Equipment and Systems –Digital Interfaces –Part 2: Single Talker and Multiple Listeners, High-Speed Transmission;

(3) IEC 61162-3 Edition 4.0 2010-11 Maritime Navigation and Radio Communication Equipment and Systems - Digital Interfaces - Part 3: Serial Data Instrument Network.

4.5.4 Technical points

(1) Non-IEC61162/NEMAO183 signals may be collected. Multiple current/voltage analog signal, switch signal, AC/DC synchronizing signal and stepped signal may be collected.

(2) Microphone signal and VHF signal may be collected simultaneously. The voice data is to be stored after compressed.

(3) The acquisition ability of radar image: the minimum requirement is to collect one radar image.

(4) The collected data may be stored into data protective capsule and other local folder through configuration program.

(5) Data in the black box may be burned onto the disc through disc-carving machine or the stored data may be downloaded through USB interface or network cable connection for the analysis or back-up.

(6) Data protection unit is normally installed on the compass deck and connected with the main unit through network switch. It is to be composed of a hard driver with sufficient capacity (normally not less than 2G), data interface, base and underwater acoustic beacon provided with battery.

(7) Safety of recording data

① The final recording medium is to be enclosed in the data protective capsule. The final recording medium is accessible through client work station for the investigation and analysis of the cause after incident.

② The data stored in the final protective capsule may be accessible with the authorization but not be deleted and changed. The access to the final recording medium is not to tamper the recording data.

(8) The power unit of VDR is to have the following functions:

① Failure alarm: sending the alarm information to the main unit when the voltage is excessively low or the main source of power is lost;

② Automatic switch: change over to the power supply to VDR system by standby storage battery when the voltage is excessively low or AC power is lost. The continuity of the system is to be maintained during the change-over of the source of power;

③ Automatic start: the system is to start automatically and operate normally while resupplied by the main source of power after the shutdown of the system or stop of the recording.

(9) Requirements for microphone: outdoor microphone is to be water resistant. Acquisition server is to carry out an acoustic self-inspection to the microphone without manual intervention once every 12 hours. The protection level of the shell: for indoor microphone IP22, for outdoor microphone IP65.

(10) Acquisition of radar image: the minimum recording period is to record a video image once every 15 seconds. If more than one radar's images are to be collected, the acquisition may be achieved by automatic switching among different sources of radar image through image switching card.

(11) The alarm information includes the information relating to source of power, recording, voice and storage. Audible and visual alarms will be given by the system in the event of failure of any of the above mentioned parts. The alarm may be mute but the visual alarm is to be kept till the failure is eliminated.

4.6 Type approval

4.6.1 General principles

The voyage data recorder is to be type approved by CCS. The type approval certificate is to be issued, maintained, modified, renewed or cancelled according to the requirements of Chapter 3 of PART ONE of Rules for Classification of Sea-going Steel Ships.

4.6.2 Selection of typical samples and arrangement of test

Types and specifications of test samples are to be technically representative and are to cover the products for which type approval is sought. All standard and optional configurations are to be selected to ensure that the system is provided with the most functions and interfaces before the test is carried out. The test samples are to be taken by CCS surveyor at the manufacturer on site.

Equipment under test (EUT) is to include: main unit, microphone (indoor and outdoor), data protection unit, UPS alarm and operation unit, UPS power supply, etc.

4.6.3 Test organization

The type approval test is to be carried out in a competent test organization acceptable to CCS. The test organization is to subject to the international/domestic laboratory certification. Some functional tests may be carried out at the manufacturer under supervision of CCS Surveyor on site if the manufacturer is qualified to carry out the test and examined and approved by CCS surveyor.

4.6.4 Type approval test items and requirements

4.6.4.1 General requirements

(1) Composition of EUT: the composition of the EUT of each test item is to be determined according to the configuration of the system, EUT is usually to include: main unit, microphone (indoor and outdoor), data protective capsule, UPS power supply and alarm unit.

(2) Determination of input signal: standard data is to be input based on the data, voice and image during the performance test and inspection. The data is to be backed up for the comparison after the test.

(3) Bridge audio: the maximum number of connectable microphones is to be connected to EUT.

(4) Communications audio: VHF is to connect the maximum number of connectable communications audio input ports to EUT.

(5) Radar image: the test signals are to be provided to EUT.

(6) IEC61162 Data input

Each IEC61162 data input interface is to entry the continuous data flow in compliance with the sentence format of IEC61162. The recording of the input data is to be stored chronologically for further comparison.

4.6.4.2 The inspection and test items required by IEC61996

(1) Visual examination

The following items are to be checked in addition to the inspection carried out according to Reg. 4.2 of Chapter 4 of CCS Guidelines for the Inspection of Shipborne Voyage Data Recorders (GD01-2002).

Description of the function of equipment and the markings are to be accurate, clear and durable. The function of beacon is to be examined with dedicated tool and the voltage of battery is to be within the specified range.

To check if all parts of the system are complete and whether necessary documents are provided (including Reg. 3.6 of GD01-2002).

(2) Test for recording period

Where the external power is connected, PC is to send the analog signal of standard data format to VDR so that the VDR is to work continuously for more than 12 hours. Then the results are to be examined according to the requirements for performance inspection (PC).

(3) Reserve power source supply test

The duration of data storage required in the Guidelines is calculated based on the data which final recording medium is saved for 12 hours. Actually, the period for the general data coverage is to be more than 12 h.

Only bridge audio is to be recorded by reserve power source, not including communications audio. A suitable alarm is to be given when the normal external electrical power is removed. The alarm is to be capable of being mute manually or to be muted automatically after 2 min.

(4) Recharging test of reserve power source

The recharging of reserve power source is satisfactory if the reserve source is recharged for a period of 10 h to operate VDR system for a continuous period of 2 h.

(5) Test of electric power interruption

On completion of the interruption test, the record of the final recording medium is to be checked that at least 11 h 45 min of the original 12-hour record is to be saved, where the record containing only the bridge audio is to be less than 5 min.

(6) System integrity test

It is to verify that the bit error rate for digital signals does not exceeding 10^{-8} by the comparison between the data stored in the final recording medium and standard data.

Automatic test of microphone every 12 hours: in general, the system is to carry out the automatic test while starts to operate and an appropriate record will be retained in the system file and an appropriate record will be generated once every 12 hours later. Verification may be carried out through the check of the test record file. A suitable alarm is to be activated if there is no response to the acoustic test without intervention of all microphones.

Alarm is to be activated when the communication between the main box and alarm unit is interrupted.

(7) Test of recording sequence

VDR system generally uses UTC as time reference and it is an independent system, which carries out time synchronization with GPS every 1 hour. Each data recorded is provided with a time label. The timing error may be verified through the accuracy of the time label. The resolution ratio of ship's position, speed and heading may be verified through the accuracy of the recorded data.

(8) Test for recording related to date and time may be verified whether the resolution ratio of time is in compliance with the requirements by the date of data and the accuracy of time label.

(9) Test of positioning device

The beacon used in the sunken data protective capsule may accept the approval certificate issued by the competent organization such as FAA and the approved products are to comply with the requirements of SAEAS8045. However, relevant functional check of the beacon and the check of the battery voltage are to be carried out.

(10) Audio frequency response test for the bridge audio

① Defining the amplitude of the reference signal level firstly;

② Drawing the amplitude-frequency curve of the port under test;

③ Reproducing the above input test signal on PC and recording the frequency and amplitude;

④ Each port operates independently and other ports are short-circuited;

⑤ For the amplitude-frequency curve of each port, the variation of the level within the specified frequency band is not to exceed 6dB.

(11) Quality index test for bridge audio

Quality index for audio transmission, see IEC60268-16.

① Test for single port

(a) With all other area microphone port inputs short-circuited, connect the STI signal generator to the port under test. Adjusting the signal generator to a level equivalent to 75 dBA and recording the signal.

(b) Replaying the record and analyzing the STI;

(c) Repeating the above steps for all other area microphone ports;

(d) Required results: not to be less than that corresponding to the quality value for the speech transmission index of 0.85.

② Test for multiple ports

(a) With all other area microphone ports having an electrical input equivalent to 65 dBA of band limited white noise, connecting the STI signal generator to the port under test. Adjusting the signal generator to level equivalent to 75 dBA;

(b) Recording the signal of the ports under test;

(c) Replaying the speech data and records and analyzing the results;

(d) Required results: not to be less than that corresponding to the quality value for the speech transmission index of 0.60.

(12) Audio noise level – signal to no signal for bridge audio

① With all other area microphone port inputs short-circuited, connecting the audio signal generator to the port under test.

② Adjusting the output level of signal generator to the reference signal level and adjusting its frequency so as to operate the VDR system, then measuring the output of the reference signal level in way of frequency point of the 1/3 octave center through replaying the speech voice;

③ Operating VDR for 30 s for each of the five conditions, such as open-circuit, short-circuit and three different out-of band signals applied. For the out-of-band tests, connecting the signal generator to each port under test and setting the input signal to the reference signal level with the frequencies of 8 kHz, 10 kHz and 12.5 kHz alternately;

④ Operating VDR for 30 s under five conditions;

⑤ Replaying the speech data and records under five conditions;

⑥ According to Table 4.17.2(2) of the Guidelines, calculating the ratio of noise level at each central frequency point to the output for the reference signal input, expressed in dB.

⑦ Measuring the ratio of noise level to the output for the reference signal input of other ports separately with the same method;

⑧ Required results:

With no signal applied to any bridge area microphone port, the reproduced signal at any replay output is to be at least 48 dB below the output level. This requirement is to be met across the frequency band over the range of 150 Hz to 6000 Hz with the inputs both open and short-circuited.

The above signal to no signal performance is to be met in the presence of out-of-band input signals and also at the reference signal level.

(13) Audio noise level – signal to noise and distortion (SINAD)

① Setting the reference signal level;

② With the other area microphone ports short-circuited, connecting the port under test via an attenuator to the signal source of the distortion meter;

③ Adjusting the source of signal so as to change the frequency of input signal of the port under test within the 1/3 octave with certain intervals. Level at each frequency is to be reduced to -20 dB by the range of 5 dB for every varying, i.e., 0 dB, –5 dB, –10 dB, –15 dB, –20 dB. Recording for each combined signal.

④ Replaying the above-mentioned records and replaying the recorded voice through a band-pass filter of 150 Hz to 6 000 Hz;

⑤ Measuring the total harmonic distortion and noise for each test condition, calculating the ratio of distortion and noise to the reference signal input, expressed in dB.

⑥ Repeating the test for the other area microphone port to obtain the minimum value of the record;

Required results:

The reproduced signal to noise and distortion (SINAD) ratio is to be more than 24 dB across the frequency band of 150 to 6000Hz.

(14) Audio frequency response for communications

The test method for audio frequency response test for communications with band width of 150 to 3500Hz is the same as that for the audio frequency response test for bridge. The requirements for the test results of these two tests are the same.

(15) Quality index test for communications audio

The quality index test for communications audio is only carried out for single channel and the test for single channel of the quality index test for bridge audio may be taken for reference.

(16) Audio noise level – signal to no signal for the communications audio

The input signal band width is 150 to 3500 Hz, the frequencies for out-of-band input signal are 5kHz, 6.3kHz and 8kHz. Other test conditions and results are the same as those of audio noise level for bridge audio.

(17) Audio noise level – ratio of signal to noise and distortion (SINAD) for communications audio

The input signal band width is 150 to 3500Hz. Other test conditions and results are the same as those of audio noise level – signal to noise and distortion for bridge audio.

(18) Radar data test

The test is to be carried out according to Reg. 4.23 of CCS Guidelines for the Inspection of Shipborne Voyage Data Recorders (GD01-2002).

(19) Tests for echo sounder, main alarms, rudder order and response, engine order and response, hull opening status, watertight and fire door status, accelerations and hull stresses, wind speed and direction

The recorded data is to be displayed item by item and the format and resolution rate are to comply with the requirements of IEC61996 ed1.0. The data is to be refreshed with the frequency of more than once a second. The data may be recorded for a period of 30 min and replayed.

Required results:

All changed data are to be accurately generated at least once a second.

(20) Functional test for data downloading and replaying

The VDR is to provide an interface for data downloading and a software for data playback. The interface for data downloading and playback software are to comply with the requirements for data downloading interface and playback software in Annex C of IEC61996-1 (2007).

4.6.4.3 Verification of ship's fixed data

The VDR final recording medium is to restore the ship's fixed data information, the format and contents of which are to comply with the relevant requirements of IEC61996. The fixed data information is to be entered to its configuration file. When the VDR system works normally, the information of the configuration file is to be recorded into the recording medium in real time. The ship's fixed data information recorded by VDR is to be replayed for verification through playback software.

4.6.4.4 Environmental and electromagnetic compatibility type test items

The environmental and electromagnetic compatibility type tests are to be carried out according to IEC60945 item by item.

4.6.5 Other examination points on type approval site

Attentions are to be paid to the following items during the site examination of the type approval of such products:

4.6.5.1 Control of the purchased parts;

4.6.5.2 Commissioning, inspection and control of system boards;

4.6.5.3 Commissioning, inspection and control of assembly;

4.6.5.4 Confirmation of the compliance of the purchased parts with the requirements of documents approved by CCS;

4.6.5.5 Confirmation of the compliance of the certificate with the products for the parts with certification requirement;

4.6.5.6 To confirm that strict management systems for non-conformity products have been established by the applicant, including the disposal of non-conformity products of purchased parts, non-conformity products of system components and non-conformity products of the system;

4.6.5.7 To confirm that the applicant at least has the necessary inspection equipment for the routine test and complete calibration/check management provisions;

4.6.5.8 Personnel of key position such as inspection personnel are to have appropriate qualification certificates;

4.6.5.9 To confirm the identification and traceability of the product;

4.6.5.10 The applicant is to have the quality management department/unit independent of the manufacturer;

4.6.5.11 Quality control points are to involve the whole process from the inspection of purchased parts to the installation inspection of parts and assembly inspection.

4.6.6 Cross-references between voyage data recorder (VDR) and simplified voyage data recorder (S-VDR):

There are two main differences between S-VDR and VDR:

Requirements for the data collection are reduced (If no data in compliance with the format of IEC61162 is provided by the equipment, S-VDR may not collect the data); requirements for the data protective capsule (VDR may only use sunken data protective capsule, S-VDR may use floating or sunken data protective capsule).

Cross-references between Recommendation on Performance Standards for Shipborne Simplified Voyage Data Recorders (S-VDRs) (MSC.163(78)) and Recommendation on Performance Standards for Shipborne Voyage Data Recorders (VDRs) (A.861(20)):

Regulation / Resolution	A.861(20) (VDR)	MSC.163(78) (S-VDR)
1. Purpose	The purpose of a voyage data recorder (VDR) is to…	(Identical)
2. Application	(Applies to all ships)	(Only applies to the existing cargo ships of 3000 gross tonnage and over constructed before 1 July 2002)
3. References	A.622(16) A.694(17), A.824(19), A.830(19), Annex 3 of MSC.64(67) Annex 4 of MSC.64(67)	In addition to the existing documents, the following are added: A.802(19) "Performance Standards for Survival Craft Radar Transponders for Use in Search and Rescue Operations"; A.810(19) "Performance Standards for Float-free Satellite Emergency Position — Indicating Radio Beacons (EPIRBs) Operating on 406 MHz"; A.812(19) "Performance Standards for Float-free Satellite Emergency Position — Indicating Radio Beacons Operating Through the Geostationary INMARSAT Satellite System on 1.6 GHZ"; A.861(20) "Recommendation on Performance Standards for Shipborne Voyage Data Recorders (VDRs)"
4. Definitions		
4.1 Voyage data recorder	Including "the final recording medium in its capsule"	Including "the final recording medium" (the words 'in its capsule' are deleted)
4.2	Sensor	(Identical)
4.3	Final recording medium	(Identical)
4.4	Playback equipment	(Identical)
4.5	Dedicated reserve power source	(Identical)
5. Operational requirements		
5.1 General		
5.1.1	The VDR should continuously maintain… referred to in 5.4	The S-VDR should continuously maintain…(identical in the latter part)
5.1.2	To permit subsequent analysis of factors surrounding an incident,…	(Identical)

Regulation / Resolution	A.861(20) (VDR)	MSC.163(78) (S-VDR)
5.1.3	The final recording medium should be installed in a protective capsule which should meet all of the following requirements: .1 be capable of being accessed following an incident but secure against tampering; .2 maximize the probability of survival and recovery of the final recorded data after any incident; .3 be of a highly visible color and marked with retro - reflective materials; and .4 be fitted with an appropriate device to aid location.	5.1.3 Final recording medium 5.1.3.1 The final recording medium should be installed in a protective capsule of either a fixed or float-free type, which should meet all of the following requirements: .1 be capable of being accessed following an incident but secure against tampering; .2 maintain the recorded data for a period of at least 2 years following termination of recording; .3 be of a highly visible color and marked with retro-reflective materials; and .4 be fitted with an appropriate device to aid location. 5.1.3.2 The fixed type protective capsule should comply with the requirements set out in resolution A.861(20) with the exception of the resulting requirements for withstanding penetration. 5.1.3.3 The float-free type protective capsule should: .1 be fitted with means to facilitate grappling and recovery; .2 be so constructed as to comply with the requirements specified in resolutions A.810(19) or A.812(19) and to minimize risk of damage during recovery operations; and .3 the device should be capable of transmitting an initial locating signal and further locating homing signal for at least 48 hours over a period of not less than 7 days/168 hours
5.1.4	The design and construction, which should be in accordance with the requirements of resolution A.694(17) and international standards acceptable to the Organization, …	(Identical)
5.2	Data selection and security	(Identical)
5.3	Continuity of operation	(Identical)
5.4 Data items to be recorded		
5.4.1	Date and time	(Identical)
5.4.2	Ship' s position	(Identical)
5.4.3	Speed	(Identical)
5.4.4	Heading	(Identical)
5.4.5	Bridge audio	(Identical)
5.4.6	Communications audio	(Identical)
5.4.7	Radar data, post - display selection	(Identical)

Regulation / Resolution	A.861(20) (VDR)	MSC.163(78) (S-VDR)
5.4.8	Echo sounder	(Echo sounder cancelled) AIS Data If it is impossible to obtain radar data1 then AIS target data should be recorded as a source of information regarding other ships. If radar data is recorded, AIS information may be recorded additionally as a beneficial secondary source of information on both other and own ship
5.4.9	Main alarms	(Main alarms cancelled) Other items Any additional data items listed by IMO with the requirements set out in resolution A.861(20) should be recorded when the data is available in accordance with the international digital interface standards2 using approved sentence formatters
5.4.10	Rudder order and response	(cancelled)
5.4.11	Engine order and response	(cancelled)
5.4.12	Hull openings status	(cancelled)
5.4.13	Watertight and fire door status	(cancelled)
5.4.14	Accelerations and hull stresses	(cancelled)
5.4.15	Wind speed and direction	(cancelled)
6	Operation	(Identical)
7	Interfacing	(Identical)

4.7 Product inspection (unit/batch inspection)

Such products are to be type approved as required by the Convention. Products without approval may not be accepted for inspection unless otherwise specified by the Headquarters.

Sampling rate: the manufacturer is to develop the sample inspection plan according to the widely used sample inspection standards (such as GB/T 2828 and ISO2859 standards) on the basis of process characteristics and quality control level and submit the plan to CCS for information. The surveyor is to examine the implementation record of the sample inspection plan during the unit/batch inspection. The performance of the product is to be inspected where deemed necessary by the surveyor.

4.7.1 Inspection items after approval:

4.7.1.1 Inspection of the series number of the product component and the version number of the software used;

4.7.1.2 Visual inspection

4.7.1.3 Inspection of visibility and marking

4.7.1.4 Inspection of insulation resistance and withstand voltage test

4.7.1.5 Inspection of the continuous operation of the system

4.7.1.6 Inspection of the reserve power source supply

4.7.1.7 Inspection of the recharging of reserve power source

4.7.1.8 Inspection of the system integrity

4.7.1.9 Inspection of basic data recording and error

4.7.1.10 Function inspection of serial port data recording

4.7.1.11 Function inspection of image acquisition recording

4.7.1.12 Function inspection of speech acquisition recording

4.7.1.13 Function inspection of data backup

4.7.1.14 Verification of the certified data protective capsule and beacon

4.7.1.15 Inspection of functions of beacons and voltage of battery

The surveyor is to witness the inspections and tests of all the above mentioned items. The applicant is to provide the inspection record/report.

4.7.2 Issue of the certificate

After satisfactory inspection of products, a certificate of marine products is to be issued. Except the data collected as specified by the Convention, the acquisition of other data differs due to the different conditions of the ship or requirements of the ship-owners. Thus the time for continuous recording will be effected. The certificate is to identify the name of the ship intended to be equipped or the ship engineering number.

4.7.3 Filling of the report

4.7.3.1 Visual inspection, inspection of visibility and marking

To check whether the markings are correct, the color of data protective capsule and whether the texts are in compliance with the requirements.

4.7.3.2 Insulation and pressure-tight tests: only for the power source.

4.7.3.3 System continuous operation test:

To record the start time of the operation of system, the duration of the continuous operation of system and to check whether the data recording, speech recording and image recording are complete and continuous; To check failure alarm information and the accuracy of the recorded data.

4.7.3.4 Reserve power source supply test:

To record the start time for power supply of reserve power source, the time when the system stops recording and the duration of power supply by the standby battery. To check whether the data recording is continuous and complete during the change-over from AC to reserve power source. The restoration time for the recording after the AC power restores.

4.7.3.5 System integrity test

(1) Function inspection of alarm unit

Indication function, gray scale adjusting button, key function, buzzer;

(2) Indication of normal operation of the system

Self-checking of microphone, indication of normal operation

(3) Alarm of abnormal operation of the system

Alarm for the failure of power source, recording of the failure alarm, alarm for the failure of communications between alarm unit and main unit, alarm for the failure of microphones;

4.7.3.6 Test for the correlation between recording and date and time:

To record the start time of the test and the completion time of the test, the consistency of the recorded time and original time in relation to time, whether the refresh rate of recorded data is in compliance with the requirements of IEC61996.

4.7.3.7 Function inspection of data backup

The system is in normal operation with all signals connected, no error occurred during download, the consistency of the recorded time and original time in relation to time; The downloaded data may be replayed with playback software and compared with the data in the data protective capsule.

4.7.3.8 Analog signal error test and recording test

Requirements for error:

To meet the requirements for the accuracy of the collected data.

To input the signal with step-down approach and filter process to the instrumentation amplifier to get isolated and amplified. The processed data is to be sent to AD acquisition circuit via filter process for AD conversion, the converted data is to be transmitted to microprocessor for processing. The processed data is to be converted into output digital signal.

4.7.3.9 Data acquisition recording test in compliance with the format of IEC61162

Whether the IEC61162 sentence system sent by the corresponding port is correct; whether the collected data is refreshed at the rate of once a second.

4.7.3.10 Function inspection of image acquisition recording

To input the video signal, whether the recording is complete and continuous, redisplaying the image, whether there are obvious color errors during the subjective test, obvious position error;

4.7.3.11 Function inspection of speech acquisition recording

Whether harmonic distortion occurs during the input of audio signal, whether the output waveform is normal during the replay of speech, whether the speech recording is complete, continuous and clear.

4.7.3.12 Other test items with special requirements

4.7.4 Inspection marks

CCS stamp is to be marked on the nameplates of the products.