Guidance For Classification And Construction

Part 1 Seagoing Ships

Volume W

GUIDANCE FOR THE APPROVAL AND TYPE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE

2022

Biro Klasifikasi Indonesia

www.bki.co.id

Guidance For Classification And Construction

Part 1 Seagoing Ships

Volume W

GUIDANCE FOR THE APPROVAL AND TYPE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE

Consolidated Edition 2022

Biro Klasifikasi Indonesia

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Foreword

This Guidance is consolidated edition 2022 of Guidance for The Approval and Type Approval of Materials and Equipment for Marine Use Part. 1 – Seagoing Ships, Volume W.

In this edition there are no new amendments added, only consolidate the 2021 edition, RCN No.1, and RCN No.2. The summary of previous edition and amendments including the implementation date are indicated in Table below:

	Edition / Guidance Change Notice (GCN)	Effective Date	Link
1.	Edition 2020	1st January 2021	🔗
2.	GCN No. 1, April 2021	1st July 2021	🔗
3.	GCN No. 2, November 2021	1st January 2022	🔗

Note: *Full previous edition and amendments including its amendment notice is available through link above.*

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Further queries or comments concerning this Guidance are welcomed through communication to BKI Head Office.

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A. General

1. Purpose

The purpose of the Guidance for The Approval and Type Approval of Materials and Equipment for Marine Use (hereinafter referred to as the Guidance), is to specify the procedure for approval of the manufacturing process and type approval, etc., for the materials and equipment for marine use delivered from manufacturing plants as finished products in the course of examinations of the construction, materials, scantlings and workmanship of the hull, equipment and machinery required by Part 1 of the Rules for Seagoing Ships (hereinafter referred to as the Rules) and other technical rules, excluding the examinations for hull outfitting work and machinery assembly and installation work carried out at shipyards. Also, the Guidance is to describe the procedure for the certification of the quality system applied to the supplier.

2. Application

2.1 The Guidance, in principle, applies to tests and inspections of materials and equipment for marine use which are, in advance, to be subjected to the approval by BKI in accordance with the requirements specified in the Rules and the Guidance relating to the Rules for Seagoing Ship and other technical rules.

2.2 The materials and equipment other than those specified in the Guidance may, where deemed appropriate by BKI, be approved in accordance with the National or International Standards, the applicable Codes, the manufacturer's specifications or equivalent thereto upon the request of manufacturer.

3. Equivalency

Even in case it is difficult to conform to the requirements in the Guidance, if BKI admits a matter as equivalent to the requirements in the Guidance, the matter may be regarded as conforming to the Guidance.

B. Definition

1. Approval of manufacturing process

Approval of manufacturing process is, on condition that the uniform quality of the products can be assured, to certify for the manufacturers that the manufacturing process complies with the requirements in the Rules for Materials (Pt.1, Vol.V) and/or the relevant standards, where deemed satisfactory by BKI as results

of carrying out the examination, tests and inspections specified in the Guidance prior to commencement of production and test of the product.

2. Type approval

Type approval is to certify for the manufacturers of the materials and equipment for marine use that the materials and equipment comply with the provisions for the type approved products in the Guidance, where deemed satisfactory by BKI as the results of carrying out the examination, tests and inspection specified in the Guidance before installation on board.

3. Type test

The verification by BKI, under prescribed test conditions, indicate that a product possesses the stipulated feature (characteristics), or those specified.

4. Test Specimen

Representative specimen, as agreed with BKI, usually taken from current production and submitted to the agreed tests.

5. Design approval

Design approval is to certify for the manufacturers that the drawings and documents specifying the particulars, construction, dimensions and materials of equipment for marine use may be dealt with as the standard design by conducting the approval of these drawings in advance, based on the requirements in Part 1 of Seagoing Ship Rules and other technical rules.

6. Approval of quality assurance system

Approval of a quality assurance system is to certify for the manufacturers that their quality system complies with the requirements in the Guidance, where deemed satisfactory by BKI as the result of carrying out the plant audit specified in the Guidance and evaluating the capability of a quality assurance of the manufacturers, as suppliers.

7. Manufacturer approval

Manufacturer approval is to certify for the manufacturers that their quality system complies with the requirements in the Guidance, where deemed satisfactory by BKI as the result of carrying out the plant audit specified in the Guidance and evaluating manufacturing process, the capability of a quality assurance of the manufacturers (e.g. paints, fire protection materials, etc.), as suppliers have type approval certificate without individual product inspection.

C. Type Testing

All those products described in the current BKI Rules of Construction as subject to type testing must undergo a type test in accordance with the procedure laid down in Fig. 1.1. On application, a type test may also be performed on products not subject to a mandatory type test.

After the successful conclusion of the tests, BKI issues type approval certificate confirming that the products which have undergone the type test meet the stipulated requirements, and that these products are approved for use on ships and structures classed by BKI.

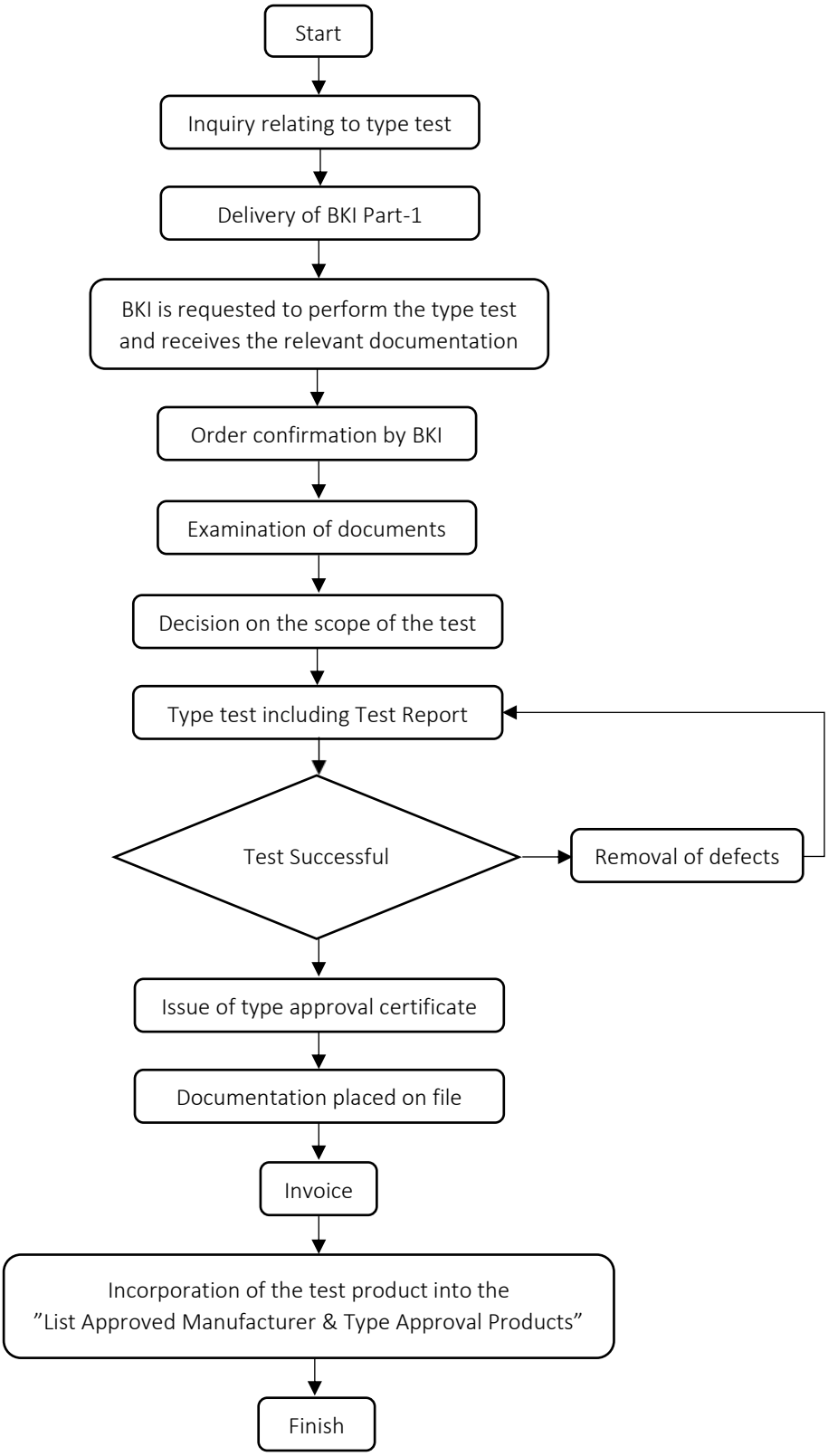
Start
Inquiry relating to type test
Delivery of BKI Part-1
BKI is requested to perform the type test and receives the relevant documentation
Order confirmation by BKI
Examination of documents
Decision on the scope of the test
Type test including Test Report
Test Successful
Removal of defects
Issue of type approval certificate
Documentation placed on file
Invoice
Incorporation of the test product into the ”List Approved Manufacturer & Type Approval Products”
Finish

Fig. 1.1

D. Publication

All products which have successfully undergone BKI's type test and for which a type approval certificate has been issued are made publicly known in the periodically updated List of Approved Manufacturer & Type Approved Products.

A list is supplied free of charge to each holder of a type approval certificate.

E. Fees

See Rules for Classification and Survey (Pt. 1, Vol. I) Sec. 1, E.

F. Payment of Invoices

See Rules for Classification and Survey (Pt. 1, Vol. I) Sec. 1, F.

G. Liability and Jurisdiction

See Rules for Classification and Survey (Pt. 1, Vol. I) Sec. 1, G.

H. Disagreement

See Rules for Classification and Survey (Pt. 1, Vol. I) Sec. 1, H

I. Obligation and Requirements

1. Obligation of Biro Klasifikasi Indonesia

BKI undertakes to treat confidentially all information and documents of which it acquires knowledge in the course of its professional activities associated with a type test.

2. Obligation of the Client

In commissioning the test, the client undertakes to perform and record in proper manner, or to cause to be so performed and recorded by a suitable institute, all the tests laid down in this Guidance.

The client undertakes as stated in Section 3, A.7 to notify BKI immediately of any alteration to the specification of type-tested products.

The client undertakes, when advised in advance, to give members of BKI's competent staff access to all manufacturing and testing facilities, and to provide him with all the information necessary to the performance of his duties.

3. Requirement to be met by client

The possibility of type testing is confined to those products whose unvarying quality is guaranteed. The client must dispose of suitable production and test equipment, a competent staff and a quality management system, which ensures a steady production quality of the products. A type test carried out by BKI does not relieve the client of his liability for the product.

J. Licensing

The transfer of type approval certificates on third parties, e.g. the issue of licences has to be agreed with BKI.

The license shall submit an application for a type test together with a declaration of consent by the licensor to the effect that the license is entitled to manufacture the product in question and that use may be made of the results of the completed type test.

BKI reserves the right to perform repeat tests on the products manufactured under licence. The scope of the tests is to be agreed between the license and BKI.

K. Type-Test Certification for Third Parties

Where it is proposed that a type-tested product is to be marketed by third parties, the letter shall submit an application together with the declaration of consent by the holder of the type approval certificate.

A type approval certificate for third parties may be issued subject to compliance with the requirements stated in I.3.

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A. General

1. Application

1.1 The requirements in this Section apply to the procedure and tests for the approval of manufacturing process of the materials in accordance with the requirements in Rules for Materials (Pt. 1, Vol. V).

1.2 Of those materials to be approved by BKI in accordance with the requirements in Rules for Materials, the requirements in this Section correspondingly apply to the procedure and tests for the approval of manufacturing process of the materials.

1.3 The manufacturers wishing to obtain the approval of manufacturing process are to comply with the requirements specified in the relevant Sub-section of this Section according to the kind of materials in addition to the requirement for the procedure and tests specified in this Sub-section.

2. Approval application

2.1 The manufacturer wishing to obtain the approval of manufacturing process is to submit the application of BKI approval together with the required documents for the approval and the required documents for reference to BKI. The application of approval and the documents could be submitted in electronic format.

2.2 Documents to be submitted

2.2.1 Documents for approval

Test plan for the approval of manufacturing process and applicable standard, codes or rules (where test methods and procedure are specified into this Guidance, IMO Res., National or International Standards, etc., the data to indicate the related standard instead of this required data may be submitted except detail drawings of test specimens).

2.2.2 Documents for reference

1) Details of products information
   A) Type of products, grade of steel, thickness and specification of products
2) Outline of workshops
   A) Name and address of the manufacturer, history, layout and dimension of works
3) Organization and quality
   A) Organizational chart
   B) Staff employed and organization of the quality control department
   C) Certification of compliance of the quality system with IS0 9001 and/or approval certificates already granted by other Classification Societies, if any.
4) Outline of manufacturing process and facilities
   A) Flow chart of the manufacturing process including quality control process on each manufacturing stage.
   B) Manufacturing facilities and equipment
5) Inspection and test
   A) Inspection and test procedures/standards
   B) Qualification of the personnel involved in activities related to the inspection and test
   C) List and documents of equipment for mechanical tests, chemical analyses and metallography, non-destructive examinations and relevant calibration procedures
   D) Details of system used for identification of materials at the different manufacturing stages
6) Service records
   A) Estimated total annual production of finished products for shipbuilding and for other applications
7) Other data deemed necessary by BKI

2.3 Notwithstanding the requirements in 1., where the Applicant is already approved by BKI and the attachments are entirely equal in content to the documents previously submitted to BKI, the documents may be partly or entirely exempted from submission except for approval test program for approval of the manufacturing process.

2.4 Where any part of the manufacturing process is assigned to other companies or other manufacturing plants, additional documents related to the manufacturing process showing the names and addresses of the other companies and plants together with the organization and method of inspection for purchasing semifinal products are to be included.

3. Data review

BKI examines the approval test program for approval of manufacturing process submitted in accordance with the requirements. in 2.2 and where deemed appropriate, the test program is approved and returned to the manufacturer.

4. Facilities and personnel of the manufacturer

4.1 The manufacturer is to be provided with necessary manufacturing facilities to secure quality required of the products. Appropriate environmental facilities, carrying appliances, etc. are to be maintained in workshops, also.

4.2 In the manufacturer, necessary inspection and test equipment together with its supplementary equipment to thoroughly perform the inspection and tests of the products are to be maintained.

4.3 In the manufacturer, the assignment of personnel is to be appropriate to maintain the quality required of the products.

5. Plant audit

5.1 Purpose

BKI will, where deemed appropriate upon review of documents and data submitted, carry out the plant audit in the presence of the Surveyor to verify that the manufacturer has a technical capability to continuously produce the proposed products of equal level in quality under the stable workmanship to the satisfaction of BKI.

5.2 Items to be audit

The plant audit is to apply to the following items in the presence of the Surveyor.

1) Quality system in general
   A) Establishment and implementation of quality system
   B) Observance and establishment of procedure for handling of customer complaints
2) Education and training of employees
   A) Control of process and quality
   B) Observance of work instruction
   C) Observance and confirmation of Q.C flow charts
   D) Control of nonconforming product and corrective action
3) Control of manufacturing and inspection equipment
   A) Observance and establishment of maintenance procedure for manufacturing equipment
   B) Calibration and control of inspection equipment
4) Others
   A) Updating of documents such as applicable standards, etc.
   B) Comprehension of related requirements for class surveys
5) Audit methods and acceptance criteria are to be as deemed appropriate by BKI.

5.3 Time for audit

The time of the audit is to correspond, in principle, to either the time when the proposed product is manufactured or the time when the approval test is carried out. In this case, the manufacturer is to provide the necessary information related to this audit.

5.4 Exemption of audit

When the manufacturer submits the application of newly produced product with the same manufacturing facilities and similar method of manufacture for products which have been approved by BKI, the audit items may be exempted wholly or partly according to the review result of the documents.

6. Approval test

6.1 The approval test is to be carried out in the presence of the Surveyor in accordance with the test method described in each Sub-section of the Guidance or equivalent method thereof. However, the test may be partly or entirely omitted subject to the approval by BKI in case any of the following 6.1.1 or 6.1.2 is relevant.

6.1.1 In case where the manufacturer has been approved by other Classification Society or an inspection organization recognized by BKI.

6.1.2 In case of approval test for the lower grade products manufactured by the similar methods which have been approved by BKI

6.2 In principle, the approval test is to be carried out at the manufacturing sites. However, it may be done at an outside of manufacturing sites subject to approval by BKI.

6.3 The test samples used for the approval test are to be selected, as a rule, from the same conditions of products in the presence of the Surveyor during the plant audit as far as practicable.

6.4 Test records

6.4.1 After completion of the approval test, the manufacturer is to prepare a record of the approval test and operation records relevant to steel making, casting, rolling and heat treatment etc. of the test products and is to submit in electronic format to BKI upon receiving confirmation by the Surveyor.

6.4.2 All results, which are in any case to comply with the requirements of the Rules, are evaluated for the approval; depending on the results, particular limitations or testing conditions, as deemed appropriate, may be specified in the approval document.

7. Notification and announcement of approval

7.1 BKI shall issue an Approval Certificate for Manufacturing Process to the Applicant, where deemed appropriate by BKI on the basis of the submitted test reports and plant audit results after completion of the approval test.

7.2 BKI announces the manufacturers who have been granted the approval of manufacturing process in the "List of Approved Manufacturer & Type Approved Products" containing the types of products and the main conditions of approval.

8. Changes in the manufacturing process

8.1 When the alteration to the specifications (materials, composition, dimension, construction, particulars, etc.), manufacturing facilities, manufacturing methods and/or quality control system has a significant effect on the property or quality of the products, or when the works was removed, the

manufacturer is to submit the application of alteration to BKI together with the detailed documents of the alteration (where practicable, to be mentioned with a comparison table form between new and old).

8.2 BKI may request a plant audit or approval test, where deemed necessary upon reviewing the contents of alteration.

8.3 For the insignificant alterations, the manufacturer shall give the contents of alteration to the Surveyor for confirmation at the appropriate time. In this case the Surveyor shall report the contents of alteration to BKI head office.

9. Validity and renewal of approval certificate

9.1 The approval certificate for manufacturing process will be valid within 5 years from the date of issue. In case where the approval certificate is renewed in accordance with the requirements specified in 8., the expiration date will not be changed. In case where the renewal audit is carried out within 3 months before the expiry date, the valid term of the approval certificate will be dated to the original renewal date.

9.2 The manufacturer who intends to have a continuation of the approval is to submit an application to BKI three months before the due date together with following data.

1) Data related to the corrective action for approved product, if any.
2) Alteration to the approved manufacturing process or specification.
3) Service records of approved products or similar products which are approved by BKI (minimum 6 months and over).

9.3 BKI is to carry out a plant audit in accordance with the requirements specified in 5. and may request an approval test where deemed necessary after the examination of application and documents thereof.

9.4 Manufacturers who have not produced the approved grades and products during the period between renewals may be required to either carry out approval tests or, on the basis of results of production of similar grades of products, at the discretion of BKI, be pre-approved.

9.5 Where for operational reasons, the renewal plant audit falls outside the period of approval, the manufacturer will still be considered as approved if agreement to this audit date is made within the period of three months after expiry of the validity. In this instance, if successful, the extension of approval will be back dated to the original renewal date.

10. Suspension or withdrawal of approval

10.1 Concerning the product quality, during the period of validity, BKI can withdraw the approval of manufacturing process in case any of following cases:

1) When the materials no longer conform to the given requirements due to amendments or establishment of conventions, laws, rules and regulations.
2) In service failures traceable to product quality and/or non-conformity of the product revealed during test, fabrication and construction.
3) When the products are produced in breach of the approval conditions or when the test results have been improperly reported.
4) Changes brought by the Manufacturer without preliminary agreement of BKI to the extent of the approval defined at the time of the approval
5) When the materials and equipment failed to pass the confirmation test and/or occasional plant audit specified in 11.

6) In case where a serious failure of the manufacturer's quality system has been identified or where the manufacturer has failed to inform any changes which will affect the approved quality system to BKI.

7) In case where the manufacturer has not undergone a renewal plant audit or where the manufacturer is refusing to undergo occasional plant audit requested by BKI.

10.2 In renewal or occasional audit for approved products, where non-conformities in the approved quality system are found, or where conditions for the issuance of the certificate or for its maintenance have deteriorated, the manufacturer is to correct the non-conformities. Such corrections are to be verified by BKI. In case where corrective actions are not taken within the specified period, BKI may suspend the approved certificate for a given period. In case where the corrective actions are not taken for the suspended period, BKI may withdraw the approval.

10.3 Having no concern with the product quality, BKI can withdraw during the period of validity, the approval of manufacturing process in the following cases:

1) When a request for withdrawal is made by the manufacturer.

2) When the approval fees are not paid.

3) When considered inappropriate for approved condition by BKI.

4) When periodical surveillance is not carried out.

10.4 A manufacturer whose approval has been withdrawn, may apply for re-approval provided that the reasons which resulted in cancellation are corrected, and BKI is to issue the approval certificate after it is confirmed that the corrective action has effectively been implemented.

10.5 Where an application for re-approval is made for product which had its approval of manufacturing process withdrawn, such application shall be handled according to initial approval of manufacturing process requirements. But, it may be considered as exceptional case in case where BKI specially accepted.

11. Confirmation test and/or occasional plant audit

11.1 The confirmation test and/or occasional plant audit may be required when serious defect is found in structure or performance, etc. of the materials and equipment retaining approval.

11.2 After completion of the confirmation test and/or occasional plant audit, the manufacturer is to prepare a record of the confirmation test and/or occasional plant audit and submit in electronic format to BKI upon receiving confirmation by the Surveyor.

B. Rolled Steels

I. Normal and Higher Strength Steels

1. Application

The requirements in this Sub-section apply to tests and inspection for the approval of manufacturing process of Normal and Higher Strength Steels as specified in Rules for Materials (Pt. 1, Vol. V) Sec.4.B.

2. Data to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI.

1) Kind of products (e.g. steel plate, shaped steel, etc.)
2) Material grade (e.g. A, D, etc.) and range of thickness
3) Aim material properties
   A) Range of chemical composition and aim analyses, including grain refining, micro alloying and residual elements, for the various grades of steel; if the range of chemical composition depends on thickness and supply condition, the different ranges are to be specified, as appropriate.
   B) Aim maximum carbon equivalent ($C_{eq.}$) according to Rules for Materials (Pt .1, Vol. V). For higher strength grades with low carbon content C < 0,13 %, aim maximum P_{cm} content.
   C) Production statistics of the chemical composition and mechanical properties (TS, YP, EL and KV). The statistics are intended to demonstrate the capability to manufacture the steel products in accordance with the requirements.
4) Steel making
   A) Steel making process and capacity of furnaces or converters
   B) Raw material used
   C) Deoxidation and alloying practice
   D) Desulphurisation and vacuum degassing installation, if any
   E) Casting methods (ingot or continuous casting): In the case of continuous casting, information relevant to type of casting machine, methods to prevent inclusions and segregation control etc., is to be provided as appropriate.
   F) Ingot or slab size and weight
   G) Ingot or slab treatment (scarfing and discarding procedures), etc.
5) Re-heating and rolling
   A) Type of furnace and treatment parameters
   B) Rolling reduction ratio of slab/bloom/billet to finished product thickness
   C) Rolling and finishing temperatures
   D) Descaling treatment during rolling
   E) Capacity of the rolling stands
6) Heat treatment
   A) Type of furnaces, heat treatment parameters and their relevant records
   B) Accuracy and calibration of temperature control devices
7) For products delivered in the controlled rolling (CR) or thermo-mechanical rolling (TM) condition, the following additional information on the programmed rolling schedules is to be given:
   A) Description of the rolling process

B) Normalizing temperature, re-crystallization temperature and Ar3 temperature and the methods used to determine them.

C) Control standards for typical rolling parameters used for the different thickness and grades of steel (temperature and thickness at the beginning and at the end of the passes, interval between passes, reduction ratio, temperature range and cooling speed of accelerated cooling, if any) and relevant method of control

D) Calibration of the control equipment

8) Recommendations for working and welding in particular for products delivered in the CR or TM condition

A) Cold and hot working recommendations if needed in addition to the normal practice used in the shipyards and workshops

B) Minimum and maximum heat input if different from the ones usually used in the shipyards and workshops (15 - 50 kJ/cm)

3. Approval tests

3.1 Test samples and specimen

3.1.1 For each grade of steel and for each manufacturing process (e.g. steel making, casting, rolling and condition of supply), test samples are in general to be selected for each kind of product.

3.1.2 Test samples are to be taken in the presence of the Surveyor from the product (plate, flat, section, bar) corresponding to the top of the ingot, or, in the case of continuous casting, a random slab from the ladle of the first heat and the last heat in one casting sequence.

3.1.3 The position of the samples to be taken in the length of the rolled product, "piece" defined in Rules for Materials (Pt.1, Vol.V) Sec. 4. A (top and/or bottom of the piece) and the direction of the test specimens with respect to the final direction of rolling of the material are indicated in Table 2.2. The position of the samples in the width of the product is to be in compliance with Rules for Materials (Pt.1, Vol.V) Sec. 4. A.

3.1.4 Test samples are to be taken from the product with the maximum thickness (dimension) to be approved. In addition, for initial approval, BKI will require selection of one test product of average thickness.

3.2 Approval test and acceptance criteria

3.2.1 Approval tests are to be carried out in the presence of the Surveyor at the manufacturing plant and approval test items are to be as given in Table 2.1.

3.2.2 Test methods and acceptance criteria are to be as given in Table 2.2. However, where accordance with these requirements are difficult, decisions are left to the discretion of BKI.

3.2.3 If the testing facilities are not available at the works, the tests are to be carried out at recognized laboratories.

3.2.4 Other test

Additional tests such as CTOD test, large scale brittle fracture tests (Double Tension test, ESSO test, Deep Notch test, etc.) or other tests may be required in the case of newly developed type of steel, outside the scope of Rules for Materials (Pt.1, Vol.V) Sec.4.B, or when deemed necessary by BKI.

3.3 Weldability test

3.3.1 Preparation of the test assemblies

Welded joints tests are to be carried out on samples of the thickest plate. Tests are required for normal strength grade E and for higher strength steels.

- butt weld test assembly welded with a heat input approximately 15 kJ/cm
- butt weld test assembly welded with a heat input approximately 50 kJ/cm

3.3.2 Welding of the test assemblies

- The butt weld test assemblies are to be prepared with the weld seam transverse to the plate rolling direction, so that impact specimens will result in the longitudinal direction.
- The bevel preparation should be preferably single or double V groove or double bevel
- The welding procedure should be as far as possible in accordance with the normal welding practice used at the yards for the type of steel in question. The welding parameters including consumables designation and diameter, pre-heating temperatures, inter-pass temperatures, heat input, number of passes, etc. are to be reported.

3.3.3 Type of tests and acceptance criteria

Kinds of tests, test methods and acceptance criteria are to be as given in Table 2.3.

3.3.4 Other tests

Additional tests such as cold cracking tests (CTS, Cruciform, Implant, Tekken, Bead-on plate), CTOD, or other tests may be required in the case of when deemed necessary by BKI.

3.4 In addition to those specified in A.6.1 a reduction of the indicated number of casts, steel plate thicknesses and grades to be tested or complete suppression of the approval tests may be considered subject to the approval by BKI on the basis of the preliminary information submitted by the manufacturer in case any of the following 3.4.1 to 3.4.5 is relevant. On the other hand, an increase of the number of casts and thicknesses to be tested may be required in the case of newly developed types of steel or manufacturing processes.

3.4.1 Approval already granted by other Classification Societies and documentation of approval tests performed

3.4.2 Approval for any grade of steel also covers approval for any lower grade (impact test temperature) in the same strength level, provided that the method of manufacture and condition of supply are similar.

3.4.3 For higher tensile steels, approval of one strength level covers the approval of the strength level immediately below, provided the steelmaking process, deoxidation and fine grain practice, casting method and condition of supply are similar.

3.4.4 Change of the approval conditions.

3.4.5 Grades of steel to be approved and availability of long term statistic results of chemical and mechanical properties

3.5 In case of multi-source slabs or changing of slab manufacturer, the rolled steel manufacturer is required to obtain the approval of the manufacturing process of rolled steels using the slabs from each slab manufacturer and to conduct approval tests in accordance with 3.2 and 3.3 above. A reduction or complete suppression of the approval tests may considered by BKI taking into account previous approval as follows:

1) The rolled steel manufacturer has already been approved for the manufacturing process using other semi-finished products characterized by the same thickness, steel grade, grain refining and micro-alloying elements, steel making and casting process.
2) The semi-finished products manufacturer has been approved for the complete manufacturing process with the same conditions (steelmaking, casting, rolling and heat treatment) for the same steel types.

4. Changes in the manufacturing process

In addition to those specified in A.8., the manufacturer has to submit to BKI the documents together with the request of changing the approval conditions, in the case of the followings:

1) Change of the manufacturing process (steel making, casting, rolling and heat treatment)
2) Change of the maximum thickness (dimension)
3) Change of the chemical composition, added element, etc.
4) Subcontracting the rolling and heat treatment, etc.
5) Use of the slabs, blooms and billets manufactured by companies other than the ones verified in the approval tests.

5. Result

5.1 All the results, which are in any case to comply with the requirements of the Rules, are evaluated for the approval; depending on the results, particular limitations or testing conditions, as deemed appropriate, may be specified in the approval document.

5.2 All the information required under B.I.2, applicable to the products submitted to the tests, is to be collected by the manufacturer and put in the dossier which will include all the results of the tests and operation records relevant to steel making, casting, rolling and heat treatment of the test products.

6. Certification

6.1 Approval

Upon satisfactory completion of the survey, approval is granted BKI.

6.2 List of approved manufacturers

The approved manufacturers are entered in a list containing the types of steel and the main conditions of approval.

7. Dealing after approval

Rolled steels which conform to the requirements in this Section are to be dealt with as an approved case in the requirements in Rules for Materials (Pt.1, Vol.V) Sec. 4, B.10.2, unless otherwise specified by BKI.

Table 2.1 Approval Test Items for Rolled Steels

Kinds	Grade	Base metal test												Brittle fracture test		Weldability test					Other Test				
		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
Rolled steel for hull	KI-A, KI-B	o	o	o		o		o			o														
	KI-D	o	o	o		o		o			o	o													
	KI-E	o	o	o		o		o			o	o			o	o	o	o	o						
	KI-A32, KI-A36, KI-A40, KI-D32, KI-D36, KI-D40	o	o	o		o		o			o	o				o	o	o	o						
	KI-E32, KI-E36, KI-E40, KI-F32, KI-F36, KI-F40	o	o	o		o		o			o	o			o	o	o	o	o						
YP47 steels	KI-E47	o	o	o		o		o			o	o		o[7]	o	o	o	o	o	o					
Brittle Crack Arrest Steels	KI-E36, KI-E40	o	o	o		o		o			o	o			o	o	o	o	o						o
	KI-E47	o	o	o		o		o			o	o		o[7]	o	o	o	o	o	o					o
High strength steels for welded structure	Refer to Rules for Materials (Pt.1, Vol.V) Sec.4.D	o	o	o		o		o	o		o	o		o	o	o	o	o	o	o					
Rolled steels for low temp. service	Refer to Rules for Materials (Pt.1, Vol.V) Sec.4.F	o	o	o		o		o	o		o	o		o	o	o	o	o	o						
Rolled steel for boilers	Refer to Rules for Materials (Pt.1, Vol.V) Sec.4.E	o	o	o		o		o	o		o							o			o	o			
Rolled steel for pressure vessels	Refer to Rules for Materials (Pt.1, Vol.V) Sec.4.E	o	o	o		o		o	o		o	o			o			o							
Round bars for chain	KI-K1, KI-K2, KI-K3	o	o	o		o		o	o		o							o							
	KI-R3, KI-R3S, KI-R4, KI-R4S, KI-R5	6)																							
Round steels bar for boiler	Refer to Rules for Materials (Pt.1, Vol.V) Sec.9.C	o	o	o		o		o	o		o														
Rolled and forged steel carbon bars	Refer to Rules for Materials (Pt.1, Vol.V) Sec.6	o	o	o		o		o	o		o														
Rolled and forged low allow steel bars	Refer to Rules for Materials (Pt.1, Vol.V) Sec.6	o	o	o		o		o	o		o														
Rolled stainless steels	Refer to Rules for Materials (Pt.1, Vol.V) Sec.4.G	o	o	o		o		o	o		o												o		
Stainless steel clad plates	Refer to Rules for Materials (Pt.1, Vol.V) Sec.4.H	o	o	o	o	o	o	o	o	o	o												o	o	

Table 2.1 Approval Test Items for Rolled Steels *(continued)*

Notes

1. *Where thermo-mechanical controlled processing (TMCP) is performed, tensile test after stress relieving is required in addition to those tests given in table.*
2. *For steel materials with consideration against through thickness properties as specified in Rules for Materials (Pt.1, Vol.V), the tensile test of through thickness direction, microscopic examination for non-metallic inclusions, ultrasonic test are required in addition to those tests given in table.*
3. *For steels other than steel plates, the strain ageing Charpy impact test, NRL drop weight test and CTOD test are not required, unless otherwise specified. However, where cast piece from the continuous casting method is used, the macrostructure of the cast piece and sulphur print test may be required.*
4. *The CTOD test, high temperature tension test and creep test as specified in the Table are performed for the purpose of evaluating low temperature toughness and high temperature characteristics, and these tests may be omitted in case appropriate records prepared by the manufacturer are available or in case BKI deems the test unnecessary.*
5. *Additional tests such as large scale brittle fracture tests (Double Tension test, ESSO test, Deep Notch test, etc.) or other tests may be required when deemed necessary by BKI.*
6. *The approval test items of round bar for offshore chains and accessories are to be in accordance with J.III.*
7. *Instead of CTOD test, deep notch test may be carried out.*
8. *Base metal test is to include corrosion test (general corrosion test, intergranular corrosion test and stress corrosion cracking test). Weldability test is to include micro structure, bend test and corrosion test (general corrosion test, intergranular corrosion test and stress corrosion cracking test).*
9. *Kind of test*

(a) Chemical analysis	*(b) Sulphur test*	*(c) Micro structure*	*(d) Macro structure*
(e) Ferrite grain size	*(f) Hardness Test*	*(g) Tensile test*	*(h) Bend test*
(i) Shearing strength test	*(j) Charpy impact test*	*(k) Strain charpy impact test*	
(l) Hydrogen embrittlement test	*(m) CTOD test*	*(n) NRL drop weight test*	*(o) Weldment tensile test*
(p) Weldment impact test	*(q) Max. Hardness test*	*(r) Macro structure*	*(s) Hydrogen crack test*
(t) High temp. Tensile test	*(u) Creep test*	*(v) Corrosion test*	*(w) Ultrasonic test.*
(x) brittle crack arrest tests			

Table 2.2 Test Items and Selection of Test Specimens

Approval test items		Position of the sample (0)	Direction of the test specimens	Approval Testing method	Acceptance criteria
Base metal	Chemical analysis	T (Top)	-	ASTM A568 or equivalent method. Ladle analysis and production analysis (from the tensile test specimens) are to be performed for C, Si, Mn, P, S and other elements as deemed necessary.	The chemical composition by ladle analysis is to comply with the requirements in Rules for Material (Pt.1, Vol.V) Sec. 4.C Excess difference in the chemical compositions between melt analysis and product analysis is not to be accepted.
	Sulphur print	T	T (Transverse)	ASTM E1180-03 or equivalent method. Length is to be greater than 600 mm (cross section in the case of cast piece)	Segregation, etc., deemed to have negative effect are not to be present
	Microscopic exam. for non-metallic inclusion	T	T	ISO 4967 or equivalent method.	Acceptance criteria is the reference.
	Macro structure	T	T	ISO 4967 or equivalent method.	
	Micro structure	T	-	Microscopic photographs (approx.100x) of base metal, joining part and cladding metal are to be taken	
	Ferrite grain size	T		ASTM E112 or equivalent method. Magnification of microscopic photographs are to be as a rule 100x.(2)	
	Hardness test	T	-	In accordance with Rules for Materials (Pt.1, Vol.V). Hardness distribution in the thickness direction is to be measured in the case of stainless clad steel.	To meet the requirements in Rules for Materials (Pt.1, Vol.V). Sec. 6.G, to be as appropriate by BKI.
	Tensile test	T	T(3)	In accordance with Rules for Materials (Pt.1, Vol.V). (4) (5)	To meet the requirements in Rules for Materials (Pt.1, Vol.V). Sec. 6.G.
		B (Bottom)	T(3)		
	Tensile test of through thickness direction	T	Thickness direction	In accordance with Rules for Materials (Pt.1, Vol.V).	To meet the requirements in Rules for Materials (Pt.1, Vol.V).
		B			
	Tensile test (stress relieved) (6)	T	T(3)	Tensile test after stress relieving at 600℃ (2 min/mm with minimum 1 hour holding)	Acceptance criteria is the reference.
		B	T(3)		
	Bend test	B	T	In accordance with Rules for Materials (Pt.1, Vol.V). However, in case of not being prescribed in the Rules , bend test is to be in accordance with recognized national or international standard which BKI considers appropriate.	Defects etc., deemed to have negative effect are not to be present
	V-notch Charpy impact test	T	P (Parallel)	Using R4 test specimen, the transition temperature curve of the absorbed energy and fracture surface ratio is to be determined by testing three pieces at each temperature. (8) (9) (also the lateral expansion to be reported.) Furthermore, the test temperature is to include the temperature as specified in Rules for Materials (Pt.1, Vol.V) and its interval is to be 10~20°C (10) V-notch Charpy impact test specimens for stainless clad steels are to be taken from the base material.	To meet the requirements in Rules for Materials (Pt.1, Vol.V). Others are the reference.
			T(7)		
		B	P		
	Strain ageing V-notch charpy impact test	T	P	Same as V-notch Charpy impact test. However The test specimens which have been maintained for one hour at 250°C after strain of 5 % have been applied is, as a rule, to be used. (8) (9) (11)	Acceptance criteria is the reference.

Table 2.2 Test Items and Selection of Test Specimens *(continued)*

Approval test items		Position of the sample	Direction of the test specimens	Approval Testing method	Acceptance criteria
Brittle fracture test	CTOD test	T	P	BS 7448 or equivalent. To be consulted with BKI the dimension of test specimen, test condition, etc., when newly performing tests at the time of approval.	Acceptance criteria is the reference.
	NRL drop weight test	T	P(7)	ASTM E 208 or equivalent method. The NDTT (Non-Ductility transition temperature) is to be determined and photographs of the tested specimens are to be taken and enclosed with the test report.	Acceptance criteria is the reference. However no fracture to be occurred at the impact test temperature specified in the Rules for Materials (Pt.1, Vol.V).
Weldability test	Weldment tensile test	T	T (to the welding direction)	in accordance with the test method described in B-1.3.3	in accordance with the test method described in B.I.3.3
	Weldment impact test	T			
	Maximum hardness test	T	-		
	Macro structure	T	-		
High temp. Characteristics tests	High temp. Tensile test	T	P	ASTM A 572 (High temp. tensile test), To be consulted with BKI on the dimension of test specimen, test condition etc., when newly performing tests at the time of Approval.	Acceptance criteria is the reference.
Corrosion resistance test	Corrosion test	T	-	Corrosion resistance accordance with Rules for Material (Pt.1, Vol.V) Annex 3 or equivalent method.	Acceptance criteria is the reference.
Non-destructive test	Ultrasonic test	T	-	NDT accordance with Rules for Material (Pt.1, Vol.V) Sec. 3. or equivalent method.	Acceptance criteria is the reference.

Notes

(0) The followings can be shown the example of the poison (Top and Bottom) where the test samples are detached

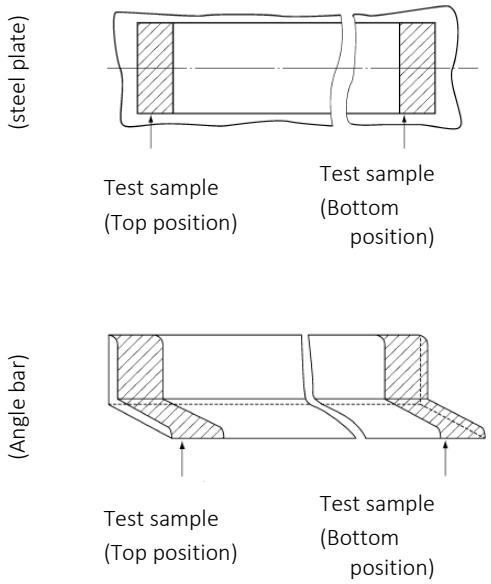


Table 2.2 Test Items and Selection of Test Specimens *(continued)*

(1) For rolled steels for hull, the content of the following elements is to be checked: *C, Mn, Si, P, S, Ni, Cr, Mo, Al, N, Nb, V, Cu, As, Sn, Ti* and, for steel manufactured from electric or open-hearth furnace, *Sb* and *B*.

(2) For thick products in general at least three examinations are to be made at surface, one quarter and mid-thickness of the product.

(3) Longitudinal direction for sections and plates having width less than 600 mm.

(4) In case of tensile test specimens of bar steels taken from steels over 40 mm in thickness, test specimens are to be taken at the middle of thickness and in accordance with the requirements of Rules for Materials (Pt.1, Vol.V).

(5) For plates made from hot rolled strip one additional tensile specimen is to be taken from the middle of the strip constituting the coil.

(6) Only for TMCP steels, or when deemed necessary by BKI.

(7) Not required for sections and plates having width less than 600 mm.

(8) For plates made from hot rolled strip one additional set of impact specimens is to be taken from the middle of the strip constituting the coil.

(9) For plates having thickness higher than 40 mm one additional set of impact specimens is to be taken with the axis located at mid-thickness.

(10) Impact test temperature of hull steels are as bellows:

Grade	Direction	Test temperature (°C)			
KI-A, KI-B, KI- KI-A 32, KI- KI-A 36, KI- KI-A 40	Longitudinal	+20	0	-20	-
KI-D, KI- KI-D 32, KI-D 36, KI-D 40		0	-20	-40	-
E, KI-E 32, KI-E 36, KI-E 40		0	-20	-40	-60
KI-F 32, KI-F 36, KI-F 40		-20	-40	-60	-80
KI-A, KI-B, KI-A 32, KI-A 36, KI-A 40	Transverse	+20	0	-20	-
KI-D, KI-D 32, KI-D 36, KI-D 40		0	-20	-40	-
E, KI-E 32, KI-E 36, KI-E 40		-20	-40	-60	-
KI-F 32, KI-F 36, KI-F 40		-40	-60	-80	-

(11) Strain ageing charpy impact test temperature of hull steels are as bellows:

Grades	Test temperature (°C)		
KI-A 32, KI-A 36, KI-A 40	+20	0	-20
KI-D, KI-D 32, KI-D 36, KI-D 40	0	-20	-40
E, KI-E 32, KI-E 36, KI-E 40	-20	-40	-60
KI-F 32, KI-F 36, KI-F 40	-40	-60	-80

Table 2.3 Weldability test Items, test methods and acceptance criteria

Test items	Direction of the test specimens	Test method	Acceptance criterai
Tensile test	T (Transverse)	Rules for Materials (Pt.1, Vol.V).	To meet the requirements of the Rules for Materials (Pt.1, Vol.V). Sec. 6.G
Charpy V-notch Impact test	T	A set of 3 Charpy V-notch impact specimens transverse to the weld with the notch located at the fusion line and at a distance 2, 5 and minimum 20 mm from the fusion line. The fusion boundary is to be identified by etching the specimens with a suitable reagent.	To meet the requirements in Rules for Materials (Pt.1, Vol.V). Sec. 4.B. Table 4.7
Maximum hardness tests	-	Hardness tests *Hυ* 5 across the weldment. The indentations are to be made along a 1 mm transverse line beneath the plate surface on both the face side and the root side of the weld as follows: Fusion line HAZ: at each 0,7 mm from fusion line into unaffected base material (6 to 7 minimum measurements for each HAZ)	The maximum hardness value should not be higher than 350 *Hυ*
Macro structure tests	T	A sketch of the weld joint depicting groove dimensions, number of passes, hardness indentations should be attached to the test report together with photo-macrographs of the weld cross section.	To be free from crack, incomplete penetration, lack of fusion, other harmful defects

II. Semi-Finished Products for Rolled Steels

1. Application

1.1 The requirements in this Sub-section apply to tests and inspection for the approval of manufacturing process of semi-finished products such as slabs, blooms and billets for the rolled steels (including rolled steel bars, to which Rules for Material (Pt. 1, Vol. V) Sec. 6 apply) as specified in Rules for Material (Pt. 1, Vol. V) Sec. 4 of the Rules.

1.2 Requirements other than those specified in this Section are to be in accordance with the requirements of Sub Section

2. Data to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI.

1) Type of products (ingots, slabs, blooms, billets)
2) Material grade (e.g. KI-A, KI-D, etc.) and range of thickness
3) Aim material properties
   A) Range of chemical composition and aim analyses, including grain refining, micro alloying and residual elements, for the various grades of steel; if the range of chemical composition depends on thickness and supply condition, the different ranges are to be specified, as appropriate.
   B) Aim maximum carbon equivalent ($C_{eq.}$) according to Rules for Material (Pt. 1, Vol. V). For higher strength grades with low carbon content C < 0,13 %, aim maximum P_{cm} content

C) Production statistics of the chemical composition and mechanical properties (TS, YP, EL and KV). The statistics are intended to demonstrate the capability to manufacture the steel products in accordance with the requirements.

4) Steelmaking

A) Steel making process and capacity of furnaces or converters

B) Raw material used

C) Deoxidation and alloying practice

D) Desulphurisation and vacuum degassing installation, if any

E) Casting methods (ingot or continuous casting): In the case of continuous casting, information relevant to type of casting machine, methods to prevent inclusions and segregation control etc., is to be provided as appropriate.

F) Ingot or slab size and weight

G) Ingot or slab treatment (scarfing and discarding procedures), etc.

3. Approval tests

3.1 Test samples and specimen

3.1.1 For each type of steel and for each manufacturing process (e.g. ingot casting, continuous casting), one test product with the maximum thickness and one test product with the minimum thickness to be approved are in general to be selected for each kind of product (ingots, slabs, blooms/billets). The selection of the casts for the test product is to be based on the typical chemical composition, with particular regard to the specified C_{eq} or P_{cm} values and grain refining micro-alloying additions.

3.1.2 The test samples are to be taken, unless otherwise agreed, from the product (slabs, blooms, billets) corresponding to the top of the ingot, or, in the case of continuous casting, a random sample.

3.2 Approval test and acceptance criteria

3.2.1 Approval tests are to be carried out in the presence of the Surveyor at the manufacturing plant and approval test items are to be as given in Table 2.4.

3.2.2 Test methods and acceptance criteria are to be as given in Table 2.4. However, where accordance with these requirements are difficult, decisions are left to the discretion of BKI.

3.2.3 In addition, for initial approval and for any upgrade of the approval, BKI will require full tests indicated in B.I.3. to be performed at rolling mill on the minimum thickness semi-finished product.

3.2.4 In case of a multi-caster work, full tests on finished products shall be carried out for one caster and reduced tests (chemical analysis and sulphur print) for the others.

3.2.5 If the testing facilities are not available at the works, the tests are to be carried out at recognized laboratories

Table 2.4 Approval test items and acceptance criteria of Semi-Finished Products for Rolled Steels

No.	Approval test items	Approval Testing method	Acceptance criteria
1.	Chemical analyses	Both the ladle and product analyses are to be reported. In general the content of the following elements is to be checked: C, Mn, Si, P, S, Ni, Cr, Mo, Al, N, Nb, V, Cu, As, Sn, Ti and, for steel manufactured from electric or open-hearth furnace, Sb and B.	The chemical composition by ladle analysis is to comply with the requirements in Rules for Material (Pt. 1, Vol. V) Sec. 4. Excess difference in the chemical compositions between melt analysis and product analysis is not to be accepted.
2.	Sulphur prints	Sulphur prints are to be taken from product edges which are perpendicular to the axis of the ingot or slab. These sulphur prints are to be approximately 600 mm long taken from the centre of the edge selected, i.e. on the ingot centreline, and are to include the full product thickness.	Segregation, etc., deemed to have negative effect are not to be present

3.3 In addition to those specified in A.6.1 a reduction of the indicated number of casts, product thicknesses and types to be tested or complete suppression of the approval tests may be considered subject to the approval by BKI on the basis of the preliminary information submitted by the manufacturer in case any of the following 3.3.1 to 3.3.3 is relevant. On the other hand, an increase of the number of casts and thicknesses to be tested may be required in the case of newly developed types of steel or manufacturing processes.

3.3.1 Approval already granted by other Classification Societies and documentation of approval tests performed.

3.3.2 Types of steel to be approved and availability of long term statistic results of chemical properties and of mechanical tests performed on rolled products.

3.3.3 Change of the approval conditions.

4. Changes in the manufacturing process

In addition to those specified in A.8, the manufacturer has to submit to BKI the documents together with the request of changing the approval conditions, in the case of the followings:

1) Change of the manufacturing process (steel making, and casting)
2) Change of the maximum thickness (dimension)
3) Change of the chemical composition, added element, etc.

5. Result

Requirement for the result not specified in this sub-section are to be in accordance with B.I.

6. Certification

6.1 On the approval certificate the following information is to be stated:

1) Types of steel (normal or higher strength)
2) Type of products (ingots, slabs, blooms, billets)
3) Steelmaking and casting processes

4) Thickness range of the semi-finished products

6.2 It is also to be indicated that the individual users of the semi-finished products are to be approved for the manufacturing process of the specific grade of rolled steel products they are going to manufacture with those semi-finished products.

III. Normal and Higher Strength Steels intended for Welding with High Heat Input

1. Application

The requirements in this Section specifies the weldability confirmation scheme of normal and higher strength hull structural steels intended for welding with high heat input over 50 kJ/cm. The weldability confirmation scheme is to be generally applied by manufacturer's option.

2. Data to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI.

1) Outline of steel plate to be certified
   - grade and thickness range
   - deoxidation practice and fine grain practice
   - aim range of chemical composition
   - aim maximum C_{eq} and P_{cm}
   - production statistics of mechanical properties (tensile and Charpy V-notch impact tests), if any
2) Manufacturing control points to prevent toughness deterioration in heat affected zone when welded with high heat input, relevant to chemical elements, steel making, casting, rolling, heat treatment etc.
3) Welding control points to improve joint properties on strength and toughness, if any.

3. Approval tests

3.1 Test plate and Test assembly

3.1.1 Test plate is to be manufactured by a process approved by BKI in accordance with the requirements in B.I. For each manufacturing process route, two test plates with different thickness are to be selected. The thicker plate (t) and thinner plate (less than or equal to t/2) are to be proposed by the manufacturer.

3.1.2 Small changes in manufacturing processing (e.g. within the TMCP process) may be considered for acceptance without testing, at the discretion of BKI.

3.1.3 One butt weld assembly is to be generally prepared with the weld axis transverse to the plate rolling direction. Dimensions of the test assembly are to be amply sufficient to take all the required test specimens.

3.2 Welding of test assembly

3.2.1 The welding procedures should be as far as possible in accordance with the normal practices applied at shipyards for the test plate concerned.

3.2.2 Welding process, welding position, welding consumable (manufacturer, brand, grade, diameter, and shield gas) and welding parameters including bevel preparation, heat input, preheating temperatures, interpass temperatures, number of passes etc. are to be reported.

3.3 Approval test and acceptance criteria

Approval test items, test methods and acceptance criteria are to be as given in Table 2.5.

Table 2.5 Weldability confirmation test Items, test methods and acceptance criteria

Test items	Direction of the test specimens	Test method	Acceptance criteria
Visual examination	–	Overall welded surface should be subject to visual examination.	Overall welded surface is to be uniform and free from injurious defects such as cracks, undercuts, overlaps etc.
Macro structure tests	T	A sketch of the weld joint depicting groove dimensions, number of passes, hardness indentations should be attached to the test report together with photo-macrographs of the weld cross section.	To be free from crack, incomplete penetration, lack of fusion, other harmful defects
Microscopic test	T	Along mid-thickness line across transverse section of the weld, one micrograph with x100 magnification is to be taken at each position of the weld metal centreline, fusion line and at a distance 2, 5, 10 and minimum 20 mm from the fusion line.	The test result is provided for information purpose only.
Hardness test	T	Along two lines across transverse weld section 1mm beneath plate surface on both face and root side of the weld, indentations by Hv5 are to be made at weld metal centreline, fusion line and each 0,7 mm position from fusion line to unaffected base metal (minimum 6 to 7 measurements for each heat affected zone).	The maximum hardness value should not be higher than 350 Hv.
Transverse tensile test	T	Two transverse (cross weld) tensile specimens are to be taken from the test assembly. Test specimens and testing procedures are to comply with the requirements of Rules for Material (Pt. 1, Vol. V)	The tensile strength is to be not less than the minimum required value for the grade of base metal.
Bend test	T	Two transverse (cross weld) test specimens are to be taken from the test assembly and bent on a mandrel with diameter of quadruple specimen thickness. Bending angle is to be at least 120°. Test specimens are to comply with the requirements of Rules for Material (Pt.1, Vol. V). For plate thickness up to 20mm, one face-bend and one root-bend specimens or two side-bend specimens are to be taken. For plate thickness over 20mm, two side-bend specimens are to be taken.	After testing, the test specimens shall not reveal any crack nor other open defect in any direction greater than 3 mm.

Table 2.5 Weldability confirmation test Items, test methods and acceptance criteria *(continued)*

Test items	Direction of the test specimens	Test method	Acceptance criteria
Impact test	T	Charpy V-notch impact specimens (three specimens for one set) are to be taken within 2,0 mm below plate surface on face side of the weld with the notch perpendicular to the plate surface. One set of the specimens transverse to the weld is to be taken with the notch located at the fusion line and at a distance 2, 5 and minimum 20 mm from the fusion line. The fusion boundary is to be identified by etching the specimens with a suitable reagent. The test temperature is to be the one prescribed for the testing of the steel grade in question. For steel plate with thickness greater than 50 mm or one side welding for plate thickness greater than 20mm, one additional set of the specimens is to be taken from the root side of the weld with the notch located at each the same position as for the face side. Additional tests at the different testing temperatures may be required for evaluating the transition temperature curve of absorbed energy and percentage crystallinity at the discretion of BKI.	The average impact energy at the specified test temperature is to comply with the requirements of Rules for Material (Pt. 1, Vol. V) depending on the steel grade and thickness. Only one individual value may be below the specified average value provided it is not less than 70% of that value.

3.4 Additional test assemblies and/or test items may be required in the case of newly developed type of steel, welding consumable and welding method, or when deemed necessary by BKI. Where the content of tests differs from those specified in Table 2.5, the program is to be confirmed by BKI before the tests are carried out.

3.5 Other test

Additional tests such as wide-width tensile test, HAZ tensile test, cold cracking tests (CTS, Cruciform, Implant, Tekken, and Bead-on plate), CTOD or other tests should be required at the discretion of BKI.

3.6 Range of certification

Range of certification for steel grades is to be the following 1) through 5) unless otherwise agreed by the Classification Society:

1) Approval tests on the lowest and highest toughness levels cover the intermediate toughness level.
2) Approval tests on normal strength level cover that strength level only.
3) For high tensile steels, approval tests on one strength level cover strength level immediately below.
4) Tests may be carried out separately subject to the same manufacturing process.
5) Certification and documentation of confirmation tests performed by other Classification Society may be accepted at the discretion of BKI.

4. Result

4.1 The manufacturer is to submit to the Classification Society the complete test report including all the results and required information relevant to the confirmation tests specified in B.III.3.

4.2 The contents of the test report are to be reviewed and evaluated by the Classification Society in accordance with this weldability confirmation scheme.

5. Certification

BKI issues the certificate where the test report is found to be satisfactory. The following information is generally required to be included on the certificate:

1) Manufacturer
2) Grade designation with notation of heat input (see B.III.6)
3) Deoxidation practice
4) Fine grain practice
5) Condition of supply
6) Plate thickness tested
7) Welding process
8) Welding consumable (manufacturer, brand, grade), if desired
9) Actual heat input applied.

6. Grade designation

6.1 Upon issuance of the certificate, the notation indicating the value of heat input applied in the confirmation test may be added to the grade designation of the test plate, e.g. "KI-E36-W 300" (in the case of heat input 300 kJ/cm applied).

6.2 The value of this notation is to be not less than 50 and every 10 added.

IV. YP47 Steel

1. Application

1.1 The requirements in this Section apply to tests and inspection for the approval of manufacturing process of YP47 Steel Plates of grade KI-E47 for longitudinal structural members in the upper deck region of container carriers as specified in Rules for Material (Pt.1, Vol.V) Sec.4.L.

1.2 Requirements other than those specified in this Sub Section are to be in accordance with the requirements of B.I.

2. Data to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI.

1) Data to be submitted are to be as given in B.I.2.
2) In addition to 1) above, aim maximum P_{cm} content

3. Approval tests

3.1 General

Approval test items, test methods and acceptance criteria not specified in these requirements are to be in accordance with B.I.

3.1.1 Extent of the approval tests

For reduction of the indicated number of casts, steel plate thicknesses, and grades to be tested requirements in B.I.3.4 are applied, except for 3.4.2 and 3.4.3.

3.2 Base Metal test

3.2.1 Charpy V-notch Impact Tests

1) Test samples are to be taken from the plate corresponding to the top of the ingot, unless otherwise agreed. In the case of continuous castings, test samples are to be taken from a randomly selected plate.
2) The location of the test sample is to be at the square cut end of the plate, approximately one-quarter width from an edge, as shown Fig. 2.1.

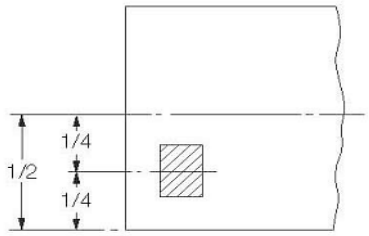


Fig. 2.1 Plates and flats

3) Samples are to be taken with respect to the principal rolling direction of the plate at locations representing the top and bottom of the plate as follows:
4) Longitudinal Charpy V-notch impact tests : Top and bottom,
5) Transverse Charpy V-notch impact tests : Top only,
6) Strain aged longitudinal Charpy V-notch impact test : Top only,
7) Charpy V-notch impact tests are required from both the quarter and mid thickness locations of the test samples. One set of 3 Charpy V-notch impact specimens is required for each impact test.
8) The Charpy V-notch impact test temperature is to be -40°C.
9) In addition to the determination of the energy value, the lateral expansion and the percentage crystallinity are also to be reported.
10) The strain aged samples are to be strained to 5% followed by heating to 250°C for 1 hour prior to testing.
11) Additionally at each location, Charpy V-notch impact tests are to be carried out with appropriate temperature intervals to properly define the full transition range.

3.2.2 Brittle fracture initiation test

1) Deep notch test or Crack Tip Opening Displacement (CTOD) test is to be carried out and the result is to be reported.
2) CTOD test is to be carried out in accordance with BS 7448 or equivalent.
3) When performing the deep notch test, manufacturer is to submit the detailed test procedure to BKI
4) Manufacturer is to be consulted with BKI the dimension of test specimen, test condition, etc.

3.2.3 Naval Research Laboratory (NRL) drop weight test

1) The test method is to comply with ASTM E208 or equivalent method.
2) Nil Ductility Test Temperature (NDTT) is to be reported for reference and photographs of the tested specimens are to be taken and enclosed with the test report.

3.3 Weldability test

3.3.1 Charpy V-notch Impact Test

1) Charpy V-notch impact tests are to be taken at a position of 1/4 thickness from the plate surface on the face side of the weld with the notch perpendicular to the plate surface.
2) One set of the specimens transverse to the weld is to be taken with the notch located at the fusion line and at a distance 2, 5 and minimum 20 mm from the fusion line.
3) The fusion boundary is to be identified by etching the specimens with a suitable reagent.
4) One additional set of the specimens is to be taken from the root side of the weld with the notch located at the same position and at the same depth as for the face side.
5) The impact test temperature is -40°C.
6) Additionally at each location, impact tests are to be carried out with appropriate temperature intervals to properly define the full transition range.

3.3.2 Y-shape weld crack test (Hydrogen crack test)

1) The test method is to be in accordance with recognized national standards such as JIS Z 3158-2016 or CB/T 4364-2013.
2) Acceptance criteria are to be as deemed appropriate by BKI.

3.3.3 Brittle fracture initiation test

1) Deep notch test or CTOD test is to be carried out.
2) Test method and results are to be in accordance with 3.3.2 of these requirements.

V. High Strength Steels for Welded Structures

1. Application

1.1 This requirement specifies the procedure for the approval of the manufacturing process of high strength steels for welded structures.

1.2 Requirements other than those specified in this sub-section are to be in accordance with the requirements of B.I.

2. Data to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI.

1) Data to be submitted are to be as given in B.I.2.
2) In addition to 1) above, delivery condition (especially for A3 temperature and description of quench and tempering process).

3. Approval tests

3.1 General

3.1.1 Approval test sample and specimen not specified in this sub-section are to be in accordance with B.I.

3.2 Approval test and acceptance criteria

3.2.1 Approval test and acceptance criteria not specified in this sub-section are to be in accordance with B.I.

3.3 Weldability tests - Butt weld test

3.3.1 For H420 to H500 grade steels: Weldability tests are to be carried out on samples of the thickest plate. Testing on higher grades can cover the lower strength and toughness grades.

1) 1x butt weld test assembly welded with a heat input 15±2 kJ/cm is to be tested as welded.
2) 1x butt weld test assembly welded with a heat input 50±5 kJ/cm for N/NR and TM and 35±3,5 kJ/cm for QT steels is to be tested as-welded.
3) 1x butt weld test assembly welded with the same heat input as given in 2) is to be post-weld heat treated (PWHT) prior to testing.

Option: Steels intended to be designated as steels for high heat input welding are to be tested with 1x butt weld test assembly in the as-welded condition and 1x test assembly in the PWHT condition, both welded with the maximum heat input being approved.

3.3.2 For H550 to H960 grade steels

In general, the thickest plate with the highest toughness grade for each strength grade is to be tested. Provided the chemical composition of the higher grade is representative to the lower grade, testing requirements on the lower grades may be reduced at the discretion of BKI.

1) 1x butt weld test assembly welded with a heat input 10±2 kJ/cm is to be tested as-welded.
2) 1x butt weld test assembly welded with a maximum heat input as proposed by the manufacturer is to be tested as-welded. The approved maximum heat input shall be stated on the manufacturer approval certificate.

Option: If the manufacturer requests to include the approval for Post Weld Heat Treated (PWHT) condition, 1x additional butt weld test assembly welded with a maximum heat input proposed by the manufacturer for the approval same as test assembly 2) is to be post-weld heat treated (PWHT) prior to testing.

3.3.3 Butt weld test assembly

.1 The butt weld test assemblies of N/NR plates are to be prepared with the weld seam transverse to the final plate rolling direction.

.2 The butt weld test assemblies of TM/TM+AcC/TM+DQ and QT plates are to be prepared with the weld seam parallel to the final plate rolling direction. The butt weld test assemblies of long products, sections and seamless tubular in any delivery condition are to be prepared with the weld seam transverse to the rolling direction.

3.3.4 Bevel preparation

.1 The bevel preparation should be preferably 1/2V or K related to thickness.

.2 The welding procedure should be as far as possible in accordance with the normal welding practice used for the type of steel in question.

.3 The welding procedure and welding record are to be submitted to BKI for review.

3.3.5 Post-weld heat treatment procedure

1) Steels delivered in N/NR or TM/TM+AcC/TM+DQ condition shall be heat treated for a minimum time of 1 hour per 25 mm thickness (but not less than 30 minutes and needs not be more than 150

minutes) at a maximum holding temperature of 580°C, unless otherwise approved at the time of approval.

2) Steels delivered in QT condition shall be heat treated for a minimum time of 1 hour per 25 mm thickness (but not less than 30 minutes and needs not be more than 150 minutes) at a maximum holding temperature of 550°C with the maximum holding temperature of at least 30°C below the previous tempering temperature, unless otherwise approved at the time of approval.

3) Heating and cooling above 300°C shall be carried out in a controlled manner in order to heat/cool the material uniformly. The cooling rate from the max. holding temperature to 300°C shall not be slower than 55°C/hr.

3.3.6 Type of tests

From the test assemblies the following test specimens are to be taken:

1) 1 cross weld tensile test - 1 full thickness test sample or sub-sized samples cover the full thickness cross section.

2) 1 set of 3 Charpy V-notch impact specimens transverse to the weld seam and 1-2 mm below the surface with the notch located at the fusion line and at a distance 2, 5 and 20 mm from the straight fusion line. An additional set of 3 Charpy test specimens at root is required for each aforementioned position for plate thickness t ≥ 50 mm. The fusion boundary is to be identified by etching the specimens with a suitable reagent. The test temperature is to be the one prescribed for the testing of the steel grade.

3) Hardness tests HV10 across the weldment. The indentations are to be made along a 1-2 mm transverse line beneath the plate surface on both the face side and the root side of the weld as follows:

   – fusion line
   – HAZ: at each 0,7 mm from fusion line into unaffected base material (6 to 7 minimum measurements for each HAZ)

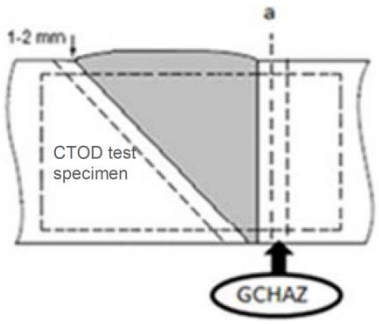
   The maximum hardness value should not be higher than 350HV for grade steels H420 to H460; not be higher than 420HV for H500 to H690; and not be higher than 450HV for H890 and H960.

   A sketch of the weld joint depicting groove dimensions, number of passes, hardness indentations should be attached to the test report together with photo-macrographs of the weld cross section.

4) CTOD test specimens are to be taken from butt weld test assembly specified in 3.3.1 2) or 3.3.2 2) in B.V. CTOD test is to be carried out in accordance with EN ISO 15653 or equivalent.

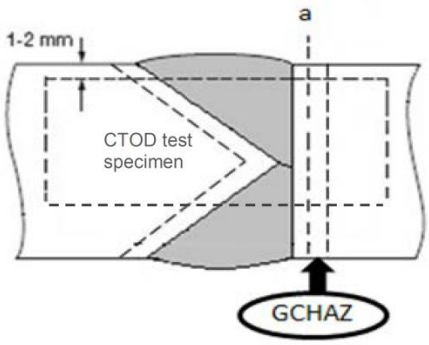
   – the specimen geometry (B = W) is permitted for plate thickness up to 50 mm. For plate thicker than 50 mm, subsidiary specimen geometry (50x50 mm) is permitted, which is to be taken 50 mm in depth through thickness from the subsurface and 50 mm in width. See Figure A1 a) and b) for more details
   – the specimens shall be notched in through thickness direction
   – grain-coarsened HAZ (GCHAZ) shall be targeted for the sampling position of the crack tip
   – the test specimens shall be in as-welded and post-weld heat treated, if applicable
   – three tests shall be performed at -10°C on each butt weld test assembly

For grades H690 and above, dehydrogenation of as-welded test pieces may be carried out by a low temperature heat treatment, prior to CTOD testing. Heat treatment conditions of 200°C for 4 h are recommended, and the exact parameters shall be notified with the CTOD test results.



Notch Location:
a : in GCHAZ

Fig. 2.2 For plate thickness t ≤ 50 mm, CTOD test specimen is to be sampled in full thickness



Notch Location:
a : in GCHAZ

Fig. 2.3 For plate thickness t > 50 mm, subsidiary test specimen with a thickness of maximum 50 mm in subsurface area is to be sampled

3.3.7 Crack susceptibility weld test (Hydrogen crack test)

Testing in accordance with national and international recognised standards such as GB/T4675.1 and JIS Z 3158 for Y-groove weld crack test. Minimum preheat temperature is to be determined and the relationship of minimum preheat temperature with thickness is to be derived.

3.3.8 Other tests

Additional tests may be required in the case of newly developed types of steel, outside the scope of Rules for Materials (Pt.1, Vol.V) Sec.4.D or when deemed necessary by BKI.

3.4 In addition to those specified in A.5.1 a reduction of the indicated number of casts, steel plate thicknesses and grades to be tested or complete suppression of the approval tests may be considered subject to the approval by BKI on the basis of the preliminary information submitted by the manufacturer in case any of the following (3.4.1) and (3.4.2) is relevant. On the other hand, an increase of the number of casts and thicknesses to be tested may be required in the case of newly developed types of steel or manufacturing processes.

3.4.1 Approval already granted by other Classification Societies and documentation of approval tests performed.

3.4.2 Grades of steel to be approved and where available the long term statistical results of chemical and mechanical properties.

3.5 In case of multi-source slabs or changing of slab manufacturer, the rolled steel manufacturer is required to obtain the approval of the manufacturing process of rolled steels using the slabs from each slab manufacturer and to conduct approval tests in accordance with 3.2 and 3.3. A reduction or complete suppression of the approval tests may be considered by BKI taking into account previous approval as follows:

- the rolled steel manufacturer has already been approved for the rolling process and heat treatment using approved other semi-finished products characterized by the same thickness range, steel grade, grain refining and micro-alloying elements, steel making (deoxidation) and casting process.
- the semi-finished products have been approved for the complete manufacturing process with the same conditions (steelmaking, casting, rolling and heat treatment) for the same steel types.

4. Changes in the manufacturing process

Changes in the manufacturing process not specified in this sub-section are to be in accordance with B.I.

5. Result

5.1 All the results are to comply with the requirements of the scheme of initial approval.

5.2 The subject manufacturer shall submit all the test results together with the manufacturing specification containing all the information required in B.V.2 and manufacturing records relevant to steel making, casting, rolling and heat treatment, applicable to the product submitted to the tests.

6. Certification

Certification not specified in this sub-section are to be in accordance with B.I.

VI. Corrosion resistant steels for cargo oil tanks

1. Application

1.1 This document specifies, as given in Rules for Materials (Pt.1, Vol.V) Sec.4.K, the scheme for the approval of corrosion resistant steels based upon corrosion testing.

1.2 The corrosion testing is to be carried out in addition to the approval testing specified in B.I for the approval of normal and higher strength hull structural steels.

1.3 The corrosion tests and assessment criteria are to be in accordance with the sub-section to Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers (MSC.289 (87)).

2. Data to be submitted

2.1 The manufacturer is to submit to BKI a request for approval, which is to include the following:

1) Corrosion test plan and details of equipment and test environments.
2) Technical data related to product assessment criteria for confirming corrosion resistance.
3) The technical background explaining how the variation in added and controlled elements improves corrosion resistance. The manufacturer will establish a relationship of all the chemical elements which affect the corrosion resistance. The chemical elements added or controlled to achieve the required level of corrosion resistance are to be specifically verified for acceptance. Verification is to be based on the ladle analysis of the steel.

4) The grades, the brand name and maximum thickness of corrosion resistant steel to be approved. Designations for corrosion resistant steels are given in Table 2.6.

5) The welding processes and the brand name of the welding consumables to be used for approval.

Table 2.6 Designations for Corrosion Resistant Steels

Type of steel	Location where steel is effective	Corrosion Resistant Designation
Rolled steel for hull	For lower surface of strength deck and surrounding structures (ullage space)	RCU
	For uper surface of inner bottom plating and surrounding structures	RCB
	For both strength deck and inner bottom plating	RCW

3. Approval of test plan

3.1 The test program submitted by the manufacturer is to be reviewed by BKI, if found satisfactory, it will be approved and returned to the manufacturer for acceptance prior to tests being carried out. Tests that need to be witnessed by BKI's Surveyor will be identified.

3.2 Method for selection of test samples is to satisfy the following:

3.2.1 The numbers of test samples is to be in accordance with the requirements of the sub-section to Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers (MSC.289 (87)).

3.2.2 The number of casts and test samples selected are to be sufficient to make it possible to confirm the validity of interaction effects and/or the control range (upper limit, lower limit) of the elements which are added or intentionally controlled, for improving the corrosion resistance. Where agreed, this may be supported with data submitted by the manufacturer.

3.2.3 Additional tests may be required by BKI when reviewing the test program against the paragraph 3.2.2

Remarks: Considerations for additional tests may include but not be limited to:

1) When BKI determines that the control range is set by the theoretical analysis of each element based on existing data, the number of corrosion resistance tests conducted in accordance with the sub-section to Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks (MSC.289 (87)) is too few to adequately confirm the validity of the control range of chemical composition;
2) When BKI determines that the data of the corrosion resistance test result obtained for setting the control range of chemical composition varies too widely;
3) When BKI determines that the validity of the corrosion resistance test result for setting the control range of chemical composition is insufficient, or has some flaws; and
4) When BKI's surveyor has not attended the corrosion resistance tests for setting the control range of chemical composition, and the BKI determines that additional testing is necessary in order to confirm the validity of the test result data.

Remarks: The chemical composition of the corrosion resistant steel is to be within the range specified for rolled steel for hull. Elements to be added for improving the corrosion resistance and for which content is not specified are to be generally within 1% in total.

4. Carrying out the approval test

4.1 The manufacturer is to carry out the approval test in accordance with the approved test plan.

5. Attendance of BKI's Surveyor for Test

5.1 The BKI's Surveyor is to be present, as a rule, when the test samples for the approval test are being identified and for approval tests, see also 3.1.

6. Test Results

6.1 After completion of the approval test, the manufacturer is to produce the report of the approval test and submit it to BKI.

6.2 BKI will give approval for corrosion resistant steel where approval tests are considered by BKI to have given satisfactory results based on the data submitted in accordance with the provisions of this sub-section.

6.3 The certificate is to contain the manufacturer's name, the period of validity of the certificate, the grades and thickness of the steel approved, welding methods and welding consumables approved.

7. Assessment Criteria for Results of Corrosion Resistance Tests of Welded Joint

7.1 The results will be assessed by BKI in accordance with the acceptance criteria specified in the sub-section to Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks (MSC.289 (87)).

VII. Brittle Crack Arrest Steels

1. Application

1.1 The requirements in this Section apply to tests and inspection for the approval of manufacturing process of Brittle Crack Arrest Steels (YP36 and YP40) for longitudinal structural members in the upper deck region of container carriers (such as hatch side coaming, upper deck, hatch coaming top and the attached longitudinals, etc.) as specified in Rules for Material (Pt.1, Vol.V) Sec. 4. L.

1.2 Requirements other than those specified in this Sub Section are to be in accordance with the requirements of B.I.

2. Data to be submitted

The following reference data in addition to those specified in A.2 and B.I.2 are to be submitted to BKI.

1) In-house test reports of the brittle crack arrest properties of the steels intended for approval
2) Approval test program for the brittle crack arrest properties (see 3.1.1 below)
3) Production test procedure for the brittle crack arrest properties.

3. Approval tests

3.1 General

Approval test items, test methods and acceptance criteria not specified in these requirements are to be in accordance with B.I.

3.1.1 Extent of the approval tests

The extent of the test program is specified in 3.2, 3.3 and 3.4.

If the manufacturing process and mechanism to ensure the brittle crack arrest properties for the steels intended for approval are same, the requirements in B.I. are to be followed for the extent of the approval tests.

The number of test samples and test specimens may be increased when deemed necessary by the BKI, based on the in-house test reports of the brittle crack arrest properties of the steels intended for approval specified in 2.1).

3.2 Type of tests

3.2.1 Brittle crack arrest tests are to be carried out in accordance with 3.3 in addition to the approval tests specified in B.I. and/or B.IV.

3.2.2 In the case of applying for addition of the specified brittle crack arrest properties for YP36, YP40 and YP47 steels of which, manufacturing process has been approved by BKI (i.e. the aim analyses, method of manufacture and condition of supply are similar and the steelmaking process, deoxidation and fine grain practice, casting method and condition of supply are the same), brittle crack arrest tests, chemical analyses, tensile test and Charpy V-notch impact test are to be carried out in accordance with this Sub Section and B.I.

3.3 Test specimens and testing procedure of brittle crack arrest tests

3.3.1 The test specimens of the brittle crack arrest tests are to be taken with their longitudinal axis parallel to the final rolling direction of the test plates.

3.3.2 The loading direction of brittle crack tests is to be parallel to the final rolling direction of the test plates.

3.3.3 The thickness of the test specimens of the brittle crack arrest tests is to be the full thickness of the test plates.

3.3.4 The test specimens and repeat test specimens are to be taken from the same steel plate.

3.3.5 The thickness of the test specimen is to be the maximum thickness of the steel plate requested for approval.

3.3.6 In the case where the brittle crack arrest properties are evaluated by K_{ca}, the brittle crack arrest test method is to be in accordance with Annex 4 of Rules for Materials (Pt.1, Vol.V). In the case where the brittle crack arrest properties are evaluated by CAT, the test method is to be in accordance with Annex 5 of Rules for Materials (Pt.1, Vol.V).

3.4 Other tests

Additional tests may be required when deemed necessary by the BKI in addition to the tests specified in 3.3.

4. Results

The test results shall comply with B.I.5.

Additionally, results of test items and the procedures shall comply with the test program approved by BKI. In the case where the brittle crack arrest properties are evaluated by K_{ca} or CAT, the manufacturer also is

to submit to BKI the brittle crack arrest test reports in accordance with Rules for Materials (Pt.1, Vol.V) Annex 4 for K_{ca} and Annex 5 for CAT.

5. Approval and Certification

Upon satisfactory completion of the survey and tests, approval is granted by BKI with the grade designation having the suffix “BCA1” or “BCA2” (e.g. EH40-BCA1, EH47-BCA1, EH47-BCA2, etc.).

6. Renewal of approval

The manufacturer is also to submit to BKI actual manufacturing records of the approved brittle crack arrest steels within the term of validity of the manufacturing approval certificate.

Note:

Chemical composition, mechanical properties, brittle crack arrest properties (e.g. brittle crack arrest test results or small-scale alternative test results) and nominal thickness are to be described in the form of histogram or statistics.

C. Steel Tubes and Pipes

1. Application

The requirements in this Sub-section apply to tests and inspection for the approval of manufacturing process of steel tubes and pipes as specified in the Rules for Material (Pt.1, Vol.V) Sec. 5.

2. Data to be submitted

2.1 The following reference data in addition to those specified in A.2. are to be submitted to BKI.

- Kind of products (e.g. Material grade, etc.)
- Method of melting process
- Method of ingot casting
- Fabrication method of steel tubes and pipes (Fabrication method is to be classified seamless steel tubes and pipes, welded steel tubes and pipes, electric-resistance welded steel tubes and pipes, etc. For welded steel tubes and pipes or electric-resistance welded steel tubes and pipes, welding working standards are to be included.)
- Method of heat treating, etc.

2.2 Where raw materials for steel tubes and pipes are provided from multisource or any part of the manufacturing process is assigned to other companies or other manufacturing plants, the manufacturer is to submit the documents for identification system for its traceability.

3. Approval tests

3.1 Selection of test samples

3.1.1 The test samples used for the approval test are to be selected, in the presence of the Surveyor, as a rule, from the steel tubes and pipes with the same conditions of material manufacturing process, fabrication method of tubes and pipes and heat treatment method.

3.1.2 As a rule, the dimensions of the test sample are standardized according to the maximum manufactured outer diameter, the maximum manufactured thickness and the closest 1/2 of these values. Furthermore, the number of test pieces is to be as deemed appropriate by BKI.

3.2 Test

3.2.1 Items of the approval test are to be as given in Table 2.7 and are to be carried out in the presence of the Surveyor except otherwise specially provided.

3.2.2 The test method and evaluation criteria are to be in accordance with the requirements in Rules for Material (Pt.1, Vol.V) Sec. 5. However, where accordance with these requirements are difficult, decisions are left to the discretion of BKI.

Table 2.7 Approval Test Items for Steel Tubes and Pipes

Test items / Steel tubes and pipes		Base metal test										High temperature characteristics test		Corrosion resistance test
		Chemical analysis	Microstructure	Tensile test	Charpy impact test	Bend test	Flattening test	Flaring test	Reverse flattening	U-shaped bend test	Hydraulic test	High temp tensile test	Creep test	Corrosion test
Steel tubes for boilers and heat exchangers	Refer to Rules for Materials (Pt.1, Vol.V) Sec.5	○	○	○			○	○	○	○	○	○	○	
Steel pipes for pressure piping		○	○	○		○	○				○	○	○	
Steel pipes for low temp. service		○	○	○	○	○	○				○			
Stainless steel pipes		○	○	○	○	○	○				○			○

Notes:

1. Approval tests for each steel tubes and pipes are to be performed for each test item indicated with a ○ mark in the Table. Moreover, the application of the flattening, flaring, reverse flattening and bending tests are to be in accordance with the requirements in Rules for Material (Pt.1, Vol.V) Sec. 2. F. Also, high temperature tensile test and creep test are not applicable to Grade 1 and Grade 2 of steel pipes for pressure piping.
2. The U-shaped bend test method for steel tubes for boilers and heat exchangers is to comply with the requirements in the JIS G 3451.
3. Where steel pipes for pressure piping and low temperature service have passed the tests for higher grade material with the similar strength level, pipe production method, heat treatment method, etc., the tests for steel pipes with lower grade may be omitted when deemed appropriate by BKI.
4. Where other steel tubes and pipes than those of the preceding 3. have passed the tests for higher strength level with similar chemical composition (carbon steel or low alloy steel), pipe manufacturing process, heat treatment method, etc., the tests for those with lower strength level may be omitted, subject to submission of their acceptable data (i,e. specification of chemical composition and heat treatment, etc.) to BKI.
5. The high temperature tensile test and creep test as specified in the Table are performed for the purpose of evaluating high temperature characteristics of steel tubes and pipes, and these tests may be omitted in case appropriate technical reports are available or in case BKI deems the tests unnecessary.
6. Where the steel tubes and pipes are not specified in the Rules or the steel tubes and pipes are used in special applications, tests other than those indicated in the Table (e,g, tests for welded parts) or the submission of reference data may be requested. Moreover, where low temperature toughness is considered necessary, the COD test is required.
7. Where the welded steel tubes and pipes are not specified in the Rules or the steel tubes and pipes are used in special applications, tests for weld joint other than those indicated in the Table are to be required.
   - Tensile test for butt weld joint
   - Flattening test
   - Charpy V-notch impact test (weld and HAZ)
   - Hardness test for butt weld joint
   - Micro and Macro test for butt weld joint
   - Non-destructive test for butt weld joint (RT and/or UT)

4. Changes in the manufacturing process

In case changes occur in the approval content among manufacturing process of steel tubes and pipes which have been granted approval beforehand, such as those given in the following 1) through 9), the manufacturer is to submit the application of alteration to BKI together with the documents in response to the content of changes.

1) Steel making process
2) Ingot-making process
3) Production process of tubes and pipes
4) Limits of outer diameter and thickness
5) Heat treatment process
6) Chemical composition, added element, etc.
7) Fabrication of steel tubes and pipes, heat treatment, etc. to outside manufacturers
8) Use of raw materials manufactured by companies other than the ones verified in the approval tests (e.g. billet, rolled steel, etc.)
9) Replace hydraulic test in product inspection with non-destructive test

5. Dealing after approval

Steel tubes and pipes which conform to the requirements in this Sub-section are to be dealt with as [in approved case] in the requirements in Rules for Material (Pt.1, Vol.V) Sec. 2 unless otherwise specified by BKI.

D. Casting and Steel Forging

I. Castings

1. Application

The requirements in this sub-section apply to tests and inspection for the approval of manufacturing process of castings as specified in Rules for Material (Pt.1, Vol.V) Sec.7, Sec. 8 and Sec.17. Anchors, chain, chain accessories and special cast iron valves shall be in accordance with the other requirements of this Guidance.

2. Data to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI.

1) Approval Range
   A) Kinds of material
   B) Melting process
   C) Casting procedure
   D) Max. mass of one castings (excluding riser, etc.)
   E) The products required the separate approval tests, if applicable
2) Method of heat treatment
3) Data for mould and casting
4) List of personnel in charge of the non-destructive test (holding of license and its kind)
5) The details of repair welds, if applicable

3. Approval tests

3.1 Test samples and specimen

3.1.1 Test samples from product to be approved shall be selected for each type of material and each casting procedure. The type of material and casting procedure shall be in accordance with Table 2.8a.

Table 2.8a The type of material and casting procedure

Kinds	Grade [1)]	Casting procedure
Carbon steel	GS–200, GS–240, G28Mn6, GS-16Mn5, GS-20Mn5, GP240GH , GP280GH, etc.	- Sand casting - Die casting - Precision casting - Centrifugal casting - Others
Low alloy steel	G20Mo5, G17CrMo5-5, G17CrMo9-10, etc.	
Austenitic stainless steel	GX2CrNi19-11 – GX2CrNiMoN26-7-4	
Carbon steel for low temperature service	G17Mn5, G20Mn5	
Nickel alloy steel for low temperature service	GS-10Ni6, G9Ni10, G9Ni14	
Martensitic stainless steel for propeller	12 Cr 1 Ni, 13 Cr 4 Ni, 16 Cr 5 Ni	
Austenitic stainless steel for propeller	19 Cr 11 Ni	
Grey Cast Iron	EN-GJL-200, EN-GJL-250, EN-GJL-300, EN-GJL-350	
Nodular Cast Iron	Nodular cast iron conforming to DIN EN 1563	

[1)] Other grades conforming to recognized standards or material specifications shall be agreed by BKI.

3.1.2 Selection of test samples and approval tests, in principle, shall be carried out in the presence of the Surveyor. However, ladle analysis, micro structure or in case BKI deems the test unnecessary may be omitted.

3.1.3 For each grade of steel and for each casting procedure, minimum 2 test samples shall be selected for each heat or cast. In case of approval for a large number of material groups and casting procedure, the number may be reduced by the approval of BKI.

3.1.4 At least one of the products from which the test samples are to be taken shall be the mass closest to the maximum.

3.2 Approval test and acceptance criteria

Kinds of tests, test methods and acceptance criteria shall be as given in Tables 2.8b. However, where compliance with these requirements is difficult, it may be changed with the approval of BKI.

Table 2.8b Test items and acceptance criteria

<table>
<tr><th>Approval test items</th><th colspan="2">Approval testing method</th><th>Acceptance criteria</th></tr>
<tr><td>Chemical analysis</td><td colspan="2">Both the ladle and product analyses are to be reported. The elements as specified in Rules for Materials (Pt.1, Vol.V) and standards applied which are added or intentionally controlled are to be checked.</td><td>The chemical composition is to comply with the requirements in Rules for Materials (Pt.1, Vol.V) and standards applied. Difference in the chemical compositions between melt analysis and product analysis shall be within the tolerance in recognized standard.</td></tr>
<tr><td>Tensile test</td><td colspan="2">One tensile specimen is to be taken from the test assembly. For products with unit weight over 10 tons, two tensile specimens are to be taken from the test assembly.</td><td>To meet the requirements in Rules for Materials (Pt.1, Vol.V) and standards applied.</td></tr>
<tr><td rowspan="8">V-notch Charpy impact test</td><td colspan="3">The test specimens specified in Rules for Materials (Pt.1, Vol.V) Sec. 2 are to be tested by three pieces at each temperature in accordance with table below. The absorbed energy for average and individual is to be determined by testing.</td></tr>
<tr><td>Material classification</td><td>Temperature</td><td>Acceptance criteria</td></tr>
<tr><td rowspan="2">Carbon steel and low alloy steel have no specific test condition in Rules for Materials (Pt.1, Vol.V) and standards applied</td><td>20°C</td><td rowspan="2">At 20°C to be 27J min,
At 0°C to be 27J min for hull structure</td></tr>
<tr><td>0°C</td></tr>
<tr><td rowspan="3">Carbon steel and low alloy steel have the specific test condition in Rules for Materials (Pt.1, Vol.V) and standards applied</td><td>20°C</td><td rowspan="3">The average absorbed energy is to be satisfied with minimum value specified in Rules for Materials (Pt.1, Vol.V) and standards applied.
At other temperature to be with reference</td></tr>
<tr><td>Required temperature</td></tr>
<tr><td>20°C lower than required temperature</td></tr>
<tr><td>Stainless steel</td><td>-196°C</td><td>Average absorbed energy is to be 27J min.</td></tr>
<tr><td rowspan="2">Carbon steel for low temperature service</td><td>-40°C</td><td rowspan="2">Average absorbed energy is to be 27J min.</td></tr>
<tr><td>-50°C</td></tr>
<tr><td>Martensitic stainless steel for propeller</td><td>20°C, 0°C, -10°C, -40°C</td><td>At -10°C to be 20J min,
At other temperature to be with reference</td></tr>
<tr><td>Austenitic stainless steel for propeller</td><td>-196°C</td><td>Average absorbed energy is to be 27J min.</td></tr>
</table>

Table 2.8b Test items and acceptance criteria *(continued)*

Approval test items	Approval testing method	Acceptance criteria
Hardness test	Hardness test for cast steel and cast iron	To meet the requirements Rules for Materials (Pt.1, Vol.V) and standards applied.
Micro structure	All photomicrographs are to be taken at 100X and 500X magnification.	Acceptance criteria is the reference.
Corrosion test	For stainless steel, ISO 3651-2 or ASTM A262 practice E or equivalent method	No crack is to be accepted
Non-destructive test	Visual examination and magnetic particle test (MT) are to be carried out for all surfaces (when MT is unavailable, liquid penetrant test may be used). Radiographic and ultrasonic inspection are to be in accordance with Rules for Materials (Pt.1, Vol.V) and standards applied	To meet the requirements in Rules for Materials (Pt.1, Vol.V) and standards applied.
Others	The others are to be tested in accordance with special order, Rules for Materials (Pt.1, Vol.V) and standards applied. The others may be additionally required by BKI where deemed necessary.	To meet the requirements in Rules for Materials (Pt.1, Vol.V) and standards applied.

4. Certification

On the approval certificate the following information is to be stated:

1) Types of material
2) Melting process
3) Casting procedure
4) Mass of the products
5) The products required the separate approval tests, if applicable

5. Changes in the manufacturing process

5.1 In case changes occur in the approval content among manufacturing process of castings which have been granted approval beforehand, such as those given in the followings, the manufacturer is to submit the application of alteration to BKI together with the documents in response to the content of changes. In this case, plant audit and approval test are to be carried out.

1) Types of material
2) Melting process
3) Casting procedure
4) Max. mass of the products
5) Relocating or changing of the manufacturing sites

5.2 If the manufacturing sites has been relocated or changed without changing the approved range, the test samples for approval test shall be included all approved casting procedure. However, the type and weight of the material may be selected by the manufacturer.

6. Dealings after approval

6.1 Castings which conform to the requirements in this ~~S~~s ub-section are to be dealt with as [in approval case] in the requirements in Rules for Material (Pt.1, Vol.V) Sec.2, C.2.3, unless otherwise specified by BKI.

6.2 If the manufacturer approved in accordance with this sub-section intends to produce the product with the other standards equivalent to the rules or standards applied at the time of the approval, it may be deemed to be 'approved' taking into account the approval range (material type, casting procedure, etc.).

II. Steel forgings

1. Application

The requirements in this sub-section apply to tests and inspection for the approval of manufacturing process of steel forging as specified in Rules for Material (Pt.1, Vol.V) Sec. 6. Steel forgings for chains are to be in accordance with the other requirements of this Guidance.

2. Data to be submitted

The following reference data in addition to those specified in A.2 are to be submitted to BKI.

1) Approval Range (Table 2.8c)
   A) Type of steel
   B) Melting process, if applicable
   C) Casting procedure, if applicable
   D) Forging process
   E) Max. mass of one forgings
   F) The products required the separate approval tests, if applicable
2) Supplier for raw material (ingot, bloom, etc.), if applicable
3) Method of heat treatment (including another manufacturer), if applicable
4) List of personnel in charge of the non-destructive test (holding of licence and its kind)
5) The details of repair welds, if applicable

3. Approval tests

3.1 Test samples and specimen

3.1.1 Test samples from product to be approved are to be selected for each type of steel and each forging process. The type of steel and forging process are to be in accordance with Table 2.8c.

Table 2.8c The type of steel and forging process

Kinds	Grade	Forging process
Carbon steel	Grades of forging steel conforming to EN 10083-2, EN 10084, EN 10250-2	- Free forging - Die forging - Ring forging - Others
Alloy steel	Grades of forging steel conforming to EN 10083-3, EN 10084, EN 10250-3, EN 10222-2, EN 10222-4	
Stainless steel	Grades of forging steel conforming to EN 10222-5, KI SUSF 304 – KI SUSF 347	
Carbon steel for low temperature service	P285NH, P285QH, P355N, P355QH	
Nickel alloy steel for low temperature service	13MnNi6-3, 12Ni14, 12Ni19, X12Ni5, X8Ni9	
Others	Applicable standards, codes, etc.	

3.1.2 Selection of test samples and approval tests, in principle, are to be carried out in the presence of the Surveyor. However, ladle analysis, micro structure or in case BKI deems the test unnecessary may be omitted.

3.1.3 For each grade of steel and for each forging process, minimum 2 test samples are to be selected for each heat or cast. In case of approval for a large number of material groups and forging process, the number may be reduced by the approval of BKI.

3.1.4 At least one of the products from which the test samples are to be taken is to be the mass closest to the maximum.

3.1.5 The test samples of semi built-up crank throws and solid crank shafts are to be from the products with max. diameter for bore of cylinder.

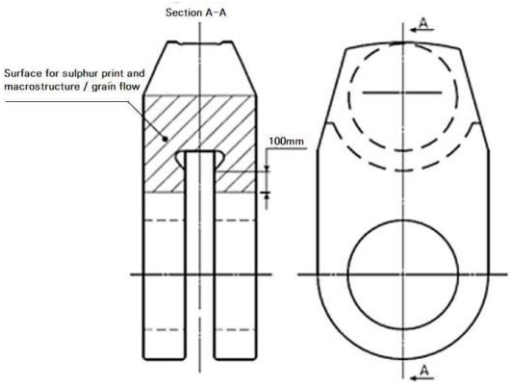
3.2 Approval test and acceptance criteria

Kinds of tests, test methods and acceptance criteria are to be as given in Table 2.8d. For solid crank shafts and semi built-up crank throws, kinds of tests, test methods and acceptance criteria are to be as given in Table 2.8d and Table 2.8e. However, where accordance with these requirements are difficult, it may be changed with the approval of BKI.

Table 2.8d Test items and acceptance criteria

Approval test items	Approval testing method		Acceptance criteria
Chemical analysis	Both the ladle and product analyses are to be reported. The elements as specified in Rules for Materials (Pt.1, Vol.V) and standards applied which are added or intentionally controlled are to be checked.		The chemical composition is to comply with the requirements in Rules for Materials (Pt.1, Vol.V) and standards applied. Difference in the chemical compositions between melt analysis and product analysis shall be within the tolerance in recognized standard.
Tensile test	– Normalized forgings: one test section from one forging per test batch – Quenched and tempered forgings: per test batch one test section from two forgings (with batches of 10 forgings or less, a test section is required from only one forging)		To meet the requirements in Rules for Materials (Pt.1, Vol.V) and standards applied.
V-notch Charpy impact test	The test specimens specified in Rules for Materials (Pt.1, Vol.V) Sec. 2 are to be tested by three pieces at each temperature in accordance with table below. The absorbed energy for average and individual is to be determined by testing.		
	Material classification	Temperature	Acceptance criteria
	Carbon steel and low alloy steel	20°C	At 20°C to be 27J min At other temperature to be with reference
		0°C	
	Stainless steel	– 196°C	Average absorbed energy is to be 27J min.
	Carbon steel for low temperature service	– 20°C	Average absorbed energy is to be 27J min.
	Nickel alloy steel for low temperature service 0,5 % Ni steel (13MnNi6-3) 2,25 % Ni steel 3,5 % nickel steel (12Ni14) 5 % nickel steel (12Ni19) 9 % nickel steel (X8Ni9)	 – 60°C – 70°C – 95°C –110°C –196°C	Average absorbed energy is to be 34J min.
Hardness test	To meet the requirements Rules for Materials (Pt.1, Vol.V) and standards applied.		To meet the requirements Rules for Materials (Pt.1, Vol.V) and standards applied.
Micro structure	All photomicrographs are to be taken at 100X and 500X magnification.		Acceptance criteria is the reference.
Corrosion test	For stainless steel, ISO 3651-2 or ASTM A262 practice E or equivalent method		No crack is to be accepted
Non-destructive test	Visual examination and magnetic particle test (MT) are to be carried out for all surfaces (when MT is unavailable, liquid penetrant test may be used). Radiographic and ultrasonic inspection are to be in accordance with Rules for Materials (Pt.1, Vol.V) and standards applied		To meet the requirements in Rules for Materials (Pt.1, Vol.V) and standards applied.
Others	The others are to be tested in accordance with special order, Rules for Materials (Pt.1, Vol.V) and standards applied. The others may be additionally required by BKI where deemed necessary.		To meet the requirements in Rules for Materials (Pt.1, Vol.V) and standards applied.

Table 2.8e Test items and acceptance criteria (semi built-up crank throws and solid crank shafts)

Approval test items	Approval testing method	Acceptance criteria
Tensile test and V-notch Charpy impact test	The test specimens are taken from journal and pin (or near area). The test specimens are arranged both parallel and transverse to the forging direction.	To meet the requirements in Rules for Materials (Pt.1, Vol.V) and standards applied.
Sulphur print and grain flow Surface for sulphur print and macrostructure / grain flow	The area of figure below is for the test 	Acceptance criteria is the reference

4. Certification

On the approval certificate the following information is to be stated:

1) Types of steel
2) Melting process, if applicable
3) Forging process, if applicable
4) Mass of the forging
5) The products required the separate approval tests, if applicable
6) The diameter of cylinder, if applicable

5. Changes in the manufacturing process

5.1 In case changes occur in the approval content among manufacturing process of steel forgings which have been granted approval beforehand, such as those given in the followings, the manufacturer is to submit the application of alteration to BKI together with the documents in response to the content of changes. In this case, plant audit and approval test are to be carried out.

1) Types of steel
2) Melting process
3) Forging process
4) Mass of the forging
5) Relocating or changing of the manufacturing sites

5.2 If the manufacturing sites has been relocated or changed without changing the approved range, the test samples for approval test are to be included all approved forging process. However, the type and weight of the material may be selected by the manufacturer.

6. Dealings after approval

6.1 Steel forgings which conform to the requirements in this Section are to be dealt with as [in approval case] in the requirements in Rules for Material (Pt.1, Vol.V) Sec.2, C.2.3, unless otherwise specified by BKI.

6.2 If the manufacturer approved in accordance with this sub-section intends to produce the product with the other standards equivalent to the rules or standards applied at the time of the approval, it may be deemed to be 'approved' taking into account the approval range (type of steel, forging process, etc.).

E. Crankshafts Under Special Requirements

1. Application

The requirements in this sub-section apply to the tests and inspection for the approval of crankshafts manufactured to reduce the dimension in accordance with the requirements of Rules for Machinery Installations (Pt.1, Vol.III) Sec. 2, C.1.3 and Rules for Materials (Pt.1, Vol. V) Sec. 6, C.4. in case where the special manufacturing processes specified in the following a) or b) are adopted.

1.1 The special forging process, namely continuous grain forging method (e.g. RR forging, TR forging or stamp forging), other than the free forging methods (block forging, upset & twisting forging and upsetting forging) used for manufacture of solid crankshaft and block forging method used for manufacture of semi-built up crankshafts.

1.2 The manufacturing processes using the surface treatments such as induction hardening, cold rolling and nitriding. However, semi-built up crank throw manufactured under special manufacturing process a) is excluded.

2. Data to be submitted

The manufacturer who intends to obtain an approval for the manufacturing process is to submit an application together with the data specified in A.2., containing information of applicable engine type, or with the data showing the details of surface treatment in the case of 1.2.

3. Approval tests

3.1 Kinds of steel

The tests are to be carried out for each kind of steels as a standard practice. Even within the category of steel forgings, normalized steels (including annealed steels or annealed steels after normalization) and quenched and tempered steels are to be considered as different kind of steels. However, for example, in case where it is intended to obtain approval for carbon steel forgings in both 520 N/mm^2 and 560 N/mm^2, tests on 560 N/mm^2 which has a higher tensile strength are to be carried out as the standard procedure. The same principle is to apply in dealing with alloy steel forgings (e.g. Cr-Mo steel forgings and Ni-Cr-Mo steel forgings).

3.2 Approval test for special forged crankshafts

3.2.1 Test specimens

The test specimen, as standard, is to be taken from the crank throw with the maximum diameter manufactured or close thereto.

3.2.2 Tests

The following tests are to be carried out on each test specimen:

1) Sulphur print test and macro-structure analysis (The specimens are to be taken from sections A-A, B-B and C-C specified in Fig 2.4)

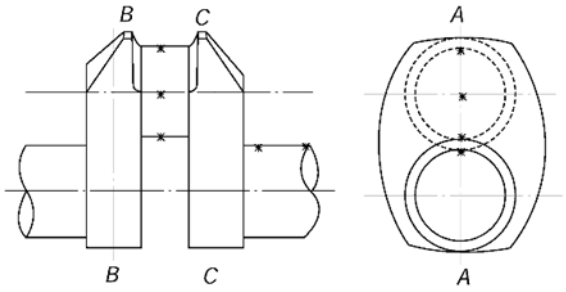


Fig. 2.4 Sampling Positions

2) Chemical composition analysis test (The specimens are to be taken from the positions asterisked in Fig 2.4)
3) Micro-structure analysis (The specimens are to be taken from the positions asterisked in Fig 2.4)
4) Microscopic test for the non-metallic inclusions (as per ISO 4967) (The specimens are to be taken from the positions asterisked in Fig 2.4)
5) Hardness test (Positions in the vicinity of pin or journal surface. In the case of quenched and tempered steels, hardness distribution from the surface to the shaft centre.)
6) Tensile test and impact test (Test specimens are to be taken as specified in Fig 2.5 as the standard.)
7) Bending fatigue test on actual crank throw. The number of test specimens is to be two or more.
8) Rotational bending fatigue test on small-size test specimens (Dia. 10 ~ 20 mm). The number of test specimens is to be not less than 10 as the standard. In case where previous data on this test are available or in case of carbon steel forgings, this test may be omitted upon approval of BKI. (Fig 2.6)

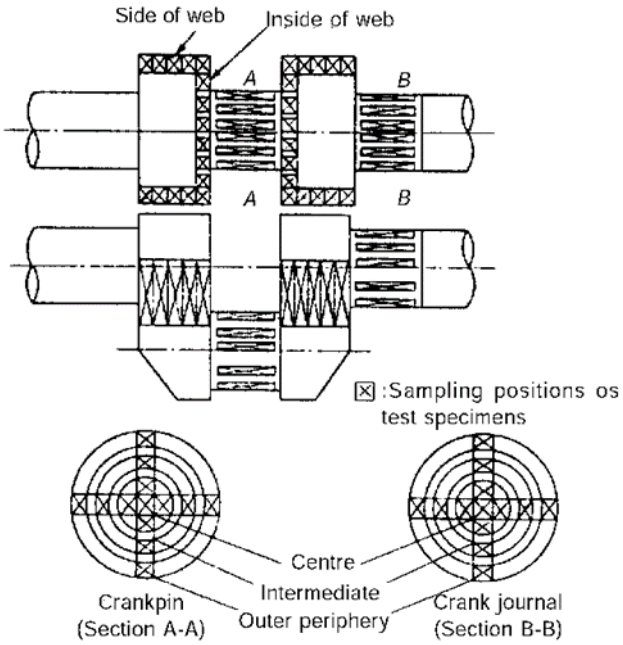


Fig. 2.5 Sampling Positions of Test Specimen

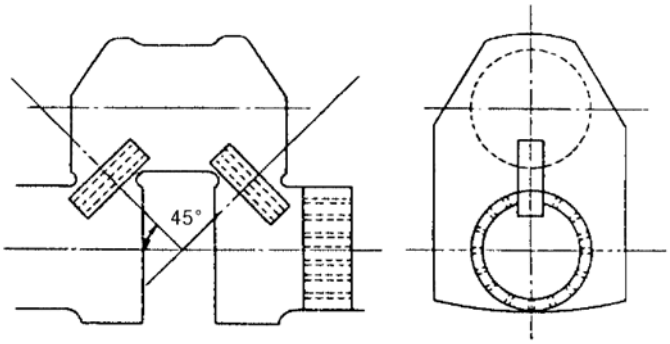


Fig. 2.6 Sampling Positions of Bend Test Specimen

3.2.3 Judgement of test results

The manufacturing process can be approved in case where the results of tests of 3.2.2 proves that the special forged crankshaft has continuous grain flow, the product quality is judged stable and the fatigue strength obtained from 3.2.2 have improved by 20 % or more when compared with the fatigue strength of a free-forged crankshaft σ_w (N/mm^2) calculated by the following formula:

When D ≤ 100, $$\sigma_w = 196 \cdot \left[1 + \frac{2}{3}\left(\frac{R_m}{440} - 1\right)\right]$$

When 100 < D < 200, $$\sigma_w = \left(216 - \frac{D}{5{,}1}\right) \cdot \left[1 + \frac{2}{3}\left(\frac{R_m}{440} - 1\right)\right]$$

When D ≥ 200 $$\sigma_w = 177 \cdot \left[1 + \frac{2}{3}\left(\frac{R_m}{440} - 1\right)\right]$$

Where

D : Diameter of test specimen (mm)

R_m : Specified minimum tensile strength (N/mm^2)

3.3 Approval tests for crankshafts with surface treatments

This requirement applies to cases where the fillets of a crankshaft are applied with induction hardening, cold rolling or nitriding, etc. In case where surface treatment is applied to all over the crankpin, journal and fillets, approval tests are to be as deemed appropriate by BKI.

3.3.1 Test specimens

The requirements specified in 3.2.1 apply correspondingly.

3.3.2 Tests

The following tests are to be carried out on each test specimen:

1) Non-destructive test (the conditions of defects on surface of the test specimens before and after the surface treatment are to be examined. The detection is to be either by magnetic particle test or liquid penetrant test.)

2) Examination of the hardness distribution, depth of hardening and residual stress (Examination is to be carried out on the surface treated areas and their vicinity. Further, in case where cold-rolling is carried out, measurements for the deformation on the cold-rolling area are to be included.)

3) Sulphur print test, microstructure test and macroscopic test (to be carried out on the sectional area in the direction of hardening depth.)

4) Bending fatigue test on actual crank throw (tests are, in principle, to be carried out on both the crank throws with and without surface treatment. In this case, the number of test specimens are to be sufficient to verify the strength improvement ratio. In this connection, the torsional fatigue tests on the actual crank throws or the test specimens having sizes similar to them are also to be carried out.)

5) Tensile test and impact test (one set of test specimens as to be taken from end portion of crankshaft with surface treatment.)

3.3.3 Judgement of test results

The manufacturing process can be approved in case when the results of tests of item 3.3.2 prove that a stability in the quality of the crankshafts with surface treatment and excellent improvement in the fatigue strength are obtained.

3.4 In case where the crankshaft manufactured under the special process as specified in 3.1 is applied with the surface treatment as specified in 3.2 the judgement for acceptance is to be determined by considering the results of tests for free forged crankshaft with surface treatment and the strength of other positions of the crankshaft than the fillets thereof.

F. Aluminium Alloys

1. Application

The requirements in this Sub-section apply to the tests and inspection for the approval of manufacturing process of aluminium alloys as specified in Rules for Materials (Pt. 1, Vol. V) Sec. 10.

2. Data to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI.

- Kind of the aluminium alloys (each material grade)
- Kind of products (plates, extruded shapes, etc.)
- Melting process
- Forming process

3. Approval test

3.1 Selection of test samples

3.1.1 Test samples used for the approval test are to, as a rule, be taken in the presence of the Surveyor from aluminium alloy plates, shapes, etc., of each melt manufactured under the same conditions of the melting process and forming process.

3.1.2 The plate thickness and dimensions for the test sample used in the approval test are, as a rule, to be maximum thickness and dimensions.

3.2 Details of test

3.2.1 Items of the approval test are to be as given in Table 2.9 and are to be carried out for each factory in the presence of the Surveyor except otherwise specially provided.

3.2.2 Testing method and acceptance criteria are to be in accordance with the Table 2.10.

4. Changes in the manufacturing process

In case changes occur in the approval content among manufacturing process of aluminium alloys which have been granted approval beforehand, the followings are to be submitted to BKI:

- Changes in the aluminium alloy making process
- Changes in the ingot-making process
- Changes in the rolling or extruding process
- Changes in the limit of thickness or dimension
- Changes in the heat treatment process
- Changes in the chemical composition, added element, etc.
- Subletting rolling, extruding, heat treatment, etc. to outside contractors
- Use of blooms and billets, etc. manufactured by other company

5. Dealings after approval

Aluminium alloys which conform to the requirements in this Sub-section are to be dealt with as [in approval case] in the requirements in Rules for Materials (Pt.1, Vol. V) Sec. 2.C.2.3, unless otherwise specified by BKI.

Table 2.9 Approval Test Items for aluminium alloys

Kinds	Grades	Temper	Test items[3]									
			Chemical analysis	Macro-structure	Micro-structure	Tensile test at room temp	Tensile test at low temp[1]	Tensile test of notched round bar [1]	Tensile test in direction of thickness[1]	Bend test	Tear test [1][2]	Corrosion resistance test
Rolled Product	KI AW-5083	O	o	o	o	o	o	o	o	o	o	
		H111	o	o	o	o				o		
		H112	o	o	o	o				o		
		H116	o	o	o	o				o		o
		H321	o	o	o	o	o	o		o	o	o
	KI AW-5086	O	o	o	o	o				o		
		H111	o	o	o	o				o		
		H112	o	o	o	o				o		
		H116	o	o	o	o				o		o
		H321	o	o	o	o	o	o		o	o	o
	KI AW-5383	O	o	o	o	o				o		
		H111	o	o	o	o				o		
		H116	o	o	o	o				o		o
		H321	o	o	o	o				o		o
	KI AW-5059	O	o	o	o	o				o		
		H111	o	o	o	o				o		
		H116	o	o	o	o				o		o
		H321	o	o	o	o				o		o
	KI AW-5456	O	o	o	o	o				o		
		H116	o	o	o	o				o		o
		H321	o	o	o	o				o		o
	KI AW-5754	O	o	o	o	o				o		
		H111	o	o	o	o				o		
Extrude Product	KI AW-5083	O	o	o	o	o	o	o	o	o		
		H111	o	o	o	o				o		
		H112	o	o	o	o				o		
	KI AW-5086	O	o	o	o	o				o		
		H111	o	o	o	o				o		
		H112	o	o	o	o				o		
	KI AW-5383	O	o	o	o	o				o		
		H111	o	o	o	o				o		
		H112	o	o	o	o				o		
	KI AW-5059	H112	o	o	o	o				o		
	KI AW-6005A	T5	o	o	o	o				o		
		T6	o	o	o	o				o		
	KI AW-6061	T6	o	o	o	o				o		
	KI AW-6082	T5	o	o	o	o				o		
		T6	o	o	o	o				o		

Notes:

(1) For aluminium alloys used at extremely low temperature such as tanks for liquefied gas carrier etc, tensile test at low temperature, tensile test of notched round bar, tensile test in the direction of thickness (thicker than 100 mm) and teat test are to carried out in addition.

(2) For tear test, other test may be applied subject to the approval by BKI.

(3) Where deemed necessary by BKI, tests related to fatigue tests, weld joint test, corrosion resistance tests and stress corrosion cracking test etc., or submission of reference data relating to these tests may be required.

Table 2.10 Approval Testing Method and Acceptance Criteria for aluminium alloy

Approval test items	Selection of test specimen		Testing method	Acceptance Criteria
	Location	Direction(1)		
Chemical analysis	T (Top part)	-	Ladle analysis and product analysis are to be performed	Chemical composition by ladle analysis is to comply with the requirements in Rules for Materials (Pt.1, Vol. V) Sec. 10
	B (Bottom part)			
Macrostructure	T	-	To be as deemed appropriate by BKI	To be as deemed appropriate by BKI
	B			
Microstructure	T	-		
	B			
Tensile test at room temperature	T	Parallel	In accordance with Rules for Materials (Pt.1, Vol. V)	In accordance with Rules for Materials (Pt.1, Vol. V) Sec. 10
		Transverse		
	B	Parallel		
		Transverse		
Tensile test at low temperature	T	Parallel	The tensile tests are to be carried out at -196 °C by using of the tensile test specimens of same size and the same dimensions for tensile test at room temperature.	Reference
		Transverse		
	B	Parallel		
		Transverse		
Tensile test of notched round bar	T	Parallel	The tensile tests are to be carried out at -196 °C by using of the tensile test specimens of notched round bar with following notch: Angle of notch : 60° Root radius of notch : 0.05 mm or less ASTM E 602 or equivalent method.	
		Transverse		
	B	Parallel		
		Transverse		
Tensile test in direction of thickness	T	direction of thickness	Test specimens are to be selected in the direction of thickness, and tensile tests are to be carried out. ASTM A 770 or equivalent method.	
	B			
Bend test	T	Parallel	Bend test is to be in accordance with recognized national or international standard which BKI considers appropriate (e.g. ISO 7438, etc.)	No crack is to be accepted.
		Transverse		
	B	Parallel		
		Transverse		
Tear test	T	Transverse	Tear strength and crack propagation energy are to be determined. Size and dimensions of tear test specimens and tear testing method are to be as deemed appropriate by BKI. ASTM B 871 or equivalent method.	Reference
	B	Transverse		
Corrosion resistance test	T	Parallel	Test method is to be as specified in Rules for Materials (Pt. 1, Vol. V) Sec. 10. A.9.5.	In accordance with Rules for Materials (Pt. 1, Vol. V) Sec. 10. A.9.5.
	B	Parallel		

Notes:

(1) When the test specimens used for the approval test cannot be taken from the test samples because of their dimensions or shapes, the direction of the selection of test specimens to be determined on a case-by-case basis upon mutual consultation by the manufacturer and BKI.

(2) Excess difference in the chemical compositions between ladle analysis and product analysis is not to be accepted.

G. Copper and Copper Alloy

I. Copper Alloy Castings

1. Application

The requirements in this Sub-section apply to the tests and inspection for the approval of manufacturing process of copper alloy casting to be used for propellers, propeller blades and bosses as specified in Rules for Materials (Pt.1, Vol.V) Sec. 16 and for valve and pump housings, shaft liners, bushes and similar parts as specified in Rules for Materials (Pt.1, Vol.V) Sec. 11. B.

2. Documents to be submitted

The following reference documents in addition to those specified in A.2. are to be submitted to BKI.

- Type of products
- Kind of the castings (each material grade) and specifications
- General description on major manufacturing facilities (moulding, melting, casting, furnace and machining installations and their capacities)
- General description on the testing and inspection facilities (various testing and inspection equipments and installations)
- Repair and NDT procedures (if any)

3. Approval tests

3.1 Test samples and specimen

3.1.1 Test samples from product to be approved shall be selected for each type of material and each casting procedure. At the products from which the test samples are to be taken shall be the thickness (dimension) closest to the maximum.

3.1.2 Test sample, from which test specimens are taken, shall be either integrally cast, be gated to the casting, be from the casting itself, or be separately cast. Separately cast sample pieces shall have the dimensions shown in Fig.2.7, shall originate from the same heat and shall be cast using the same mould material.

3.1.3 Test sample, from which test specimens are receive substantially the same casting practices as the production castings represented. Alternatively, subject to agreement with BKI sampling in accordance with other recognized standards may be accepted.

3.1.4 The dimensions of the test sample shall be similar to the relevant wall thickness of the casting represented, but the smallest thickness of the sample shall not be less than 28 mm and needs not to exceed 75 mm. Other test sample sizes require special consideration.

3.1.5 Test samples and test specimens shall be taken out in final delivery condition and shall not be subjected to any separate heat treatment.

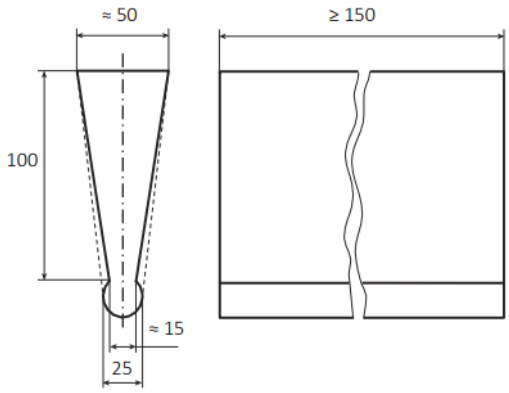


Fig. 2.7 Test Sample for Separately Cast

3.2 Approval test and acceptance criteria

3.2.1 Approval tests are to be in accordance with the Table 2.11.

Table 2.11 Approval Testing Method and Acceptance Criteria for copper alloy castings

Test item	Test method	Acceptance criteria
Chemical composition	Analysis of chemical composition on ladles and separately cast test specimens is to be carried out	To comply with the Rules for Materials (Pt.1, Vol.V) Sec. 16.F and Sec. 11. B. 1
Tensile test	Tensile tests are to be carried out in accordance with the requirements specified in Rules for Materials (Pt.1, Vol.V) Sec. 16.G and Sec. 11. B. 1.	To comply with the Rules for Materials (Pt.1, Vol.V) Sec. 16.G and Sec. 11. B. 1.
Micro-structure analysis	High quality photomicrographs showing the microstructure at 100x and 500x magnification shall be prepared with a brief description. The micro structure of propellers alloy types CU 1 and CU 2 shall be verified by determining the proportion of alpha phase. The proportion of alpha phase shall be determined as the average value of 5 counts.	To comply with the Rules for Materials (Pt.1, Vol.V) Sec. 16.F
Non-destructive test	For propellers, visual examination and liquid penetration testing are to be carried out for all surfaces. For other castings, as a minimum the following areas shall be checked by liquid penetration testing: 1. at all accessible fillets and abrupt changes of section 2. at positions where surplus metal has been removed by flame cutting, scarfing or arc-air gouging 3. at positions where repair welds are made. Radiographic and ultrasonic inspection are to be in accordance with Rules for Materials (Pt.1, Vol.V) and standards applied.	To meet the requirements in Rules for Materials (Pt.1, Vol.V) Sec. 16, I. and standards applied.
Other test	To be as deemed appropriate by BKI, e.g. pressure testing, corrosion tests, impact tests, bend tests, etc.	To be as deemed appropriate by BKI

3.2.2 Notwithstanding the requirements in the 3.2.1 some parts of the tests may be omitted in case of propellers with a diameter of 2,5 m or less.

4. Dealings after approval

Copper alloy castings which conform to the requirements in this Sub-section are to be dealt with as [in approval case] in the requirements in Rules for Materials (Pt.1, Vol.V) Sec. 2.C.2.3, unless otherwise specified by BKI.

II. Copper and Copper Alloy Pipes

1. Application

The requirements in this Sub-section apply to the tests and inspection for the approval of manufacturing process of seamless round drawn copper and copper alloy pipes for general purpose supplied in the size range from 3 mm up to and including 450 mm outside diameter and from 0,3 mm up to and including 20 mm wall thickness as specified in Rules for Materials (Pt.1, Vol. V) Sec. 11. A.4.1.

2. Documents to be submitted

The following reference documents in addition to those specified in A.2. are to be submitted to BKI.

- Kind of copper and copper alloy pipes (each material grade)
- General description on the manufacturing facilities of raw materials (including the capacity of moulding, melting, casting facilities and furnace, etc.) and the reference data by which it can be assured how the material is produced.
- Method of manufacture (reheating of billet, heat treatment, finishing, etc)
- General description on the testing and inspection facilities (various testing and inspection equipments and installations)
- Repair and NDT procedures (if any)

3. Approval tests

3.1 Selection of test samples

3.1.1 The test samples used for the approval test are to be selected, in the presence of the Surveyor, as a rule, from the copper and copper alloy pipes with the same conditions of material manufacturing process, fabrication method of pipes and heat treatment method.

3.1.2 As a rule, the dimensions of the test sample are standardized according to the maximum manufactured outer diameter and 1/2 of this value. Furthermore, the number of test pieces is to be as deemed appropriate by BKI.

3.2 Approval tests

3.2.1 Approval tests specified in Table 2.12 are to be carried out, in the presence of the Surveyor unless otherwise specified by BKI.

3.2.2 Testing method and acceptance criteria are to be in accordance with the Table 2.13. Where it is difficult to comply with test methods and evaluation criteria specified in this Sub-section, the decision may apply to standards authorized by BKI (officially recognized establishment).

4. Dealings after approval

Copper and copper alloy tubes which conform to the requirements in this Sub-section are to be dealt with as [in approval case] in the requirements in Rules for Materials (Pt. 1, Vol. V) Sec. 2.C.2.3, unless otherwise specified by BKI.

Table 2.12 Approval Test Items for copper and copper alloy tubes

Material Code	Approval Test Items								
	Chemical analysis	Tensile Test	Hardness test	Flattening test	Expanding test[1)]	Stess corrosion resistance test	Grain Size	Hydrogen embrittlement test	NDT[2)]
Cu-DHP	o	o	o	o	o		o	o	o
CuNi2Si	o	o	o	o	o		o		o
CuNi10Fe1Mn	o	o	o	o	o		o		o
CuNi30Mn1Fe	o	o	o	o	o		o		o
CuZn20Al2As	o	o	o	o	o	o	o		o

1) In case where not more than 76 mm in outside diameter
2) Eddy current test is to be applied. However, hydrostatic or pneumatic test can be applied if agreed by the Surveyor.

Table 2.13 Approval Testing Method and Acceptance Criteria for copper and copper alloy tubes

Approval test items	Approval testing method	Acceptance criteria
Chemical analysis	Chemical analysis is to be carried out in accordance with the standards authorized by BKI (officially recognized establishment).	To meet the requirements in EN 12449 or equivalent standard
Tensile test	In accordance with Rules for Materials (Pt.1, Vol.V)	To meet the requirements in Rules for Materials (Pt.1, Vol. V) Sec. 11 or EN 12449 or equivalent standard
Hardness test	In accordance with EN 10003-1 or ISO 6507-1 or equivalent standard	To meet the requirements in EN 12449 or equivalent standard
Flattening test	In accordance with ISO 8492 or equivalent. Distance between flattening plates is to be 3 times of tube thickness	No surface crack
Expanding test	In accordance with ISO 8493 or equivalent. The outside diameter of the tube end shal be expanded by 30% using a conical mandrel with an angle of 45°.	No surface crack
Stess corrosion resistance	In accordance with EN ISO 196 or ISO 6957 or equivalent standard	No surface crack
Grain Size	In accordance with EN ISO 2624 or equivalent standard	To meet the requirements in Rules for Materials (Pt.1, Vol. V) Sec. 11, A.8.6
Eddy current test	In accordance with EN 1971 or equivalent standard	To be free of harmful defects
Hydrostatic test	In accordance with Rules for Materials (Pt.1, Vol.V) Sec. 11, A.9.10	To be free of leakages
Pneumatic test	Pneumatic test is to be carried out with the air pressure of 0,4 MPa, maintained in the water for 5 sec.	To be free of leakages

H. Special Cast Iron Valves

1. Application

The requirements in this Section apply to the tests and inspection for the approval of manufacturing process of special cast iron valves (black heart malleable castings and spheroidal graphite iron castings which has elongation of 12 % or above) specified in Rules for Machinery Installation (Pt. 1, Vol. III) Sec. 11.

2. Approval tests

Approval tests specified in Table 2.14 are to be carried out to verify the material quality of special cast iron in the presence of the Surveyor. Tensile test and charpy impact test are to be carried out on the test specimens separately cast and on those taken from the valve body of the largest size.

Table 2.14 Approval Testing Method and Acceptance Criteria for special cast iron valves

Kinds	Test item	Test method	Acceptance criteria
Spheroidal graphite iron castings	Tensile test	The separately cast test sample is to be of U-type specified in Rules for Material (Pt. 1, Vol. V) Sec. 8. Tensile test is to be carried out on two test specimens taken from test sample at room temperature (in case of boiler mounting valves, at each temperature of 200°C, 300°C and 400°C). Two test specimens (Specimen shape B according to Fig. 2.1 of Rules for Material (Pt. 1, Vol. V,)) for tensile test at room temperature are to be taken from the valve body. (the separately cast test sample is to be heat treated as same as applied to the valve body.)	To comply with the Rule requirements
	Charpy impact test	Three each test specimens are to be taken from test sample and flange of valve body.	To comply with the Rule requirements
	Hardness test	Valve body is to be cut and hardness at each position is to be measured (Brinnel Hardness Test, 3000 kg).	To comply with the Rule requirements
	Micro-structure analysis	Structural ferritization and spheroidization of graphite are to be examined.	To be as deemed appropriate by BKI
	chemical composition	For the analysis of total carbon, a drilling machine is not to be used.	To comply with the Rule requirements
Grey cast iron castings	Tensile test	Test specimen is to be in accordance with Fig. 2.4 of Rules for Materials (Pt. 1, Vol. V), Sec. 2. and shall not be separately casted or machined unless approved by BKI. Two each test specimens are to be subjected to tensile test under the same temperature conditions as in Spheroidal graphite iron castings. The tensile test on the test specimens taken from valve body is to be as specified in Spheroidal graphite iron castings.	To comply with the Rule requirements
	Charpy impact test	The same as in Spheroidal graphite iron castings	To comply with the Rule requirements
	Hardness test	The same as in Spheroidal graphite iron castings	To comply with the Rule requirements
	Micro-structure analysis	Examination is to be carried out on the matrix and graphitization	To be as deemed appropriate by BKI
	chemical composition	The same as in Spheroidal graphite iron castings	To comply with the Rule requirements

3. Dealings after approval

Special cast iron valves which conform to the requirements in this Section are to be dealt with as [in approval case] in the requirements in Rules for Materials (Pt. 1, Vol. V) Sec. 2. C.2.3, unless otherwise specified by BKI.

I. Anchors

1. Scope

1.1 The requirements in this Sub-section apply to tests and inspection for the approval of manufacturing process of ordinary anchors made of steel castings as specified in Rules for Hull (Pt.1, Vol.II) Sec.18.C.

1.2 The anchor manufacturers who conform to the requirements in this Sub-section are to be dealt with as the approved manufacturers of steel castings in accordance with the requirements Rules for Material (Pt.1, Vol.V) Sec. 7.A.3

1.3 In case where the anchor is manufactured by the methods other than those rules specified in 1.1, the requirements of this Sub-section can be applied.

2. Application procedures

2.1 Documents to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI.

- Kinds and material grade of anchor (including drawing and dimension table of anchor)
- Maximum mass of the anchor
- Working standards for casting and heat treatments
- Non-destructive testing standards (including personnel requirements)
- Test data of sea bed holding power and information concerning the anchor (if any)
- Outline of manufacturing plant
- Approval test plan
- Facilities, technical staffs and organization for anchor manufacturing

2.2 Omission of preference data

The submission on the data may be omitted in case where the anchor under application is manufactured at the same facilities as used for other anchor on which an approval of BKI was given previously with a manufacturing process considered by BKI nearly identical to the process and control system already approved.

3. Confirmation of manufacturing and quality control procedure

3.1 Confirmation survey of manufacturing and quality control procedure

The confirmation survey is to be carried out in order to confirm that the manufacturers is capable of manufacturing anchors under the informed condition (manufacturing facilities technical capacity organizations for quality control and test and inspection system) at the stable quality on a continuous basis and at the same time is to practically verify that anchors will be manufactured in the future under the same manufacturing process as applied for approval.

3.2 Omission of confirmation survey

Where application is placed for extending the scope of approval on anchors to be manufactured in identical manufacturing plant under almost the same manufacturing process with the case of the anchor already approved in the past only examination of the technical documents is to be made and the confirmation survey may be omitted.

3.3 Investigating items of confirmation survey

The following items are to be examined in the confirmation survey:

- Inspection organization and claim handling system.
- Manufacturing and inspection facilities.
- Status of quality control system.

4. Approval test

4.2 Approval test items, test methods and acceptance criteria are to be as given in Table 2.15.

Table 2.15 Approval Testing Method and Acceptance Criteria for anchors

Test item	Test method and acceptance criteria
Material test	a) Anchors are to be manufactured and tested in accordance with the requirements in Rules for Materials (Pt.1, Vol.V) Sec. 7.B and comply with the requirements for castings for welded construction. The steel is to be fine grain treated with Aluminium. b) Unless otherwise agreed the test samples are to be either integrally cast or gated to the castings.
Drop test	– Each piece of the cast steel anchor is to be lifted 4 metres in height and dropped on an steel slab on the hard ground without any crack or other defect. – Where shank and arms are cast in one piece in stock anchor, the anchor is first to be lifted to the specified height with its shank and arms in a horizontal position and then dropped on the steel slab, and to be lifted once more to the specified height with the crown downwards and dropped on two steel blocks on the slab arranged to enable the anchor to give shock at the middle of each arm without making the crown touch the slab, and are to be found free from cracks, deformation or other defects. – Where the slab is broken by the impact, the anchor is to be re-tested with a new slab. – Dropping is to be made for 3 attempts at least.
Hammering test	The anchor is to be slung clear of the ground and thoroughly hammered with a hammer which the mass is 3 kg and over, and is to be found free cracks or other defects.
Load test	in accordance with Rules for Materials (Pt.1, Vol.V) Sec. 12.F.3
Visual inspection	in accordance with Rules for Materials (Pt.1, Vol.V) Sec. 12.F.2
Non-destructive test (NDT)	To be carried out the extended non-destructive examination in accordance with the Rules for Materials (Pt.1, Vol.V) Sec. 12.F.2

4.3 Impact test, macro structure test and/or hardness test, etc. may be additionally required by BKI where deemed necessary

4.4 Selection of test samples and approval tests, in principle, are to be carried out in the presence of the Surveyor.

5. Dealings After Approval

Anchors which conform to the requirements in this Sub-section are to be dealt with as [in approval case] in the requirements in Rules for Materials (Pt.1, Vol.V) Sec. 1.E and Sec. 2.C.2.3.2, unless otherwise specified by BKI.

J. Chains & Accessories

I. Marine Chains

1. Application

1.1 The requirements in this sub section apply to tests and inspection for the approval of manufacturing process of electrical welded and steel cast chains used for anchor chains and steering chains specified in Rules for Materials (Pt.1, Vol.V) Sec. 13.A.3 3.2

1.2 Of those forged welded or other manufacturing process chains, the requirements in this sub section correspondingly apply to the tests and inspection for the approval of the manufacturing process of chains.

1.3 The manufacturer who makes steel cast chains in accordance with the requirements of this sub section may be considered to comply with the requirements of manufacturing process in Rules for Materials (Pt.1, Vol.V) Sec. 13.A.2 / Rules for Materials (Pt.1, Vol.V) Sec. 1.D

2. Data to be submitted

The following reference data in addition to those specified in sub section A.2. are to be submitted to BKI.

1) Kind of chains
2) Manufacturing process
3) Materials
4) Heat treating method (including furnace types, means of specifying, controlling and recording of temperature and chain speed and allowable limits, quenching bath and agitation, cooling method after exit)
5) Diameter of test chain, maximum chain diameter.
6) In addition to the above, the following reference data are to be submitted to BKI according to the manufacturing process.
    A) Electrically welded chains
        a) Manufacturing process and manufacturing facilities
            i) Explanations on manufacturing process
            ii) Outline of the manufacturing factory
            iii) Principal items of manufacturing and inspection facilities other than welding machines (tensile testing machine of chains, preheater, bending machine, stud applier, etc.)
        b) Welding machines
            i) Name and type of welding machine, and name of its manufacturer
            ii) Particulars of welding machine (output, pressurizing force, retaining force)
            iii) Pressurizing mechanism (drawings are to be attached)
            iv) Diameter of chain link weldable
        c) Working standards
            i) Inspection organization chart
            ii) Contents of inspection at the reception of raw materials

iii) Bar cutting, heating and bending including method, temperatures, temperature control and recording

iv) Working standards applicable to each size of chain link for flash butt welding (welding current, force, time, flash allowance, upsetting allowance, preheating temperature and period, etc.)

v) Flash removal include method and inspection

vi) Stud manufacturing process and dimensions

vii) Stud insertion and welding standards

viii) Details of product inspection

B) Cast chains

a) Manufacturing process and manufacturing facilities

i) Explanations on manufacturing process

ii) Outline of manufacturing factory

iii) Principal manufacturing and inspection facilities

b) Steelmaking

i) Type and capacity of steelmaking furnace

ii) Steelmaking process

iii) Range of chemical composition

c) Working standards

i) Moulding work

ii) Casting procedure (drawing showing the location and its dimensions of riser is to be attached.)

iii) Finishing work

iv) Details of product inspection

v) Repairing procedures

3. Approval test

3.1 Approval test

The approval test is to be carried out on each chain under application for each manufacturing factory. The contents of approval test are to be as indicated in Table 2.16 and the test is to be carried out in the presence of the Surveyor unless otherwise specified.

3.2 Test chains

The link and test specimens used in the approval test are to be taken from the test chains in the presence of the Surveyor.

3.3 Omission of approval test for manufacturing process

3.1.1 When the test for Grade KI-K1 chains has been passed, the approval test for manufacturing process for studless chains of the same or of the smaller diameter manufactured by the same electric welding method may be omitted.

3.1.2 When the test for Grade KI-K2 chains has been passed, the approval test for manufacturing process for studless chains of the same or of the smaller diameter manufactured by the same electric

welding method and the approval test for the manufacturing process of Grade KI-K1 chains, may be omitted.

3.1.3 The manufacturing process of the enlarged link and end link may be approved up to those with the diameter corresponding to that of common link provided that they are manufactured by the same manufacturing process of the common link or by the electric welding method.

4. Changes in the approval content

When major changes are intended to be made in the manufacturing process already approved, the application procedure required for a new approval application is to be taken. The major changes include the items given below where, however, the witness of the approval test by the Surveyor may be dispensed with, or reduction in the approval test items may be accepted for the manufacturer whose product quality control standards and inspection standards are considered appropriate. In this case, however, submission of the results of tests on material properties and related data is required.

1) Increase in the maximum diameter of chain to be manufactured
2) Change in casting procedure
3) Changes in heat treatments (quenching, annealing, tempering, etc.)
4) New installation of welding machine
5) New installation of furnace for heat treatment
6) Other changes for which approval test is considered necessary

Table 2.16 Approval Test Items and Acceptance Criteria for Marine Chains

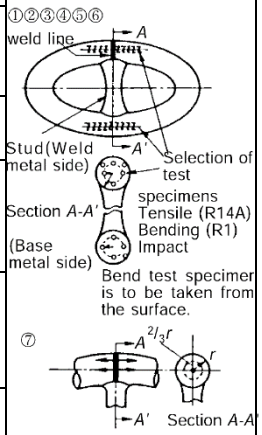
Test chains for approval test							
No.1 No.2 No.3 No.4 No.5 ..... No.32 No.33 No.34							
Test item			**Numbers of test specimens**	**Numbers of test link (example)**	**Selection of test specimen and details of test specimen**	**Test procedure**	**Acceptance criteria**
Mechanical properties test of link	Base metal	① Tensile test	1	No.1		①, ②, ④, ⑤: To conform to Rules for Material (Pt.1, Vol.V) of chain is to be 25 mm and the bending angle is to be not less than following angle : 120°. ③, ⑥: Testing temperature of impact test is to be referred to Notes 6. ⑦: is to be examined at its centre and the point 2/3 r for the structure of HAZ, base metal and weld zone (× 100) ⑧: Welded portion of link in longitudinal section is to be macroetched. ⑨: Sulphur print of longitudinal section of link is to be taken ⑩: Hardness distribution of base metal and weld zone is to be measured at proper intervals.	To conform to Rules for materials (Pt.1, Vol. V)
		② Bending test	1	No.1			To be free of harmful defects
		③ Impact test	1set (Grade KI-K1chain) 3sets(Others)	No.3~4			see Notes 6.
	weld zone	④ Tensile test	2	No.1			Measured tensile strength is to exceed that of the base metal.
		⑤ Bending test	2	No.2			To be free of harmful defects
		⑥ Impact test	1set (Grade 1 chain) 3sets(Others)	No.3~4			see Notes 6.
		⑦ Micro-test	2	No.5			Coarse grain area in HAZ and degree of heat treatment are to be examined.
		⑧ Macro test	1	No.5			To be free of harmful defects
		⑨ Sulphur print	1	No.7			To be free of harmful defects
		⑩ Hardness test	3	No.5			For reference only.
Test of testing object of chains		⑪ Proof test	2 lengths	No.1~5 No.9~13		⑪, ⑫, ⑭, ⑮: To conform to Rules for Hull (Pt.1, Vol. II, sec. 18). ⑬: After proof test, chain length and dimensions of each link are to be measured.	To conform Rules for Hull (Pt.1, Vol. II, sec. 18).
		⑫ Breaking test	2 lengths	No.15~19 No.30~34			Actual breaking load is to be measured in addition to conform to Rules for Hull (Pt.1, Vol. II, sec. 18).
		⑬ Dimension test	2 lengths	No.1~5 No.9~13			Check dimensional changes in addition to conform to Rules for Hull (Pt.1, Vol. II, sec. 18).
		⑭ Mass inspection	2 lengths	No.1~5 No.9~13			To conform to Rules for Hull (Pt.1, Vol. II, sec. 18).
		⑮ Visual inspection	2 lengths	No.1~5 No.9~13			To conform to Rules for Hull (Pt.1, Vol. II, sec. 18).

Table 2.16 Approval Test Items and Acceptance Criteria for Marine Chains *(continued)*

Notes:

1. The test links used in the approval test are to, in principle, be of the desired largest diameter for approval.
2. In the case of cast links, their mechanical properties tests are to be carried out in a manner corresponding to those applied to weld zone. Of those items of test on the testing object, the bending test and compression test may be substituted by magnetic particle testing.
3. When deemed necessary by BKI, non-destructive testing may be requested.
4. In the case of the approval test in association with the change in the manufacturing process as shown in sub section J.4., the diameter and number of test link, or the approval test items may be reduced.
5. When steel materials, manufacturing process or heat treatment methods which are not specified in the Rules are to be employed, BKI may request other tests or submission of reference materials in addition to the specified test items.
6. Temperature of impact test are to be in accordance with the folloeing tables

Kind of chain	Temperature	Minimum absorbed average energy (J)	
		Base metal	Flash butt weld zone
KI-K1	0°C	To be with reference	To be with reference
KI-K2	20°C, 0°C and -20°C	At 0°C to be of 50J, At other temperature to be with reference.	To be with reference
KI-K3	20°C, 0°C and -20°C	At 0°C to be of 60J, At other temperature to be with reference.	At 0°C to be of 50J, At other temperature to be with reference.

II. Marine Chain Accessories

1. Application

1.1 The requirements in this sub section apply to the tests and inspection for the approval of manufacturing process of the connecting shackles, kenter shackles, anchor shackles and swivels (hereinafter referred to as the "chain accessories") specified in the Rules for Hull (Pt.1, Vol.2) Sec.18.

1.2 The requirements in this sub section apply to the manufacturing process of the enlarged link and end link are manufactured by a chain accessories manufacturer other than the manufacturer of the chain.

1.3 The manufacturer who makes cast chains in accordance with the requirements of this sub section may be considered to comply with the requirements of manufacturing process in the Rules for Materials (Pt.1, Vol.V) Sec. 13.A.2 / Rules for Materials (Pt.1, Vol.V) Sec. 1.D.

2. Data to be submitted

The following reference data in addition to those specified in sub section A.2. are to be submitted to BKI including 1) to 5) of sub section J.I.2

1) Cast chain accessories

   To be in accordance with the provisions in sub section J.I.2 6)

2) Forged chain accessories
   - A) Manufacturing process and facilities
     - a) Explanations on the manufacturing process
     - b) Outline of the manufacturing factory
     - c) Principal forging facilities and their capacities
     - d) Type and capacity of the furnace for heat treatments
     - e) Inspection and testing facilities
   - B) Work standards
     - a) Details of acceptance inspection for raw materials (bloom, billet, round bar steel, etc.) and names of their suppliers

b) Forging procedure (drawings to be attached)

c) Heat treatment procedures and their control standards

d) Details of product inspection

3. Approval test

3.1 Approval test

The approval test is to be carried out on each item of chain accessories under application for each manufacturing factory. The details of approval test are to be as indicated in Table 2.17 and the test is to be carried out in the presence of the Surveyor unless otherwise specified.

3.2 Test chain accessories

The test specimens used in the approval test are to be taken from the test chain accessories under application in the presence of BKI Surveyor.

3.3 Omission of approval test

3.3.1 When the test for chain accessories of higher grade has been passed, the approval test for manufacturing process for chain accessories of the same or of the smaller diameter manufactured by the same casting or forging method may be omitted.

3.3.2 When the test either for swivel or for kenter shackle has been passed, the approval test for manufacturing process for another product not subjected to approval test may be omitted provided that discrimination between the casting procedure and forging procedure is specified.

3.3.3 When the test either for swivel or for kenter shackle has been passed, the approval test for manufacturing process for the enlarged link and end link of the same diameter as that of the swivel and kenter shackle or less may be omitted.

3.3.4 When the test for anchor shackle has been passed, the approval test for manufacturing process of the connecting shackle of the same diameter thereof or less may be omitted.

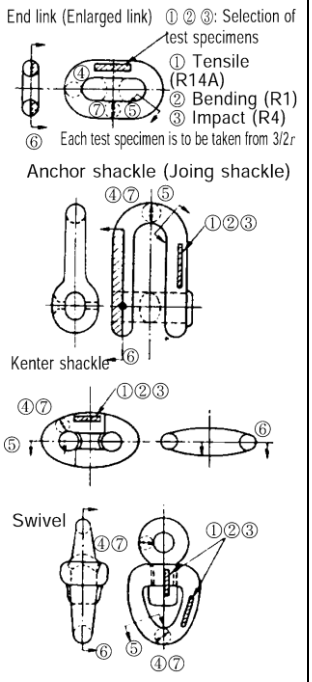
3.3.5 When the test either for connecting shackle or anchor shackle has been passed, the approval test for manufacturing process of the enlarged link and end link of the same diameter there of or less may be omitted.

3.3.6 The diameter of the chain accessories shown in items 3.3.1 through 3.3.5 above corresponding to that of the common link to which they are fitted.

4. Changes in the manufacturing process

Where major changes significantly affecting the manufacturing process already approved have been made, the requirements in Sub Section J.I.4. are to apply.

Table 2.17 Approval Test Items and Acceptance Criteria for Marine Chains Accessories

Test item		Numbers of test specimens	Selection of test specimen and details of test specimen	Test procedure	Acceptance criteria
Mechanical properties test of chain accessories	①Tensile test	2		① and ②: To conform to Rules for Materials (Pt.1, Vol.V), The bending radius of chain accessories is to be 25mm. And the bending angle is to be not less than following angle : 120°. ③: Testing temperature of impact test is to be referred to NOTES 6. ④: To be examined at its surface, 2/3 r and centre (magnifying power: × 100) ⑤: Areas shown in the figure are to be macroetched. ⑥: Sulphur print of the chain accessory in longitudinal section is to be taken. ⑦: Hardness distribution in diametric direction is to be measured at proper intervals. ⑧, ⑨, ⑪: To conform to Rules for Materials (Pt.1, Vol.V) Sec.13 / Rules for Hull (Pt.1, Vol.II) Sec.18 D. ⑩: Measurements of each part of chain accessories after subjected to proof test are to be taken for dimensions.	To conform to Rules for Materials (Pt.1, Vol.V)
	②Bending test	2			To be free of harmful defects
	③Impact test	see Notes 6			see Notes 6.
	④Micro test	3			The degree of heat treatment in diametric direction is to be examined.
	⑤Macro test	1			To be free of harmful defects.
	⑥Sulphur print	1			To be free of harmful defects.
	⑦Hardness test	1			For reference only.
Tests on testing object of chain accessories	⑧Proof test	1			To conform to Rules for Materials (Pt.1, Vol.V) Sec.13.
	⑨Breaking test	1			1.1 times of the specified breaking load is only required to be loaded, and no actual breaking is required.
	⑩Dimension inspection	1			To conform to Rules for Materials (Pt.1, Vol.V) Sec.13. In addition, dimensional changes are to be measured.
	⑪Visual inspection	1			To conform to Rules for Materials (Pt.1, Vol.V) Sec.13.

Notes:

1. The test chain accessories used for approval test are to, in principle, be two or three, in number, of the larges diameter under application.
2. BKI, when deemed necessary, may request non-destructive test.
3. In the case of the approval test required in connection with the change in the manufacturing process as shown in Sub Section J.I.4, BKI may reduce the requirements in the diameter and number of test chain accessories with respect to the test items.
4. When any steel materials, manufacturing process or heat treatment not specified in the Rules are intended to be used, BKI may request other testing procedure or submission of reference data in addition to those specified in the Rules.
5. Two specimens for each test of tensile test specimens, bending test specimens and Charpy V-notch impact test specimens are to be taken from the test samples specified in Rules for Materials (Pt.1, Vol.V) Sec.7 and Sec.6, on both cast and forged chain accessories, tested to satisfy the specified values in addition to the mechanical properties tests given in this Table.
6. Temperature of impact test are to be in accordance with following tables.

Kind of chain accessories	Number of test specimen	Temperature	Minimum absorbed average energy (J)
KI2 chain accessories	1 set	0°C	To be with reference
KI3 chain accessories	2 set	0°C and -20°C	At 0°C to be of 60J, At other temperature to be with reference

III. Offshore Chains and Chain Accessories

1. Application

1.1 The requirements in this sub section apply to the tests and inspection for the approval of manufacturing process of the offshore chain and chain accessories (hereinafter called chains and chain accessories) specified in Rules for Materials (Pt.1, Vol.V) Sec.13.C.

1.2 Chains and chain accessories are to comply with the additional requirements, which are J.I for offshore chains and J.II for offshore chain accessories, other than the above 1.1.

2. Materials

2.1 Kind of materials, mechanical properties used in chains and chain accessories are to comply with Rules for Materials (Pt.1, Vol.V) Sec.13.C.2 "Material".

2.2 Manufacturers propriety specifications for R4S and R5 may vary subject to design conditions and the acceptance of BKI.

2.3 Each grade is to be individually approved. Approval for a higher grade does not constitute approval of a lower grade.

3. Chain Approval of manufacturing process

3.1 Chains are to be manufactured only by works approved by BKI

3.2 Data to be submitted

1) Kind of chains
2) Manufacturing process
3) Materials
4) Heat treating method (including furnace types, controlling and recording of temperature and chain speed and allowable limits, quenching bath and agitation, cooling method after exit)
5) Diameter of test chain, maximum chain diameter
6) In addition to the above, the following reference data are to be submitted for approval and review to BKI.
   A) Bar heating and bending including method, temperatures, temperature control and recording
   B) Proof and break loading including method, method of measurement, and recording
   C) Manufacturer's surface quality requirement of mooring components
   D) Manufacturing process, manufacturing facilities and Welding machines description according to J.I.2, 6) A) a) and b).
   E) Working standards
      a) Inspection organization chart
      b) Contents of inspection at the reception of raw materials
      c) Bar cutting, heating and bending including method, temperatures, temperature control and recording
      d) Working standards applicable to each size of chain link for flash butt welding (welding current, force, time, flash allowance, upsetting allowance, preheating temperature and period, etc.)
      e) Flash removal including method and inspection

f) Stud manufacturing process and dimensions

g) Stud insertion method for stud link chain

h) Non-destructive examination procedures

i) Details of product inspection

3.3 Calibration of furnaces

Calibration of furnaces shall be verified by measurement and recording of a calibration test piece with dimensions equivalent to the maximum size of link manufactured. Thermocouples are to be placed both on the surface and in a drilled hole located to the mid thickness position of the calibration block.

3.4 Approval test

3.4.1 Approval test

The approval test is to be carried out on each chain under application for each manufacturing factory. The contents of approval test are to be as indicated in Table 2.18 and the test is to be carried out in the presence of the Surveyor unless otherwise specified.

3.4.2 Test chains

The link and test specimens used in the approval test are to be taken from the test chains in the presence of the Surveyor.

3.5 Changes in the approval content

When major changes are intended to be made in the manufacturing process already approved, the application procedure required for a new approval application is to be taken. The major changes include the items given below where, however, the witness of the approval test by the Surveyor may be dispensed with, or reduction in the approval test items may be accepted for the manufacturer whose product quality control standards and inspection standards are considered appropriate. In this case, however, submission of the results of tests on material properties and related data is required.

1) Increase in the maximum diameter of chain to be manufactured
2) Change in casting procedure
3) Changes in heat treatments (quenching, annealing, tempering, etc.)
4) New installation of welding machine
5) New installation of furnace for heat treatment
6) Other changes for which approval test is considered necessary

4. Approval of quality system at chain and accessory manufacturers

Chain and accessory manufacturers are to have a documented and effective quality system approved by A.5.2. The quality system is to be additionally submitted during witnessing of tests by Surveyor in order to approve the chain and chain accessories.

5. Approval of forges and foundries for chain accessories

5.1 Forges and foundries intending to supply finished or semi-finished accessories are to be approved by BKI. The approval is to be limited to a nominated supplier of forged or cast material. If an accessory manufacturer wishes to use material from a number of suppliers, a separate approval must be carried out for each supplier.

5.2 The approval will normally be limited to the type of accessory and the IACS designated mooring grade of material up to the maximum diameter or thickness equal to that of the completed accessory used for qualification. Qualification of accessory pins to maximum diameters is also required. Individual accessories of complex geometries will be subject to BKI requirements.

5.3 Forges and foundries are to provide evidence that the manufacturing process produces material that is resistant to strain ageing, temper embrittlement and for R4S and R5 grades, hydrogen embrittlement. A heat treatment sensitivity study simulating accessory production conditions shall be applied in order to verify mechanical properties and establish limits for temperature and time combinations. (Cooling after tempering shall be appropriate to avoid temper embrittlement). All test details and results are to be submitted to BKI.

5.4 For initial approval, Three CTOD tests are to be tested with a standard 2 × 1 single edge notched bend specimen in accordance with a recognized international standard such as BS 7448 Parts 1 & 2. The specimen location is as shown in Table 2.18 notes 7. The minimum test piece size shall be 50 × 25 mm for chain diameters less than 120 mm, and 80 × 40 mm for diameters 120 mm and above. The tests are to be taken at minus 20°C and the results are to be submitted to BKI.

5.5 Calibration of furnaces shall be verified by measurement and recording of a calibration test piece with dimensions' equivalent to the maximum size of link manufactured. Thermocouples are to be placed both on the surface and in a drilled hole located to the mid thickness position of the calibration block.

Table 2.18 Approval Test Items and Acceptance Criteria for Offshore Chains

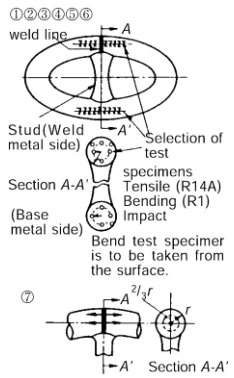
Test chains for approval test							
No.1 No.2 No.3 No.4 No.5 ..... No.32 No.33 No.34							
Test item			Numbers of test specimens	Numbers of test link (example)	Selection of test specimen and details of test specimen	Test procedure	Acceptance criteria
Mechanical properties test of llink	Base metal	① Tensile test	1	No.1		①, ②, ④, ⑤: To conform to Rules for Materials (Pt.1, Vol.V), The bending radius of Grades R3, R3S & R4 chain accessories is to be 25mm. Grade R4S and R5 chains are to be as deemed appropriate by BKI And the bending angle is to be not less than following angle 30° for Grade R4, 45° for Grade R3S, 60° for Grade R3. And Grade R4S and R5 chains are to be as deemed appropriate by BKI ③, ⑥: Testing temperature of impact test is to be referred to Notes 6. ⑦: is to be examined at its centre and the point 2/3 r for the structure of HAZ, base metal and weld zone (× 100) ⑧: Welded portion of link in longitudinal section is to be macroetched. ⑨: Sulphur print of longitudinal section of link is to be taken. ⑩: Hardness distribution of base metal and weld zone is to be measured at proper intervals. ⑪: To be comply with Notes 7	To conform to Rules for Materials (Pt.1, Vol.V) Sec.13.C.2 "Material"
		② Bending test	1	No.1			To be free of harmful defects
		③ Impact test	3sets	No.3~4			see Notes 6.
	Weld zone	④ Tensile test	2	No.1			Measured tensile strength is to exceed that of the base metal.
		⑤ Bending test	2	No.2			To be free of harmful defects
		⑥ Impact test	3sets	No.3~4			see Notes 6.
		⑦ Micro-test	2	No.5			Coarse grain area in HAZ and degree of heat treatment are to be examined.
		⑧ Macro test	1	No.5			To be free of harmful defects
		⑨ Sulphur print	1	No.7			To be free of harmful defects
		⑩ Hardness test	3	No.5			For reference only. However, hardness is to be max 330 for Grade R4S, and 340 for Grade R5.
		⑪ CTOD test	6 (from 3 links on each weld side and	No.5			To be comply with CTOD minimum values of Notes 7
Test of testing object of chains		⑫ Proof test	2 lengths	No.1~5 No.9~13		⑫, ⑬, ⑮: To conform to Rules for Materials (Pt.1, Vol.V) Sec.13.C.4 "Testing and Inspection of Finished Chain" ⑭ : After proof test, chain length and dimensions of each link are to be measured	To conform to Rules for Materials (Pt.1, Vol.V) Sec.13.C.3 and 4
		⑬ Breaking test	2 lengths	No.15~19 No.30~34			Actual breaking load is to be measured in addition to conform to Rules for Materials (Pt.1, Vol.V) Sec.13.C.4 "Testing and Inspection of Finished Chain".
		⑭ Dimension test	2 lengths	No.1~5 No.9~13			Check dimensional changes in addition to conform to Rules for Materials (Pt.1, Vol.V) Sec.13, C.4 "Testing and Inspection of Finished Chain".
		⑮ Mass inspection	2 lengths	No.1~5 No.9~13			To conform to Rules for Materials (Pt.1, Vol.V) Sec.13.C.4 "Testing and Inspection of Finished Chain".
		Visual inspection	2 lengths	No.1~5 No.9~13			To conform to Rules for Materials (Pt.1, Vol.V) Sec.13.C.4 "Testing and Inspection of Finished Chain".

Table 2.18 Approval Test Items and Acceptance Criteria for Offshore Chains *(continued)*

Notes:

1. The test links used in the approval test are to, in principle, be of the desired largest diameter for approval.
2. In the case of cast links, their mechanical properties tests are to be carried out in a manner corresponding to those applied to weld zone. Of those items of test on the testing object, the bending test and compression test may be substituted by magnetic particle testing.
3. When deemed necessary by BKI, non-destructive testing may be requested.
4. In the case of the approval test in association with the change in the manufacturing process as shown in 3.5, the diameter and number of test link, or the approval test items may be reduced.
5. When steel materials, manufacturing process or heat treatment methods which are not specified in the Rules are to be employed, BKI may request other tests or submission of reference materials in addition to the specified test items.
6. Temperatures of impact test are to be in accordance with following tables.

Kind of chain	Temperature	Minimum absorbed average energy (J)	
		Base metal	Flash butt weld zone
Grade R3 chain	0°C, -20°C and -40°C	At 0°C to be of 60J, At -20°C to be of 40J, At -40°C to be with reference.	At 0°C to be of 50J, At -20°C to be of 30J, At -40°C to be with reference.
Grade R3S chain		At 0°C to be of 65J, At -20°C to be of 45J, At -40°C to be with reference.	At 0°C to be of 53J, At -20°C to be of 33J, At -40°C to be with reference.
Grade R4 chain		At -20°C to be of 50J, At other temperature to be with reference.	At -20°C to be of 36J, At other temper- ature to be with reference.
Grade R4S chain		At -20°C to be of 56J, At other temperature to be with reference.	At -20°C to be of 40J, At other temper- ature to be with reference.
Grade R5 chain		At -20°C to be of 58J, At other temperature to be with reference.	At -20°C to be of 42J, At other temper- ature to be with reference.

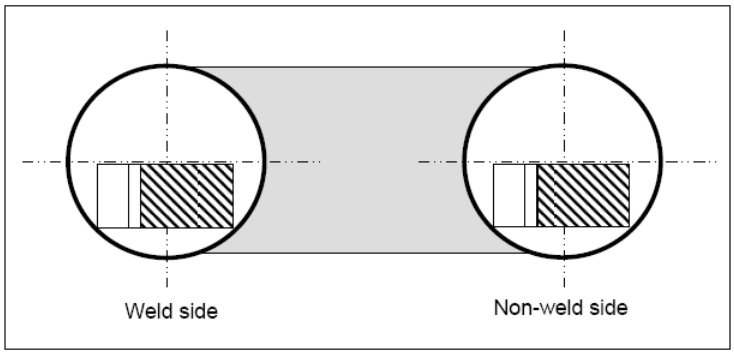
7. CTOD test required for offshore mooring chain is to comply with the followings

   For initial approval, CTOD tests are to be tested in accordance with a recognized international standard such as BS 7448 Parts 1 & 2. The CTOD test piece is to be a standard 2 × 1 single edge notched bend piece, test location as shown in Figure 1. The minimum test piece size shall be 50 × 25 mm for chain diameters less than 120 mm, and 80 × 40 mm for diameters 120 mm and above. CTOD specimens are to be taken from both the side of the link containing the weld and from the opposite side. Three links are to be selected for testing, a total of six CTOD specimens. The tests are to be taken at minus 20 ℃ and the acceptance criteria is to be the values and more than the values indicated below:

Chain type	R3 (mm)		R3S (mm)		R4 (mm)		R4S & R5 (mm)	
	BM	WM	BM	WM	BM	WM	BM	WM
Stud link	0,20	0,10	0,22	0,11	0,24	0,12	0,26	0,13
Studless	0,20	0,14	0,22	0,15	0,24	0,16	0,26	0,17

   BM : Base metal

   WM : Weld metal



8. For R4S and R5 chain, prior to approval, the manufacturer is to have undertaken experimental tests or have relevant supporting data to develop the chain material. The tests and data may include fatigue tests, hot ductility tests (no internal flaws are to develop whilst bending in the link forming temperature range), welding parameter research, heat treatment study, strain age resistance, temper embrittlement study, stress corrosion cracking (SCC) data and hydrogen embrittlement (HE) study, using slow strain test pieces in hydrated environments. Reports indicating the results of experimental tests are to be submitted.

5.6 Approval test

5.6.1 Approval test

The approval test is to be carried out on each item of chain accessories under application for each manufacturing factory. The details of approval test are to be as indicated in Table 2.19 and the test is to be carried out in the presence of the Surveyor unless otherwise specified.

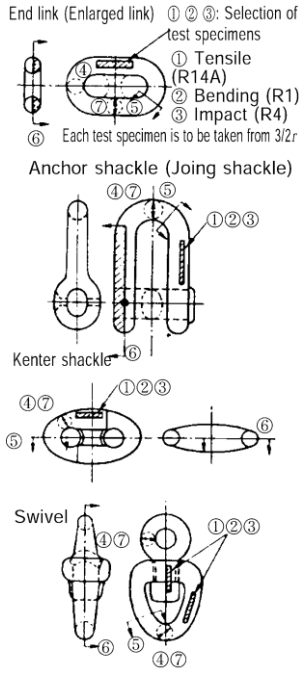
5.6.2 Test chain accessories

The test specimens used in the approval test are to be taken from the test chain accessories under application in the presence of the Surveyor.

5.7 Changes in the manufacturing process

Where major changes significantly affecting the manufacturing process already approved have been made, the requirements in 3.5 are to apply.

Table 2.19 Approval Test Items and Acceptance Criteria for Offshore Chains Accessories

Test item		Numbers of test specimens	Selection of test specimen and details of test specimen	Test procedure	Acceptance criteria
Mechanical properties test of chain accessories	① Tensile test	2		① and ②: To conform to Rules for Materials (Pt.1, Vol.V), The bending radius of Grades R3, R3S & R4 chain accessories is to be 25mm. Grade R4S and R5 chains are to be as deemed appropriate by BKI. And the bending angle is to be not less than following angle: 30° for Grade R4, 45° for Grade R3S, 60°. And Grade R4S and R5 chains are to be as deemed appropriate by BKI. ③: Testing temperature of impact test is to be referred to Notes 6. ④: To be examined at its surface, 2/3 r and centre (magnifying power : × 100) ⑤: Areas shown in the figure are to be macroetched. ⑥: Sulphur print of the chain accessory in longitudinal section is to be taken. ⑦: Hardness distribution in diametric direction is to be measured at proper intervals. ⑧: To conform to 5.4 ⑨, ⑩, ⑫: To conform to Rules for materials (Pt.1,Vol.V) Sec.13.C.5. ⑪: Measurements of each part of chain accessories after subjected to proof test are to be taken for dimensions.	To conform to Rules for Materials (Pt.1, Vol.V) Sec.13.C.2 "Material"
	② Bending test	2			To be free of harmful defects
	③ Impact test	see Notes 6			see Notes 6.
	④ Micro test	3			The degree of heat treatment in diametric direction is to be examined.
	⑤ Macro test	1			To be free of harmful defects
	⑥ Sulphur print	1			To be free of harmful defects.
	⑦ Hardness test	1			For reference only. However, hardness is to be max 330 for Grade R4S, and 340 for Grade R5.
	⑧ CTOD test	3			To be as deemed appropriate by BKI.
Tests on testing object of chain accessories	⑨ Proof test	1			To conform to Rules for Materials (Pt.1, Vol.V) Sec.13.C.4 "Testing and Inspection of Accessories"
	⑩ Breaking test	1			1.1 times of the specified breaking load is only required to be loaded, and no actual breaking is required.
	⑪Dimension inspection	1			To conform Rules for Materials (Pt.1, Vol.V) Sec.13.C.5 "Testing and Inspection of Accessories". In addition, dimensional changes are to be measured.
	⑫ Visual inspection	1			To conform to Rules for Materials (Pt.1, Vol.V) Sec.13.C.5 "Testing and Inspection of Accessories".

Notes:

1. The test chain accessories used for approval test are to, in principle, be two or three, in number, of the larges diameter under application.
2. BKI, when deemed necessary, may request non-destructive test.
3. In the case of the approval test required in connection with the change in the manufacturing process as shown in 3.5, BKI may reduce the requirements in the diameter and number of test chain accessories with respect to the test items.
4. When any steel materials, manufacturing process or heat treatment not specified in the Rules are intended to be used, BKI may request other testing procedure or submission of reference data in addition to those specified in the Rules.
5. Two specimens for each test of tensile test specimens, bending test specimens and Charpy V-notch impact test specimens are to be taken from the test samples specified in Rules for Material (Pt.1, Vol. V) Sec. 13, on both cast and forged chain accessories, tested to satisfy the specified values in addition to the mechanical properties tests given in this Table.
6. Temperature of impact test are to be in accordance with following tables.

Kind of chain accessories	Number of test specimen	Temperature	Minimum absorbed average energy (J)
Grade R3 chain accessories	3 set	0°C, -20°C and -40°C	At 0°C to be of 60J, At -20°C to be of 40J, At -40°C to be with reference
Grade R3S chain accessories	3 set		At 0°C to be of 65J, At -20°C to be of 45J, At -40°C to be with reference
Grade R4 chain accessories	3 set		At -20°C to be of 50J, At other temperature to be with reference
Grade R4S chain accessories	3 set		At -20°C to be of 56J, At other temperature to be with reference
Grade R5 chain accessories	3 set		At -20°C to be of 58J, At other temperature to be with reference

7. For R4S and R5 chain accessories, prior to approval, the manufacturer is to have undertaken experimental tests or have relevant supporting data to develop the chain accessory material. The tests and data may include fatigue tests, hot ductility tests (no internal flaws are to develop whilst bending in the link forming temperature range), welding parameter research, heat treatment study, strain age resistance, temper embrittlement study, stress corrosion cracking (SCC) data and hydrogen embrittlement (HE) study, using slow strain test pieces in hydrated environments. Reports indicating the results of experimental tests are to be submitted.

K. Wire rope

1. Application

The requirements in this section apply to the tests and inspection for the approval of manufacturing process of wire rope as specified in Rules for Material (Pt.1, Vol.V) Sec.14.

2. Approval tests

2.1 Selection of test samples

2.1.1 For strand test, a suitable length of a strand is to be cut off the rope and un-stranded. The number of wires to be taken therefrom for tests is to be as specified in of Rules for Material (Pt.1, Vol.V) Sec.14 D and E.

2.1.2 For rope test, one test piece is to be taken suitable length from end of each length of steel wire ropes.

Table 2.20 Number of test pieces for individual wires test

Composition mark	Number of test pieces
6 x 7	3
6 x 12	6
6 x 19	6
6 x 24	8
6 x 30	10
6 x 37	12
6 x WS (36)	19

2.2 Approval tests and acceptance criteria

2.2.1 The approval test is to be carried out on each grade of steel wire ropes under application for each manufacturing factory. The details of approval test are to be as indicated in Table 2.21 and the test is to be carried out in the presence of the Surveyor. Provided, however, approval test is carried out in the presence of inspector of the organization authorized by BKI (officially recognized establishment), the test witnessed by the Surveyor of BKI may be omitted.

2.2.2 Notwithstanding the requirements in the 2.2.1, the test may be done by sampling subject to BKI approval.

2.2.3 Where it is difficult to comply with the test method and evaluation criteria specified in 2.2.1, the decision may apply to recognized standards authorized by BKI (officially recognized establishment).

Table 2.21 Approval Test Items and Acceptance Criteria for wire ropes

Kinds	Test item	Test method	Acceptance criteria
strand test	Diameters and Appearance	(1) The difference between the maximum and minimum diameters of the individual wires is to be measured at any two or more positions by the micro meter (2) Through the entire length, cross section of individual wires is to be rounded with smooth surface. Individual wires should also be free from defects such as scratch which is detrimental to practical use.	To comply with the Rules for Material (Pt.1, Vol.V) Sec.14
	Breaking tests (1)	(1) The test piece is to be set to the testing machine and gradually pulled until break down. The difference between individual breaking load and average value is to be calculated. (2) The distance between grips is to be 100 mm where the diameter of test piece is less than 1,0 mm, or 200 mm where the diameter of test piece is 1,0 mm and over	The difference between individual breaking load and average value is to be within ± 8 %
	Twisting Tests (1)	The test piece with the length 100 times the diameter of the test piece is to be gripped hard at the ends, and then, depending on the twisting speed of each strand, one end is to be revolved until the test piece is broken down. Where they are broken down, the number of times of twisting is to be measured.	To comply with the Rules for Hull (Pt.1, Vol.2) Sec.18 F.
	Wrapping Tests	The test pieces are to be wrapped at least eight times around the wire with the same diameter as the test piece. Where they are unwrapped, the number of broken test pieces is to be measured.	
	Mass of Zinc Coating	To be as deemed appropriate by BKI	To be as deemed appropriate by BKI
rope test	Diameters and Appearance	(1) The diameter of steel wire ropes is taken as an average diameter measured at any two or more positions except within 1,5 m from the ends of ropes. (2) Through the entire length, wire ropes should be free from defects such as dent, scratch which are detrimental to	To comply with the Rules for Hull (Pt.1, Vol.2) Sec.18 F.
	Breaking tests (1)	(1) The test piece of which both ends are either loosened and solidified to cone with suitable metal alloy or gripped by other suitable methods, is to be set to the testing machine and gradually pulled until breaks down. (2) One test piece is to be taken from each length of steel wire ropes. (3) The distance between the grips is to be set according to the diameter of ropes. However, it needs not exceed 2 m.	To comply with the Rules for Hull (Pt.1, Vol.2) Sec.18 F.

Notes:

(1) Where the test piece has broken down at the parts of the grips before reaching the required breaking load, one more test piece taken from the steel wire rope may be retested.

L. Synthetic Fibre Ropes

1. Application

1.1 The requirements in this sub section apply to the tests and inspection for the approval of manufacturing process of synthetic fibre ropes at approved works.

1.2 Where it is difficult to comply with test methods and evaluation criteria specified in this sub section, the decision may apply to standards authorized by BKI (officially recognized establishment).

2. Data to be submitted

BKI may request to submit the data about following tests for raw textiles for synthetic fibre ropes:

- Linear strength and elongation tests
- Chemical resistance test

3. Approval tests

3.1 Selection of test samples

Test pieces are to be taken suitable length from end of each length of synthetic fibre ropes. The number of rope to be taken for tests is to be as specified in Table 2.22.

Table 2.22 Approval Test Items and Acceptance Criteria for synthetic fibre ropes

<table>
<tr><th>Test item</th><th>Test method</th><th>Acceptance criteria</th></tr>
<tr><td>Construction & Diameter</td><td>Construction and diameter of synthetic fibre ropes are to be measured in accordance with Rules for Hull (Pt.1, Vol.II) Sec. 18.F.</td><td>To comply with the Rules for Hull (Pt.1, Vol.II) Sec. 18.F</td></tr>
<tr><td>Tensile tests in wet and dry conditions</td><td>(1) Tensile tests on three each test specimens are to, in principle, be carried out for each of the test conditions given in Table below and breaking strength and elongation are to be measured. For rope having diameter higher than 60 mm, one additional tensile test specimen is to be taken from the rope of maximum diameter.
(2) The gauge length of the test specimen is to be 30 times or more of the rope diameter, however it needs not to exceed 1,0 meter.
<table>
<tr><th>Kind of rope / Diameter of test rope</th><th>Vinylon rope polyester rope nylon rope</th><th>Polyethylene rope polypropylene rope</th></tr>
<tr><td rowspan="2">12 ~ 24 mm</td><td>Wet conditio(1)</td><td>Wet condition(3)</td></tr>
<tr><td>Dry condition(2)</td><td>Dry condition(2)</td></tr>
<tr><td rowspan="2">40 ~ 60 mm</td><td>Wet condition(1)</td><td>Wet condition(3)</td></tr>
<tr><td>Dry condition(2)</td><td>Dry condition(2)</td></tr>
</table>
Notes:
(1) The test specimen is to be soaked in water at normal temperture for a period of 30 minutes or more, then taken out and subjected to tensile test at room temperature.
(2) The test specimen in dry condition is to be subjected to tensile test at room temperature.
(3) The test specimen is to be soaked in warm water at temperature of 35±2°C for a period of 30 minutes or more, then taken out and immediately subjected to tensile test at room temperature.</td><td>(1) Except on cases with vinylon and nylon in wet condition, respective breaking loads are to satisfy the requirements specified in Rules for Hull (Pt.1, Vol.II) Sec. 18.F.
(2) The breaking loads of vinylon and nylon in wet conditions are to be 80 % or more and 90 % or more respectively of the values specified in above (1)
(3) Values with respect to elongation are to be for reference only.</td></tr>
</table>

Table 2.22 Approval Test Items and Acceptance Criteria for synthetic fibre ropes *(continued)*

<table>
<tr><th>Test item</th><th>Test method</th><th>Acceptance criteria</th></tr>
<tr><td>Abrasion resistance tensile test</td><td>(1) A total of six test specimens are to be taken from ropes with diameter from 12 to 24 mm. Three of them are to be set in the abrasion resistance testing machine with the following particulars, and are to be subjected to repeated strokes for 500 times.
– Stroke: 200~300 mm
– Abrasion speed: 50 strokes/min.
– Abrasion surface: Grinder with particle size No. 120
– Tensile load: 98 N
(2) Those three tested specimens together with other three non-tested specimens are to be placed in a thermostatic oven kept at a temperature of 20 °C and a humidity of 65 %, and left there for one hour.
(3) They are then to be taken out, and be subjected to tensile tests for measuring the tensile strength and elongation, whereby the strength values of the rope before and after abrasion are to be compared.
(4) For other test conditions than those shown above, they are to be considered appropriate by BKI.</td><td>The ratio of the residual abrasion strength to the strength without abrasion (the residual abrasion strength ratio) is to satisfy the values given in table below.<table><tr><th>Kind of rope</th><th>Residual abrasion strength ratio (%)</th></tr><tr><td>Vinylon rope</td><td>min. 50</td></tr><tr><td>Polyethylene rope</td><td>min. 55</td></tr><tr><td>Polyester rope</td><td>min. 55</td></tr><tr><td>Polypropylene rope</td><td>min. 55</td></tr><tr><td>Nylon rope</td><td>min. 55</td></tr></table></td></tr>
<tr><td>Weather resistance test</td><td>(1) A total of six test specimens are to be taken from ropes with diameter from 12 to 24 mm. Three of these test specimens are to be placed in the weather resistance test machine controlled to the following conditions where they are to be left for 200 hours or more.
– Weathering light: Sunshine carbon arc light or ultraviolet carbon arc light
– Temperature of black panel: 63 ± 1 °C
– Period of water spray: 18 min/2 hours
(2) The six test specimens including those three non tested specimens are then to be placed in a thermostatic oven kept at a temperature of 20 °C and a humidity of 65 %, and left there for one hour. These test specimens are to be taken out, tensile strength and elongation are to be measured, and the strength after the weathering resistance test and that of the test specimens not subjected to such weathering resistance test are to be compared.</td><td>The ratio of the former to the latter (the residual weathering strength ratio) is to satisfy the values given in table below.<table><tr><th>Kind of rope</th><th>Residual weathering strength ratio (%)</th></tr><tr><td>Vinylon rope</td><td>min. 90</td></tr><tr><td>Polyethylene rope</td><td>min. 80</td></tr><tr><td>Polyester rope</td><td>min. 90</td></tr><tr><td>Polypropylene rope</td><td>min. 80</td></tr><tr><td>Nylon rope</td><td>min. 80</td></tr></table></td></tr>
</table>

3.2 Approval tests and acceptance criteria

3.2.1 The approval test is to be carried out on each kind of ropes under application for each manufacturing factory. The details of approval test are to be as indicated in Table 2.22 and the test is to be carried out in the presence of the Surveyor. Provided, however, approval test is carried out in the presence of inspector of the organization authorized by BKI (officially recognized establishment), the test witnessed by the Surveyor of BKI may be omitted.

3.2.2 The procedures of the test for raw textiles for synthetic fibre ropes refer to the Table 2.23

Table 2.23 Approval Test Items and Acceptance Criteria for raw textiles for synthetic fibre ropes

Test item	Test method	Acceptance criteria
Linear strength and elongation tests	(1) The test procedures of filament and split are to be in accordance with ASTM 4268, and those of span are to be correspondingly on accordance with ASTMD2256 (Testing Method for Tensile Strength of Spun Yarns). (2) The number of test specimens used in the test is to be 10 and average value of the linear strength and elongation on these test specimens are to be obtained.	The average value of linear strength and elongation obtained are to comply with the requirements given in Table 2.24.
Chemical re-sistance test	(1) The chemical resistance tests are to comprise alkali-resistance test and acid-resistance test. (2) In alkali-resistance test, the test specimen is to be socked in 10% caustic soda solution at a temperature 20±2°C for a period of 24 hours, whereas in acid-resistance test, the test specimen is to be socked in 10% acid solution at a temperature 20±2°C for a period of 24 hours, and then rinsed with water, and the linear strength is to be measured by the same method as in (1) above. (3) The number of test specimens are to be 10 for each chemical solution. The linear strength is to be converted into the value of residual strength ratio of chemical resistance by following equation. $\text{Residual chemical resistance strength ratio} = \frac{\text{linear strength(g) after chemical processing}}{\text{linear strength(g) before chemical processing}} \times 100(\%)$	These average values are to satisfy the values given in Table 2.24.

Table 2.24 Standard Tensile Strength Values for Raw Textiles

Kind of raw textiles			Mechanical properties		Residual chemical resistance strength ratio(%)	
			Linear strength(g/D)	Linear elongation (%)	10% sulphuric acid	10% caustic soda
Vinylon	for Grade 1	Span, mono-filament	4,0 min.	9 ~ 18	90 min.	90 min.
	for Grade 2	Multi-filament	6,0 min.	9 ~ 18	90 min.	90 min.
Polyethylene	for Grade 1	Mono-filament	6,5 min.	5 ~ 25	90 min.	90 min.
	for Grade 2	Mono-filament	8,5 min.	5 ~ 15	95 min.	95 min.
Polyester		Multi-filament	5,5 min.	10 ~ 20	90 min.	90 min.
Polypropylene	for Grade 1	Span	4,5 min.	10 ~ 20	90 min.	90 min.
		Mono-filament	6,0 min.	10 ~ 20	90 min.	90 min.
	for Grade 2	Multi-filament	6,5 min.	15 ~ 25	90 min.	90 min.
		Special mono-filament	6,0 min.	5 ~ 15	90 min.	90 min.
		Special multi-filament	5,5 min.	5 ~ 15	90 min.	90 min.
		Split	4,0 min.	5 ~ 15	90 min.	90 min.
Nylon		Multi-filament	6,5 min.	15 ~ 30	80 min.	80 min.

Note:
g/D signifies gram/denier

4. Yarn test

In case where manufacturer's testing equipment does not have enough capacity for tensile test of fibre rope, yarn test may be substitute for tensile test specified in Table 2.22 provided that yarn test specimens are to be taken from fibre rope strand in question and, for calculating the breaking load, realization factor authorized by BKI shall be multiplied to the average yarn test value.

M. FRP Ships

1. Application

The requirements in this sub section apply to tests and inspection for the approval of manufacturing process of Fiberglass Reinforced Plastic Ships (hereinafter referred to as FRP ships) as specified in Rules for Fiberglass Reinforced Plastics Ships (Pt.3, Vol.V) and Rules for High Speed Crafts (Pt.3, Vol.III).

2. Data to be submitted

The following data are to be submitted to BKI in addition to those specified in A.2

2.1 Data described manufacturer's name and product name for polyester resins, fiberglass reinforcing materials, core materials for sandwich construction, etc.

2.2 Test methods and test records of the FRP test specimens cut from FRP which are of the same laminate composition and moulded by the same procedure and at the same workshop as the actual hull laminates (including tensile strength, tensile modulus, flexural strength, flexural modulus, barcol hardness, glass content, specific gravity, etc., and test report of shearing strength in case of sandwich construction)

3. Workshops

The workshops manufacturing FRP ships intended to be registered to BKI, are to comply with the requirements in Table 2.25 to maintain sufficient mechanical properties and a good quality of moulding.

Table 2.25 Facility standard for FRP ship manufacturing workshop

Facility	Equipment	Facility standard
General		(1) The laminating shops are to be of such construction as to be free from penetration of draught, dust and moisture, and to be provided with heating system to keep to keep the temperature above 15 °C. In this case, the method partially beaming the infrared rays is not to be generally permitted. (Recommended air temperature and humidity are 16°C to 25 °C and 60 % to 70 % respectively) (2) The shops are to be designed so that resin and fiberglass are not to be deteriorated with the elapse of the time and the fiberglass reinforcements are not to be contaminated by soil, dust, moisture, etc. (3) The standard specification for the construction and repair of FRP ships shall be clearly established and moulding of FRP is to be carried out under the supervision of a well-experienced technical expert.
Standard of facilities		The manufacturer of FRP ships is to provide with the facilities which can manufacture the FRP ships about G/T 20 tons by hand lay-up.
Laminating shops	Area	The laminating shops are to have sufficient spaces to carry out the laminating works and mould releasing operation for the largest ships intended to be manufactured.
	Structural conditions	The structure of the laminating shops is to be of an steel frame or an steelconcrete. The ceiling and surrounding walls are to be of a fireproof structure and to be protected against moisture, rain and draught, and the ground is to be of concrete construction. For the purpose of sun lighting, the partial use of inflammable materials for the ceiling may be allowed. A sufficient spaces carrying out the outfitting works are to be arranged not to cause inconvenience in doing their works, or their works are to be carried out in the separated room.

Table 2.25 Facility standard for FRP ship manufacturing workshop *(continued)*

Facility	Equipment	Facility standard
Facilities in laminating shops	Temperature conditioners	The laminating shops are to have temperature conditioners not to fall below 15°C in winter season and rise above 30°C in summer season at one meter distance from the floor level.
	Ventilation systems	Ventilation systems in accordance with the relevant law are to be provided to exhaust styrene gases and other harmful gases.
	Dust collectors	The suitable dust collectors are to be provided in order to exhaust dusts yielded during laminating operation.
	Lighting and shields	Lighting equipment are to be so arranged that the operation of laminating are not disturbed. Also, the skylights and windows of the laminating shops are to be provided with suitable means of shielding so that the laminates are not exposed to direct sunlight.
	Transportation	Transportation equipment of suitable capacity are to be provided and arranged.
	Fire fighting and detection systems	Fire fighting and detection systems are to be provided in accordance with the relevant law. The caution sign of "Flammables" is to be indicated in shops. The smoking room is to be arranged outside the laminating shops.
	Electric equipment	Electrical equipment in the laminating shops is to be of explosion-protected electrical appliance, except that the ventilation systems are provided completely.
	Glass cutting	The glass cutting tables are to be so arranged as to be properly subdivided or separated from the laminating shops.
	Resin mixing	The mixing equipment and the weighing machines are to be provided in any case. Where the resin mixing room is provided, it is to be of a fireproof construction.
	Cleaning	The separated room with the ventilator is to be provided so as to clean the laminating equipment and FRP components weighing machines.
Other facilities of the laminating shops	Storage	A catalyst, resin, solvent, etc., are to be stored in cool and dark spaces in accordance with the relevant law, and the fiberglass reinforcements and core materials are to be stored in dust-free and dry spaces.
	Sanitary	A washstand, a bathroom, necessary medicine for eye-washing, etc., are to be provided considering the number of workers.
	Storage for moulds	Moulds used repeatly are to be stored free from rain and wind, and they are to be properly kept so that the internal surface of moulds can not be contaminated and
	Air compressor	The air compressors of suitable capacity with an air cleaner are to be provided outside the laminating shops.
	Management of waste matter	The incinerators for waste matters are to be equipped and the waste matters are to be treated considering a fire and environmental pollution. Where the incinerator is not provided, the waste matters are to be requested to the specialty dealers concerned of industrial waste products. Also, the procedure of management for ashes incinerated and incombustibles is to be established in accordance with the relevant law.

4. Approval tests

4.1 Approval test is to be carried out for FRP (including FRP laminates and sandwich laminates) used for hull construction of FRP ships.

4.2 Construction of FRP test sample and approval test are to be conducted in accordance with the requirements in Rules for Fiberglass Reinforced Plastics Ships (Pt.3, Vol.V) Sec.4.

4.3 Tests specified in 4.2 are to be carried out in the presence of BKI Surveyor. Where tests are carried out by a recognized inspecting agency, it may be omitted at the discretion of BKI.

N. Boiler and Pressure Vessel

1. Application

The requirements in this Sub-section applies to the manufacturers which have the activity categories such as the manufacturing process, or manufacturing process and design, or manufacturing process, design and test of the Boilers and Class I & II Pressure Vessels prescribed in Rules for Machinery Installations (Pt. 1, Vol. III) Sec. 7 I and 8.

2. Documents to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI. (if any)

1) Kind of product and activity categories
2) Types (models) of pressure vessels and/or boilers being produced (including design pressure, max. dimension or capacity)
3) In case of an application for boilers and/or class I pressure vessels, design drawings of boiler and/or class I pressure vessel having the max dimension or the max. condition (if the drawings are already approved by BKI, the submission of drawings may be waived appropriately)
4) Manufacturing flow chart indicating all of the production processes and relative testing & inspection points
5) Reference to written procedures for testing and inspection (Procedures need not be submitted, but must be available for review at the manufacturer's works upon request)
6) A list and description of equipment used for mechanical testing, pressure testing, non-destructive testing and production & machining facilities
   - Equipment for material preparation and forming, cutting machines, bending rollers, bending presses, machining equipment, adjustment and position equipment
   - Equipment for surface treatment and processing
   - Equipment for preheating
   - Equipment for welding, welding processes used
   - Equipment for heat treatment, including type of furnace, size, temperature range, temperature control and recording
   - Equipment for hydraulic pressure testing
7) Qualification of personnel engaged in testing and inspection
8) Details for welding
   - WPS for all types of materials and thickness ranges for which approval is sought
   - Relevant PQR, quality requirements for welding operator, list of certified welders with qualification range, welding method, position and material type

3. Approval test

3.1 Approval tests are to be carried out with the representative boiler or class I pressure vessel in production in the presence of the Surveyor. However, class II pressure vessel may be used if the manufacturer has the capability of producing class II pressure vessels only.

3.2 Approval tests listed below should at least be carried out to confirm that applied type of products is in compliance with the requirements of Rules for Machinery Installations (Pt. 1, Vol. III) Sec. 7.I and 8.

1) Review of documentation from manufacturer and verification of the procedures (requirements for identification and traceability of the products, materials and welding details)

2) Non-destructive testing, in compliance with agreed procedures and Rule requirements
3) Hydraulic test in compliance with Rule requirements
4) Welding workmanship approval tests according to Rules for Welding (Pt. 1, Vol. VI) Sec. 13 and 14.

4. After approval

After obtaining the approval, witnessing of welding workmanship approval test may be waived at the discretion of the Surveyor.

O. Approval of Manufacturing Process of Acrylic Windows used for Viewports

I. Acrylic Plastic Materials

1. Application

The requirements in this sub-section apply to the tests and inspection for the approval of manufacturing process of Acrylic Plastic Materials to be used for acrylic windows, as specified in Rules for Small Vessel up to 24 m (Pt.3, Vol. VII) Sec. 1.

2. Documents to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI.

1) Kind of the acrylic material and specifications
2) General description on major manufacturing facilities (moulding, melting, casting, furnace and machining installations and their capacities)
3) General description on the testing and inspection facilities (various testing and inspection equipment and installations)
4) Safety data sheet
5) Storage and processing instructions
6) A declaration in writing by the applicant that the tested materials comply with those for which the approval is requested, and that the sample is manufactured in accordance with the Rules and Guidance of Biro Klasifikasi Indonesia.
7) Copy of the test certificate of a recognized testing body, i.e. an accredited testing laboratory or a notified testing body.

3. Approval test

3.1 Acrylic materials approval tests are to be conducted in accordance with the Table 2.26.

Table 2.26 Approval Testing Method and Acceptance Criteria for Acrylic Materials

Test item	Properties	Test method	Acceptance criteria
Tensile Test	Ultimate tensile strength	ASTM D 638 [1] or DIN 53 455[1] (specimen type 3)	To comply with the requirements in Rules for Small Vessel up to 24 m (Pt.3, Vol. VII) Table 1.7a
	Elongation at break (in relation to necking zone)		
	Modulus of elasticity	ASTM D 638 [1] or DIN 53 457	
Compressive test	Compressive yield strength	ASTM D 695 [1] or DIN 53 454[1] (Size of test specimen: 25 x 12,5 x 12,5 mm)	
	Modulus of elasticity	ASTM D 695 [1] or DIN 53 457	
	Compressive deformation	ASME PVHO-1, para 2-3.7 (c)	
Ultraviolet test	Ultraviolet transmittance	ASME PVHO-1 method, para 2-3.7(d)	
Clarity test	Visual clarity	ASME PVHO-1, para 2-3.7 (e)	
Residual monomers test	Residual monomers Methyl methacrylate Ethyl acrylate	ASME PVHO-1, para 2-3.8	
Other test	As deemed appropriate		

3.2 Tests specified in 3.1 are to be carried out in the presence of BKI Surveyor. Where tests are carried out by a recognized inspecting agency, it may be omitted at the discretion of BKI.

4. Dealing after approval

4.1 For each batch of acrylic plastic processed to windows the manufacturer has to issue a Manufacturer Inspection Certificate containing at least the following details:

- number and date of Certificate
- manufacturer's name and address
- designation and application of casting type
- batch number, quantity, shape and size of castings
- marking of castings
- results of tests
- stamp and signature

4.2 Each casting is to be provided at one point at least with a marking which identifies the type of casting, the batch number, the date of manufacture and the name of the manufacturer.

II. Acrylic Windows

1. Application

The requirements in this sub-section apply to the tests and inspection for the approval of manufacturing process of Acrylic Windows to be used for viewport, as specified in Rules for Small Vessel up to 24 m (Pt.3, Vol. VII) Sec. 1.

2. Documents to be submitted

The following reference data in addition to those specified in A.2. are to be submitted to BKI.

1) Types (models) of acrylic windows being produced (including design pressure, max. dimension)
2) Manufacturing flow chart indicating all of the production processes and relative testing & inspection points
3) Reference to written procedures for testing and inspection (Procedures need not be submitted, but must be available for review at the manufacturer's works upon request)
4) A list and description of following equipment:
   - Equipment for forming, cutting machines, machining equipment.
   - Equipment for surface treatment and processing
   - Equipment for heat treatment, including type of furnace, size, temperature range, temperature control and recording
   - Equipment for hydraulic pressure testing
5) Competency of personnel engaged in production and testing

3. Approval test

3.1 Approval tests are to be carried out with the representative acrylic windows in production in the presence of the Surveyor.

3.2 Acrylic windows shall be subjected to a pressure test not exceed 1,5 times the design pressure of the window and shall be applied for at least 1 hour but not more than 4 hours. After the pressure test, window shall not exhibit scratches, cracks and permanent deformation.

4. Dealing after approval

4.1 For each window or series of windows the manufacturer shall issue a component certificate specifying all the stages of manufacture such as cutting, sticking, polishing, forming and tempering. In addition the scope of tests, the test results, the marking of the windows and the date of manufacture shall be indicated.

4.2 Each window shall be permanently marked with at least the following details:

- Design pressure (PR) (bar)
- Design temperature (°C)
- BKI approval stamp
- Manufacturer's name or identifying mark
- Serial number and year of manufacture
- Direction of pressure, if it is not clear.

Wherever possible, the marking shall be engraved in the non-load-bearing portion of the window edge. The use of punches is not allowed.

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Section 3 Type Approval

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A. General

1. General

1.1 Application

The requirements in this Section apply to the procedures and tests for type approval of materials and equipment for which approval of BKI is to be obtained in advance before they are used in ships in accordance with the requirements in the Technical Rules of BKI. However, the materials and equipment, other than those specified in the Technical Rules may be approved upon request of the manufacturer. In this case, the requirements in this Section are correspondingly applied.

1.2 The manufacturers wishing to obtain the type approval are to comply with the requirements specified in the relevant Sub-section of this Section according to the kind of materials and equipment in addition to the requirement for the procedures and tests specified in this Sub-section.

1.3 Definition

1.3.1 Mass production method means to be produced by either lot production method or quasi-lot production method defined in the followings.

1.3.2 Lot production method means a production method in which the parts are produced in a batch as a unit and the batch is manufactured repeatedly.

1.3.3 Quasi-lot production method means a production method in which the parts are produced in a batch as a unit whereas the machinery is produced as a unit.

2. Approval application

2.1 The applicant

The applicant is, in principle, to be the manufacturer of the materials and equipment. However, the applicant, where deemed appropriate by BKI, need not always be the manufacturer of the materials and equipment.

2.2 The manufacturer wishing to obtain a type approval is to submit the application of type approval, together with the required data for approval and the required data for reference, to BKI in electronic format. However, the required data previously submitted to BKI, according to the Technical Rules, may be exempted from submission.

2.3 Data to be submitted

2.3.1 Data for approval

1) Type test program and applicable standards, codes or rules (when the test methods, procedures, etc. in the Guidance, IMO Resolution, Sandard Nasional Indonesia, etc. apply, their number and subject stipulation instead of submission may be accepted except details of test specimens.)
2) Relevant drawings (fully detailed sectional assembly, drawings for main component parts) and documents as bellows:
   A) Product specifications

B) All product details, catalogues, data sheets, calculations and functional descriptions, parts list, etc., (if any)

C) Application and operational limitation

D) Drawings showing the interaction between the main component (if any)

E) PCB (Printed Circuit Board) Lay-out/circuit diagram (if any)

F) Wiring diagram, connection diagram (if any)

G) System block diagram (control logic) (if any)

H) Name and version No of software to be installed and Quality Assurance Plan (if any)

I) Installation and operation manual (if necessary)

J) marking methods

2.3.2 Data for reference

1) Particulars and specifications of products

2) Outline of company

A) Data on history, outline and layout of manufacturing plants

B) Organization and management structure, including subsidiaries to be included in the approval/certification

3) When plant audit is required in accordance with the requirements in 5., the following reference data may be submitted.

A) Data on major manufacturing facilities

B) Data on manufacturing process

C) Data of in-house standards or codes

D) Data of quality control system

E) Data on major inspection and testing facilities

F) Service records

G) List of subcontractors and their products

H) For a newly developed product, documents related to tests and their results for its development

2.4 Notwithstanding the requirements in 2.2, where the applicant is already approved by BKI and the attachments are entirely equal in content to the documents previously submitted the submission of documents may be partly or wholly exempted except for the approval test program.

3. Document review

BKI examines the type test program, drawings and data and where deemed appropriate, those are to be approved and returned to the manufacturers.

4. Type test

4.1 After completion of the document reviews (if necessary, including plant audit specified in 5., the type tests are to be carried out for the optionally chosen test specimens in the presence of the Surveyor in accordance with the approved type test program and test method described in each Section of the Guidance or equivalent method thereof.

4.2 Products which have been failed to pass the type tests specified in 4.1 shall not be retested without revision of drawings and/or specifications. If, following analysis of the experimental data from tests, it is found that the failure of type tests has been caused by the poor test conditions, etc., retest without revision may be permitted subject to BKI's approval.

4.3 In principle, the type tests are to be carried out at the manufacturing sites. However, the test may be done outside of manufacturing sites subject to BKI's approval.

4.4 The type tests may be partly or wholly omitted, subject to the approval by BKI, in cases where the manufacturer has been approved by other Classification Society or an inspection organization recognized by BKI.

4.5 Test records

After completion of the type tests, the manufacturer is to submit the test records in electronic format to BKI.

5. Plant audit

BKI may request the plant audit specified in Section 2.A.5. to assure the manufacturing process (including that of subcontractor's works) and quality assurance of the products.

6. Notification and announcement of approval

6.1 BKI is to issue a Type Approval Certificate, to the applicant, where deemed appropriate by BKI on the basis of the plant audit report and the submitted test reports after completion of the type test.

6.2 The Certificate shall clearly state that the type and scope of products and any limitations or restrictions imposed.

6.3 Where real ship tests are required, BKI is to issue a Provisional Type Approval Certificate to the applicant, where deemed appropriate by BKI on the basis of the submitted test reports after completion of the type test except the real ship tests.

6.4 BKI is to issue a Type Approval Certificate, to the applicant, where deemed appropriate by BKI on the basis of the submitted test reports after completion of the real ship tests.

6.5 BKI announces the manufacturers who have been granted the type approval in the "List of The Approved Manufacturer & Type Approved Equipment" including approval conditions.

7. Changes in the approved contents

7.1 When the alteration to the specifications (materials, composition, dimension, construction, particulars, etc.), manufacturing facilities, manufacturing methods and/or quality control system has a significant effect on the property or quality of the products, or when the works was removed, the manufacturer is to submit the application of alteration to BKI together with the detailed documents of the alteration (where practicable, to be mentioned with a comparison table form between new and old). BKI may request an occasional plant audit or confirmation test, where deemed necessary upon reviewing the contents of alteration.

7.2 For the insignificant alterations, the manufacturer shall give the contents of alteration to the Surveyor for confirmation at the appropriate time. In this case the Surveyor shall report the con- tents of alteration to the head office.

7.3 When the manufacturing sites (including that of subcontractor's works) were changed or added, the manufacturer is to submit the application for alteration to BKI together with the detailed documents of the alteration. BKI is to carry out the plant audit equivalent to Section 2.A.5. and to reissue ‘Type Approval Certificate’ in which the alteration is noted.

8. Validity and renewal of approval certificate

8.1 Validity of approval certificate

8.1.1 The type approval certificate will be valid within five years from the date of issue. In case where the approval certificate is renewed in accordance with the requirements specified in 7., the expiration date will not be changed. In case where the renewal audit is carried out within 3 months before the expiry date, the valid term of the approval certificate will be dated to the original renewal date.

8.1.2 Where BKI issued a provisional type approval certificate, the validity of the type approval certificate described in 6.3 above will be residual period within five years from issued date of provisional type approval certificate.

8.2 Periodical surveillance

8.2.1 Periodical surveillance shall be carried out to the approved manufacturer in case the individual product certificate is not required.

8.2.2 In the periodical surveillance, it is confirmed by BKI that the approved quality system, etc. of the manufacturer are maintained satisfactorily.

8.2.3 Periodical surveillance is to be carried out after 2 years but not 3 years passing from the initial or the renewal approval date.

8.3 Renewal of approval certificate

8.3.1 BKI may reissue type approval of a product without retesting, provided that no alteration of components or construction has been made to the product. However, the Fire protection materials are to be in accordance with the provisions in Y.3. The manufacturer who intends to have a continuation of the approval is to submit an application to BKI three months before the due date together with the following data:

- Data related to the corrective action for approved product, if any
- Alteration to the approved manufacturing process or specification
- Service records of approved products or similar products which are approved by BKI (minimum 6 months and over)

8.3.2 BKI may request an approval test and/or plant audit, where deemed necessary, after the examination of application and documents thereof.

8.4 Extension of approval certificate

8.4.1 At the request of the manufacturer, BKI may extend the validity of approval certificate within the period of three months after expiry of the validity. In this case, the renewed approval certificate will be valid within five years from the expiry date of old approval certificate.

8.4.2 At the request of the manufacturer, BKI may extend the validity of Provisional Type Approval Certificate for one time only, in case where the manufacturer submit the data including reasons of not completing the real ship test required and details of real ship test schedule, etc. However, the extension can be made within two years from the expiry date of Provisional Type Approval Certificate.

9. Confirmation test and/or occasional plant audit

9.1 The confirmation test and/or occasional plant audit may be required when serious shortcoming is found in structure or performance, etc. of the materials and equipment already approved.

9.2 After completion of the confirmation test and/or occasional plant audit, the manufacturer is to prepare a record of the confirmation test and/or occasional plant audit and submit in electronic format to BKI upon receiving confirmation by the Surveyor.

10. Suspension or withdrawal of approval

10.1 BKI can withdraw the type approval in case any of the following cases.

1) When the materials and equipment no longer confirm to the given requirements due to amendments or establishment of conventions, laws, rules and regulations.
2) When serious shortcoming is found in structure or quality of the materials and equipment already approved after being installed in ships.
3) When the products are produced in breach of the approval conditions or when the test results have been improperly reported.
4) Changes brought by the Manufacturer without preliminary agreement of BKI to the extent of the approval defined at the time of the approval
5) When the materials and equipment failed to pass the confirmation test and/or occasional plant audit specified in 9.
6) In case where a serious failure of the manufacturer's quality system has been identified or where the manufacturer has failed to inform any changes which will affect the approved quality system to BKI.
7) In case where the manufacturer has not undergone a renewal plant audit or where the manufacturer is refusing to undergo occasional plant audit requested by BKI.

10.2 In renewal or occasional audit for approved products, where non-conformities in the approved quality system are found, or where conditions for the issuance of the certificate or for its maintenance have deteriorated, the manufacturer is to correct the non-conformities. Such corrections are to be verified by BKI. In case corrective actions are not taken within the specified period, BKI may suspend the approved certificate for a given period. In case the corrective actions are not taken for the suspended period, BKI may withdraw the approval.

10.3 Having no concern with the product quality BKI can withdraw, during the period of validity, the type approval in the following cases:

1) When a request for withdrawal is made by the manufacturer.
2) When the approval fees are not paid.
3) When considered inappropriate for approved condition by BKI.

10.4 A manufacturer whose approval has been withdrawn, may apply for re-approval provided that the reasons which resulted in cancellation are corrected, and BKI is to issue the approval certificate after it is confirmed that the corrective action has effectively been implemented.

10.5 Where an application for reapproval is made for product which had its type approval withdrawn, such application shall be handled according to initial type approval requirements. But, it may be considered as exceptional case in case where BKI specially accepted.

11. Marking

The approved products are to be identified by a mark showing that they are the products approved by BKI.

12. Quality control

12.1 The manufacturing process and the quality control of the products are to be assured in accordance with the same procedure and system as they have been surveyed and examined by BKI under the manufacturer's responsibility.

12.2 The in-house test results for production are to be available for review whenever requested by BKI.

B. Welding Materials

1. Application

The requirements in this Sub Section apply to tests and inspection for the welding materials in accordance with the requirements in Rules for Welding (Pt.1, Vol.VI) Sec. 5.

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

1) The following data related to manufacturing process and quality control:
   A) In the case of covered electrodes:
      a) Kind of welding materials, data on manufacturing process
      b) Data on type proportion of main component, shattering, mixing and churning of coating flux
      c) Date on coating method, off-centering and drying methods
      d) Data on final processing
   B) In the case, other than covered electrodes:
      a) Data on chemical composition, manufacturing process, acceptance criteria, wire drawing method and rust protection of core wire
      b) Data on main composition, manufacturing process, grain size distribution, etc. of flux
      c) Data on manufacturer of welding wire, flux, etc.
2) Data on storage method
3) Data on packaging and marking
4) Recent test records, or experiments and research data on welding materials for which approval is desired
5) Data on the content of warning if they are provided against usage such as chemical composition of weldment, mechanical properties, welding current, welding voltage, welding speed, welding position, type of shielding gas, etc.

3. Type tests

Type tests are to be done in accordance with the requirements in Rules for Welding (Pt.1, Vol.VI) Sec. 5.

4. Periodical inspection

4.1 General

The manufacturer of welding materials is to be subjected to the periodical inspection in the presence of Surveyor at each manufacturing plant within three months before or after the expiry of the validity.

4.2 Application for periodical inspection

Manufacturers are to submit to BKI an approval application from which includes for each brands of the welding materials (Marks of core wire in combination with flux for the case of automatic welding materials).

4.3 Items to be covered by periodical inspection

1) The periodical inspections are to, in principle, be conducted at the manufacturing plant in the presence of the Surveyor.

2) The test in periodical inspection is to be conducted in accordance with requirements Rules for Welding (Pt.1, Vol.VI) Sec. 5 using the welding materials taken at random by the Surveyor.

3) The periodical inspection is to be completed within the effective period of the approval certificate. However, for unavoidable circumstances, the periodical inspection may be completed within a period of three months after the expiration date upon the approval by BKI.

4.4 Test records

After completion of the test in periodical inspection the manufacturer is to prepare test records and submit them in electronic format to BKI upon receiving confirmation by the attending Surveyor.

4.5 Withdrawal of approval

In case where periodical survey specified in 4.1 to 4.4 above has not been carried out, BKI may withdraw the approval.

5. Change in the approval content

5.1 Application for change

Application for change is to be treated in accordance with Rules for Welding (Pt.1, Vol.VI) Sec. 5.

5.2 Content of the tests

5.2.1 Type tests and confirmation tests are to, in principle, be conducted at the manufacturing plant in the presence of the Surveyor.

5.2.2 The additional type tests under the provision of 5.2.1 afore-mentioned, are to be done in accordance with the following:

1) Change of grade

The additional tests are to be done in accordance with the requirements Rules for Welding (Pt.1, Vol.VI) Sec. 5.

2) Addition of welding position

Tests, of which test assemblies are specified to be prepared for additional welding positions in the provisions of Rules for Welding (Pt.1, Vol.VI) Sec. 5.B.

3) Enlargement of maximum diameter of electrode or wire

Tests required are to be carried out at the largest diameter of electrode or wire in accordance with the requirements in Rules for Welding (Pt.1, Vol.VI) Sec. 5.B.

4) Addition of shield gas

Additional tests are to be done in accordance with the requirements of Rules for Welding (Pt.1, Vol.VI) Sec. 5.C.

5) Others

As deemed necessary, the tests required by BKI basing on the nature and extent of the change, are to be done.

5.2.3 When confirmation test is required under the provision of 5.2.2, the details of the confirmation test is to be informed by BKI taking consideration of the nature and extent of the changes.

5.3 Submission of test record and certificate of approval

5.3.1 Type test record and confirmation test record are to be submitted in accordance with A.4.5 and A.9.2 respectively.

5.3.2 In case when items described in the certificate of approval is changed, the manufacturer is to return the certificate to BKI.

6. Packing and marking

The manufacturers are to be specially noted the following points on the packing and marking of the approved welding materials.

6.1 The approved welding materials are to be packed thoroughly to keep the quality during their transportation and storage.

6.2 All boxes or packages of the approved welding materials are to be clearly marked with the following descriptions together with the mark of approval by BKI.

- Brand
- Name of manufacturer
- Grade or mark of welding materials
- Kind of gas, if used
- Electric current and its polarity
- Welding position
- Date and number of production
- Size (diameter of core wire, length of electrode, grain size of flux for automatic submerged arc welding, etc.)

C. Anti-Corrosive and Non-Slip Paints

I. Anti-Corrosive Paints

1. Application

The requirements in this sub section apply to tests and inspections for the type approval of primer coating or marine heavy-duty coating upon request.

2. Documents to be submitted

The following reference documents are to be submitted to BKI in addition to those specified in A.2.

1) In-house inspection department, claim handling organization and inspection facilities.
2) Reference materials and data relating to the manufacturing process and quality control system: Blending details of key components (including the content of aluminium), matters relating to mixing and storage procedures.
3) Matters relating to packaging, packing and shipment.
4) Instructions for the application of the paint for which brand approval is made:

   Surface preparation, required thickness of coat, painting procedure, and matters relating to drying process and multiple coatings.
5) In-house test results and real ship service experience of the paint brand for which approval is made. Approval certificates issued by other authorities, if any.
6) Matters relating to falling ball impact test and explosion test.

3. Type tests

3.1 Test coupons

3.1.1 Number of test coupons

Three each test coupons for each test item specified in Table 3.1 are to be prepared.

3.1.2 Shape of test coupon

1) Test coupon for physical properties test to conform to the requirements specified in Table 3.1.
2) Test coupon for corrosion resistance test standard shape of the test coupon is to be as shown in Fig 3.1. On one face of the test coupon, the paint of the brand under approval application, and on the other side there of, the paint of ordinary brand (one each oil paint, vinyl and others) for comparative assessment are to be coated. Three test coupons coated on both side with the paint of brand under approval application and each one of test coupon coated with ordinary paint may be accepted as a alternative means. The final coat may be the paint of the brand under approval application or the comparative paint.
3) Prior to the test the test specimen is to be stamped with BKI's stamp.

3.1.3 Surface treatment, primer paint and coating

The surface treatment and painting are to be carried out in accordance with the instruction submitted under the provisions 2.4). The film thickness of paint is to be of the minimum recommended by the manufacturer.

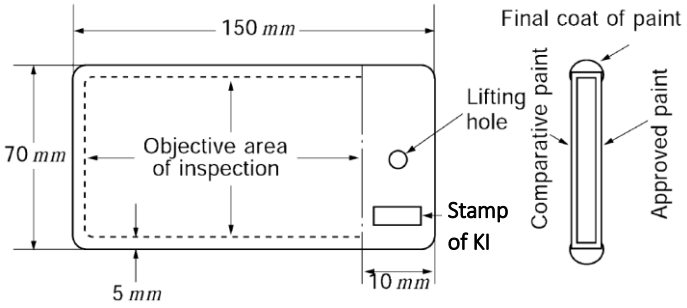


Fig 3.1 Test Coupon for Corrosion Resistance Test

3.2 Test details and acceptance criteria

3.2.1 Approval test for the paint of the brand under approval application are to be carried out in the presence of the Surveyor at the manufacturing plant and approval test items are to be as given in Table 3.1

3.2.2 The testing procedures and acceptance criteria are to be as given in Table 3.1. However, in case where these requirements are found impracticable due to special type of paints, separate considerations may be given.

3.2.3 In case when materials other than salt water, crude oil and gasoline are scheduled to load in the tank applied CoC, corrosion resistance test for the materials is to be carried out. The test method considered appropriate by BKI is to be applied.

3.2.4 Gasoline immersion test, salt water/gasoline immersion test and salt water / crude oil immersion test may not be required for the paint used for sea water ballast tanks.

3.2.5 During execution of the corrosion resistance tests, the Surveyor may attend and make investigation necessary for verification.

4. Manufacturer approval

The manufacturer is to be subjected to Manufacturer approval in accordance with Section 6.

Table 3.1 Test details and acceptance criteria of anti-corrosive paints

Kind	Test item	Testing procedures	Acceptance criteria
Physical properties test	Cross-cut adhesion test (ISO 2409)	The test coupon is to be of a mild steel plate of a suitable size for testing. With a sharp knife point the paint coat on the test coupon is to be pierced right down to the steel surface in both the horizontal and vertical directions at 25 places at 2 mm pitch. Stick adhesive tape on the squared-off area encompassed by the 5th vertical and the horizontal line and pull off the tape quickly to judge with the unaided eyes how much of the coat is left on the test coupon.	For a successful test, small peelings are occurred on squared off area and the peeling off area of three test coupons are to be within 5~15% of total test area.
	Erichsen test (ISO 20482)	A mild steel test coupon of approximately 100 mm x 90 mm x 0,8 mm coated on a single side is to be subjected to the Erichsen test with a punch diameter of 20 mm, pushing speed 0,1 mm/sec, and pushing distance 6 mm.	For a successful peeling off area of at least two out of test coupons are to be within 1,0 cm^2.

Table 3.1 Test details and acceptance criteria of anti-corrosive paints *(continued)*

Kind	Test item	Testing procedures	Acceptance criteria
Physical properties test	Falling ball impact test	A mild steel test coupon of approximately 200 mm x 100 mm x 4 mm coated on one side is to be fixed on a steel base with the painted surface facing upwards and subjected to falling ball impact test with a weight of 300 grams dropped thrice from a height of 24 m. Thereafter the condition of the paint surface is to be checked after leaving the test coupon at room temperature for a period of one hour.	If cracks and peelings occur in two out of three test coupons and more, the test is not to be approved.
	Flex cracking Test	A 150 mm × 50 mm × 0,3 mm tinned plate is to be painted on one side and flexed through 180° at room temperature keeping the coated side as the outer side (flexing diameter 10 mm, flexing time approximately 1 second).	If cracks and peelings occur in two out of three test coupons and more, the test is not to be approved.
Corrosion resistance test	Salt water immersion test	The test coupon is to be immersed in a 5 % salt water kept at a temperature of 50 ± 5°C over a period of 3000 hours (except for CoC: 360 hours) or more. At such times as before immersion, 1000 th hour from the initiation of immersion (taking photographs only), and on completion of immersion, the film thickness of paint is to be measured and colour photographs are to be taken at each such time.	The acceptance criteria for the corrosion resistance tests are to be as given in Table 3.2.
Corrosion resistance test	Gasoline immersion test	The test coupon is to be immersed in gasoline for 3000 hours (except for CoC: 360 hours) under room temperature. At such time as before immersion, 1,000th hour from the initiation of immersion (taking photographs only), and on completion of immersion, the film thickness of paint is to be measured and colour photographs are to be taken at each such time.	The acceptance criteria for the corrosion resistance tests are to be as given in Table 3.2
Corrosion Resistance test	Hot water immersion test	Fill a container with tap water and heat it to a temperature 80 ± 5°C and keep the test coupon immersed in it continuously for 1000 hours (except for CoC : 168 hours) and then take it out and examine the condition of the paint. If there is no abnormality, the test coupon is to be examined after being left for 2 hours. The film thicknesses of paint before and after immersion are to be measured with colour photographs taken.	The acceptance criteria for the corrosion resistance tests are to be as given in Table 3.2
	Alternate salt Water immersion test	After immersing in a 3% salt water solution under room temperature for a period of 168 hours (7 days), the test coupon is to be taken out and left in air for 168 hours. Taking this as one cycle, the test coupon is to be subjected to 10 (except for CoC: 2) such cycles consecutively. The paint film thickness is to be measured and colour photographs of the test coupon are to be taken on completion of the 5th cycle and before immersion of the next attempt.	
	Alternate gasoline/salt water immersion test	Two tanks respectively filled with 3% salt water solution and gasoline are to be prepared and the test coupon is to be immersed in either of them for a period of 168 hours (7 days) and then taken out and immersed in the other tank for another 168 hours. Considering this as one cycle, the process is to be repeated for 10 cycles (except for CoC: 2 cycles). Colour photographs and paint film thickness measurements before immersion, on the 5th cycle, and on completion of the test are to be taken.	The acceptance criteria for the corrosion resistance tests are to be as given in Table 3.2

Table 3.1 Test details and acceptance criteria of anti-corrosive paints *(continued)*

Kind	Test item	Testing procedures	Acceptance criteria
Corrosion Resistance test	Alternate salt water /crude oil immersion test	Tests similar to (c) above are to be carried out with 3% salt water solution and crude oil. Colour photographs and paint film thickness measurements before immersion, on the 5th cycle (only photograph is to be taken), and on completion of the test are to be taken.	The acceptance criteria for the corrosion resistance tests are to be as given in Table 3.2.
	Salt water spray test (ISO 9227)	Continuous test with salt water spray is to be carried out for a period of 3000 hours (except for CoC: 360 hours) or more. Colour photographs and paint film thickness measurements before immersion, on the 1,000th hour, and on completion of the test are to be taken.	
Real ship tests		(A) The paints, which have passed the paint film performance tests successfully, are to be subjected to real ship tests. For the real ship and specific painting areas, the manufacturer may give instructions after obtaining approval of BKI. The painting procedures and surface treatment are to be as instructed by the document under the provision C.I.2.4), and after application of the paints, visual inspection of paint coat, taking color photographs are to be carried out in the presence of the Surveyor. In ships having a post-painting period of two years, visual inspection, and taking of colour photographs are to be carried out at time of drydocking in the presence of the Surveyor. (B) If the paint has been applied to a ship which has already been put into service 2 years or more, this paint may be regarded as test sample in (A). (C) The primer coating does not require real ship tests.	Standard blistered or peeled off area of the paint coat is to be 1% or less of the total painted area.

Table 3.2 Acceptance Criteria

Class of defects	Size of crack or blister (mm)	Coefficient of defect	No. of defects × coefficient of defect Total number of defects of three test coupons
A (fine)	1 or below	3	10 or below
B (small)	1~2	5	
C (medium)	2~3	7	
D (large)	4 or more	10	

II. Non-slip Paints

1. Application

The requirements in this sub section apply to tests and inspections for the type approval of non-slip paints.

2. Documents to be submitted

The reference documents in addition to those specified in A.2. are to be submitted to BKI in accordance with C.I.2. The tests are to be made by using specimens of the final product.

3. Type tests

3.1 Test coupons

Three each test coupons for each test item specified in Table 3.3 are to be prepared.

3.2 Test details and acceptance criteria

Sampling of the precise amounts and test as follows should be done for each type of manufacture in the presence of Surveyor. Also, other tests may be added at the discretion of BKI.

3.2.1 Physical properties test

Tests are to comply with the requirements given in Table 3.3.

Table 3.3 Test details and acceptance criteria of Physical properties test

Test item	Testing procedures	Acceptance criteria
Cross-cut adhesion test	To be in compliance with Table 3.1. However, remove sand additives and paint with the thickness on the maker's advice.	To be in compliance with Table 3.1.
Erichsen test	To be in compliance with Table 3.1.	Acceptance criteria is the reference.
Falling ball impact test	To be in compliance with Table 3.1 However, thickness of sample to be 6 mm and weight to be 1 kg.	To be in compliance with Table 3.1.
Flex cracking test	To be in compliance with Table 3.1.	Acceptance criteria is the reference.
Abrasion test	To be in compliance with ASTM D 4060 [1]. However, 3 samples are to be taken for an average.	Within 40% abrasion

Notes:

[1] To be based on resilient calibrase wheels No. CS-17, 1000 cycles, 1 kg load given in ASTM D 4060. But the others for consideration of paints to be determined on a case-by-case basis upon mutual consultation by the manufacturer and BKI.

3.2.2 Friction test

1) 3 (three) samples are to be prepared from worn part of the abrasion test finished samples. Friction test procedure is in accordance with Test Method B (Horizontal Pull test) of ASTM D 4518. The rubber plate has Shore-A hardness 60~70 is to be adhered to the surface of sliding steel plate. However, other test procedure may be applied at the discretion of BKI.
2) An average of 5 times on friction test is to be taken from each condition (Dried condition, Wet condition with Synthetic Sea Water according to ASTM D 1141, Oily condition with Engine Oil). Also, coefficient of friction is given by the following formula.

$$\text{Coefficient of friction} = \frac{\text{Load when sliding steel plate start to move}}{\text{Weight of sliding steel plate}}$$

3) Average coefficient friction value of 3 samples is not to be less than those obtained by the following formula. Also, each coefficient friction value is not to be less than 0,7.

Section	Dry Condition	Wet Condition	Oily Condition
Acceptance Criteria	0,9	0,85	0,75

3.2.3 Corrosion resistance test

Saline water spray test and gasoline deposition test are carried out for corrosion resistance test. Also, test procedure and acceptance criteria are to comply with C.I.3.2. However, the test time is to be 360 hours.

3.2.4 Non-flammability test

The procedure and acceptance criteria of the non-flammability test are to comply with Y.4. 3

D. Acid Resisting Paints

1. Application

The requirements in this Sub-section apply to tests and inspections for the type approval of acid resisting paints in accordance with the requirements in Rules for Electrical Installations (Pt.1, Vol.IV).

2. Documents to be submitted

The following reference data are to be submitted to the BKI in addition to those specified in A.2.

- Mixture ratio of main compositions for each symbol of products.
- Data for mixture and storage
- Instruction for painting (surface treatment, recommended dry film, thickness application method, drying and over coating method, etc.)
- Marking
- In-house test results (approval certificates issued by other authorities, if any)

3. Type tests

Approval tests are to comply with the requirements given in Table 3.4.

Table 3.4 Test details and acceptance criteria of acid resisting paints

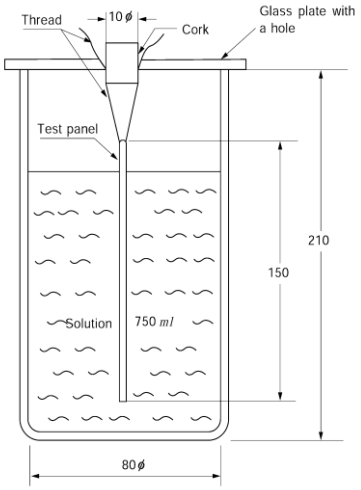
Kind	Testing procedures
Test specimen	The glass panel (150 mm×70 mm×2 mm) which is coated on both side is to be used as test specimen, unless otherwise specially specified. Four pieces of test panels are to be made according to coating method and drying condition designated by the manufacturer. The edges of three test specimens are to be duplicated with paraffin or wax, etc. at least 5 mm in width and one test panel is to be used for comparison. (refer to Fig 3.1)
Test method	1) A glass bottle for one test panel is prepared as shown in Fig 3.2 and each bottle is filled with acid solutions (5 %, 7,5 %, 10 %) designated by the manufacturer up to 150 mm in depth and then maintained the temperature of solution at designated temperature. The test panel is to be hung by thread so that it may be immersed up to 120 mm as shown in Fig 3.2 and left it immersed for 480 hours. After 480 hours, the test panel is removed from the glass bottle and washed carefully with water and then drained off.  Fig 3.2 Glass Bottle for Test (unit: mm)

Table 3.4 Test details and acceptance criteria of acid resisting paints (continued)

Kind	Testing procedures
	The test panel is placed perpendicularly at room temperature for two hours and paint film is examined. In this case, edge of test panel and paint film within 10 mm in width from the immersion level are not examined. 2) The inlet of the glass bottle is to be properly faced and the hole of glass plate is plugged with a cork. The test panel is hung with two strings of thread fixed to it and penetrated through the gap between the glass plate and the cork. So, the height of the test panel is adjusted by the length of the thread fixed to it.
Acceptance criteria	Two test panels and over are to be examined with the test panel for comparison. In this case, paint film is to be free from cracks, blistering, peeling, pin holding, softening and elusion. There is to be no great change in color and gloss.

4. Manufacturer approval

The manufacturer is to be subjected to Manufacturer approval in accordance with Section 6.

E. Loading Computer

1. Application

1.1 The requirements of this sub section apply to tests and inspection for type approval of loading computer fitted on board (hardware) for the calculation of stability in accordance with the requirements of Rules for Hull (Pt.1, Vol.II) Sec. 1, E and for the calculation of longitudinal strength in accordance with the requirements of Rules for Hull (Pt.1, Vol.II) Sec. 5, A and for type approval of container lashing calculation computer in accordance with the requirements of Rules for Stowage and Lashing of Containers (Pt.4, Vol.I).

1.2 Related to 1.1 above, the design approval of BKI for the software (program) used in the loading computer and on board stability computers refer to requirements specified in Section 4.B and in container lashing calculation program refer to requirements specified in Section 4.C of this Guidance.

1.3 The requirements of this sub section apply to the computer used on land to assist several ships.

2. Data to be submitted

The environmental test procedures are to be submitted to BKI in addition to those specified in A.2.

3. Requirements

3.1 Construction

The loading computer is to have sufficient endurance and no difficulty for operating under the following conditions, except where fitted in a special place. Also, humidity is to be considered especially, and a self-monitoring function is recommended to be computerized to prevent fallacy or error caused by failure in the circuit, etc.

1) Ambient temperature: 0°C to 45°C
2) Vibration:
   - Amplitude ±1,0 mm at 2^{+3}_{0} Hz to 13,2 Hz
   - Acceleration ±0,7 G at 13,2 Hz to 100 Hz
   - The vibration during operation is to range from 2 Hz to 100 Hz with an acceleration of ± 0,05
3) Inclination:
   - Longitudinal inclination 10°
   - Transverse inclination 22,5°
4) Power supply variation:

   A) A.C. power supply

	Permanent value	Transient value
Voltage (rated)	± 10%	± 20%, 1,5 sec
Frequency (rated)	± 5%	± 10%, 5 sec

   B) D.C. power supply

   +30 % to -25 % for rated voltage for equipment connected to the battery during charging
   +20 % to -25 % for rated voltage for equipment not connected to the battery during charging

3.2 The loading computer is to have proper input/output function including printer. When the printer is provided separately, the type test for the printer is not required.

4. Test and inspection

4.1 Environmental test

Environmental tests of loading computer are followed by test item 1 through 9 of Table 3.34. However, the tests for loading computer to be used on land are not required as a rules.

F. High Holding Power Anchors and Super High Holding Power Anchors

1. Application

1.1 The requirements in this Sub-section apply to tests and inspection for the approval of high holding power anchors and very high holding power anchors in accordance with requirements in Rules for Materials (Pt.1, Vol.V) Sec. 12.

1.2 The manufacturer who supplies the raw materials of anchors which is subjected to the requirements in this Sub-section is to obtain approval of manufacturing process of raw materials in accordance with the requirements in each Section of Rules for Materials (Pt.1, Vol.V).

1.3 The manufacturer who makes cast anchors in accordance with the requirement of this Sub-section may be considered to comply with the requirements of manufacturing process in Rules for Materials (Pt.1, Vol.V) Sec.1.A.

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

- Kind and type of the anchor
- Maximum mass of the anchor
- Test data of sea bed holding power and information concerning the anchor
- Working standards for welding or casting and heat treatments
- Non-destructive testing standards

3. Type tests

3.1 Type test and acceptance criteria

3.1.1 The type test is to be carried out on an anchor with the mass closest to the maximum applied mass on the test item specified in Table 3.5 in the presence of the Surveyor. However, in case where these requirements are found impracticable due to special type of anchors, separate considerations may be given.

3.1.2 The testing procedures and acceptance criteria are to be as given in Table 3.5. However, in case where these requirements are found impracticable, separate considerations may be given.

Table 3.5 Type test and acceptance criteria of anchor

Test item	Test method	Acceptance criteria
Material test	1) To be in compliance with Rules for Materials (Pt. 1, Vol.V). Cast anchor is to be subjected to the impact test according to the requirements in Rules for Materials (Pt.1, Vol.V) Sec. 12. 2) Test specimens of cast anchor are to, in principle, be taken from the body and the test blocks attached thereto.	To meet the Rule requirements
Proof test	To be in compliance with Rules for Materials (Pt.1, Vol.V) Sec. 12.	
Visual inspection	To be in compliance with Rules for Materials (Pt.1, Vol.V) Sec. 12.	
Non-destructive test	To be carried out the extended non-destructive examination in accordance with Rules for Materials (Pt.1, Vol.V) Sec. 12.	

Table 3.5 Type test and acceptance criteria of anchor *(continued)*

Test item	Test method	Acceptance criteria
Holding power test	1) Holding power test is to include the holding power measuring test and embed test and is to be carried out on anchors of different mass for respective modes of test in accordance with the requirements specified in Table 3.6. Where sufficient data are submitted, and if BKI considers appropriate, all or part of the holding power measuring test may be omitted. 2) The holding power measuring test is to be carried out in three types of the soil shown Table 3.6 where the anchor is to be dragged at a fixed speed (as slow as practicable). The sea bed for testing is to be of virgin bed for each attempt of testing. 3) Tests are normally to be carried out from a tug but alternatively shore based tests may be accepted.	To be as deemed appropriate by BKI

Table 3.6 Items of Holding Power Test and Numbers of Attempts [1]

Type of anchor		Holding power measuring test Soil of sea bed [3]
Two pieces of test anchors	A[2]	3
	a[2]	3
Two pieces of anchors for comparison [4]	B[2]	1
	b[2]	1

Notes:

(1) The number of test attempts given in this Table may be increased/decreased as considered appropriate by BKI.

(2) Anchors "A" and "B" are to have nearly compatible masses, and the mass of anchor "a" and "b" are to, in principle, have a mass equivalent to 1/10 (1/5 for the very high holding power anchor) of that of anchor "A" and " B" or more.

Anchor "A" and "B" are to, in principle, have a mass a equivalent to 1/10 (1/5 for the very high holding power anchor) of the maximum mass to be approved or more

(3) The tests are to be carried out using three kinds of soils, i.e, sand, mud, clay, etc

3.2 Test records

After completion of the type test, the manufacturer is to prepare records of the type test as follows, and is to submit in electronic format to BKI upon receiving confirmation by the Surveyor.

- Test records and work records of the manufacturing process on the test anchor (steelmaking process, casting process, heat treatments, etc.)
- Testing procedure and test arrangement (explanatory drawings on the testing procedure and test arrangement are to be attached thereto)
- The results of holding power measuring test (in addition to the results of holding power measuring test (Hp/W = Holding Power/Mass), holding power characteristics curves are to be attached thereto.)
- Properties of the soil of the sea bed (hardness, composition) and flatness of the sea bed.
- The dragging speed of the anchor in the holding power measuring test.

G. Emergency Towing Arrangements and Equipment for Mooring at SPM

I. Emergency Towing Arrangements

1. Application

1.1 The requirements in this sub section apply to tests and inspections for the type approval of emergency towing arrangements (hereinafter called ETA) for ships in accordance with requirements in Rules for Hull (Pt.1, Vol II) Sec.24 F. The type approval of emergency towing arrangements is made for a whole arrangement consisting of the components given in the Table 3.7.

Table 3.7 Major Components of the ETA

Components	Forward ETA	Aft ETA
Pick-up gear	(Optional)	Yes
Towing pennant	(Optional)	Yes
Chafing gear	Yes	(Depending on design)
Fairlead	Yes	Yes
Strong point	Yes	Yes
Pedestal roller	Yes	(Depending on design)

1.2 The type approval of emergency towing arrangements is made for each of forward ETA and aft ETA.

1.3 The applicant of the type approval is not necessarily to be a manufacturer of the components, but to be those responsible for quality of the products.

1.4 The manufacturer who makes major components of the ETA shall obtain the Approval of Manufacturing Process of raw materials in accordance with the requirements in the Rules for Approval Manufacturers and Service Suppliers (Pt.1, Vol.XI).

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

- Outline of manufacturing process of each major component
- General arrangement of ETA and detailed assembly drawing of each component (materials of all components to be specified)
- Operation manual of ETA (including each case of operation by ship's main power and emergency power)
- Introduction of applicant and manufacturers of components
- Kind, mechanical properties and chemical composition of major materials for each component
- Method of heat treatment (if any required by the applied standard)
- Method of non-destructive test and list of qualified persons and qualification grade
- Data of quality control system of each component

3. Type tests

3.1 Test methods and acceptance criteria

3.1.1 Approval tests of ETA are to be carried out in the presence of the Surveyor at the manufacturing plant and approval test items are to be as given in Table 3.8.

3.1.2 The testing procedures and acceptance criteria are to be as given in Table 3.8. However, in case where these requirements are found impracticable, decisions are left to the discretion of BKI.

Table 3.8 Type test and acceptance criteria of Emergency Towing Arrangements (ETA)

Test item	Test method	Acceptance criteria
Strength test	A) Strength components of ETA, i.e., towing pennant, chafing gear, fairlead and strongpoint, etc., are to be assembled and fitted on the test unit according to the manufacturer's drawings. Tensile loads are to be applied and kept for at least 1 minute to the towing pennant or chafing gear with the tensile force directions and test loads as given in the following (a) and (b). a) Tensile force directions i) 90 °C from the ship's centerline to port and starboard, and 30 °C vertical downwards ii) 0 °C sideway from the ship's centerline, and 30 °C vertical downwards b) Test loads i) 2000 kN for 1000 kN type ETA ii) 4000 kN for 2000 kN type ETA B) Towing pennant, chafing gear, fairlead and strongpoint to be used for the strength test in (A) above, are to be of the products as follows: a) Towing pennant, chafing chain and their connecting parts. They are to be made by a manufacturer with the manufacturing process approved by BKI in principle, and to be accepted to the production test by BKI. b) Fairlead and strongpoint They are to comply with the requirements in the Rules for Materials (Pt.1, Vol.V) and the Rules for Welding (Pt.1, Vol.VI) and to be wholly examined by ultrasonic test in principle, but, if impracticable, may be examined by effective non-destructive test such as magnetic particle test. C) For other major components of strength member than those in (B) above, BKI may require certain tests or inspections prior to the strength test, if deemed necessary.	Each component of the ETA is to neither be broken nor destroyed.
Deployment test	A deployment test as given in the following (A) and (B) is to be carried out during night time condition using prototypes fitted on a ship according to the manufacturer's drawings. In this test, only emergency power is to be used. A) The aft ETA is to be deployed in accordance with the operation manual prepared by the manufacturer, and the following (a) and (b) are to be verified. a) It is to be capable of being deployed within 15 minutes in harbour conditions. Time duration of deployment operation is counted from the time when a lid of the pick-up gear container is opened, to the time when inboard termination of the towing pennant or chafing gear touches to the strongpoint without any trouble. b) The pick-up gear is to be designed for manual operation by one person taking into account the absence of power.	ETA is to be deployed in accordance with the operation manual prepared by the manufacture

Table 3.8 Type test and acceptance criteria of Emergency Towing Arrangements (ETA) (continued)

Test item	Test method	Acceptance criteria
	B) The forward ETA is to be deployed within 1 hour in harbour conditions in accordance with the operation manual prepared by the manufacturer. Ten persons in max are to be employed in the deployment work on board the ship during the test.	
Strength test for wire rope terminations of towing pennant	Wire rope terminations of towing pennant such as splicing, socket, etc., are to be prototype tested for 3 pieces of test specimens in accordance with the manufacturer's specifications, by the test load specified in (A) of strength test above for at least 1 minute.	In case where even 1 piece of the test specimen could not withstand the test load, the proposed termination is not to be accepted.
Others	To be as deemed appropriate by BKI	To be as deemed appropriate by BKI

II. Equipment for Mooring at SPM

1. Application

1.1 The requirements in this sub section apply to tests and inspections for the type approval of the equipment for mooring at SPM in accordance with the requirements of the Rules for Single Point Mooring (Pt.5, Vol.IX).

1.2 The applicant of the type approval is not necessarily to be a manufacturer of the components, but to be those responsible for quality of the products.

1.3 The manufacturer who makes major components of the equipment for mooring at SPM shall obtain the Approval of Manufacturing Process of raw materials in accordance with the requirements in Section 2.

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

- Outline of manufacturing process of each major component
- General arrangement of the equipment for mooring at SPM and detailed assembly drawing of each component (materials of all components to be specified)
- Strength calculation sheets with 2 times the required safety factor
- Operation manual of the equipment for mooring at SPM
- Introduction of applicant and manufacturers of components
- Kind, mechanical properties and chemical composition of major materials for each component
- Method of heat treatment (if any required by the applied standard)
- Method of non-destructive test and list of qualified persons and qualification grade
- Data of quality control system of each component

3. Type tests

3.1 Test methods and acceptance criteria

3.1.1 Components of equipment for mooring at SPM are to be assembled and fitted on the test unit according to the manufacturer's drawings. Tensile loads are to be applied with the proof test loads equivalent to the safe working load specified in Table 3.9 and following tensile test direction, and kept for at least 1 minute. Upon completion of type test, components of equipment for mooring at SPM are to have no permanent deformation.

1) 90 degrees from the ship's centerline to port and starboard, and 30 degrees vertical downwards
2) 0 degrees sideway from the ship's centerline, and 30 degrees vertical downwards

Table 3.9 Safety working load

Deadweight (ton)	Safe working load (SWL) (ton)
DWT ≤ 100 000	200
100 000 < DWT ≤ 150 000	250
150 000 < DWT	350

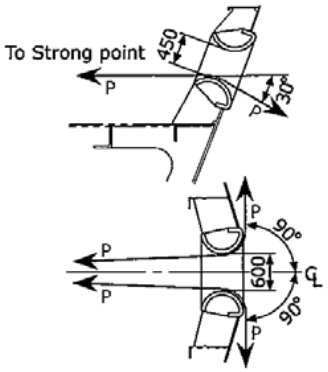


Fig 3.3 Tensile force directions

3.1.2 Chain stoppers and fairleads are to be wholly examined by ultrasonic test in principle, but, if impracticable, may be examined by effective non-destructive test such as magnetic particle test.

H. Diesel Engines

1. Application

1.1 The requirements in this sub section apply to tests and inspection for the approval of new type diesel engines or no service records to BKI on the basis of the requirements in the Rules for Machinery Installations (Pt.1, Vol.III) Sec.2.

1.2 The definition of low, medium and high speed engine in this section, is to be according to Rules for Machinery Installations (Pt.1, Vol.III) Sec.2, B.3.2.

1.3 An approval for a particular type of engine of which tests and inspection carried out at any place at any manufacture will be accepted for all engines of the same type including different number of cylinders built by licensees and licensors.

1.4 The requirements in this Sub Section apply, in general, to each engine type of which either of the following is different to that of an approved engine type.

1) Bore
2) Stroke
3) Method of injection (direct or indirect injection)
4) Valve and injection operation (by cams or electronically controlled)
5) Kind of fuel (liquid, dual-fuel, gaseous)
6) Working cycle (2-stroke, 4-stroke)
7) Turbo-charging system (pulsating or constant pressure)
8) Charging air cooling system (with or without intercooler, number of stages)
9) Cylinder arrangement (in-line or V-type)

   One type test will be considered adequate to cover a range of different numbers of cylinders.

   However, a type test of an in-line engine may not always cover the V-type. As required by BKI, separate type tests may be required for the V-type. On the other hand, a type test of a V-type engine covers the in-line engines, unless the bmep is higher. Items such as axial crankshaft vibration, torsional vibration in camshaft drives, and crankshafts, etc. may vary considerably with the number of cylinders and may influence the choice of engine to be selected for type testing.

10) Cylinder power, speed and cylinder pressures

   A. The engine is generally type approved up to the tested ratings and pressures (100% corresponding to MCR).

   B. Provided documentary evidence of successful service experience with the classified rating of 100% is submitted, an increase may be permitted without a new type test if the increase from the type tested engine is within the following range. In this case, if crankshaft calculation and crankshaft drawings are modified, the drawing approval is to be required.

      a. 5 % of the maximum combustion pressure, or
      b. 5 % of the mean effective pressure, or
      c. 5 % of the rpm

   C. Providing maximum power is not increased by more than 10%, an increase of maximum approved power may be permitted without a new type test provided engineering analysis and evidence of successful service experience in similar field applications (even if the application is not classified) or documentation of internal testing are submitted if the increase from the type tested engine is within the following range.

      a. 10 % of the maximum combustion pressure, or

b. 10 % of the mean effective pressure, or

c. 10 % of the rpm

D. De-rated engine

If an engine has been drawing approved, and internal testing per Stage A is documented to a rating higher than the one type tested, the Type Approval may be extended to the increased power, mean effective pressure (mep), rpm upon submission of an extended delivery test report as belows.

a. Test at over speed (only if nominal speed has increased)

b. Rated power, i.e. 100 % output at 100 % torque and 100 % speed corresponding to load point 1 in Fig 3.4, 2 measurements with one running hour in between

c. Maximum permissible torque (normally 110 %) at 100 % speed corresponding to load point 3 in Fig 3.4, or maximum permissible power (normally 110 %) and speed according to nominal propeller curve corresponding to load point 3a in Fig 3.4, ½ hour

d. 100 % power at maximum permissible speed corresponding to load point 2 in Fig 3.4, ½ hour

1.5 Where the manufacturer applies to the approval by manufacturer's rating not the maximum continuous output of engine, BKI correspondingly apply to the requirements in this sub section.

1.6 An integration test demonstrating that the response of the complete mechanical, hydraulic and electronic system is as predicted maybe carried out for acceptance of sub-systems (Turbo Charger, Engine Control System, Dual Fuel, Exhaust Gas treatment…) separately approved. The scope of these tests shall be proposed by the designer/licensor taking into account of impact on engine

2. Data to be submitted

In addition to those specified in A.2., the documents are to be submitted according to the Rules for Machinery Installations (Pt.1, Vol.III) Sec.2 B.

3. Type tests

3.1 Objectives

The type testing is to be arranged to represent typical foreseen service load profiles, as specified by the engine builder, as well as to cover for required margins due to fatigue scatter and reasonably foreseen in-service deterioration as followings.

1) Parts subjected to high cycle fatigue (HCF) such as connecting rods, cams, rollers and spring tuned dampers where higher stresses may be provided by means of elevated injection pressure, cylinder maximum pressure, etc

2) Parts subjected to low cycle fatigue (LCF) such as “hot” parts when load profiles such as idle - full load - idle (with steep ramps) are frequently used.

3) Operation of the engine at limits as defined by its specified alarm system, such as running at maximum permissible power with the lowest permissible oil pressure and/or highest permissible oil inlet temperature.

3.2 Safety precautions

1) Before any test run is carried out, all relevant equipment for the safety of attending personnel is to be made available by the manufacturer/shipyard and is to be operational, and its correct functioning is to be verified.

2) This applies especially to crankcase explosive conditions protection, but also overspeed protection and any other shut down function.

3) The inspection for jacketing of high-pressure fuel oil lines and proper screening of pipe connections (as required in Table 3.10, Stage B.9)) is also to be carried out before the test runs.

4) Interlock test of turning gear is to be performed when installed

3.3 Test Stages

The type tests are subdivided into three stages below.

1) Stage A (Internal tests)

Functional tests and collection of operating values including test hours during the internal tests, the relevant results (including photographs which show the conditions of each component after the internal tests) of which are to be presented to BKI before stage B

2) Stage B (Type tests)

Operation test in the presence of the Surveyor.

3) Stage C (Component inspection)

Component inspections by the Surveyor after completion of the test programme. The engine manufacturer will have to compile all results and measurements for the engine tested during the approval tests in a report, which will have to be submitted to BKI.

3.4 The complete type testing program is subject to approval by BKI. The extent the Surveyor's attendance is to be agreed in each case, but at least during stage B and C. Testing prior to the witnessed type testing (stage B and C), is also considered as a part of the complete type testing program.

3.5 Upon completion of complete type testing (stage A through C), a type test report is to be sub mitted to BKI for review. The type test report is to contain the followings:

1) Overall description of tests performed during stage A. Records are to be kept by the builders QA management for presentation to BKI.

2) Detailed description of the load and functional tests conducted during stage B.

3) Inspection results from stage C.

3.6 The type testing is to substantiate the capability of the design and its suitability for the intended operation. Special testing such as LCF and endurance testing will normally be conducted during stage A. High speed engines for marine use are normally to be subjected to an endurance test of 100 hours at full load. Omission or simplification of the type test may be considered for the type approval of engines with long service experience from non-marine fields or for the extension of type approval of engines of a well-known type, in excess of the limits given in 1.4.

Propulsion engines for high speed vessels that may be used for frequent load changes from idle to full are normally to be tested with at least 500 cycles (idle - full load - idle) using the steepest load ramp that the control system (or operation manual if not automatically controlled) permits. The duration at each end is to be sufficient for reaching stable temperatures of the hot parts.

3.7 Measurements and recordings

1) During all testing the ambient conditions (air temperature, air pressure and humidity) are to be recorded.

2) As a minimum, the following engine data are to be measured and recorded.

– Engine rpm and torque

- Maximum combustion pressure and Mean indicated pressure for each cylinder – For engines where the standard production cylinder heads are not designed for such measurements, a special cylinder head made for this purpose may be used. In such a case, the measurements may be carried out as part of Stage A and are to be properly documented. Where deemed necessary e.g. for dual fuel engines, the measurement of maximum combustion pressure and mean indicated pressure may be carried out by indirect means, provided the reliability of the method is documented.
- Charging air pressure and temperature
- Exhaust gas temperature
- Fuel rack position or similar parameter related to engine load
- Turbocharger speed
- All engine parameters that are required for control and monitoring for the intended use (propulsion, auxiliary, emergency)

Calibration records for the instrumentation used to collect data as listed above are to be presented and reviewed by the attending Surveyor. Additional measurements may be required in connection with the design assessment.

3.8 Details of tests

Test items on stage A, B and C are to be as given in Table 3.10**.** However, during the stage B, deviations from the items, if any, are to be agreed with BKI.

Table 3.10 Details of test in stage A, B and C

Test stage	Details of test
Stage A (internal test)	1) During the internal tests, the engine is to be operated at the load points important for the engine designer and the pertaining operating values are to be recorded. The load conditions to be tested are also to include the testing specified in the applicable type approval programme. 2) At least the following conditions are to be tested: – Normal Case: – The load points 25%, 50%, 75%, 100% and 110% of the maximum rated power for continuous operation, to be made along the normal (theoretical) propeller curve and at constant speed for propulsion engines (if applicable mode of operation i.e. driving controllable pitch propellers), and at constant speed for engines intended for generator sets including a test at no load and rated speed. – The limit points of the permissible operating range. These limit points are to be defined by the engine manufacturer. – For high speed engines, the 100 hr full load test and the low cycle fatigue test apply as required in connection with the design assessment. – Specific tests of parts of the engine, required by BKI or stipulated by the designer.

Table 3.10 Details of test in stage A, B and C *(continued)*

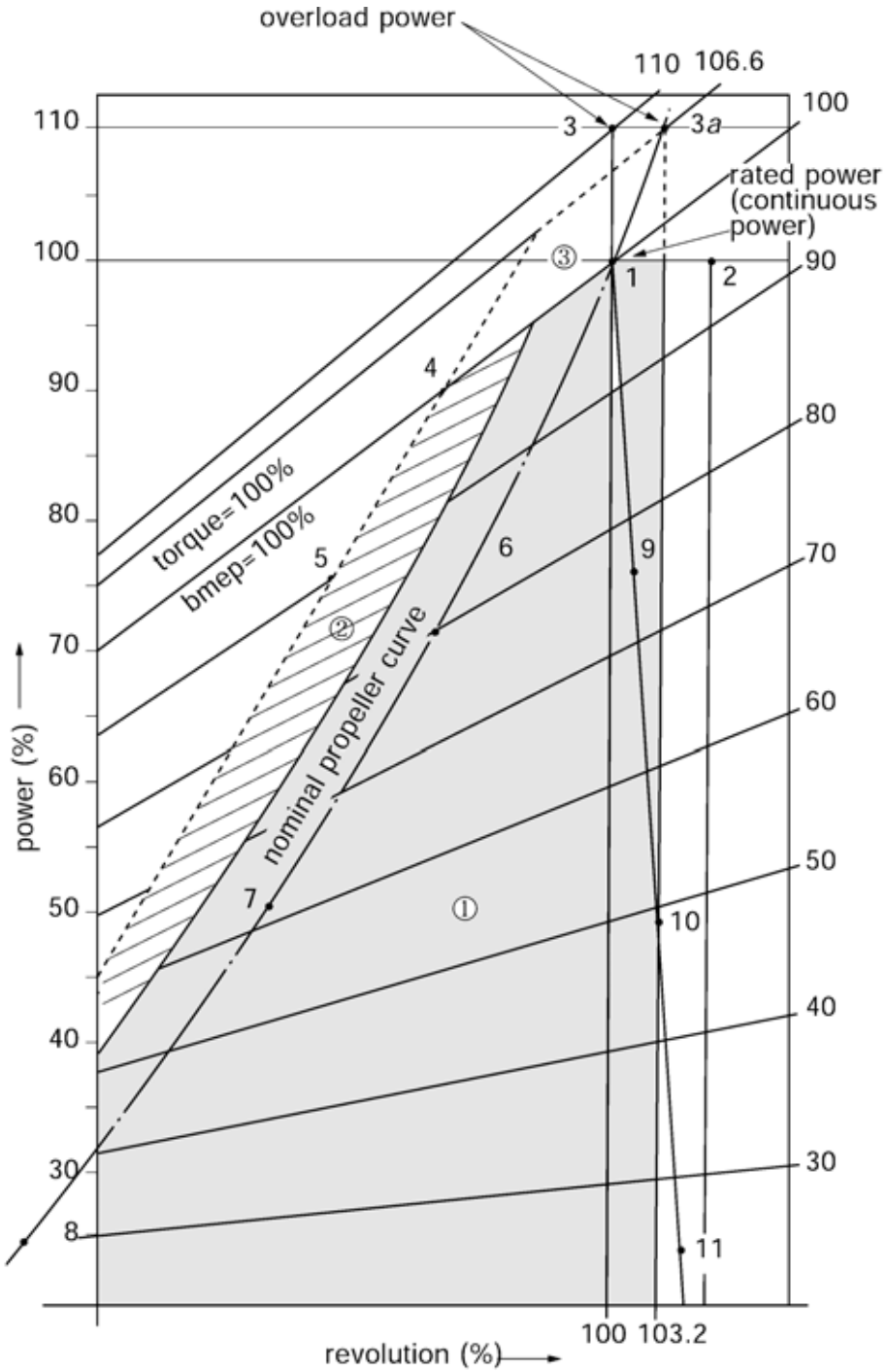
Test stage	Details of test
Stage B (witnessed test)	1) The tests listed below are to be carried out in the presence of a Surveyor. The achieved results are to be recorded and signed by the attending Surveyor after the type test is completed. 2) The over-speed test is to be carried out and is to demonstrate that the engine is not damaged by an actual engine overspeed within the overspeed shutdown system set-point. This test may be carried out at the manufacturer's choice either with or without load during the speed overshoot 3) Load points The engine is to be operated according to the power and speed diagram (see Fig. 3.4). The data to be measured and recorded when testing the engine at the various load points have to include all engine parameters listed in 3.7. The operating time per load point depends on the engine size (achievement of steady state condition) and on the time for collection of the operating values. Normally, an operating time of 0,5 hour can be assumed per load point, however sufficient time should be allowed for visual inspection by the Surveyor. The load points are: – Rated power (MCR), i.e. 100% output at 100% torque and 100% speed corresponding to load point 1, normally for 2 hours with data collection with an interval of 1 hour. If operation of the engine at limits as defined by its specified alarm system (e.g. at alarm levels of lub oil pressure and inlet temperature) is required, the test should be made here. – 100% power at maximum permissible speed corresponding to load point 2. – Maximum permissible torque (at least and normally 110%) at 100% speed corresponding to load at point 3, or maximum permissible power (at least and normally 110%) and 103,2% speed according to the nominal propeller curve corresponding to load point 3a. Load point 3a applies to engines only driving fixed pitch propellers or water jets. Load point 3 applies to all other purposes. – Load point 3 (or 3a as applicable) is to be replaced with a load that corresponds to the specified overload and duration approved for intermittent use. This applies where such overload rating exceeds 110% of MCR. Where the approved intermittent overload rating is less than 110% of MCR, subject overload rating has to replace the load point at 100% of MCR. In such case the load point at 110% of MCR remains. – Minimum permissible speed at 100% torque, corresponding to load point 4. – Minimum permissible speed at 90% torque corresponding to load point 5. (Applicable to propulsion engines only). – Part loads e.g. 75%, 50% and 25% of rated power and speed according to nominal propeller curve (i.e. 90,8%, 79,3% and 62,9% speed) corresponding to points 6, 7 and 8 or at constant rated speed setting corresponding to points 9, 10 and 11, depending on the intended application of the engine. – Crosshead engines not restricted for use with C.P. propellers are to be tested with no load at the associated maximum permissible engine speed.

Table 3.10 Details of test in stage A, B and C *(continued)*

Test stage	Details of test
Stage B (witnessed test)	4) During all these load points, engine parameters are to be within the specified and approved values. 5) Operation with damaged turbocharger – For 2-stroke propulsion engines, the achievable continuous output is to be determined in the case of turbocharger damage. – Engines intended for single propulsion with a fixed pitch propeller are to be able to run continuously at a speed (r.p.m.) of 40% of full speed along the theoretical propeller curve turbocharger is when one out of operation. (The test can be performed by either by-passing the turbocharger, fixing the turbocharger rotor shaft or removing the rotor) 6) Functional tests – Verification of the lowest specified propulsion engine speed according to the nominal propeller curve as specified by the engine designer (even though it works on a water-brake). During this operation, no alarm shall occur. – Starting tests, for non-reversible engines and/or starting and reversing tests, for reversible engines, for the purpose of determining the minimum air pressure and the consumption for a start. – Governor tests: tests for compliance with Rules for Machinery Installations (Pt.1, Vol.III) Sec.2.F. 7) Integration test For electronically controlled diesel engines, integration tests are to verify that the response of the complete mechanical, hydraulic and electronic system is as predicted for all intended operational modes. The scope of these tests is to be agreed with the Society for selected cases based on the FMEA required in Rules for Machinery Installations (Pt.1, Vol.III) Sec.2.B 8) Fire protection measures Verification of compliance with requirements for jacketing of high-pressure fuel oil lines, screening of pipe connections in piping containing flammable liquids and insulation of hot surfaces: – The engine is to be inspected for jacketing of high-pressure fuel oil lines, including the system for the detection of leakage, and proper screening of pipe connections in piping containing flammable liquids. Proper insulation of hot surfaces is to be verified while running the engine at 100% load, alternatively at the overload approved for intermittent use. Readings of surface temperatures are to be done by use of Infrared Thermoscanning Equipment. Equivalent measurement equipment may be used when so approved by the Society. Readings obtained are to be randomly verified by use of contact thermometers.

Table 3.10 Details of test in stage A, B and C *(continued)*

Test stage	Details of test
Stage C (Opening up for Inspections)	1) The crankshaft deflections are to be measured in the specified (by designer) condition (except for engines where no specification exists). 2) High speed engines for marine use are normally to be stripped down for a complete inspection after the type test. 3) For all the other engines, after the test run the components of one cylinder for in-line engines and two cylinders for V-engines are to be presented for inspection as follows engines with long service experience from non-marine fields can have a reduced extent of opening): – piston removed and dismantled – crosshead bearing dismantled – guide planes – connecting rod bearings (big and small end) dismantled (special attention to serrations and fretting on contact surfaces with the bearing backsides) – main bearing dismantled – cylinder liner in the installed condition – cylinder head, valves disassembled – cam drive gear or chain, camshaft and crankcase with opened covers. (The engine must be turn able by turning gear for this inspection.) 4) For V-engines, the cylinder units are to be selected from both cylinder banks necessary and different crank throws. 5) If deemed by the surveyor, further dismantling of the engine may be required



① range of continuous operation

② range of intermitted operation

③ range of short-time overload operation

Fig 3.4 Power/Revolution Diagram

I. Crankcase Explosion Relief valves

1. Application

The requirements in this Sub section apply to tests and inspections for the type approval of crankcase explosion relief valves intended to be fitted to engines and gear cases in accordance with the requirements of Rules for Machinery Installations (Pt.1, Vol.III) Sec. 2. F.3.1. This test procedure is only applicable to explosion relief valves fitted with flame arresters.

2. Document to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

- Accreditation certificate of test house
- Details of test vessel and attachment
- Test data performed previously at the manufacturer's works

3. Type tests

3.1 Test houses

The test houses where testing is carried out are to be accredited to a recognized standard, e.g. ISO/IEC 17025:2017, and the test facilities are to be equipped so that they can perform and record explosion testing in accordance with the requirements in this Sub section

3.2 Valves to be tested

3.2.1 The valves used for type test shall be selected from the manufacturer's normal production line by the Surveyor witnessing the tests and three valves for each size shall be selected. However, in case where the valves produced in series comply with the requirements specified in 3.4., type test may be exempted.

3.2.2 The valves selected for type testing are to have been previously tested at the manufacturer's works to demonstrate that the opening pressure is in accordance with the specification within a tolerance of ±20% and that the valve is air tight at a pressure below the opening pressure for at least 30 seconds.

3.2.3 In case where the orientation of installation could be changed, the valves are to be tested for each intended installation orientation.

3.3 Approval tests are to comply with the requirements given in Table 3.11.

Table 3.11 Type test and acceptance criteria of Crankcase Explosion Relief valve

Kinds	Requirements
Explosion test process	1) All explosion tests to verify the functionality of crankcase explosion relief valves are to be carried out using an air and methane mixture with a methane concentration of 9,5 % ±0,5%. The pressure in the test vessel is to be not less than atmospheric and not exceed 0,2 bar. 2) The concentration of methane in the test vessel is to be measured in the top and bottom of the vessel and is not to differ by more than 0,5%. 3 The ignition of the methane and air mixture is to be made at the centreline of the test vessel at a position approximately one third of the height or length of the test vessel opposite to where the valve is mounted. 4) The ignition is to be made using a maximum 100 joule explosive charge.

Table 3.11 Type test and acceptance criteria of Crankcase Explosion Relief valve *(continued)*

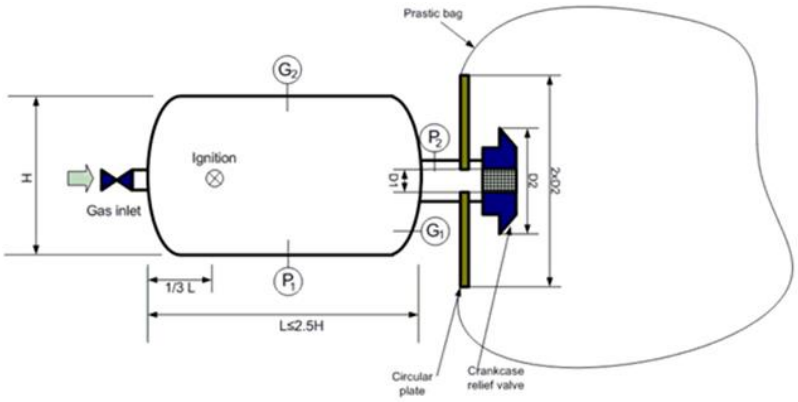
Kinds	Requirements
Test vessel for explosion testing	1) The test vessel for explosion testing is to have documented dimensions. The dimensions are to be such that the vessel is not "pipe like" with the distance between dished ends being not more than 2,5 times its diameter. The internal volume of the test vessel is to include any standpipe arrangements. 2) The pressure measuring equipment is to be capable of measuring the pressure in the test vessel in at least two positions, one at the valve(P2 in Fig. 3.5) and the other at the test vessel centre (P1 in Fig. 3.5). The measuring arrangements are to be capable of measuring and recording the pressure changes throughout an explosion test at a frequency recognising the speed of events during an explosion. The result of each test is to be documented by video recording and if necessary by recording with a heat sensitive camera. 3) The test vessel is to be provided with a flange, located centrally at one end perpendicular to the vessel longitudinal axis, for mounting the explosion relief valve. The test vessel is to be arranged in an orientation consistent with how the valve will be installed in service, i.e., in the vertical plane or the horizontal plane. 4) A circular plate is to be provided for fitting between the pressure vessel flange and valve to be tested with the following dimensions: A) Outside diameter of 2 times the outer diameter (D2 in Fig. 3.5) of the valve top cover. B) Internal bore having the same internal diameter (D1 in Fig. 3.5) as the valve to be tested. 5) The test vessel is to have connections for measuring the methane in air mixture at the top (G2 in Fig. 3.5) and bottom (G1 in Fig. 3.5). 6) The test vessel is to be provided with a means of fitting an ignition source at a position approximately one third of the height or length of the test vessel opposite to where the valve is mounted. I 7) The test vessel volume is to be as far as practicable, related to the size and capability of the relief valve to be tested. In general, the volume is to correspond to the requirement for the free area of explosion relief valve to be not less than 115 cm^2/m^3 of crankcase gross volume. This means that the testing of a valve having 1150 cm^2 of free area, would require a test vessel with a volume of 10 m^3. Where the free area of relief valves is greater than 115 cm^2/m^3 of the crankcase gross volume, the volume of the test vessel is to be consistent with the design ratio. In no case is the volume of the test vessel to vary by more than +15% to -15% from the design cm^2/m^3 volume ratio. 8) The test facilities are to have equipment for controlling and measuring a methane gas in air concentration within a test vessel to an accuracy of ± 0,1%.  Fig 3.5 test vessel for explosion testing

Table 3.11 Type test and acceptance criteria of Crankcase Explosion Relief valve *(continued)*

Kinds		Requirements
Explosion testing	General	1) Where valves are to be installed on an engine or gear case with shielding arrangements to deflect the emission of explosion combustion products, the valves are to be tested with the shielding arrangements fitted. 2) Successive explosion testing to establish a valve's functionality is to be carried out as quickly as possible during stable weather conditions. 3) The pressure rise and decay during all explosion testing is to be recorded. 4) The external condition of the valves is to be monitored during each test for indication of any flame release by video and heat sensitive camera. 5) For obtaining the type approval, the explosion testing for each valves shall be done for three stages respectively.
	Stage 1	Two explosion tests are to be carried out with the flange opening fitted with the circular plate covered by a 0,05 mm thick polythene film. These tests establish a reference pressure level for determination of the effects of a relief valve in terms of pressure rise in the test vessel
	Stage 2	1) Two explosion tests are to be carried out on three different valves of the same size. Each valve is to be mounted in the orientation that it requires approval for installation i.e., in the vertical or horizontal position with the circular plate located between the valve and pressure vessel mounting flange. 2) The first of the two tests on each valve is to be carried out with a 0,05 mm thick polythene bag, having a minimum diameter of three times the diameter of the circular plate and volume not less than 30% of the test vessel, enclosing the valve and circular plate. Before carrying out the explosion test the polythene bag is to be empty of air. The polythene bag is required to provide a readily visible means of assessing whether there is flame transmission through the relief valve following an explosion. (During the test, the explosion pressure will open the valve and some unburned methane/air mixture will be collected in the polythene bag. When the flame reaches the flame arrester and if there is flame transmission through the flame arrester, the methane/air mixture in the bag will be ignited and this will be visible.) 3) Provided that the first explosion test successfully demonstrated that there was no indication of combustion outside the flame arrester and there are no visible signs of damage to the flame arrester or valve, a second explosion test without the polythene bag arrangement is to be carried out as quickly as possible after the first test. During the second explosion test, the valve is to be visually monitored for any indication of combustion outside the flame arrester and video records are to be kept for subsequent analysis. The second test is required to demonstrate that the valve can still function in the event of a secondary crankcase explosion. 4) After each explosion, the test vessel is to be maintained in the closed condition for at least 10 seconds to enable the tightness of the valve to be ascertained. The tightness of the valve can be verified during the test from the pressure/time records or by a separate test after completing the second explosion test.
	Stage 3	Carry out two further explosion tests as described in Stage 1. These further tests are required to provide an average base line value for assessment of pressure rise recognising that the test vessel ambient conditions may have changed during the testing of the explosion relief valves in Stage 2.
Assessment and Records		1) The valves to be tested are to have evidence of design appraisal/approval by BKI 2) The designation, dimensions and characteristics of the valves to be tested are to be recorded. This is to include the free area of the valve and of the flame arrester and the amount of valve lift at 0,2 bar. 3) The test vessel volume is to be determined and recorded. 4) For acceptance of the functioning of the flame arrester there is not to be any indication of flame or combustion outside the valve during an explosion test. This should be confirmed by the test laboratory taking into account measurements from the heat sensitive camera.

Table 3.11 Type test and acceptance criteria of Crankcase Explosion Relief valve *(continued)*

Kinds	Requirements
Assessment and Records	5) The pressure rise and decay during an explosion is to be recorded, with indication of the pressure variation showing the maximum overpressure and steady under pressure in the test vessel during testing. The pressure variation is to be recorded at two points in the pressure vessel. 6) The effect of an explosion relief valve in terms of pressure rise following an explosion is ascertained from maximum pressures recorded at the centre of the test vessel during the three stages. The pressure rise within the test vessel due to the installation of a relief valve is the difference between average pressure of the four explosions from Stages 1 and 3 and the average of the first tests on the three valves in Stage 2. The pressure rise is not to exceed the limit specified by the manufacturer. 7) The valve tightness is to be ascertained by verifying from the records at the time of testing that an under pressure of at least 0,3 bar is held by the test vessel for at least 10 seconds following an explosion. This test is to verify that the valve has effectively closed and is reasonably gas-tight following dynamic operation during an explosion. 8) After each explosion test in Stage 2, the external condition of the flame arrester is to be examined for signs of serious damage and/or deformation that may affect the operation of the valve. 9) After completing the explosion tests, the valves are to be dismantled and the condition of all components ascertained and documented. In particular, any indication of valve sticking or uneven opening that may affect operation of the valve is to be noted. Photographic record of the valve condition are to be taken and included in the report.

3.4 Design series qualification

3.4.1 The qualification of quenching devices to prevent the passage of flame can be evaluated for other similar devices of identical type where one device has been tested and found satisfactory.

3.4.2 The quenching ability of a flame arrester depends on the total mass of quenching lamellas/mesh. Provided the materials, thickness of materials, depth of lamellas/thickness of mesh layer and the quenching gaps are the same, then the same quenching ability can be qualified for different sizes of flame arresters subject to (a) and (b) being satisfied. However, valves which could not be subjected to this method shall be verified by the method as deemed appropriate by BKI.

(a) $$\frac{n_1}{n_2} = \sqrt{\frac{S_1}{S_2}}$$

(b) $$\frac{A_1}{A_2} = \frac{S_1}{S_2}$$

Where:

n_1 = total depth of flame arrester corresponding to the number of lamellas of size 1 quenching device for a valve with a relief area equal to S_1

n_2 = total depth of flame arrester corresponding to the number of lamellas of size 2 quenching devices for a valve with a relief area equal to S_2

A_1 = free area of quenching device for a valve with a relief area equal to S_1

A_2 = free area of quenching device for a valve with a relief area equal to S_2

3.4.3 The qualification of explosion relief valves of larger sizes than that which has been previously satisfactorily tested in accordance with this Sub section can be evaluated where valves are of identical type and have identical features of construction subject to the following:

1) The free area of a larger valve does not exceed three times + 5% that of the valve that has been satisfactorily tested.
2) One valve of the largest size, subject to 1), requiring qualification is subject to satisfactory testing required by 3.2.2 and stage 2 explosion testing specified in Table 3.11 except that a single valve will be accepted in item 1) of stage 2 explosion testing and the volume of the test vessel is not to be less than one third of the volume required in item 7) of test vessel specified in Table 3.11.
3) The assessment and records are to be in accordance with the requirements specified in Table 3.11 noting that item 6) will only be applicable to Stage 2 for a single valve.

3.4.4 The qualification of explosion relief valves of smaller sizes than that which has been previously satisfactorily tested in accordance with this Sub sections can be evaluated where valves are of identical type and have identical features of construction subject to the following:

1) The free area of a smaller valve is not less than one third of the valve that has been satisfactorily tested.
2) One valve of the smallest size, subject to 1), requiring qualification is subject to satisfactory testing required by 3.2.2 and stage 2 explosion testing specified in Table 3.11 except that a single valve will be accepted in item 1) of stage 2 explosion testing and the volume of the test vessel is not to be more than the volume required in item 7) of test vessel specified in Table 3.11.
3) The assessment and records are to be in accordance with the requirements specified in Table 3.11 nothing that item 6) will only be applicable to Stage 2 for a single valve.

3.4.5 Valves passed the type tests specified in this Sub section and valves having sizes between valves qualified according to the requirements in 3.4.3 and 3.4.4 may be qualified without type tests provided that calculation result of 3.4.2 is satisfactory.

3.5 Test report

The test facility is to deliver a full report that includes the following information and documents:

- Test specification.
- Details of test pressure vessel and valves tested.
- The orientation in which the valve was tested, (vertical or horizontal position).
- Methane in air concentration for each test.
- Ignition source
- Pressure curves for each test.
- Video recordings of each valve test.
- The assessment and records stated in Table 3.11

J. Crankcase Oil Mist Detection Arrangements

1. Application

The requirements in this sub section apply to tests and inspections for the type approval of crankcase oil mist detection arrangements in accordance with the requirements of the Rules for Machinery Installations (Pt.1, Vol.III) Sec. 2.F.3.3.

2. Data to be submitted

Drawings, detailed manufacturing data and test records are to be submitted to BKI in addition to those specified in A.2.

3. Design requirements

Oil mist detection arrangements are to be designed and fitted in accordance with the following requirements.

3.1 The oil mist detection arrangements are to be installed in accordance with the engine designer's and oil mist manufacturer's instructions and recommendations. Items and contents to be included in the instructions and recommendations are to comply with the requirements in the Rules for Machinery Installations (Pt.1, Vol.III) Sec. 2.F.4.3.

3.2 Alarms and shutdowns for the oil mist detection arrangements and the system arrangements are to be in accordance with the requirements in the Rules for Automations (Pt.1, Vol.VII) Sec. 2.C.

3.3 Where sequential oil mist detection arrangements are provided the sampling frequency and time is to be as short as reasonably practicable.

3.4 The oil mist detection arrangements are to provide an indication that any lenses fitted in the equipment and used in determination of the oil mist level have been partially obscured to a degree that will affect the reliability of the information and alarm indication.

3.5 The oil mist detection arrangements are to provide a alarm indication in the event of a foreseeable functional failure in the equipment and installation arrangements.

3.6 Where oil mist detection equipment includes the use of programmable electronic systems, the arrangements are to be in accordance with the requirements in the Rules for Automations (Pt.1, Vol.VII) Sec. 2.C.

3.7 Oil mist detection arrangements are to be capable of being tested on the test bed and onboard under engine at standstill and engine running at normal operating conditions.

4. Type tests

4.1 Approval tests are to comply with the requirements given in Table 3.12.

4.2 Panel of the oil mist detection arrangement is to be type tested in accordance with Table 3.34 of Sub-section V of the Guidance except that the test items are to be the functional tests, electrical power supply failure test, power supply variation test, dry heat test, damp heat test, vibration test, EMC test, insulation resistance test, high voltage test and static and dynamic inclinations, if moving parts are contained.

4.3 Detectors are to be type tested in accordance with Table 3.34 of Sub-section V. of the Guidance except that the test items are to be the functional tests, electrical power supply failure test, power supply

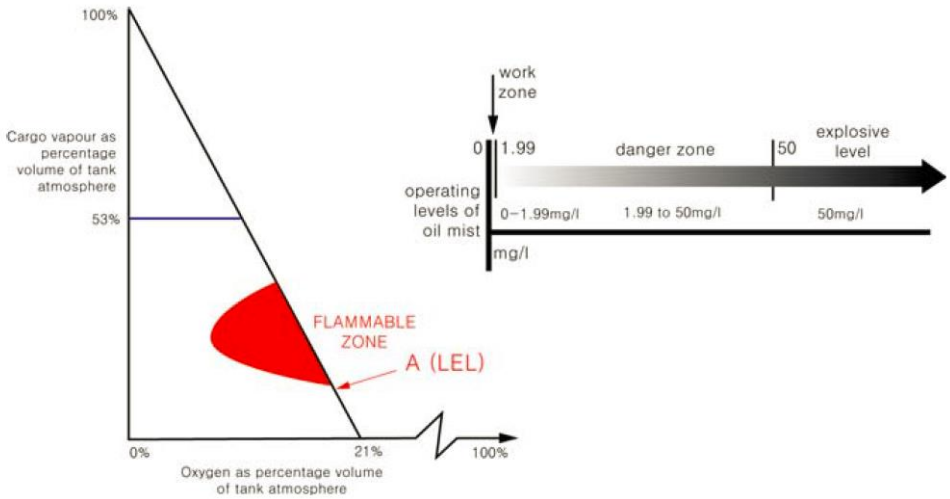
variation test, dry heat test, damp heat test, vibration test, insulation resistance test, high voltage test and static and dynamic inclinations, if moving parts are contained.

4.4 Test report

The test house is to provide a full report that includes the following information and documents:

- Test specification.
- Details of devices tested.
- Results of tests.

Table 3.12 Type tests of crankcase oil mist detection/monitoring and alarm equipment and systems

Kinds	Requirements
Testing methods	1) The concentration of oil mist in the test vessel is to be measured in the top and bottom of the vessel and is not to differ by more than 10 %. 1) The oil mist detection arrangements are to be capable of detecting oil mist in air concentrations of between 0 and 10 % of the lower explosive limit (LEL). (The LEL corresponds to an oil mist concentration of approximately 50 mg/l (13 % oil-air mixture). Refer to Fig 3.6)  Fig 3.6 Explosion curve of oil-air mixture and operating levels of oil mist 2) The operation of the alarm indicators for oil mist concentration in air are to be verified and are to provide an alarm at a maximum setting corresponding to 5 % of the LEL corresponding to approximately 2,5 mg/l. 3) Two sets of oil mist detection arrangements are to be tested. One set is to be tested in the clean condition and the other in a condition that represents the maximum degree of lens obscuration that is stated as being acceptable by the manufacturer.
Assessment	After completing the tests, the satisfactory operation of oil mist detection arrangements and the condition of all components should be ascertained.

K. Exhaust Gas Turbochargers

1. Application

Where the manufacturer obtained the Approval of Quality Assurance System specified in Section 5 of the Guidance apply to the Type Approval of exhaust gas turbochargers (hereinafter referred to as the turbochargers in this Section) manufactured at the same manufacturing plant by mass production methods, in principle, BKI apply to the requirements of this sub section for the tests and inspection of turbochargers. See also Rules for Machinery Installations (Pt.1, Vol.III) Sec.3 III.

2. Data to be submitted

In addition to those specified in A.2, the documents are to be submitted according to Rules for Machinery Installations (Pt.1, Vol.III) Sec.3.III.A.2.1.

3. Type tests

3.1 Applicable to Categories B and C.

3.2 The type test for a generic range of turbochargers may be carried out either on an engine (for which the turbocharger is foreseen) or in a test rig.

3.3 Turbochargers are to be subjected to at least 500 load cycles at the limits of op-eration. This test may be waived if the turbocharger together with the engine is subjected to this kind of low cycle testing, see Rules for Machinery Installations (Pt.1, Vol.III) Sec.3.

3.4 The suitability of the turbocharger for such kind of operation is to be preliminarily stated by the manufacturer.

3.5 The rotor vibration characteristics shall be measured and recorded in order to identify possible sub-synchronous vibrations and resonances.

3.6 The type test shall be completed by a hot running test at maximum permissible speed combined with maximum permissible temperature for at least one hour. After this test, the turbocharger shall be opened for examination, with focus on possible rubbing and the bearing conditions.

3.7 The extent of the surveyor's presence during the various parts of the type tests is left to the discretion of BKI.

L. Hydraulic Motors and Hydraulic Pumps

1. Application

1.1 Where the manufacturer obtained the Approval of Alternative Certification Scheme specified in Section 5 of the Guidance apply to the Type Approval of individual units of hydraulic pumps and hydraulic motors intended to be used for steering gear, windlass, cargo winch and other deck machinery, opening/closing appliance of watertight door, side thruster and other auxiliaries for essential use, manufactured at the same manufacturing plant by mass production methods, in principle, BKI apply to the requirements of this sub section for the tests and inspection of them.

1.2 Hydraulic motors and hydraulic pumps in this sub section mean those in the types of gear, screw, vane and piston.

2. Type tests

2.1 The type tests are to be carried out on the hydraulic motors and hydraulic pumps random selected one for each type from the production line.

2.2 The items of the type tests are to be, in principle, as follows:

1) Construction instruction
2) Pressure test
3) Operational performance test
   A) Performance test
   B) Continuous running test
   C) Vibration test
   D) Temperature rise test
   E) Relief valve test
4) Overhaul inspection of major components after operational performance tests
   A) Gear type and screw type
      – Casing, cover, gear, screw, shaft, bearing and relief valve
   B) Vane type
      – Casing, cover, vane, rotor, bush, cam ring, driving shaft and relief valve
   C) Axial piston type
      – Driving shaft, bearing piston, rod, cylinder block, valve plate, cam plate, pump casing, bearing casing, cover, flexible shaft coupling, controller and servo system
   D) Radial piston type
      – Driving shaft, crankshaft, bearing, piston, rod, side guide, cam curve, pump casting, slide block, cylinder casting, cover, relief valve and servo system
5) Other test required by BKI.

2.3 Representative type of hydraulic pumps and hydraulic motors intended to be used for steering gear is to be performed continuous running test for 100 hours. Testing methods are to comply with the requirements, each type of pumps used as a power unit is to be subjected to a running test for a duration of not less than 100 hours. The test arrangements are to be such that the pump may run in idle condition, and at maximum delivery capacity at maximum working pressure. The passage from one condition to another is to occur at least as quickly as on board. During the test, idling periods are to be alternated with periods at maximum delivery capacity at maximum working pressure. During the whole test no abnormal

heating, excessive vibration or other irregularities are permitted. After the test, the pump is to be disassembled to ascertain that there is no abnormality. The test may be waived for power unit which has been proved to be reliable in marine service.

3. Tests of individual Hydraulic Motors and Hydraulic Pumps after approval

Construction instruction, pressure test and performance test of safety devices during operation are to be carried out. In case where noise and/ or vibration which is required to be ascertained is occurred, overhaul inspection may be requested by BKI.

M. Air Compressors

1. Application

1.1 Where the manufacturer obtained the Approval of Alternative Certification Scheme specified in Section 5 of the Guidance apply to the Type Approval of air compressors manufactured at the same manufacturing plant by mass production methods, in principle, BKI apply to the requirements of this Sub-section for the tests and inspection of air compressors.

1.2 The air compressors to which the requirements of this Sub section apply are those used for the starting of diesel engines, controls of machinery and equipment, power sources and general service, and are of the piston type or vane type.

2. Type tests

2.1 The type tests are to be carried out on the air compressors random selected one for each type from the production line.

2.2 The items of the type test are to be, in general, as follows:

1) Construction instruction
2) Leakage test and pressure test
3) Operational performance test
   A) Continuous running test (for one hour)
   B) Performance test
   C) Operational test of safety devices
4) Overhaul inspection of major components after operational tests Cylinder head, cylinder, piston, piston pin, connecting rod, crankshaft, bearing (small end and big end bearing, main bearing), crankcase, suction valve, discharge valve, intercooler, after cooler, attached pump (lubricating oil and cooling water), outlet non-return valve and relief valve
5) Other tests required by BKI

3. Tests of individual Air Compressors after approval

Construction instruction, pressure test and performance test of safety devices during operation are to be carried out. In case where noise and/or vibration which is required to be ascertained is occurred, overhaul inspection may be requested by BKI.

N. Machinery and Equipment for Ships

1. Application

The requirements of this Sub-Section apply to tests and inspections for the approval of the machinery and equipment listed below for which approval of BKI is to be obtained in advance before being fitted in ships.

1) Flexible couplings (Rules for Machinery Installations (Pt.1, Vol.II) Sec.5.G.2)
2) Propeller shafts with corrosion resisting (Rules for Machinery Installations (Pt.1, Vol.III) Sec. 4.D.3.2)
3) Stern tube bearings (Rules for Machinery Installations (Pt.1, Vol.III) Sec.4.D.5.2)
4) Stern tube sealing devices (Rules for Machinery Installations (Pt.1, Vol.III) Sec.4.D.3.1).
5) Pipes of special materials (Rules for Machinery Installations (Pt.1, Vol.III) Sec.11.B.2.7)
6) Piping systems for ships carrying liquefied gases in bulk (Rules for Ships Carrying Liquefied Gas in Bulk (Pt.1, Vol.IX) Sec.5, 5.3)
7) Others as deemed necessary by BKI

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

1) Technical information on the machinery and equipment (work procedure manual, etc.)
2) Test records (when preliminary test is carried out)

3. Type tests

3.1. General

The tests specified in the relevant provisions of the Rules and Guidance relating to the machinery and equipment, and additionally, the detailed tests peculiar to the machinery and equipment as prescribed in 3.2 are to be carried out.

3.2. Details of Tests

In the type test program, the test items specified in Table 3.13 as applicable to the machinery and equipment concerned and additionally those deemed necessary by BKI are to be included.

Table 3.13 Type test item of machinery and equipment of ship

Kinds	Type test item
flexible couplings	In the type tests of flexible couplings, the following items (a) through (e) are to be included. For systems intended to control a deflection as well as a torsion, the tests in (a) through (e) are to be carried out under the condition of imposing the maximum allowable deflection. (a) Test to confirm the allowable mean torque (b) Test to confirm the maximum allowable transient torque (c) Test to confirm the allowable alternating torque (imposing the mean torque) (d) Test to confirm the value of torsional rigidity (e) Other tests as deemed necessary by BKI due to the own construction

Table 3.13 Type test item of machinery and equipment of ship (continued)

Kinds	Type test item
Propeller shafts liner	(A) In the type tests for propeller shafts with rubber sleeve, following items are to be included. (a) The following physical tests by the method indicated in ISO 23529. In these tests, test specimens are to be vulcanized under the condition shown in"Work Procedure Manual" for the maximum diameter of propeller shaft for which an approval will be given. (i) Tensile test (including elongation test) (ii) Hardness test (iii) Tear test (iv) Test for static modulus of elasticity (v) Aging tests relating to items (i) through (iv) (vi) Dipping test (vii) Adhesion test (bonded parts between rubber, ebonite, shaft and sleeve (b) Peeling test by the method indicated in ISO 23529. In this case, the test shaft is to be of a model shaft with the maximum diameter worked up in accordance with the "Work Procedure Manual". (c) Following items are to be included in the "Work Procedure Manual" referred to in items (a) and (b) and 2.1). (i) The shape of the copper alloy sleeve on which rubber sleeve is bound. (ii) Work details including the materials used, construction, dimensions, vulcanizing conditions (temperature, pressure and time interval) of the portion of rubber sleeve. (iii) The procedure of permanent marking on the product (serial No., date of manufacture, name of company who carried out the work, BKI`s approval No., material of the mark tag, size, etc.) (B) In the type tests of propeller shafts with synthetic resin sleeve, following items are to be included. (a) Watertightness verification test with the test shaft worked up in accordance with the "Work Procedure Manual" This test is to be carried out as the endurance test of the watertightness at the portion between synthetic resin sleeve and copper alloy sleeve under repeated twisting and bending loads. In this case, the construction drawing of the test shaft and the drawing of the test rig are to be indicated in the type test program. (b) Adhesion test correspondingly in accordance with ISO 23529 (adhesion between the bonded areas of synthetic resin, shaft and sleeve) (c) Water absorption rate test at the portion of synthetic resins is to be as deemed appropriate by BKI. (d) Falling ball impact test at the portion of synthetic resins correspondingly in accordance with ISO 6603-1. (e) Real ship tests The shafts which have passed the type tests, are to be subjected to real ship tests. In ships having a post-installing period of two years, the condition of coatings is to be confirmed in the presence of the Surveyor. (f) Following items are to be included in the “Work Procedure Manual” referred to (a) and 2.1) (i) Environmental conditions involved in the work (ii) Environment control system relating to temperature, humidity, sanitation, etc. (iii) Work procedure of the shape at the portion of the copper alloy sleeve where synthetic resin sleeve is bound (iv) Work details including the materials, construction, dimensions, etc. at the portion of synthetic resin sleeve (v) The procedure of permanent marking on the product (serial No., date of manufacture, name of company who carried out the work, BKI`s approval No., material of the mark tag, size, etc. (C) Type tests of propeller shafts liners with other materials are to be as deemed appropriate by BKI.

Table 3.13 Type test item of machinery and equipment of ship (continued)

Kinds	Type test item
Stern tube bearings	(A) Confirmation tests for the characteristics of materials (a) In the case of vulcanized rubber, the following tests specified in ISO 23529. (i) Tensile test (ii) Hardness test (iii) Tension set test (iv) Adhesion test (v) Test for adhesion to metals (except those not to be adhered to metals) (vi) Tear test (vii) Compression set test (viii) Dipping test (in the case of a water-lubricated system, tests are to be carried out using sea water) (ix) Aging test (b) In the case of materials other than those specified above in (a), tests according to pertinent national standards or other equivalent standards concerning the contents of (a) according to the materials. (B) Abrasion test (C) Seizure critical load test (D) Running test (In this case, confirm that the bearing pressures during the tests are to be verified are not less than 0,8 MPa for an oil-lubricated system, and are not less than 0,2 MPa for a water-lubricated system respectively.) (E) "Type test program" submitted according to A.2.3.1 1) is to include the following items: (a) Drawing of the test rig (b) Drawing of the product (specified the materials, dimensions, etc.) (c) Condition of tests (lubrication system, shaft speed, bearing load, hydraulic pressure, test time, etc.)
Stern tube sealing devices	(A) "Type test program" submitted according to A.2.3.1 1) is to include the following items: (a) Drawings of the test rig (b) Drawings of test product specifying the construction, materials, dimensions, etc. (c) Plans of test conditions specifying the lubrication system, shaft speed range, surface pressure of the bearing, hydraulic pressure, test hours, etc. (B) In principle, the duration of performance tests is to be not less than 1,000 hours. The temperature (keep up 55°C and less), quantity of leakage (or consumption) per hour and pressure, etc. are to be checked in accordance with 'Type test program' during the tests. Dismantle after the tests and inspect the dimensions, wear and corrosion, etc. The consumption of lubricating oil per day is to be 2 ℓ and less for the oil-lubricated system.
Pipes of Special materials	In the type tests for pipes of special materials, the following items are to be included according to their applications and kinds of materials as deemed necessary by BKI: (A) Tests specified in ISO 1436 & 3862 (Rubber hoses and hose assemblies wire-reinforced hydraulic type), etc. (B) Flame-resistant test This test applies to piping system containing fuel oil, lubricating oil, hydraulic oil and sea water where leakage or failure could result in fire or flooding in the machinery space. The testing procedures are to be as follows: The test pipe at the design pressure (in the case of less than 0,5 MPa, 0,5 MPa is to be taken) and the design temperature (the temperature at outlet, in the case of less than 80°C, 80°C is to be taken) with fluid flowing through is to be exposed to a flame on the surface and held at a temperature of 800°C for a period of 30 minutes. Following the fire test, a pressure test is to be carried out at a pressure twice the design pressure (in the case of less than 1 MPa, 1 MPa is to be taken), whereby it is to be verified that the test pipe is free from abnormality. (C) For rubber hoses used for the contact freezer, the tests specified in the following (a) and (b): (a) Pressure test at a pressure twice the design pressure or 2 MPa, whichever is the greater (b) Rupture test at a pressure of 8 MPa or more

Table 3.13 Type test item of machinery and equipment of ship (continued)

Kinds	Type test item
Cargo pipings, pumps and cargo hoses of ships carrying liquefied gases in bulk	Type tests specified in Rules for Ships Carrying Liquefied Gas in Bulk (Pt.1, Vol.IX) Sec.5. 5.13. are to be carried out in accordance with following requirements. Type tests of other systems and equipment which BKI deems necessary are to be considered by BKI in each case. (A) Valve: The following type tests are to be performed on each size and type of valve. (a) Hydrostatic test of the valve body at a pressure equal to 1,5 times the design pressure for all valves. (b) Cryogenic testing consisting of valve operation and leakage verification at design temperature, and a seat and stem leakage test at a pressure equal to 1,1 times the design pressure for valves other than safety valves. (c) Cryogenic testing consisting of safety valve set pressure and leakage verification at design temperature for safety valves. (B) Expansion bellows: The following type tests are to be performed on each type of expansion bellows. (a) A type element of the bellows, not pre-compressed, should be pressure tested at not less than 5 times the design pressure without bursting. The duration of the test should not be less than 5 min. (b) A pressure test should be performed on a type expansion joint complete with all the accessories such as flanges, stays and articulations, at twice the design pressure at the extreme displacement conditions recommended by the manufacturer without permanent deformation. Depending on the materials used, BKI may require the test to be at the minimum design temperature. (c) A cyclic test (thermal movements) should be performed on a complete expansion joint, which is to successfully withstand at least as many cycles, under the conditions of pressure, temperature, axial movement, rotational movement and transverse movement, as it will encounter in actual service. Testing at ambient temperature is permitted, when this testing is at least as severe as testing at the service temperature. (d) A cyclic fatigue test (ship deformation) should be performed on a complete expansion joint, without internal pressure, by simulating the bellows movement corresponding to a compensated pipe length, for at least 2,000,000 cycles at a frequency not higher than 5 cycles/s. This test is only required when, due to the piping arrangement, ship deformation loads are actually experienced. (e) BKI may waive performance of the tests referred to in this paragraph provided that complete documentation is supplied to establish the suitability of the expansion joints to withstand the expected working conditions. When the maximum internal pressure exceeds 1,0 MPa gauge this documentation is to include sufficient test data to justify the design method used, with particular reference to correlation between calculation and test results. (C) Cargo pumps: The following type tests are to be performed on each size and type of pumps. However, for the pump designed the same as an existing pump approved by BKI and having satisfactory in-service experience, consideration may be given to waiving the tests. (a) hydrostatic test of the pump body equal to 1,5 times the design pressure (b) the capacity tests in compliance with the following (i) For submerged pumps, the capacity test is to be carried out with the design medium or with a medium below the design temperature. (ii) For deep well pumps, the capacity test may be carried out with water. In addition, for deep well pumps, a spin test to demonstrate satisfactory operation of bearing clearances, wear rings and sealing arrangements is to be carried out at the design temperature. (c) After completion of tests, the pump is to be opened out for examination. (D) Cargo hoses: Each new type of cargo hose, complete with end-fittings, are to be type tested at a normal ambient temperature. However, for the cargo hose designed the same as an existing cargo hose approved by BKI and having satisfactory in-service experience, consideration may be given to waiving the tests. (a) cycle pressure test of 200 pressure cycles from zero to at least twice the specified maximum working pressure. (b) bursting pressure test of at least 5 times its specified maximum working pressure at the extreme service temperature.

Table 3.13 Type test item of machinery and equipment of ship (continued)

Kinds	Type test item
Gas fuel pipings and pumps for gas fueled ships	Type tests specified in The Guidance for The Use of Gas as Fuel for Ship (Pt.1, Vol.1) Sec. 16.7.1.1., Sec. 16.7.1.2. are to be carried out in accordance with the type test requirements of cargo pipings and pumps of ships carrying liquefied gases in bulk.
Fuel pipings for fuel cell systems on board of ships	Type tests specified in The Guidance for The Use of Gas as Fuel for Ship (Pt.1, Vol.1) Sec. 16.7.1.1., Sec. 16.7.1.2. are to be carried out in accordance with the type test requirements of cargo pipings and pumps of ships carrying liquefied gases in bulk.

3.3 BKI may request assurance of on-board performance of the machinery and equipment for same specific vessels as a condition of approval.

O. Plastic Piping System

1. Application

The requirements of this Sub-section apply to tests and inspection for the approval of plastic piping systems in accordance with the requirements in the Rules for Machinery Installation (Pt.1, Vol.III) Sec. 11. B.2.6.

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

2.1 General Information

1) Dimensions of plastic piping system
2) Maximum internal and external working pressure
3) Working temperature range
4) Intended services and installation locations
5) The level of fire endurance
6) Electrically conductive
7) Intended fluids
8) Limits on flow rates
9) Serviceable life
10) Installation instructions (Precautions at work site, repair procedures and criteria for determining whether repairs are necessary or not)
11) Packing, handling and marking methods
12) Storage means of products

2.2 Drawings and supporting documentation

1) Certificates and reports for relevant tests previously carried out.
2) Details of relevant standards.
3) All relevant design drawings, catalogues, data sheets, calculations and functional descriptions.
4) Fully detailed sectional assembly drawings showing pipe, fittings and pipe connections.

2.3 Materials (as applicable)

1) The resin type.
2) Catalyst and accelerator types, and concentration employed in the case of reinforced polyester resin pipes or hardeners where epoxide resins are employed.
3) A statement of all reinforcements employed where the reference number does not identify the mass per unit area or the text number of a roving used in a filament winding process, these are to be detailed.
4) Full information regarding the type of gel-coat or thermoplastic liner employed during construction, as appropriate.
5) Cure/post-cure conditions. The cure and post cure temperatures and times employ resin/ reinforcement ratio.
6) Winding angle and orientation.

7) Joint bonding procedures and qualification tests results, see Rules for Machinery Installations (Pt.1, Vol.III) Sec.11. B.2.6.8.8.5.

2.4 Physical properties

Strength of pipes against bending, twisting and strength of bonded section against abrasions by sand, sludge, etc. Data on types of joint, working procedures. In the data, those relating to bending strength and fatigue strength at standard bends and joints are to be included.

3. Type tests

The requirements in Table 3.14 are, in principle, to be considered as the criteria for the type tests of plastic piping system. For application of the tables, see below:

1) For those asterisked in the column of criteria, test results shall satisfactory to the manufacturer's reference.
2) Flame spread, fire endurance, electric conductivity and durability against chemicals test in Table 3.14 are to be carried out, where they are required in Rules for Machinery Installation (Pt.1, Vol III) Sec. 11. B.2.6.
3) For those with maximum working temperature exceeding 80 °C, boiled water absorption rate test in Table 3.14 may additionally be required.
4) Where testing method other than those given in Table 3.14 is employed, it may be judged as deemed appropriate by BKI in consideration of the equivalency.
5) Judgements for acceptance are to be made in accordance with the following procedures and criteria:
   A) Rate of water absorption is to be judged on average values of three test specimens.
   B) For flame spread, judgement is to be made on each of the three test specimens.
   C) For heat dependence of material, the acceptance criteria are to be satisfied by the mean value of the three test specimens or at least that of two test specimens.
   D) For other test items, tests are to be conducted on at least three test specimens where the test result of each test specimen is to satisfy the acceptance criterion.

Table 3.14 Testing methods and Criteria of Plastic pipes

Testing items	Testing method	Criteria
Strength against internal pressure of pipe	Short Term: *ASTM D* 1599 Long Term (>100,000 h): *ASTM D*1598, *D*2992	*
Strength against external pressure of pipe	*ASTM D* 2924	* (collapsed pressure not less than 3bar.)
Strength against impact force	*ISO* 9653, *ASTM D* 2444	* (After test, test sample should be pass the pressure test at 2,5 times of design pressure for 1 hour)
Tensile strength	*ASTM D*2105, *D*2290	*
External loading characteristics	*ASTM D*2412	*
Resistance to cyclic internal pressure (Expansion Couplings)	*ISO* 15306	*
External Pressure Resistance (Expansion Couplings)	*ASTM D* 2924	*

Table 3.14 Testing methods and Criteria of Plastic pipes *(continued)*

Testing items	Testing method	Criteria
Heat dependence of material	ISO 75-2 Method A	Minimum heat distortion temperature ≥ 80°C
Electric conductivity	ASTM D257	Surface electrical resistance not more than 0,1 MΩ/m
Flame spreads (Fire durability)	*IMO Res. A*753(18) Appendix 3	To have low surface flame spread characteristics not exceeding average values listed in the FTP code, Annex 1, Pt 5
Fire endurance	*IMO Res. A*753(18), Appendix 1, 2	L1 : Fire endurance test (IMO Res. A 753(18) Appendix 1) in dry conditions, 60 min. L2 : Fire endurance test (IM O Res. A 753(18) Appendix 1) in dry conditions, 30 min. L3 : Fire endurance test (IM O Res. A 753(18) Appendix 2) in wet conditions, 30 min.
Aging	*ISO*9142 or Manufacturer's Standards [1]	* (The characteristics of the product will not be degraded depending on the environmental conditions.)
Fatigue	*ISO*15306 or Manufacturer's Standards [1]	* (Product shall not be affected by the fatigue fracture at average service pressure)
Water absorption rate	ISO8361[1]	* (The product shall not be degraded by absorbing the intended fluids)
Erosion	Manufacturer's Standards or Service Records [1]	* (The functions of product will not be affected by erosion until 7m/s of design flow rate)
Durability against chemicals	*ASTM C*581[1]	* (The material properties will not be affected by the intended fluids)

Notes:
[1] Recognized laboratory's test reports, manufacturer's test reports or service records may be accepted instead of type test provided that BKI considers appropriate.

4. Marking

The plastic piping system approved by BKI are to be marked with the following.

1) Type of product or trade name
2) BKI stamp to prove that the product is approved by BKI.
3) Nominal pressure, [G] for those with low flame spread characteristics, [D] for those with electric conductivity, material of which pipe or fitting is made.
4) Fire endurance level for those with fire endurance

P. Flexible Hose Assembly

1. Application

1.1 The requirements of this Sub-Section apply to tests and inspection for the approval of flexible hose assembly of metallic or non-metallic hose normally with prefabricated end fittings ready for installation in accordance with the requirements in Rules for Machinery Installations (Pt.1, Vol.III) Sec. 11.U.

1.2 The requirements of this Sub-Section apply to the flexible hose assembly used in fuel, lubricating oil, hydraulic oil, bilge, ballast, fresh water cooling, sea water cooling, fire extinguishing, compressed air, auxiliary steam (pipe Class III) exhaust gas and thermal oil systems as well as in secondary piping systems in accordance with Rules for Machinery Installations (Pt.1, Vol.III) and may also apply to the flexible hose assembly intended for other uses except for high pressure fuel oil injection systems and fixed extinguishing systems.

2. Document to be submitted

The following reference documents are to be submitted to BKI in addition to those specified in A.2

- Description of design and cross-sectional drawings, manufacturer's specification mentioned national or international standard.
- Specification of the materials (inner tube, outer tube, couplings etc. mentioned national or international standard).
- Welding or brazing procedure specification (only for metallic hose assembly).
- Mounting procedure of the couplings to the hoses.
- Design pressure (or maximum working pressure).
- Temperature range.
- Type of medium to be covered.
- Special operational limitations.
- Marking of the hose assembly.
- A detailed information, in case where the flexible hose or fitted coupling is made by different manufacturers.

3. Type test

3.1 Test sample

Prototype tests are to be carried out for each size of hose assembly. However, for ranges with more than 3 different diameters, the prototype tests are to be carried out for at least:

- the smallest diameter,
- the largest diameter,
- intermediate diameters selected based on the principle that prototype tests carried out for a hose assembly with a diameter D are considered valid only for the diameters ranging between 0,5 D and 2 D.

For fire resistance tests the specimens shall be selected in accordance with ISO 15540:2016

In case where the flexible hose assemblies do not pass all or any part of the tests in the following table, two assemblies of the same size and type that failed are to be retested and if even one of the assemblies fails the second test, then that size and type of the assembly is to be considered unacceptable.

3.2 Test condition

The temperature of a test room is to be maintained at 20 ~ 30 °C and it is to be recorded in the test report. The test is to be carried out with test specimen which is left for more than 24 hours after vulcanized and subsequently in the test room maintaining the standard temperature more than one hour before test.

3.3 Test items, test method and criteria

3.3.1 Prototype test programmes for flexible hose assembles are to be submitted by the manufacturer and are to be sufficiently detailed to demonstrate performance in accordance with the specified standards.

3.3.2 For a particular hose type complete with end fittings, the tests, as applicable, are to be carried out on different nominal diameters for pressure, burst, impulse, and fire resistance in accordance with the requirements of the relevant Standard. The following Standards are to be used as applicable:

1) ISO 6802:2018 – Rubber and plastics hoses and hose assemblies with wire reinforcements – Hydraulic impulse test with flexing.
2) ISO 6803:2017 – Rubber or plastics hoses and hose assemblies – Hydraulic-pressure impulse test without flexing.
3) ISO 15540:2016 – Fire resistance of hose assemblies – Test methods.
4) ISO 15541:2016 – Fire resistance of hose assemblies – Requirements for test bench.
5) ISO 10380:2012 – Pipework – Corrugated metal hoses and hose assemblies.

Other Standards may be accepted where agreed by BKI.

3.3.3 All flexible hose assemblies are to be satisfactorily burst tested to an International Standard[1] to demonstrate they are able to withstand a pressure of not less than four times the design pressure without indication of failure or leakage.

3.3.4 In addition to the above tests, additional tests may be required if deemed necessary by BKI.

4. Markings

Type approved flexible metal hose assemblies are to be permanently marked by the manufacturer with the following details:

- Hose manufacturer's name or trademark.
- Date of manufacture (month/year).
- Designation type reference.
- Nominal diameter, Pressure rating, Temperature rating.

Where a flexible hose assembly is made up of items from different manufacturers, the components are to be clearly identified and traceable to evidence of prototype testing.

5. Product Inspection after type approval

Flexible hose assembly of metallic or non-metallic materials used for Class I and II pipe fittings is subjected to a hydrostatic test at a pressure 1,5 times of the design pressure.

[1] The International Standards, e.g., EN or SAE for burst testing of non-metallic hoses, require the pressure to be increased until burst without any holding period at 4 x Maximum Working Pressure.

Q. Mechanical Joints

1. General

The requirements of this sub section apply to tests and inspection for the approval of mechanical joints in accordance with the requirements in Rules for Machinery Installations (Pt.1, Vol.III) Sec.11, D.

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

1) Complete description of the product
2) Typical sectional drawings with all dimensions necessary for evaluation of joint design
3) Complete specification of materials used for all components of the assembly
4) Test reports (when preliminary test is carried out) or other previous relevant tests.
5) Initial information
   A) Maximum design pressures (pressure and vacuum)
   B) Maximum and minimum design temperatures
   C) Conveyed media
   D) Intended services
   E) Maximum axial, lateral and angular deviation, allowed by manufacturer
   F) Installation details

3. Type tests

The aim of tests is to demonstrate ability of the pipe joints to operate satisfactory under intended service conditions. The scope and type of tests to be conducted e.g. applicable tests, sequence of testing, and the number of specimen, is subject to approval and will depend on joint design and its intended service in accordance with the requirements in the Rules.

Unless otherwise specified, the water or oil as test fluid is to be used.

3.1 Test items

Testing requirements for mechanical joints are to be as indicated in Table 3.17.

Table 3.17 Test items for mechanical joints

Test items		Notes and references			
		Compression couplings and pipes unions	Slip-on joints		Notes and references
			Grip type & Machine grooved type	Slip type	
1	Tightness test	o	o	o	Table 3.18
2	Vibration (fatigue) test,	o	o	-	Table 3.18
3	Pressure pulsation test [1]	o	o	-	Table 3.18
4	Burst pressure test	o	o	o	Table 3.18
5	Pull-out test	o	o	-	Table 3.18

Table 3.17 Test items for mechanical joints *(continued)*

Test items		Notes and references			
		Compression couplings and pipes unions	Slip-on joints		Notes and references
			Grip type & Machine grooved type	Slip type	
6	Fire endurance test	o	o	o	Table 3.18 (If required in Rules for Machinery Installations (Pt.1, Vol.III) Sec.11. B, Table 11.1a)
7	Vacuum test	o [3]	o	o	Table 3.18 (for suction lines only)
8	Low temperature test	-	-	-	Table 3.18 (for those used at low temperature)
9	Repeated assembly test	o [2]	o	-	Table 3.18

Abbreviations : o : test is required.
- : test is not required.

Note:

1 for use in those systems where pressure pulsation other than water hammer is expected.

2 except press type and sewage type.

3 except joints with metal-to-metal tightening surfaces.

3.2 Alternative testing in accordance with national or international standards may be accepted where applicable to the intended use and application.

3.3 Unless otherwise specified, the water or oil as test fluid is to be used.

3.4 Selection of test specimen

3.4.1 Test specimens are to be selected from production line or at random from stock.

3.4.2 Where there are various sizes from type of joints requiring approval, minimum of three separate sizes representative of the range, from each type of joints are to be subject to the tests listed in Table 3.17

3.5 Mechanical joint assembly

3.5.1 Assembly of mechanical joints should consist of components selected in accordance with 3.4 and the pipe sizes appropriate to the design of the joints.

3.5.2 Where pipe material would affect the performance of mechanical joints, the selection of joints for testing is to take the pipe material into consideration.

3.5.3 Where not specified, the length of pipes to be connected by means of the joint to be tested is to be at least five times the pipe diameter.

3.5.4 Before assembling the joint, conformity of components to the design requirements is to be verified.

3.5.5 In all cases the assembly of the joint shall be carried out only according to the manufacturer instructions.

3.5.6 No adjustment operations on the joint assembly, other than that specified by the manufacturer, are permitted during the test.

3.6 Test results acceptance criteria

3.6.1 Where a mechanical joint assembly does not pass all or any part of the tests in Table 3.17, two assemblies of the same size and type that failed are to be tested.

3.6.2 In this case, only those tests which mechanical joint assembly failed in the first instance, are to be repeated. In the event where one of the assemblies fails the second test, that size and type of assembly is to be considered unacceptable.

3.6.3 The methods and results of each test are to be recorded and reproduced as and when required.

4. Methods of tests

4.1 The outlines of testing methods in Table 3.17 are as given in Table 3.18.

Table 3.18 The outlines of testing methods of mechanical joints

Test item	Kinds	Type test method
1.Tightness test	All mechanical joints	In order to ensure correct assembly and tightness of the joints, all mechanical joints are to be subjected to a tightness test, as follows. (1) Mechanical joint assembly test specimen is to be connected to the pipe or tubing in accordance with the requirements of 3.5 and the manufacturers instructions, filled with test fluid and de-aerated. Mechanical joints assemblies intended for use in rigid connections of pipe lengths, are not to be longitudinally restrained. Rigid connections are joints, connecting pipe length without free angular or axial movement. Pressure inside the joint assembly is to be slowly increased to 1,5 times of design pressure. This test pressure is to be retained for a minimum period of 5 minutes. In the event where there is a drop in pressure and there is visual indication of leakage, the test (including fire test) shall be repeated for two test pieces. If during the repeat test one test piece fails, the testing is regarded as having failed. Other alternative tightness test procedure, such as pneumatic test, may be accepted. (2) For compression couplings a static gas pressure test is to be carried out to demonstrate the integrity of the mechanical joints assembly for tightness under the influence of gaseous media. The pressure is to be raised to maximum pressure or 7 MPa which ever is less. (3) Where the tightness test is carried out using gaseous media as permitted in (1) above, then the static pressure test mentioned in (2) above need not be carried out.
2. Vibration (fatigue) test	General	(1) In order to establish the capability of the mechanical joint assembly to withstand fatigue, which is likely to occur due to vibrations under service conditions, mechanical joints assembly is to be subject to the following vibration test. (2) Conclusions of the vibration tests should show no leakage or damage, which could subsequently lead to a failure.
	Compression couplings, pipe unions	Compression couplings, pipe unions or other similar joints intended for use in rigid connections of pipe are to be tested in accordance with this method described as follows. (A) Two lengths of pipe is to be connected by means of the joint to be tested. (B) One end of the pipe is to be rigidly fixed while the other end is to be fitted to the vibration rig. (C) The test rig and the joint assembly specimen being tested is to be arranged as shown in Fig 3.7.

Table 3.18 The outlines of testing methods of mechanical joints *(continued)*

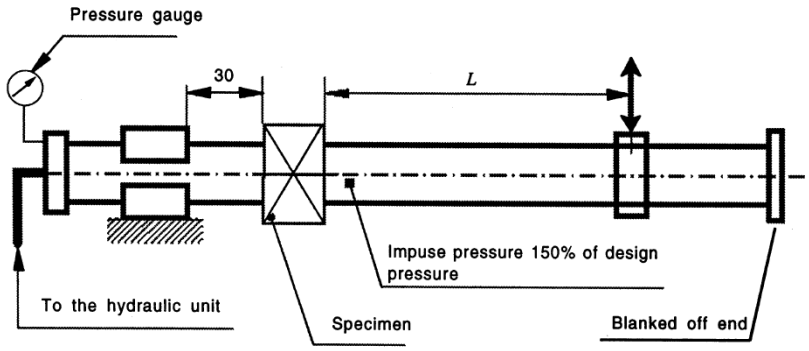
<table>
<tr><th>Test item</th><th>Kinds</th><th>Type test method</th></tr>
<tr><td rowspan="2">2. Vibration (fatigue) test</td><td>Compression couplings, pipe unions</td><td>


Fig 3.7 Example of equipment for vibration(fatigue) test

(D) The joint assembly is to be filled with test fluid, de-aerated and pressurised to the design pressure of the joint.
(E) Pressure during the test is to be monitored.
(F) In the event of drop in the pressure and visual signs of leakage the test is to be repeated as described in 3.6.
(G) Visual examination of the joint assembly is to be carried out for signs of damage which may eventually lead to joint leakage.
(H) Re-tightening may be accepted once during the first 1000 cycles.
(I) Vibration amplitude is to be within 5% of the value calculated from the following formula:

$$A = \frac{2 \times S \times L^2}{3 \times E \times D}$$

where:
A = single amplitude (mm)
L = length of the pipe (mm)
S = allowable bending stress in N/mm^2 based on 0,25 of the yield stress
E = modulus of elasticity of tube material (for mild steel, E = 210 kN/mm^2)
D = outside diameter of tube (mm)

(J) Test specimen is to withstand not less than 107 cycles with frequency 20~50 Hz without leakage or damage.
</td></tr>
<tr><td>Grip Type and Machine grooved type joints</td><td>Grip type joints and other similar joints containing elastic elements are to be tested in accordance with the following method. A test rig of cantilever type used for testing fatigue strength of components may be used.
(A) The test specimen being tested is to be arranged in the test rig as shown in Fig 3.8
(B) Two lengths of pipes are to be connected by means of joint assembly specimen to be tested
(C) One end of the pipe is to be rigidly fixed while the other end is to be fitted to the vibrating element on the rig.</td></tr>
</table>

Table 3.18 The outlines of testing methods of mechanical joints *(continued)*

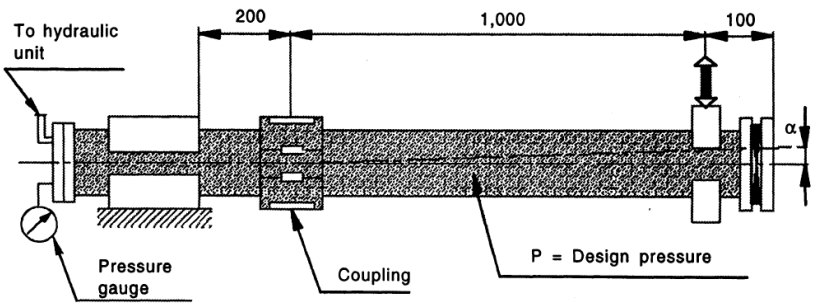
<table>
<tr><th>Test item</th><th>Kinds</th><th>Type test method</th></tr>
<tr><td></td><td>Grip Type and Machine grooved type joints</td><td>


Fig 3.8 Example of Equipment for Vibration(fatigue) test

(D) The length of pipe connected to the fixed end should be kept as short as possible and in no case, exceeds 200 mm.
(E) Mechanical joint assemblies are not to be longitudinally restrained.
(F) The assembly is to be filled with test fluid, de-aerated and pressurized to the design pressure of the joint.
(G) Preliminary angle of deflection of pipe axis is to be equal to the maximum angle of deflection, recommended by the manufacturer.
(H) The amplitude is to be measured at 1m distance from the center line of the joint assembly at free pipe end connected to the rotating element of the rig. (See Fig. 3.8)
(I) Parameters of testing are to be as indicated below and to be carried out on the same assembly
<table>
<tr><th>Number of cycles</th><th>Amplitude (mm)</th><th>Frequency (Hz)</th></tr>
<tr><td rowspan="3">3 x 10^6</td><td>± 0,06</td><td>100</td></tr>
<tr><td>± 0,5</td><td>45</td></tr>
<tr><td>± 1,5</td><td>10</td></tr>
</table>
(J) Pressure during the test is to be monitored.
(K) In the event of a drop in the pressure and visual signs of leakage the test is to be repeated as described in 3.6.
(L) Visual examination of the joint assembly is to be carried out for signs of damage which may eventually cause leakage.
</td></tr>
<tr><td>3. Pressure pulsation test</td><td>Mechanical joint assembly</td><td>
In order to determine capability of mechanical joint assembly to withstand pressure pulsation likely to occur during working conditions, joint assemblies intended for use in rigid connections of pipe lengths, are to be tested in accordance with the following method. The mechanical joint test specimen for carrying out this test may be the same as that used in the test in 1. (1) of this Table provided it passed that test.
(1) The vibration test in 2. of this Table and the pressure pulsation test are to be carried out simultaneously for compression couplings and pipe unions.
(2) The mechanical joint test specimen is to be connected to a pressure source capable of generating pressure pulses of magnitude as shown in Fig 3.9
(3) Impulse pressure is to be raised from 0 to 1,5 times the design pressure of the joint with a frequency equal to 30~100 cycles per minute.
(4) The number of cycles is not to be less than 5×10^5
(5) The mechanical joint is to be examined visually for sign of leakage or damage during the test.
</td></tr>
</table>

Table 3.18 The outlines of testing methods of mechanical joints *(continued)*

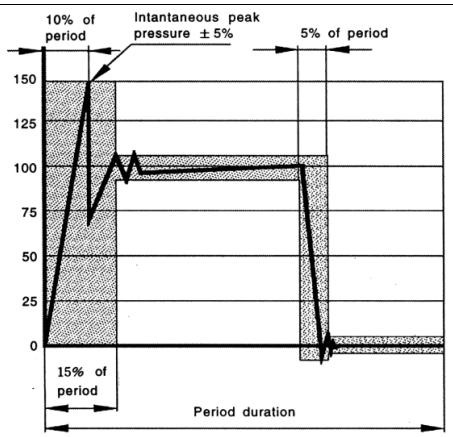
Test item	Kinds	Type test method
3. Pressure pulsation test	Mechanical joint assembly	 Fig 3.9 Example of Equipment for Pressure Pulsation Test
4. Burst pressure test	Mechanical joint assembly	In order to determine the capability of the mechanical joint assembly to withstand a pressure 4 times the design pressure, the following burst test is to be carried out. For design pressure above 20 MPa the required burst pressure will be specially considered by BKI. (1) Mechanical joint test specimen is to be connected to the pipe or tubing in accordance with the requirements of 3.5, filled with test fluid, de-aerated and pressurized to test pressure with an increasing rate of 10 % per minute of test pressure. (2) The mechanical joint assembly intended for use in rigid connections of pipe lengths is not to be longitudinally restrained. (3) Duration of this test is not to be less than 5 minutes at the maximum pressure. (4) Where consider convenient, the mechanical joint test specimen used in tightness test in 1. of this Table, same specimen may be used for the burst test provided it passed the tightness test. (5) The specimen may have small deformation whilst under test pressure, but no leakage or visible cracks are permitted.
5. Pull-out test	Mechanical joint assembly	In order to determine ability of a mechanical joint assembly to withstand axial load likely to be encountered in service without the connecting pipe from becoming detached, following pull-out test is to be carried out. (1) Pipe length of suitable size is to be fitted to each end of the mechanical joints assembly test specimen. (2) The test specimen is to be pressurized to design pressure. When pressure is attained, an external axial load is to be imposed with a value calculated by the following formula: $L = \frac{\pi}{4} \cdot D^2 \cdot \rho$ where: D = pipe outside diameter (mm) ρ = design pressure (N/mm2) L = applied axial load (N) The pressure and axial load are to be maintained for a period of 5 minutes (3) During the test, pressure is to be monitored and relative movement between the joint assembly and the pipe measured. (4) The mechanical joint assembly is to be visually examined for drop in pressure and signs of leakage or damage. (5) There is to be no movement between mechanical joint assembly and the connecting pipes.

Table 3.18 The outlines of testing methods of mechanical joints *(continued)*

Test item	Kinds	Type test method
6. Fire endurance test	Mechanical joint assembly	(1) In order to establish capability of the mechanical joints to withstand effects of fire which may be encountered in service, mechanical joints are to be subjected to a fire endurance test. The fire endurance test is to be conducted on the selected test specimens as per the following standards. (a) ISO 19921:2005 Ships and marine technology – Fire resistance of metallic pipe components with resilient and elastomeric seals – Test methods (b) ISO 19922:2005 Ships and marine technology – Fire resistance of metallic pipe components with resilient and elastomeric seals – Requirements imposed on the test bench. (2) If the fire test is conducted with circulating water at a pressure different from the design pressure of the joint (however of at least 5 bar) the subsequent pressure test is to be carried out to 1,5 times the design pressure. (3) If the fire test is required in Rules for Machinery Installation (Pt.1, Vol.III) Table 11.14 to be "**8 min dry + 22 min wet**" or "**30 min dry**", i.e. conducted for a period of time without circulating of water, the following test conditions apply: (a) Test condition "**8 min dry + 22 min wet**" The test piece is not required to be rinsed with the test medium (water) in preparation for the test as required in Paragraph 7.2 of ISO 19921:2005. The exposure to fire is to be started and continued for 8 minutes with the sample dry; after 8 minutes of dry test condition the piping system is to be filled with water and test pressure is to be increased up to at least 5 bar within 2 minutes, then maintained to at least 5 bar. After further 22 minutes (i.e. 30 minutes from initial exposure to fire) the exposure to fire is to be stopped and a hydrostatic pressure test as specified in (2). is to be carried out. (b) Test condition "**30 min dry**" The exposure to fire is to be started and continued for 30 minutes with the sample dry. After 30 minutes the exposure to fire is to be stopped and a hydrostatic pressure test as specified in (2) is to be carried out. *Note* *1. For fire tests in dry condition the pressure inside the test specimen is to be monitored for a rise due to heating of the enclosed air. Means of pressure relief should be provided where deemed necessary.* *2. High pressures created during this test can result in failure of the test specimen. Precautions shall be taken to protect personnel and facilities.* *3. Paragraph 7.5 of ISO 19921:2005 does not apply to the dry tests and no forced air circulation is to be arranged.* *4. For fire endurance test requiring exposure time greater than 30 minutes test conditions are adjusted to meet the extended required total exposure time. In all cases for dry-wet test the minimum dry test exposure time is 8 minutes.* (4) A selection of representative nominal bores may be tested in order to evaluate the fire resistance of a series or range of mechanical joints of the same design. When a mechanical joint of a given nominal bore (Dn) is so tested then other mechanical joints falling in the range Dn to 2xDn (both inclusive) are considered accepted. (5) Alternative test methods and/or test procedures considered to be at least equivalent may be accepted at the discretion of BKI in cases where the test pieces are too large for the test bench and cannot be completely enclosed by the flames.

Table 3.18 The outlines of testing methods of mechanical joints *(continued)*

Test item	Kinds	Type test method
6. Fire endurance test	Mechanical joint assembly	(6) Where thermal insulation is acceptable as a means of providing fire resistance, following requirements apply: (a) Thermal insulation materials applied on couplings are to be non-combustible according to ISO 1182:2010 as required by the Fire Test Procedures Code defined in Regulation 3 of SOLAS Chapter II-2 as amended by IMO resolutions up to MSC. 421(98). Precautions are to be taken protect the insulation from being impregnated with flammable oils. (b) At least the fire endurance and the vibration testing in Table 3.17 are to be carried out with thermal insulation in place. (c) A service restriction is to be stated on the type approval certificate that the mechanical joints are to be fitted with thermal insulation during the installation in cases where the mechanical joints are used where fire resistance is required, unless mechanical joints are delivered already fitted with thermal insulation before installation.
7. Vacuum test	Mechanical joint assembly	In order to establish capability of mechanical joint assembly to withstand internal pressures below atmosphere, similar to the conditions likely to be encountered under service conditions, following vacuum test is to be carried out. (1) Mechanical joint assembly is to be connected to a vacuum pump and subjected to a pressure 170 hPa absolute. (2) Once this pressure is stabilized the mechanical joint assembly test specimen under test are to be isolated from the vacuum pump and this pressure is to be retained for a period of 5 minutes. (3) No internal pressure rise is permitted.
8.Repeated assembly test	Mechanical joint assembly	Mechanical joint test specimen are to be dismantled and reassembled 10 times in accordance with manufacturers instructions and then subjected to a tightness test as defined in 1. of this Table.

R. Air Pipe Automatic Closing Devices

1. Application

The requirements in this Section apply to tests and inspection for the approval of air pipe automatic closing devices extending above weather decks in accordance with the requirements in Rules for Machinery Installations (Pt.1, Vol.III) Sec. 11, R.1.3.

2. Design and Materials

2.1 Design of the air pipe automatic closing devices is to comply with the following requirements.

2.1.1 An air pipe automatic closing device is to prevent the free entry of water into the tanks and allow the passage of air or liquid to prevent excessive pressure or vacuum coming on the tank. For vacuum, air pipe automatic closing devices are to be made for relieving vacuum in the tanks when the tanks are also being pumped out.

2.1.2 The open ends of air pipes to fuel oil and cargo oil tanks are to be furnished with the flame-screens which can be readily removed for cleaning or renewal and deemed appropriate by BKI. The clear area through the mesh of the flame-screens is not to be less than the required sectional area of the air pipe.

2.1.3 Air pipe closing devices are to be designed so that they can withstand both ambient and working conditions up to an inclination of ± 40° without failure or damage.

2.1.4 Air pipe closing devices are to be constructed to allow inspection of the closure and the in-side of the casing as well as for changing the seals.

2.1.5 In case of air pipe closing devices of the float type, suitable guides are to be provided to ensure unobstructed operation under all working conditions of heel and trim as specified in 2.1.3.

2.1.6 Efficient ball or float seating arrangements are to be provided for the closures. Bars, cage or other devices are to be provided to prevent the ball or float from contacting the inner chamber in its normal state and made in such a way that the ball or float is not damaged when subjected to water impact due to a tank being overfilled.

2.1.7 Air pipe closing devices are to be self-draining.

2.1.8 The clear area through an air pipe closing device is to be at least equal to the area of the inlet.

2.1.9 The maximum allowable tolerances for wall thickness of ball floats are not to exceed ± 10 % of the nominal thickness.

2.1.10 The inner and the outer chambers of an automatic air pipe head is to be of a minimum thickness of 6 mm.

2.2 Materials of the air pipe automatic closing devices is to comply with the following requirements.

2.2.1 Casings of air pipe closing devices are to be of approved metallic materials adequately protected against corrosion.

2.2.2 For galvanized steel air pipe heads, the zinc coating is to be applied by the hot method and the thickness is to be 70 to 100 µm.

2.2.3 For areas of the head susceptible to erosion (e.g. those parts directly subjected to ballast water impact when the tank is being pressed up, for example the inner chamber area above the air pipe, plus an

overlap of 10 degree or more either side) an additional harder coating should be applied. This is to be an aluminium bearing epoxy, or other equivalent, coating, applied over the zinc.

2.2.4 Closures and seats made of non-metallic materials are to be compatible with the media in-tended to be carried in the tank and to sea water at ambient temperatures between -25 °C and 85 °C.

2.3 The flame-screens installed in automatic air pipe outlets are to comply with the following.

2.3.1 They are to be made of corrosion resisting material.

2.3.2 They are to comprise two fitted screens of at least 20 × 20 mesh spaced 25,4 ± 12,7 mm apart or single fitted screen of at least 30 × 30 mesh, or to have a performance equivalent thereto.

3. Type tests

3.1 Testing of air pipe automatic closing devices

The following tests, specified in Table 3.19, for air pipe automatic closing devices by each type and size are to be carried out at the manufacturer's works or other acceptable location by BKI.

3.2 Impact and compression loading tests for the floats are to be carried out as specified in Table 3.19.

Table 3.19 Test methods and acceptance criteria for air pipe automatic closing devices

Kinds	Test Item	Type test method	Acceptance criteria
Air pipe automatic closing devices	Tightness test	An automatic closing device is to be subjected to a series of tightness tests involving not less than two (2) immersion cycles under each of the following conditions. (1) The automatic closing device is to be submerged slightly below the water surface at a velocity of approximately 4 ml/min. and then returned to the original position immediately. The quantity of leakage is to be recorded. (2) The automatic closing device is to be submerged to a point slightly below the surface of water. The submerged velocity is to be approximately 8 m/min. and the air pipe vent head is to remain submerged for not less than 5 minutes. The quantity of leakage is to be recorded. (3) Each of the above tightness tests is to be carried out in the normal position as well as at an inclination of ± 40° under the strictest conditions for the device. In case where such strictest conditions are not clear, tests shall be carried out at an inclination of 40 degrees with the device opening facing in three different directions: upward, downward, sideway (left or right). (see Fig 3.10.1)	The maximum allowable leakage per cycle is not to exceed 2 ml/mm of nominal diameter of inlet pipe during any individual test.
	Discharge/ Reverse flow test	The air pipe head shall allow the passage of air to prevent excessive vacuum developing in the tank. A reverse flow test shall be performed. A vacuum pump or another suitable device shall be connected to the opening of the air pipe leading to the tank. The flow velocity shall be applied gradually at a constant rate until the float gets sucked and blocks the flow. The velocity at the point of blocking shall be recorded. 80% of the value recorded will be stated in the certificate.	The maximum allowable leakage per cycle is not to exceed 2 ml/mm of nominal diameter of inlet pipe during any individual test.
	Confirmation of the flow characteristic	Measuring of the pressure drop versus rate of volume flow is to be carried out using water and with any intended flame or insect screen in place.	To be as deemed appropriate by BKI

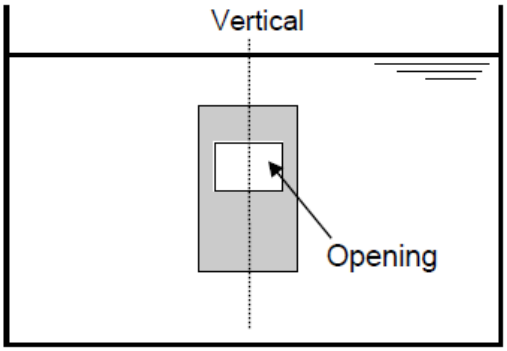
Table 3.19 Test methods and acceptance criteria for air pipe automatic closing devices (continued)

Kinds	Test Item	Type test method	Acceptance criteria
Non-metallic floats	Impact test	(1) The test may be conducted on a pendulum type testing machine. The floats are to be subjected to 5 impacts of 2,5 N-m each. (2) Subsequently the floats are to be subjected to 5 impacts of 25 N-m each. At this impact energy level some localized surface damage at the impact point may occur.	The floats are not to suffer either permanent deformation, cracking or surface deterioration at this impact loading.
	Compression loading test	(1) Compression tests are to be conducted with the floats mounted on a supporting ring of a diameter and bearing area corresponding to those of the valve seating with which it is intended that float shall be used. (2) For ball type float, loads are to be applied through a concave cap of the same internal radius as the test float and bearing on an area of the same diameter as the seating. (3) For a disc type float, loads are to be applied through a disc of equal diameter as the float. (4) A load of 350 kg is to be applied over one minute and maintained for 60 minutes. The deflection is to be measured at intervals of 10 minutes after attainment of the full load.	The record of deflection against time is to show no continuing increase in deflection and, after release of the load, there is to be no permanent deflection.
Metallic floats	Impact test	Tests are to be conducted in accordance with the impact test of non-metallic floats. The tests are to be carried out at room temperature and in the dry condition.	According to the requirement for impact test of non-metallic floats.

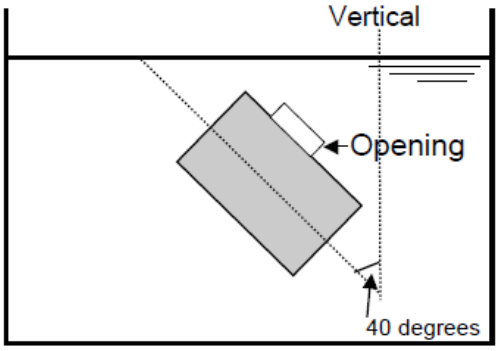
Table 3.20 Temperature and Condition of Test

Test temperature (°C) / Test condition	-25	20	85
Dry	O	O	O
After immerging in water	O	O	O
After immerging in fuel oil		O	

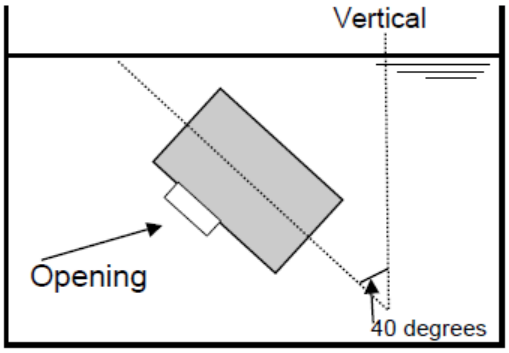
Notes:
1. Type tests are to be performed for each test item indicated with a O mark in this Table.
2. Immerging in water and fuel oil is to be for 48 hours at least.



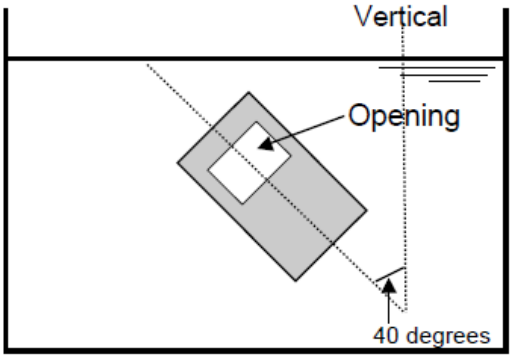
(1) Normal position



(2) Inclination 40 degree opening facing upward



(3) Inclination 40 degree opening facing downward



(4) Inclination 40 degree opening facing sideways

Fig 3.10 Example of tightness test

S. Level Indicators

1. Application

1.1 In accordance with the requirements in the Rules for machinery Installations (Pt.1, Vol.III) Sec.11. R.2, Sec.15.B.7, Rules for Ship Carrying Liquefied Gas in Bulk (Pt.1, Vol.IX) and Rules for Ships Carrying Dangerous Chemicals in Bulk (Pt.1, Vol.X), the requirements in this Sub-section apply to tests and inspection for the approval of pneumatic, electric and/or electronic type level indicators installed in tanks, cofferdams, etc.

1.2 The level indicators include all parts of the device from the detector to the display.

2. Construction

The construction of the level indicator is to satisfy the following requirements.

2.1 To be able to adequately withstand ship vibration, ship motions, trim and heel.

2.2 For devices which are used in tanks carrying flammable liquid, special consideration is to be given against prevention of generation and charge of static electricity.

2.3 To be able to withstand the most severe pressure and temperature expected during working conditions and, for parts in contact with the liquid, to have adequate compatibility between the device and the liquid considered.

2.4 The construction in addition of the above is also to be as follows:

1) To be such that maintenance and inspection can be carried out easily and safely
2) To have appropriate devices installed to prevent metal fittings from coming loose.

2.5 To be provided with a mechanism to correct specific gravity where necessary.

2.6 Electrical parts of the level indicator which is installed within the dangerous zones are to be of explosion protective construction as specified in each of the relevant Parts of the Rules.

3. Type tests

3.1 The type tests are to include the following 1) through 5) depending on application and type of level indicators.

1) In addition to conformity with the requirements in 2. confirmation of whether the test sample agrees with the established specifications for completion, construction, dimensions and used parts.
2) Confirmation of whether the test sample performs as specified where the configuration is in the regular installed direction and in 22,5° inclined direction under the working condition given in the following.
   A) Parts located out of the tank: normal temperature and maximum working pressure.
   B) Parts located inside the tank and on the tank walls: maximum and/or minimum working temperature (However, where this temperature is within the range of 0°C and 60°C, normal temperature may be used instead.) and maximum working pressure.
3) For devices in which the liquid level is measured by use of floats and where the float is not fixed during navigation, confirmation of whether specified performance can be realized after a drop test in which the float is dropped from a height of 3 m onto a steel plate in 10 mm thickness. (However, where a damping device such as springs are provided at the top and bot tom edge of the guide, tests may be carried out with such devices installed, although the tests are to be repeated at least ten times.)

4) For devices in which the liquid level is measured by use of floats, confirmation of whether any damage occurs to the rubbing parts where the same equipped pipes and wires are set up horizontally and the float and guide are made to contact each other at the same places much as practicable. Then, for devices which the float is not fixed during navigation, rubbing tests which the float is slided 5,000 times between 5 m span are to be carried out.

5) For the electrical parts of the devices, testing as given in the following. However, the type tests are to comply with the requirements in V.4.2 and, in case the explosion-protected construction is required, type tests also are to comply with the requirements in T.7 of this Guidance.

A) Dry heat test

B) Damp heat test

C) Vibration test

D) Inclination test

E) Electrical power supply variation test

3.2 Additional tests other than those of 3.1 may be requested, where deemed necessary by BKI.

T. Electrical Equipment and Cables

1. General

1.1 Application

The requirements in this Sub-section apply to tests and inspection for the type of electrical equipment and cables in accordance with the requirements in the Rules for Electrical Machinery (Pt.1, Vol.IV) Sec. 20 and 21.

1.2 Items subject to the tests

Electrical equipment and cables subject to the type test are to be as the requirements in Table 3.21.

2. Data to be submitted

Data are to be submitted to BKI in accordance with the requirements in A.2 and the following drawings and documents are to be included for explosion-protected electrical equipment. Items 4), 5) and 6) are, however, required for intrinsically safe type electrical equipment only. Items 7) to 15) are, however, required for busbar trunking system only.

1) Drawings of detailed sectional assembly and arrangement of components
2) List of electrical parts and materials
3) Functional descriptions of explosion-protected constructions
4) Electric circuit diagrams
5) Sectional assembly drawings of transformers with earthed screens and component parts (relays, photocouplers, etc.) used for maintenance of intrinsic safety
6) Construction drawings and circuit diagrams of safety barriers
7) References to design standards, rules, specifications etc.
8) Test results
9) Applicant's proposal for product sample test
10) Documentation of reliability and endurance on board ships and offshore units (if any).
11) Special operational limitations.
12) Field of application: i.e. general power, bulk head and deck penetration etc.
13) List of the busbar trunking systems covered by the type approval giving the following information for each variant if applicable:
    - Rated operation voltage (V)
    - Rated insulation voltage (V)
    - Rated impulse withstand voltage (V)
    - Rated current (A)
    - Rated peak withstand current (kA)
    - Rated short-time withstand current (kA/sec)
    - Pollution degree
    - De-rating factor at 45 °C ambient temperature
    - Mechanical loads
    - Conductor dimensions (mm or mm^2)
    - Insulation thickness (mm)

- Clearance and creepage distances (mm)
- Fillers and bedding thickness (mm)
- Inner and outer sheath thickness (mm)
- Metallic covering diameter (mm)
- Overall diameter or dimensions (mm)

14) Construction details:
- Conductor material: Copper or maritime atmospheric resistant aluminium
- Insulation material (if any)
- Fillers and bedding material (if any)
- Inner and outer sheath material (if any)
- Metal covering (if any)
- Material outer braid or armour (if any)
- Tap off units (if any)
- Degrees of protection provided by enclosures (IP code).

15) Test program, which as a minimum includes the elements for type testing. The test program shall refer to the relevant IEC standards for each test.

Table 3.21 Electrical equipment and cables subject to the type test

No.	Kinds	Electrical equipment and cables subject to the type test
1	Fuses	Cartridge fuses (renewable and non-renewable) and plug type fuses used for the protection of the low-voltage electric circuits.
2	Electromagnetic contactors and protective relays	Electromagnetic contactors and protective relays used for motors and other loads connected to the low voltage electric circuits.
3	Explosion-protected electric equipment	Electrical equipment of the flameproof type, intrinsically safe type, increased safety type and pressurized protected type (limited to sealed type) used in the spaces on board flammable or explosive gas or vapour (hereinafter reffered to as explosive gas) exists or may exist in the atmosphere.
4	Switchgear	– Circuit-breakers, load switches and disconnect switches for direct connection to the main busbars or non-protected distribution busbars of main, emergency and propulsion switchboards – Standardized switchgear units manufactured in series with reduced clearance and creepage distances.
5	Cables and accessories	– Cables and insulated wires used for power circuits, lighting circuits, supply and distribution circuits of interior communication, control circuit, etc. – Sealing compound and packing systems for bulkhead and deck penetrations – Busbar trunking systems – Cable trays/protective casings made of plastic materials
6	Generator / mains supply protection devices	– Short-circuit protection – Overcurrent protection – Reverse-power protection – Automatically synchronizing device – Under frequency protection – Over- and under voltage protection – Differential protection – Earth fault monitoring

Table 3.21 Electrical equipment and cables subject to the type test *(continued)*

No.	Kinds	Electrical equipment and cables subject to the type test
7	Steering gear and rudder-propeller systems	Input devices such as: – Phase failure relays – Level sensors Steering gear control systems with all components important for the function such as: – Steering mode selector switch – Follow up/ non-follow up control devices
8	Variable pitch propeller controls with all components important for the functioning	
9	Machinery control systems	– Open and closed loop control for speed and power of internal combustion engines (main and auxiliary engines) and electrical actuators. – Safety devices – Safety systems
10	Ship's control and safety systems	– Fire detection and alarm systems – Suction-type smoke-detection systems – Loading instrument (loading computer). – Automatic stop devices and control units for heel compensation systems. – Flame detectors, remotely controlled valves, control electronics and fire detection systems for fixed water-based local application fire-fighting systems (FWBLAFFS) – Combustion engine crankcase oil mist detection monitoring device/system
11	Electrically supplied LLL-systems.	
12	Monitoring, protection and management systems of battery systems.	
13	Rotating machinery	Generators and motors
14	Transformer	Power transformer

3. Type tests

Type tests are to be carried out in accordance with the requirements in 3.1. to 3.14 for each product. In case where the BKI deemed necessary, however, additional tests and/or an increase in the number of test samples may be required. For products specified in foreign standards, test items and the number of test samples will be decided at each case in accordance with the contents of the standards.

3.1 Test method of fuses

The details of test are to comply with the recognized code (IEC 60269 series, etc.). Where deemed necessary, the ambient temperature may be modified.

3.2 Test method of electromagnetic contactors

The details of test are to comply with the recognized code (IEC 60947-1, IEC 60947-4 etc.). Where deemed necessary, the ambient temperature may be modified.

3.3 Test method of explosion-protected electric equipment

3.3.1 Test items and number of samples

The test items marked "O" in Table 3.22 are to be conducted on one test sample per each explosion-protection type.

Table 3.22 Test Items of Explosion Protected Equipment

Test items \ Types of explosion protection	Flameproof type	Intrinsically safe type	Increased safety type	Pressurized protected type
Construction inspection	○	○	○	○
Temperature rise test	○	○	○ (note)	○
Mechanical strength test	○	○	○	○
Explosion test	○			
Pressurization test				○
Spark ignition test		○		
Other test deemed necessary	○	○	○	○

Note:

Temperature rise test in the locking test for motors is to be included.

Remarks:

1. The mechanical strength test is to apply to movable apparatus, inspection windows, lighting fittings, portable lamps with batteries, plug-sockets and flexible fittings.
2. Other tests deemed necessary are to include thermal shock (heat resistance) test, water-tight test, air-tight test, function test of protective devices, etc.

3.3.2 Test methods

Test methods are to comply with the requirements given in Table 3.23 or IEC 60079 series.

Table 3.23 Test methods and acceptance criteria for explosion-protected equipment

<table>
<tr><th>Types</th><th>Test item</th><th>Test method</th><th>Acceptance criteria</th></tr>
<tr><td rowspan="2">Flameproof type electric equipment</td><td>(A) Explosion withstand test</td><td>(a) The enclosure is filled with the flammable mixture which will produce the explosion pressure specified in Table bellows according to the internal volume and tested by repeatedly igniting and exploding the mixture 10 times
<table>
<tr><td>Internal volume (cm^3)</td><td>Less than 2</td><td>2 over 100 incl.</td><td>over 100</td><td>over 100</td></tr>
<tr><td>Internal pressure (MPa)</td><td>Necessary for Fabrication</td><td>0,8 or over</td><td>1.0 or over</td><td>1.0 or over</td></tr>
</table>
(b) The gaps of the enclosure may be sealed temporally to perform the test.</td><td>The enclosure is not to be damaged or obstructively deformed</td></tr>
<tr><td>(B) Flame propagation test</td><td>(a) The flammable mixture having flame propagation characteristic which can prove the safe guardness against each gas involved in each explosion class is filled inside and outside the enclosure and is ignited inside the enclosure and exploded repeatedly 15 times. In case where the pressure specified in (A) of this Table is available in this test, the explosion withstand test above may be included in this test.
(b) The position considered as the flame propagation is most ready to occur in the enclosure is to be selected for the position of ignition.</td><td>The flame propagation is not to occur</td></tr>
</table>

Table 3.23 Test methods and acceptance criteria for explosion-protected equipment *(continued)*

<table>
<tr><th>Types</th><th>Test item</th><th>Test method</th><th>Acceptance criteria</th></tr>
<tr><td rowspan="5">Flameproof type electric equipment</td><td>(C) Tempera-ture rise test</td><td>To pass the rated current to the equipment (as for lighting fixtures, by turning or the maximum applicable lamp with the rated current) until the temperature at each part is saturated.
The temperature rise of the external parts of the enclosure is not to exceed the limit specified in Table below
(Standard ambient temperature 50°C)
<table>
<tr><td>Ignition group</td><td>G_1</td><td>G_2</td><td>G_3</td><td>G_4</td><td>G_5</td></tr>
<tr><td>Limit of temperature rise</td><td>310</td><td>190</td><td>110</td><td>60</td><td>30</td></tr>
</table></td><td></td></tr>
<tr><td rowspan="2">(D) Mechanical strength test</td><td>(a) The steel ball falling test of light transparent plate, light trans- parent window and inspection window;
The transparent plate (except for the cylindrical glass globes for fluorescent lamp) is dropped by the steel ball specified in Table below on the weakest part considered of the plate under the condition being fitted on to the equipment or equivalent condition.
<table>
<tr><td>Transparent material</td><td>Mass of steel ball (g)</td><td>Drooping height (cm)</td></tr>
<tr><td>Glove</td><td>95 (diameter approximately 28,5 mm)</td><td>100</td></tr>
<tr><td>Cylindric glass</td><td>50 (diameter approximately 23,0 mm)</td><td>100</td></tr>
<tr><td>Sheet glass</td><td>200 (diameter approximately 36,5 mm)</td><td>200</td></tr>
</table>
This test is, in principle, to be carried out on three test specimens and each of them is required to pass the test. For the indicating lamps, in case where the steel ball cannot strike the glass cover through the penings of the guard, the test is to be conducted by dropping a steel ball sufficiently small to directly strike.</td><td>Not to cause any damage and cracks which may impair the flame-proofness</td></tr>
<tr><td>(b) The strength test of cylindrical glass globe for fluorescent lamp
The cylindrical glass globe is dropped by a steel ball of 50 g (diameter approximately 23 mm from a height of 100 cm on the weakest part considered of the cylindrical glass globe under the condition being fitted on to the equipment and held horizontally. And, the cylindrical glass globe is applied the internal hydrostatic pressure of not less than 2,0 MPa for 15 seconds. This test is, in principle, to be carried out on three test specimens and each of them is required to pass the test.</td><td>The cylindrical glass globe is not to be damaged and is to withstand the internal hydrostatic pressure.</td></tr>
<tr><td>Drop test for portable type apparatus</td><td>The portable type apparatus is dropped three times on to the steel plate of 6 mm in thickness from a height of 1,5 m by changing the position to collide.</td><td>Not to be impairer the flame-proofness</td></tr>
<tr><td>Thermal shock test</td><td>The electric apparatus with light transparent windows or inspection windows is poured by water at a temperature of 10 °C lower than the room temperature (minimum 5 °C) onto the electric apparatus after the electric apparatus has been operated until the temperature of the light transparent material is saturated. This test is, in principle, to be carried out on three test specimens and each of them is required to pass the test. The test, however, may be omitted in case where the light transparent material can be considered to have a little temperature rise and to pass the thermal shock test apparently judging from test results in the past.</td><td>Not to cause cracks of damage on the light trans parent material</td></tr>
</table>

Table 3.23 Test methods and acceptance criteria for explosion-protected equipment *(continued)*

Types	Test item	Test method	Acceptance criteria
Intrinsically safe type electrical equipment	Temperature rise test	The temperature rise of the parts in contact with explosive gas of the intrinsically safe type electrical equipment is measured under the normal operational condition and under the maximum current or voltage which can be generated in time of fault. The test, however, may be omitted in case where the temperature rise of the apparatus can be considered not to exceed the limit apparently judging from the test results in the past.	not to exceed the limit specified in the temperature rise test of flameproof type electric equipment
	Spark ignition test	The intrinsically safe type electric equipment, at all parts of intrinsically safe circuit, is to be carried out the spark ignition test specified in the following (a) to (e) by using the IEC type spark ignition testing apparatus to verify that any sparks in normal operation and abnormal condition (short circuit, earth fault, breakage of cable, etc.) do not ignite explosive gas or vapour specified in Table 3.21. This test applies to the first product and may be omitted for the subsequent products of the same manufacturer in case where the voltage or the current of the circuit specified in the following (a) does not exceed that of the spark ignition test circuit by 20%. (a) The spark ignition test is to be conducted in way of the circuit where the maximum voltage or current can be generated in normal operation and abnormal condition. For the safety barrier, however, the test is to be conducted at the connecting terminals of the intrinsically safe circuit side by applying the intrinsically safe rated voltage to the non-intrinsically safe circuit side. The intrinsically safe rated voltage means the voltage generated in the non-intrinsically safe circuit in normal operation and abnormal condition and the maximum voltage in the non-intrinsically safe circuit side of the safety barrier at which the intrinsical safety can be ensured. (b) The value of the testing voltage or the testing current is to be the value obtained from multiplying the maximum voltage or current in normal operation and abnormal condition in the circuit to be intrinsical safe by the safety factor. The safety factor is, in principle, to be 2. (c) The number of revolutions of the testing equipment is to be more than 200 times per each pole for the d.c. circuit and more than 1000 times for the a.c. circuit. (d) The test gas is, in principle, to comply with either of the following: (i) 1 Class: Propane-air mixture gas (5,25 ± 0,25 vol%) (ii) 2 Class: Ethylene-air mixture gas (7,8 ± 0,5 vol %) (iii) 3 Class: Hydrogen-air mixture gas (21 ± 2 vol%) (e) The sensitivity of the spark ignition testing equipment before and after the test is to be adjusted so that the maximum ignition current becomes approximately 65 mA for ethylene-air mixture gas and approximately 30 mA for hydrogen-air mixture gas when the sparks are produced in the gas by inserting the testing equipment into the electric circuit as shown in Figure below.	The intrinsically safe type electric equipment, at all parts of intrinsically safe circuit, is to pass the spark ignition test

Table 3.23 Test methods and acceptance criteria for explosion-protected equipment *(continued)*

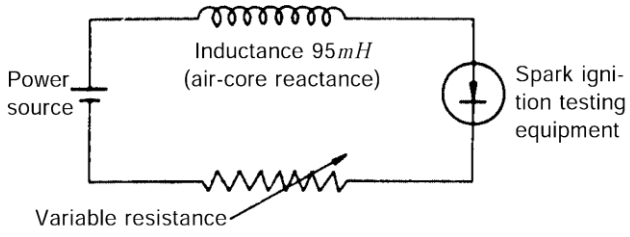
<table>
<tr><th>Types</th><th>Test item</th><th>Test method</th><th>Acceptance criteria</th></tr>
<tr><td rowspan="2">Intrinsically safe type electrical equipment</td><td>Spark ignition test</td><td> 

Fig. Circuit Diagram of Spark Ignition Test</td><td>The intrinsically safe type electric equipment, at all parts of intrinsically safe circuit, is to pass the spark ignition test</td></tr>
<tr><td>Drop test for portable type apparatus</td><td>Portable type apparatus is dropped onto the steel plate of 6 mm in thickness fixed on the floor from an effective height of 1,5 m. The test is to be carried out three times by changing the positions to collide which are selected as the weakest positions judging from the structural features of the test specimen.</td><td>Not to be damaged on the external covers and not to cause damage or deformation in the internal circuit which may impair the intrinsical safety</td></tr>
<tr><td rowspan="2">Increased safety type electrical equipment</td><td>Tempera-ture rise test</td><td>The temperature rise of the increased safe type electrical equipment is to comply with the following (a) to (d) by being continuously supplied under the rated voltage, the rated output or capacity.
(a) Temperature rise of electrical equipment against explosive gas
The temperature rise of the all parts which may be exposed to explosive gas is measured. The temperature rise of insulating windings and bulb socket is to comply with the requirements of the following (b) and (c).
(b) Temperature rise of insulating windings. The temperature rise of the insulating windings used for the electric equipment is to be 15°C lower than the value specified in Rules for Electrical Installation (Pt.1, Vol.IV) Sec. 20 A.4.3.4. The thermometer method may be used only when the resistance method is hardly applied.
(c) Temperature rise of bulb socket
The temperature rise of the rim and the soldered part of the bulb is not to exceed 145°C.
(d) Temperature rise of leading part of external cable
The temperature rise of the cable entry points is not to exceed 20°C and that of the branching points of the conductor is not to exceed 30°C.</td><td>The temperature rise of the all parts which may be exposed to explosive gas is not to exceed the limit given in Table below.
<table>
<tr><td>Ignition group</td><td>G1</td><td>G2</td><td>G3</td><td>G4</td></tr>
<tr><td>Enclosures and their parts</td><td>310</td><td>190</td><td>110</td><td>60</td></tr>
<tr><td>Surface of lamps lighting fittings</td><td>350</td><td>300</td><td>250</td><td>150</td></tr>
</table></td></tr>
<tr><td>Thermal shock test</td><td>The protective lamp cover of the lighting fitting is poured by a water jet with a diameter of approximately 1 mm and with a temperature of approximately 20°C onto the parts having the highest temperature, after applying the rated voltage to the maximum applicable bulb until the temperature rise of the outside surface of the protective lamp cover is saturated.</td><td>The protective lamp cover of the lighting fitting is not to be damaged or cracked</td></tr>
</table>

Table 3.23 Test methods and acceptance criteria for explosion-protected equipment *(continued)*

<table>
<tr><th>Types</th><th>Test item</th><th>Test method</th><th>Acceptance criteria</th></tr>
<tr><td rowspan="2">Increased safety type electrical equipment</td><td>Waterproof test</td><td>The electrical equipment is to be tested according to the requirements of test method for IPX4 specified in IEC 60529.</td><td>To comply with the requirements of waterproof test and is to have the waterproof performance accordingly necessary for the place where the electrical equipment is intended to be installed.</td></tr>
<tr><td>Mechanical strength test of lighting fittings</td><td>The lighting fittings are dropped by a steel ball (as the end of object) of 25 mm in diameter and a mass specified in Table below at the tip onto the weakest part considered from the height specified in the Table, under the condition being fitted on a fixed table.
<table>
<tr><th rowspan="2">Electrical apparatus</th><th rowspan="2">Mass of steel ball (kg)</th><th colspan="3">Height of fall (m)</th></tr>
<tr><th>Enclosures</th><th>Lamp Protective cover</th><th>Guard</th></tr>
<tr><td>Incandaescent lights and mercury lights</td><td>1</td><td>-</td><td>0,7</td><td>-</td></tr>
<tr><td></td><td>2</td><td>2</td><td>-</td><td>2</td></tr>
<tr><td>Fluorescent lights</td><td>1</td><td>2</td><td>0,7</td><td>2</td></tr>
</table></td><td>Not to be damaged</td></tr>
<tr><td rowspan="2">Pressurized protective Type electrical equipment (sealed type only)</td><td>Temperature rise test</td><td>The temperature rise test is to be carried out in accordance with that of flameproof type electrical equipment.</td><td>The temperature rise of the external parts of the enclosure is not to exceed the limit specified in table of the flameproof type electrical equipment.</td></tr>
<tr><td>Internal pressure test</td><td>The internal pressure test is to comply with the followings.
(a) Internal pressure maintaining test.
Being filled with the protective gas up to the specified value,
(b) Operating test of protective device
The pressure of the protective gas falls below the specified value. The test is, in principle, to be conducted for 5 times.</td><td>(a) The internal pressure of the equipment is to be satisfactorily maintained.
(b) The device indicating the pressure fall is to operate satisfactorily.</td></tr>
</table>

3.4 Test method of switchgear

The details of test are to comply with the recognized code (IEC 60947-1, IEC 60947-2, IEC 62271-100 etc.). Where deemed necessary, the ambient temperature may be modified.

3.5 Test method of Cables and accessories

3.5.1 Cables and insulated wires

1) The details of test are to comply with the recognized code IEC 60092-350, etc. given in Table 3.24. Where deemed necessary, the ambient temperature may be modified.

2) In addition to a. above, tests for vertical flame spread of vertically bunched cable are to be carried out in accordance with IEC 60332-1 (single vertical insulated cable) or IEC 60332-3-22 (vertically-mounted bunched cables).

Table 3.24 Type test item of cables

No.	Test items	IEC code
1	Visual inspection	
2	Conductor resistance test	IEC 60092-350, 5.2.2
3	Voltage test	IEC 60092-350, 5.2.3
4	Insulation resistance	IEC 60092-350, 6.9 & 7.2
5	Conductor examination	IEC 60092-350, 6.4
6	Insulation thickness	IEC 60092-350, 6.5 & 8.2
7	Non-metallic sheaths thickness	IEC 60092-350, 6.6 & 8.3
8	External diameter	IEC 60092-350, 6.7
9	Hot-set test for insulations and sheaths	IEC 60092-350, 6.8
10	Increase in a.c. capacitance after immersion in water	IEC 60092-350, 7.3
11	High voltage test for 4 h	IEC 60092-350, 7.4
12	Mutual capacitance (control and instrumentation cables only)	IEC 60092-350, 7.5
13	Inductance to resistance ratio (control and instrumentation cables only)	IEC 60092-350, 7.6
14	Mechanical properties of insulation before and after ageing	IEC 60092-350, 8.4
15	Mechanical properties of sheaths before and after ageing	IEC 60092-350, 8.5
16	Compatibility test	IEC 60092-350, 8.6
17	Loss of mass test on PVC insulation and PVC (ST1 and ST2) sheaths	IEC 60092-350, 8.7
18	Test for the behaviour of PVC insulation and PVC (ST1 and ST2) and SHF1 sheaths at high temperatures (hot pressure test)	IEC 60092-350, 8.8
19	Test for the behaviour of PVC insulation and PVC sheath (ST1 and ST2) and SHF1 and SHF2 sheaths at low temperature	IEC 60092-350, 8.9
20	Special test for low temperature behaviour (when required)	IEC 60092-350, 8.10
21	Test of the metal coating of copper wires	IEC 60092-350, 8.11
22	Galvanizing test	IEC 60092-350, 8.12
23	Test for resistance of PVC insulation and PVC (ST1 and ST2) and SHF1 sheaths to cracking (heat shock test)	IEC 60092-350, 8.13
24	Ozone resistance test for insulation and for sheaths	IEC 60092-350, 8.14
25	Oil immersion test for sheaths	IEC 60092-350, 8.15
26	Mud drilling fluid test (when required)	IEC 60092-350, 8.16
27	Fire tests	IEC 60092-350, 8.17
28	Determination of hardness for HEPR and HF HEPR	IEC 60092-350, 8.18
29	Determination of elastic modules for HEPR and HF HEPR	IEC 60092-350, 8.19
30	Durability of print	IEC 60092-350, 8.20

3.5.2 Sealing compound and packing systems for bulkhead and deck penetrations

The type test for sealing compound and packing systems for bulkhead and deck penetrations are in accordance with AJ.

3.5.3 Busbar trunking system

.1 Testing

Test for busbar trunk are to be carried out in accordance with Table 3.25.

Table 3.25 Test methods for busbar trunk

Kinds	Type test method
Visual inspection	By visual inspection, it is to be verified that the test sample (e.g. prototype) is in compliance with the approved plan
Electrical /mechanical tests	The tests shall be according to the relevant parts of the following: 1. Temperature rise (IEC 61439-1/6, 10.10.2) 2. Short circuit strength (IEC 61439-1/6, 10.11.5) 3. Mechanical impact (IEC 61439-1/6, 10.2.6) 4. Ability to withstand mechanical loads (IEC 61439-1/6, 10.2.) 5. Insulation resistance test for main and auxiliary circuits (if applicable) Rules for Electrical (Pt.1, Vol.IV) Sec.5 6. Power-frequency withstand voltage (IEC 61439-1, 10.9.2) 7. Impulse withstand voltage (IEC 61439-1, 10.9.3 8. Clearance & creepage distances (IEC 61439-1, 10.4) 9. Verification of protection degree (IEC 60529) 10. Flame retardance test (if applicable) (IEC 60332-3-10) 11. Bulk head and deck penetration tests (if applicable) (see AJ) 12. Mechanical/particular characteristics of sheathing compounds (if applicable) (IEC 60092-350, IEC 60092-360 Table 6+8) 13. Smoke density test (if applicable) (IEC 61034-2) 14. EMC test (if containing electronic parts) (IEC 61000) 15. Terminals for external conductors (IEC 61439-1/6, 10.8)
Environmental tests	Tests related to endurance and reliability of the product on board ships, e.g. vibration test, shall take account of the environmental strains on board vessels. In case of insufficient experience from service on board ships (or equivalent), the following tests may be required as type tests: – Vibration test according to Sub-Section V. Table 3.34, No.8 – Damp heat test according to Sub-Section V. Table 3.34, No.7 – Salt mist test according to Sub-Section V. Table 3.34, No.13

.2 Application limitations

Limitation may apply with regard to watertightness and gastightness for bulkhead and deck penetration modules. In some cases, evidence of torsion-resistant may be required

3.5.4 Cable trays/protective casings made of plastic materials

The type test for cable trays/protective casings made of plastic materials are in accordance with Sub-Section U.3.3.

3.6 Generator / mains supply protection devices

The tests shall be according to the relevant parts on Sub-Section V. Table 3.34.

3.7 Steering gear and rudder-propeller control systems

The tests shall be according to the relevant parts on Sub-Section V. Table 3.34.

3.8 Variable pitch propeller controls with all components

The tests shall be according to the relevant parts on Sub-Section V. Table 3.34.

3.9 Machinery control systems

The tests shall be according to the relevant parts on Sub-Section V. Table 3.34.

3.10 Ship's control and safety systems

The tests shall be according to the relevant parts on Sub-Section V. Table 3.34.

3.11 Electrically supplied LLL-systems

The test shall be according to the ISO 15370.

3.12 Monitoring, protection and management systems of battery systems.

The tests shall be according to the relevant parts on Sub-Section V. Table 3.34.

3.13 Test method for rotating electrical machinery

3.13.1 Technical documentation check and visual inspection

Technical documentation of machines rated at 100kW and over is to be available for examination by the Surveyor.

A visual examination is to be made of the machine to ensure, as far as is practicable, that it complies with technical documentation

3.13.2 Measurement of winding resistance

The winding resistances shall be measured and recorded using an appropriate bridge method or voltage and current method.

3.13.3 No load test

The fully assembled machines, including all control and supplementary elements (e.g. winding and bearing temperature sensors, current and voltage transformers), shall undergo no load tests.

Machines are to be operated at no load and rated speed whilst being supplied at rated voltage and frequency as a motor or if a generator it is to be driven by a suitable means and excited to give rated terminal voltage.

During the running test, the vibration of the machine and operation of the bearing lubrication system, if appropriate, are to be checked.

3.13.4 Load test and heat run test

For generators the voltage, and for motors the speed shall be checked as a function of the load.

A) The temperature rises are to be measured at the rated output, voltage, frequency and the duty for which the machine is rated and marked in accordance with the testing methods specified in IEC 60034-1:2017, or by means of a combination of other tests.

B) For the machine with rating for continuous running duty, a heat test shall be performed until thermal equilibrium has been reached.

C) For the machine with rating for short-time duty, a heat test shall be performed whose duration corresponds to the time given in the rating

D) For the machine with rating for periodic duty, a heat test shall be performed until the steady-state temperature corresponding to the required mode of operation is reached. The steady-state temperature pass for reached when the temperature rises by not more than 2 K per hour.

E) Machines with separate cooling fans, air filters and heat exchangers shall be tested together with this equipment.

F) An extrapolation of the measured values to the disconnection time (t = 0) is not necessary if the reading takes place within the periods listed in Table 3.26.

G) The heat run shall be completed with the determination of the temperature rise. The maximum permissible values shown in Table 3.27 shall not be exceeded.

Table 3.26 Time limits for data acquisition

Rated power [kW/kVA]	Time elapsed after disconnection [second]
up to 50	30
over 50 up to 200	90
over 200 up to 5000	120
over 5000	by agreement

Table 3.27 Permitted temperature-rises of air cooled machines at an ambient temperature of 450 °C (difference values in K)

No.	Machinery component		Method of measurement [3]	Insulation class				
				A	E	B	F 1	H 1
1	AC windings of machines		R	55	70	75	100	120
2	Commutator windings		R	55	70	75	100	120
3	Field windings of AC and DC machines with DC excitation, other than those specified under 4		R	55	70	75	100	120
4	a) Field windings of synchronous machines with cylindrical rotors having DC excitation winding, embedded in slots except synchronous induction motors		R	–	–	85	105	125
	b) Stationary field windings of DC machines having more than on layer		R	55	70	75	100	120
	c) Low-resistance field windings of AC and DC machines and compensation windings of DC machines having more than one layer		R Th	55	70	75	95	115
	d) Single-layer field windings of AC and DC machines with exposed bare or varnished metal surfaces and single-layer compensation windings of DC machines		R Th	60	75	85	105	125
5	Permanently short-circuited, insulated windings		Th	55	70	75	95	115
6	Permanently short-circuited, uninsulated windings		The temperature rises of these parts shall in no case reach such values that there is a risk of injury to any insulation or other material on adjacent parts or to the item itself					
7	Iron cores and other parts not in contact with windings							
8	Iron cores and other parts in contact with windings		Th	55	70	75	95	115
9	Commutators and slip rings, open or enclosed		Th	55	65	75	85	105
10	Plain bearings	measured in the lower bearing shell or in the oil sump after shutdown		45				
11	Roller bearings Roller bearings with special grease	measured in the lubrication nipple bore or near the outer bearing seat		45 75				
12	Surface temperature			Reference 35 [2]				

[1] These values may need correction in the case of high-voltage AC windings.

[2] Higher temperature rises may be expected on electrical machines with insulation material for high temperatures. Where parts of such machinery may be accidentally touched and there is a risk of burns (> 80 °C), BKI reserves the right to request means of protection such as a handrail to prevent accidental contacts.

[3] R = resistance method, Th = thermometer method.

H) Heat tests on machines of identical construction made not more than 3 years previously can be recognized.

I) The referenced temperature rise shall be at least 10 % lower than that listed in Table 3.27.

The following tests shall be carried out at approximately normal operating temperatures.

3.13.5 Overload/overcurrent test

Overload test is to be carried out as a type test for generators as a proof of overload capability of generators and excitation system, for motors as a proof of momentary excess torque. The overload test can be replaced at routine test by the overcurrent test. The over current test shall be the proof of current capability of windings, wires, connections etc. of each machine. The overcurrent test can be done at reduced speed (motors) or at short circuit (generators).

The overload/overcurrent test shall be performed according to the following requirement:

- Generators at 1,5 times the rated current for 30 s
- for general purpose rotating machines, the withstand of the following excess torque shall be demonstrated
- for AC induction motors and DC motors, 1,6 times rated torque for 15 s, without stalling or abrupt change in speed (under gradual increase of torque), the voltage and frequency being maintained at their rated value
- for AC synchronous machine with salient poles, 1,5 times rated torque for 15 s, without, without falling out of synchronism, the voltage, frequency and excitation current being maintained at their rated value
- for AC synchronous machine with wound (induction) or cylindrical rotor, 1,35 times rated torque for 15 s, without, without falling out of synchronism, the voltage, frequency and excitation current being maintained at their rated value
- for general purpose rotating machine, the withstand of the following excess current shall be demonstrated
- for AC motors, 1,5 times rated current for not less than 2 min
- for commutator machines, 1,5 times rated current for 60 s at highest full-field speed
- for anchor windlass motors, at 1,5 times the rated torque for two minutes. Overload tests already performed on motors of identical construction may be recognized.
- The current of the operating stage corresponding to twice the rated torque shall be measured and indicated on the rating plate.
- The overload/overcurrent test is not necessary, if a BKI type test for motors and generators is available.

3.13.6 Short-circuit test

It is to be verified that under steady-state short-circuit conditions, the generator with its voltage regulating system is capable of maintaining, without sustaining any damage, a current of at least 3 times the rated current for a duration of at least 2 s or, where precise data is available, for a duration of any time delay which will be fitted in the tripping device for discrimination purposes.

1) In order to provide sufficient information to the party responsible for determining the discrimination settings in the distribution system where the generator is going to be used, the generator manufacturer shall provide documentation showing the transient behaviour of the short circuit current upon a sudden short-circuit occurring when excited, and running at nominal speed. The influence of the automatic voltage regulator shall be taken into account, and the setting parameters for the voltage regulator shall be noted together with the decrement curve. Such a decrement curve

shall be available when the setting of the distribution system's short-circuit protection is calculated. The decrement curve need not be based on physical testing. The manufacturer's simulation model for the generator and the voltage regulator may be used where this has been validated through the previous type test on the same model.

2) A sudden-short-circuit test may be demanded
   - to determine the reactances
   - if there is any concern regarding mechanical and electrical strength.

   Synchronous generators which have undergone a sudden-short-circuit test shall be thoroughly examined after the test for any damage.

3.13.7 Overspeed test

As proof of mechanical strength, a two minute over speed test shall be carried out as follows:

- for generators with their own drive, at 1,2 times the rated speed
- for generators coupled to the main propulsion plant and not arranged in the main shafting, at 1,25 times the rated speed
- for shaft generators arranged in the main shafting and whose construction makes testing impracticable, proof by computation of mechanical strength is required
- for motors with one nominal speed, at 1,2 times the no-load speed
- for variable-speed motors, at 1,2 times the maximum no-load speed
- for motors with series characteristics, at 1,2 times the maximum speed shown on the rating plate, but at least at 1,5 times the rated speed

The overspeed test may be dispensed with in the case of squirrel-cage machines

3.13.8 Winding test (high-voltage test)

1) The test voltage shall be as shown in Table 3.28. It shall be applied for 1 minute for each single test.

   The voltage test shall be carried out between the windings and the machine housing, the machine housing being connected to the windings not involved in the test. This test shall be performed only on new, fully assembled machines fitted with all their working parts.

   The test voltage shall be a practically sinusoidal AC voltage at system frequency.

   The maximum anticipated no-load voltage or the maximum system voltage is to be used as reference in determining the test voltage.

Table 3.28 Test voltages for the winding test

No.	Machine or machinery component	Test voltage (r.m.s.) dependent on rated voltage U of the subject winding
1	Insulated windings of rotating machines of output less than 1 kW (kVA), and of rated voltages less than 100 V with the exception of those in items 4 to 8	2 U + 500 V
2	Insulated windings of rotating machines of size less than 10.000 kW (kVA), with the exception of those in item 1 and items 4 to 8	2 U + 1000 V, with a minimum of 1500 V
3	Insulated windings of rotating machines of size 10.000 kW (kVA) or more with the exception of those in items 4 to 8 rated voltage up to 11.000 V	2 U + 1000 V
4	Separately excited field windings of DC machines	1000 V + twice the maximum excitation voltage but not less than 1500 V

Table 3.28 Test voltages for the winding test *(continued)*

No.	Machine or machinery component	Test voltage (r.m.s.) dependent on rated voltage U of the subject winding
5	Field windings of synchronous generators, synchronous motors and rotary phase converters	
	rated field voltage up to 500 V	10 times rated field voltage, with a minimum of 1500 V
	over 500 V	4000 V + twice rated field voltage
	When a machine is intended to be started with the field winding short-circuited or connected across a resistance of value less than ten times the resistance of the winding	10 times the rated field voltage, minimum 1500 V, maximum 3500 V
	When the machine is intended to be started either with the field winding connected across a resistance of value equal to, or more than, ten times the resistance of the winding, or with the field windings on open-circuit with or without a field dividing switch	1000 V + twice the maximum value of the r.m.s. voltage, which can occur under the specified starting conditions, between the terminals of the field winding, or in the case of a sectionalized field winding between the terminals of any section, with a minimum of 1500 V
6	Secondary (usually rotor) windings of induction motors or synchronous induction motors if not permanently short-circuited (e.g. if intended for rheostatic starting)	
	for non-reversing motors or motors reversible from standstill only	1000 V + twice the open-circuit standstill voltage as measured between slip rings or secondary terminals with rated voltage applied to the primary windings
	for motors to be reversed or braked by reversing the primary supply while the motor is running	1000 V + four times the open-circuit secondary voltage as defined in item 6a)
7	Exciters (exception below)	as for the windings to which they are connected
	Exception 1: Exciters of synchronous motors (including synchronous induction motors) if connected to earth or disconnected from the field windings during starting	twice rated exciter voltage + 1000 V, with a minimum of 1500 V
	Exception 2: Separately excited field windings of exciters	as under item 4
8	Assembled group of machines and apparatus	A repetition of the tests in items 1 to 7 above should be avoided if possible, but if a test on an assembled group of several pieces of new machines, each one of which has previously passed its high-voltage test, is made, the test voltage to be applied to such assembled group shall be 80 % of the lowest test voltage [1]

[1] Where a number of windings belonging to one or more machines are connected together, the test voltage is dictated by the maximum voltage to earth which can occur.

2) Any repetition of the voltage test which may be necessary shall be performed at only 80 % of the nominal test voltage specified in Table 3.28.

3) Electrical machines with medium voltage ratings shall be subjected to a lightning impulse withstand voltage test acc. to IEC publication 60034-15. The test shall be carried out for the coils as a random sample test.

3.13.9 Insulation resistance measurement

The insulation resistance measurement shall be carried out at the end of the test sequence, with the machine at operating temperature, if possible. Insulation resistance is to be measured between:

- All current carrying parts connected together and earth
- All current carrying parts of different polarity or phase, where both ends of each polarity or phase are individually accesible

Minimum values of the measuring voltage and the insulation resistance shall be taken from Table 3.29.

Table 3.29 Minimum values for measurement voltage and insulation resistance

Rated voltage [V]			Measurement voltage [V]	Insulation resistance [MΩ]
	Un ≤	250	2 × Un	1
250	< Un ≤	1000	500	1
1000	< Un ≤	7200	1000	$\frac{U_n}{1000}+1$
7200	< Un ≤	15000	5000	$\frac{U_n}{1000}+1$

The maximum anticipated no-load voltage or the maximum system voltage shall be taken for the rated voltage.

3.13.10 Test of degree of protection

See Rules for Electrical Installations (Pt.1, Vol.IV) Sec. 1.K.

3.13.11 Bearing check

Upon completion of the above tests, machines which have sleeve bearings are to be opened upon request for examination by BKI Surveyor, to establish that the shaft is correctly seated in the bearing shells.

3.13.12 Test of voltage regulator

See Rules for Electrical Installations (Pt.1, Vol.IV) Sec. 3.B.2

3.14 Transformer

3.14.1 Heat test

The test shall be performed to determine the temperature rise, which shall not exceed the maximum permissible values shown in Table 3.30.

Temperature rise tests on transformers of identical construction and carried out not more than 3 years previously may be recognized. The referenced temperature rise shall be 10 % below the values shown in Table 3.30.

Table 3.30 Permissible temperature rise of transformer and reactance coil windings with an ambient temperature of 45 ^{0}C

Insulation class	A	E	B	F	H
Temperature rise [K]	55	70	75	95	120

The following tests shall be performed at approximately operating temperature.

3.14.2 Induced overvoltage test

The windings shall be tested at twice the rated voltage and at increased frequency to verify that the insulation between turns is sufficient and satisfactory.

The duration of the test shall be

$$120\text{s} \cdot \frac{\text{rated frequency}}{\text{testf frequency}}$$

but not less than 15 seconds.

3.14.3 Short-circuit test

On request, the transformers, in co-operation with their protection device, shall be able to withstand without damage the effect of external short-circuits.

3.14.4 Winding test

The test voltage shown in Table 3.31 shall be applied between the winding parts to be tested and all other windings, which are to be connected to the core and the frame during the test.

The test voltage shall be applied for 1 minute.

Table 3.31 Test voltage for transformers and reactance coil windings

Maximum operating voltage [V]	Alternating withstand voltage [V]
≤ 1000	3000
3600	10000
7200	20000
12000	28000
17500	38000

3.14.5 Determination of insulation resistance

The measurement of insulation resistance shall be carried out at the end of the test sequence with a DC voltage of at least 500 V.

The insulation resistance shall be at least:

- 5 MΩ between primary and secondary winding
- 2 MΩ for the remaining insulation

U. Cable Laying

1. Application

The requirements in this Sub-section apply to tests and inspection for the approval of fire stop method for bunched cables (ex: fire stop mat, hereinafter referred to fire stop methods in this Sub-section) and non-metallic cable bands which are required an advance approval by BKI in accordance with the requirements in Rules for Electrical Installations (Pt.1, Vol.IV) Sec.21 and Sec. 12.D.6.

2. Data to be submitted

The manufacturer or constructer is to submit to BKI the drawings and documents specified in 2.1 for the approval of the fire stop methods, and those specified in 2.2 for the approval of non-metallic cable bands in addition to those specified in A.2.

2.1 Fire stop methods of cable

1) Characteristic of materials
2) Instructions for work procedures (in case of paints being used, the painting method and procedure including painting condition and the dry film thickness of paint are to be specified)
3) Copies of certificates or test records issued by official organizations (if any)

2.2 Non-metallic cable bands

1) Type name
2) Construction plan (including principal dimensions)
3) Characteristic of materials
4) Copies of certificates or test records issued by official organizations (if any)

3. Type tests

3.1 Prevention methods of flame spread through cable

The type tests for prevention methods of flame spread through cable are to be carried out in accordance with IEC 60332-3-22.

3.2 Non-metallic cable bands

The type tests for non-metallic cable bands are, according to the purpose and kind, to be carried out in accordance with the requirements given in Table 3.32.

Table 3.32 Approval test method and acceptance criteria for non-metallic cable bands

Kind	Test item	Approval test method and acceptance criteria
Test specimens		The tests are to be done with the ten test specimens which were left in air for 30 minutes prior to tests, after conditioned at 20 ± 2°C and 50 ± 2% relative humidity for 24 hours.
Test method	Flame retardant test	(a) The test specimens are to be set upright in a test box of 1,200 ± 25 mm high, 300 ± 25 mm wide, 450 ± 25 mm deep, opened front face, nonmetallic bottom and other faces made of wire net and the distance from the lowest side of specimens to the bottom is to be adjusted to 50 mm. (b) The heating source from gas burner with tip of inner diameter 10 mm is to be blue flame of length of 100 mm and temperature of 800 ± 50°C.

Table 3.32 Approval test method and acceptance criteria for non-metallic cable bands *(continued)*

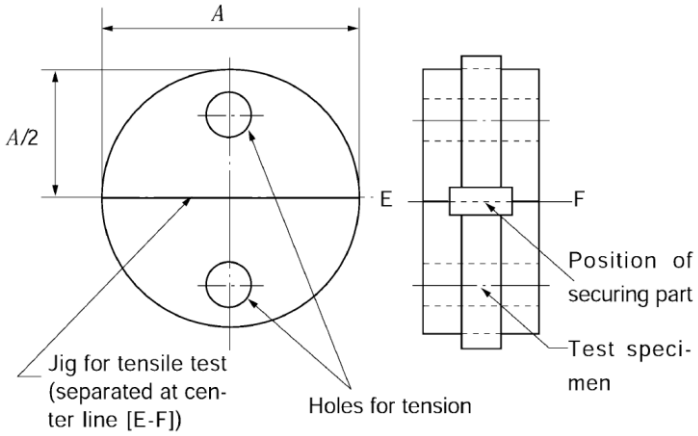
<table>
<tr><th>Kind</th><th>Test item</th><th>Approval test method and acceptance criteria</th></tr>
<tr><td>Test method</td><td>Flame retardant test</td><td>(c) The bottom of burner is to be at an angle of 45° against the specimens and the flame center is to be positioned at the height of 50 mm above the lowest side of specimen. The flame is to be applied for 60 seconds.
(d) When the flame is removed, the flame ignited on the specimen is to be self-extinguished and the burnt trace is not to reach to the top of upper part as cleaned.</td></tr>
<tr><td rowspan="2">Test method</td><td>Mechanical property test before and after aging test</td><td>(a) The tensile strength for ten test specimens is to be measured using the jig shown in Fig 3.11 before and after the aging test. The length of A described in the Figure is 30 mm for specimens of 200 mm length or less, and is chosen as appropriate for those of more than 200 mm length.
 

Fig 3.11 Attachment for Test Specimen of Cable Band
(b) The test specimens are to be placed at a temperature of 90 ± 2°C for 240 hours.
(c) The required tensile strength before and after aging test is shown in Table below.
<table>
<tr><th rowspan="2">Length of test specimen (mm)</th><th colspan="2">Min. tensile strength (N)</th></tr>
<tr><th>before aging test</th><th>after aging test</th></tr>
<tr><td>200 or below</td><td>250</td><td>188</td></tr>
<tr><td>over 200</td><td>500</td><td>375</td></tr>
</table></td></tr>
<tr><td>Bending test of low temperature</td><td>(a) Effective length of specimen except securing part and end is to be tested.
(b) After the aging test in (b) of Mechanical property test before and after aging test above, the diameter of round bar which is not more than 5 times of thickness of test specimens and specimens are to be placed at temperature of - 25 ± 2°C for four hours, and the test specimens are spirally rolled on the bar 5 times at the speed of one revolution per 5 seconds.
(c) When the test specimens rolled on the round bar are placed at room temperature, any crack is not to be allowed.</td></tr>
</table>

3.3 Non-metallic cable trays/protective casings

The type tests for cable trays/protective casings made of plastics materials are, according to the purpose and kind, to be carried out in accordance with the requirements given in Table 3.33.

Table 3.33 Type tests for cable trays/ protective casings made of plastics materials

Test item	Approval test method and acceptance criteria
Impact Resistance Test	The test should be performed according to IEC 60082-2 using the pendulum hammer. (a) The test should be carried out on samples of cable tray lengths or cable ladder lengths of 250 mm ± 5 mm long. Samples of ladder should consist of two side-members with one rung positioned centrally. Samples of mesh trays should be prepared in such a way that there will be a wire in the centre.

Table 3.33 Type tests for cable trays/ protective casings made of plastics materials *(continued)*

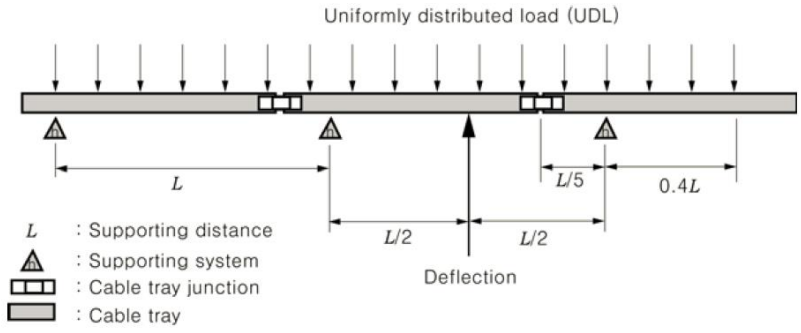
<table>
<tr><th colspan="2">Test item</th><th>Approval test method and acceptance criteria</th></tr>
<tr><td colspan="2">Impact Resistance Test</td><td>(b) Before the test, plastics components should be aged at a temperature of 90°C ± 2°C for 240 h continuously.
(c) The samples should be mounted on wooden fibreboard of thickness 20 mm ± 2 mm.
(d) The samples to be tested should be placed in a refrigerator, the temperature within which is maintained at the declared temperature below with a tolerance of ±2°C.
-25°C to 90°C for outdoor use
+ 5°C to 90°C for indoor use.
Consideration will be given to the use of plastics cable trays/protective casings in the cold environment where the ambient temperature is below -25°C provided the mechanical properties of the plastics can be maintained for the intended purpose and the installation location. In this particular instance, the cold bend and cold impact properties of the material should also be considered.
(e) After 2 h, the samples should, in turn, be removed from the refrigerator and immediately placed in the test apparatus.
(f) At 10 s ± 1s after removal of each sample from the refrigerator the hammer should be allowed to fall with impact energy, mass of the hammer and fall height as bellows:
(g) The impact should be applied to the base, or the rung, in the first sample, to one of the side members in the second sample, and to the other side member in the third sample.
<table>
<tr><th>Approximate energy(J)</th><th>Mass of hammer (kg)</th><th>Fall height(mm)</th></tr>
<tr><td>10</td><td>5.0</td><td>200 ± 2</td></tr>
</table>
In each case, the impact should be applied to the centre of the face being tested.
(h) After the test, the samples should show no signs of disintegration and/or deformation that will impair the safety.</td></tr>
<tr><td rowspan="3">Safe Working Load (SWL) Test</td><td>application</td><td>Tests should be carried out for the smallest and largest sizes of cable trays lengths or cable ladder lengths, having the same material, joint and topological shape.</td></tr>
<tr><td>Test temperature</td><td>Cable trays/protective casings and joints should be tested at the declared temperatures according to (d) of impact resistance test above. Alternatively, tests can be carried out:
(a) at any temperature within the declared range if documentation is available which states that the relevant structural properties of the materials as used within the system do not differ by more than 5% of the average between the maximum and minimum property values, or,
(b) only at maximum temperature within the range, if documentation is available, which states that the relevant structural properties of the materials, as used within the system decrease when the temperature is increasing, or
(c) at maximum and minimum temperature only.</td></tr>
<tr><td>Test loads</td><td>All loads should be uniformly distributed (UDL) over the length and width of the samples as shown in Fig 3.12. The loads should be applied in such a way that a UDL is ensured even in the case of extreme deformation of the samples.


Fig 3.12 UDL applying method</td></tr>
</table>

Table 3.33 Type tests for cable trays/ protective casings made of plastics materials *(continued)*

Test item		Approval test method and acceptance criteria
Safe Working Load (SWL) Test	Load test	(a) To allow for settlement of the samples, a pre-load of 10% of the test load unless otherwise specified, should be applied and held for at least 5 min, after which the measurement apparatus should be calibrated to zero. (b) The load should then be gradually increased evenly longitudinally and transversely up to the test load continuously or when a continuous increase is impractical, the load may be increased by increments. These increments should not exceed about a quarter of the safe working load. The load increments should be distributed through the load plates longitudinally and transversely as evenly as is practical. (c) After loading, the deflection should be measured at the points specified to give a practical mid-span deflection. (refer to Fig 3.12) The samples should be left, and the deflections measured every 5 minutes until the difference between two consecutive sets of readings is less than 2 % with regard to the first set of the two consecutive sets of readings. The first set of readings measured at this point is the set of deflections measured at the test load. (d) The maximum deflection should not exceed L/100 where L is the distance between the supports. (refer to Fig 3.12) (e) When subject to the test load the samples, their joints and internal fixing devices, should show no damage or crack visible to normal view or corrected vision without magnification
	Breaking test	(a) The load should then be increased to 1,7 times the test load. (b) The samples should be left, and the deflections measured every 5 min until the difference between two consecutive sets of readings is less than 2 % with regard to the first set of the two consecutive sets of readings. (refer to Fig 3.5) (c) The samples should sustain the increased loading without collapsing. Buckling and deformation of the samples is permissible at this loading.
Flame Retardant Test		The cable trays/protective casings should be at least flame retardant. They should be tested in accordance with Table 3.43 of Y.4. of this Guidance.
Smoke and Toxicity Test		The cable tray/protective casings should be tested in accordance with Y. 4 of this Guidance
Resistivity Test		(a) Cable trays/protective casings passing through a hazardous area should be electrically conductive. The cable tray/protective casings should be tested in accordance with IEC 60093. (b) The volume resistivity level of the cable trays/protective casings and fittings should be below 10^5 ohm and the surface resistivity should be below 10^6 ohm. The resistance to earth

V. Automatic and Remote Control Systems

1. Application

1.1 The requirements of this Sub-section apply to tests and inspection for the type approval of the automatic and remote-control systems (device, units and sensors, etc) including basic softwares (if any) for use in the marine environment in accordance with the requirements in the Rules for Automation (Pt.1, Vol.VII) Sec. 7.E. However, fire detection system and gas detection system are to comply with the following requirements.

1.1.1 Fire detection system is to comply with the Recognized Standard.

1.1.2 Design requirements and performance tests for gas detection system for measurement and detection of fixed/portable combustible gases are to comply with IEC 60079-29-1 or equivalent standard. However audible alarm level and signal characteristics are to comply with IMO Res. A.830(19).

1.1.3 Gas detection system for oxygen detection and measurement is to comply with the Recognized Standard. However, audible alarm level and signal characteristics are to comply with IMO Res. A.830(19).

1.1.4 Compass safe distance test for the automatic and remote control systems that are to be installed less than 5 m from magnetic compass is to be carried out in accordance with IEC 60945:2002, paragraph 11.2.

1.2 Electrical and electronic equipment on board ships, required neither by BKI Rules nor by International conventions, liable to cause electromagnetic disturbance are to be of type which fulfil the test requirements of test specification item 20 and 21 of Table 3.34

1.3 The automatic and remote control systems are to be provided with a degree of protection appropriate to the location in accordance with the requirements in Rules for Electrical Installations (Pt.1, Vol.IV) Sec. 1, K.

2. Documents to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

2.1 General

2.1.1 All documentation shall provide relevant information in a clear and unambiguous manner.

2.1.2 Symbols and abbreviations used shall be explained, or referenced to an appropriate international standard or code recognized by BKI.

2.2 Hardware

2.2.1 System block diagram, showing the arrangement, input and output devices and interconnections

2.2.2 Wiring diagram (electrical systems), piping diagram (pneumatic or hydraulic systems)

2.2.3 Details of input and output devices

2.2.4 Details of power supplies

2.3 System functional description

2.3.1 System specifications

2.3.2 System performance for normal or abnormal equipment operation.

2.3.3 Instructions for normal and abnormal operating modes;

2.3.4 Transfer of control

2.3.5 Redundancy or reversionary mode

2.3.6 Test facilities

2.3.7 Failure detection and identification facilities (automatic and manual)

2.3.8 Data security

2.3.9 Access restriction

2.3.10 Special aspects requiring user attention.

2.3.11 In addition, documentation shall be provided concerning procedures for:

- start-up
- restoration of functions
- maintenance and periodical testing
- data back-up
- software reloads and system regeneration
- failure location and repair

2.4 Software

2.4.1 Quality plan

2.4.2 Software shall be fully described, e.g.:

- a description of the basic software installed in each hardware unit;
- a description of the communication software installed on nodes in a network;
- descriptions of application software (not program listings);
- tools for system set-up and process equipment configuration.

2.4.3 The description of application software shall include, e.g.:

- information of system modules that must be operative in order to maintain functions including dependencies on other systems;
- detail of each module at a level sufficient to understand its function;
- relationship between the software modules that must be operative in order to maintain each function;
- data and control flow between software modules;
- configuration of the software, including priority schemes;
- switching mechanisms for redundant systems.

2.4.4 A schedule of anticipated equipment operation ranges and limits for alarm and safety functions shall be provided.

2.5 User interface

2.5.1 Control station design and arrangement shall be detailed including drawings, dimensions, pictures, etc. of each user input or output device at a level sufficient to assess the working principles.

2.5.2 Details of screen based computer dialogue shall be produced, including:

- description of the functions allocated to each input device;
- details of individual screen views, e.g. schematics, colour photos, etc.;
- description of menu operation.

2.6 Failure analysis for safety related functions only is to be carried out using appropriate means such as FMEA and the results are to be submitted to BKI

3. Type test report

Upon completion of the type test, the manufacturer is to submit to BKI the complete test report including test conditions, test results and required information.

4. Type test

4.1 Hardware

4.1.1 General

1) Tests are to be carried out under following atmosphere conditions, rated electrical source voltage and rated electrical source frequency unless otherwise specified.
   J) temperature: 25 ± 10 °C
   K) relative humidity: 60 ± 30 %
   L) atmospheric pressure: 96 kPa ± 10 kPa
2) Measuring and testing equipment used in the type test are to be calibrated in accordance with the related standards and/or codes.
3) The number of EUT (Equipment Under Test) is, as a rule, to be one for each type. However, additional EUT may be required when deemed necessary by BKI.
4) Raising and lowering rate of temperature is to be within 1 °C /min (mean value for 5 minutes) unless otherwise specified.
5) Power supply variation test and pressure test are applied on pneumatic and hydraulic type equipment only.
6) Flame retardant test is to be generally applied by manufacturer's option to demonstrate that plastic components of the equipment under test with a large mass are flame retardant and self-extinguishing under the influence of flame.

4.1.2 Test methods and criteria

1) After the drawings and documents submitted in accordance with the requirements in 2. have been examined, tests are to be carried out in accordance with the testing condition and method of Table 3.34 in the presence of BKI's surveyor, and they are to be proven to satisfy the criteria of Table 3.34.
2) Where tests which do not fully comply with the testing condition and method, and the criteria of Table 3.34, they may comply with a standard deemed appropriate by BKI such as IEC, Standard Nasional Indonesia (SNI) or other recognized standard.
3) In contrast to a complete performance test, a functional test is a simplified test sufficient to verify that the equipment under test (ETU) has not suffered any deterioration caused by the individual environmental tests.
4) In application to high voltage test of Table 3.34, if agreed by BKI, the test may be carried out by referring of Rules for Electrical Installations (Pt.1, Vol.IV) Sec.20.

4.2 Software

4.2.1 Module tests

Software module tests are to provide evidence that each module performs its intended function and does not perform unintended functions.

4.2.2 Subsystem tests

Sub-system testing is to verify that modules interact correctly to perform the intended functions and do not perform unintended functions.

4.2.3 System test

System testing is to verify that subsystems interact correctly to perform the functions in accordance with specified requirements and do not perform unintended functions.

4.3 Performance tests

4.3.1 Integration tests

Programmable electronic system integration testing is to be carried out using satisfactorily tested system software, and as far as practicable intended system components.

4.3.2 Fault simulation

Faults are to be simulated as realistically as possible to demonstrate appropriate system fault detection and system response. The results of any required failure analysis are to be observed.

Table 3.34 Environmental test items, testing conditions and methods, and criteria

No.	Test Item	Testing condition and method	Criteria
1	Visual inspection	Examine the external, structure, etc., of the equipment.	The equipment complies with the specifications.
2	Performance test	- Check the operation of the equipment. - Check the self-monitoring features if provided. - Check the specified protection against an access to the memory. - Check against the effect of un-erroneous use of control elements in the case of computer systems. - When the EUT is required to comply with an international performance standard, e.g. protection relays, verification of requirements in the standard are to be part of the performance testing required in this initial test and subsequent performance tests after environmental testing.	The equipment operates satisfactory.
3	Electrical power supply failure test	- Check the operation of the equipment when the electrical power supply is interrupted 3 times for 5 minutes. (interruption time is 30 seconds each time) - The time of 5 minutes may be exceeded if the equipment under test needs a longer time for start-up, e.g. booting sequence. For equipment which requires booting, one additional power supply interruption during booting to be performed - Check the possible corruption of programme or data held in programmable electronic systems (where applicable)	The equipment operates satisfactory without manual calibration after restoration of the electrical power supply.

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>4</td><td>Electrical power supply variation test</td><td>- Check the operation of the equipment when the electrical power supply varies as shown in the following
AC supply
<table>
<tr><th>Combination</th><th>Voltage variation permanent (%)</th><th>Frequency variation permanent (%)</th></tr>
<tr><td>1</td><td>+6</td><td>+5</td></tr>
<tr><td>2</td><td>+6</td><td>-5</td></tr>
<tr><td>3</td><td>-10</td><td>-5</td></tr>
<tr><td>4</td><td>-10</td><td>+5</td></tr>
<tr><td></td><td>Voltage transient (%)</td><td>Frequency transient (%)</td></tr>
<tr><td></td><td>1,5 sec</td><td>5 sec</td></tr>
<tr><td>5</td><td>+20</td><td>+10</td></tr>
<tr><td>6</td><td>-20</td><td>-10</td></tr>
</table>
DC supply
<table>
<tr><td rowspan="3">For the equipment not related to a battery (%)</td><td>Voltage tolerance continuous</td><td>± 10</td></tr>
<tr><td>Voltage cyclic variation</td><td>5</td></tr>
<tr><td>Voltage ripple</td><td>10</td></tr>
<tr><td rowspan="2">For the equipment related to a battery (%)</td><td>For thr equipment connected to a battery during charging</td><td>-25 ~ +30</td></tr>
<tr><td>For the equipment not connected to a battery charging</td><td>-25 ~ +20</td></tr>
</table>
- Check the possible corruption of programme or data held in programmable electronic systems (where applicable)</td><td>- No abnormality is observed.
- The equipment operates satisfactory.</td></tr>
<tr><td>5</td><td>Power supply variation test</td><td>Check the operation of the equipment when the pneumatic and the hydraulic power supplies are maintained continuously +20 % and -20 % of the working pressure for at least 15 minutes.</td><td>- No abnormality is observed.
- The equipment operates satisfactory.</td></tr>
<tr><td>6</td><td>Dry heat test</td><td>- The test shall be carried out at 25 ±2 °C in atmospheric temperature.
- The absolute humidity shall not exceed 20 g of water vapor per cubic meter of air (corresponding approximately to 50 % relative humidity at 35°C).
- Test A: The equipment is at an operating condition and apply the environmental condition of +70±2°C for 16 hours. And check the operation of the equipment during the last 1 hour at the test temperature and after recovery. Dry heat at 70 °C is to be carried out to automation, control and instrumentation equipment subject to high degree of heat, for example mounted in consoles, housings, etc. together with other heat dissipating power equipment. (see Fig. 3.13)
- Test B: For the equipment installed in air-conditioned spaces, the environmental condition of +55 ±2°C for 16 hours may be applied. Check the operation of the equipment during the last 1 hour at the test temperature and after recovery. Where the equipment is attached with other equipment in the console and housing, test A is to be performed. (see Fig 3.13)
- Detailed test methods are referred to Test Bb for non-heat dissipating equipment or Test Be for heat dissipating equipment of IEC 60068-2-2:2007.</td><td>- No abnormality is observed.
- The equipment operates satisfactory.</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

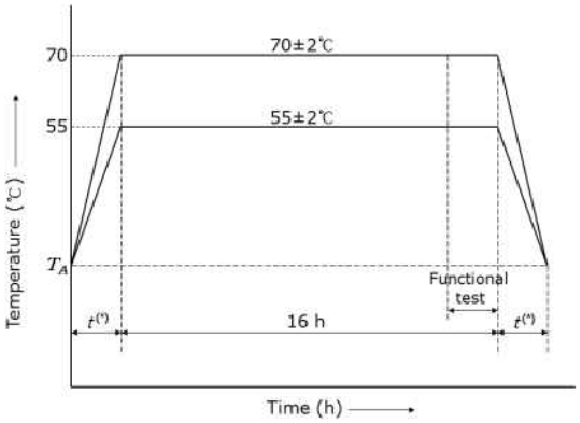
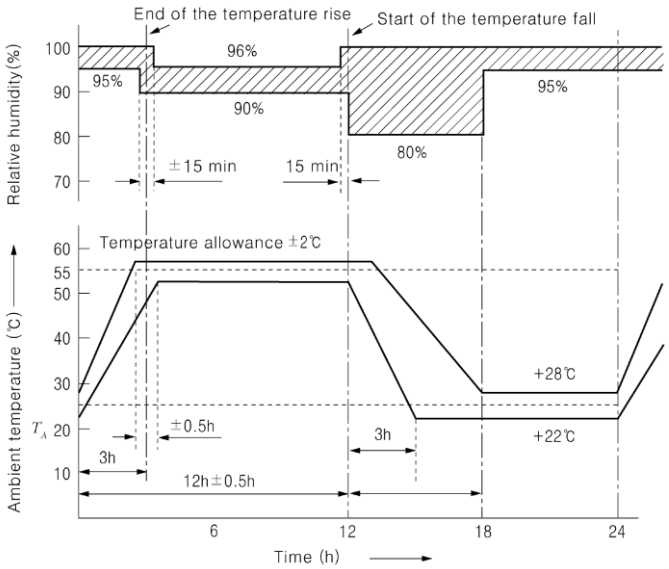
No.	Test Item	Testing condition and method	Criteria
6	Dry heat test	 Fig 3.13 Program of dry heat test ***Note*** *(*) Raising and lowering rate of temperature is to be within 1°C/min.(mean value for a period within 5 minutes)*	- No abnormality is observed. - The equipment operates satisfactory.
7	Damp heat test	- The test shall start with 25°C ± 3°C and at least 95% humidity. - The temperature in the chamber shall be continuously raised to 55 ±2 °C during 3h±30 min. During this period, the relative humidity shall be not less than 95 %, except during the last 15min when it shall be not less than 90 %. (see Fig 3.14) - The temperature shall then be maintained 55 ±2 °C until 12h ±30 min from the start of the cycle. During this period, the relative humidity shall be 93±3%, except for the first and last 15 min when it shall be between 90% and 100%.  Fig 3.14 Program of damp heat test - 2 cycles shall be carried out as shown in Fig 3.14. The equipment is kept under operating condition during complete 1st cycle and switched off during 2nd cycle except for the operation test. And check the operation of the equipment during the first 2 hours of the 1st cycle at the environmental condition, during the last 2 hours of 2nd cycle at the environmental condition and after recovery - Insulation resistance measurements are carried out before and after test. - Detailed test methods are referred to Test Db of IEC 60068-2-30:2005.	- No abnormality is observed. - The equipment operates satisfactory.

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>8</td><td>Vibration test</td><td>- The equipment is at an operating condition and apply the sweeping of vibration specified in the following over the frequency range of 2(+3,-0) Hz ~ 100 Hz in order to find resonance points. (points of which amplification factor: (Q ≥ 2 are considered resonance points.)
<table>
<tr><th>Frequency</th><th>Amplitude or Acceleration</th></tr>
<tr><td>2 (+3, 0) ~ 13,2 Hz</td><td>Amplitude ± 1,0 mm</td></tr>
<tr><td>13,5 ~ 100 Hz</td><td>Acceleration ± 0,7 g</td></tr>
</table>
- When resonance points do not exist, apply the vibration of acceleration ±0,7 g at 30 Hz for 90 minutes as an endurance test.
- When resonance points exist, repeat the test with necessary provisions to avoid resonance or apply the vibration (same amplitude or acceleration of resonance point) at the resonance frequency for 90 minutes as an endurance test. However, where sweep test is to be carried out instead of the discrete frequency test and a number of resonant frequencies is detected close to each other, duration of the test is to be 120 min.
- Sweep over a restricted frequency range between 0,8 and 1,2 times the critical frequencies can be used where appropriate. Critical frequency is a frequency at which the equipment being tested may exhibit:
  - malfunction and/or performance deterioration
  - mechanical resonances and/or other response effects occur, e.g. chatter
- during the vibration test, functional tests are to be carried out;
- The test is carried out in three axis directions.
- It is recommended as guidance that Q does not exceed 5,
- For the equipment intended to be installed in severe vibration conditions such as diesel engines, air compressors, the vibration level specified in the following is applied.
<table>
<tr><th>Frequency</th><th>Amplitude or Acceleration</th></tr>
<tr><td>2 (+3, 0) ~ 25,0 Hz</td><td>Amplitude ± 1,6 mm</td></tr>
<tr><td>25,0 ~ 100 Hz</td><td>Acceleration ± 4,0 g</td></tr>
</table>
- More severe conditions may exist for example on exhaust manifolds of diesel engines especially for medium and high-speed engine. Values may be required to be in these cases 40 Hz to 2000 Hz- acceleration ±10,0 g at 600 °C duration 90 minutes.
- Detailed test methods are referred to Test Fc of IEC 60068-2-6:2007.</td><td>- No abnormality is observed.
- The equipment operates satisfactory.</td></tr>
<tr><td>9</td><td>Inclination test</td><td>a) inclined to the vertical at an angle of at least 22,5°
b) inclined to at least 22,5° on the other side of the vertical and in the same plane as in (a),
c) inclined to the vertical at an angle of at least 22,5° in plane at right angles to that used in (a),
d) inclined to at least 22,5° on the other side of the vertical and in the same plane as in (c).
Note: The period of testing in each position should be sufficient to fully evaluate the behaviour of the equipment.
- Using the directions defined in a) to d) above, the equipment is to be rolled to an angle of 22,5° each side of the vertical with a period of 10 seconds.
- The test in each direction is to be carried out for not less than 15 minutes.
- On ships for the carriage of liquified gases and chemicals, the emergency power supply is to remain operational with the ship flooded up to a maximum final athwart ship inclination of 30°.
Note: These inclination tests are normally not required for equipment with no moving parts.
- Detailed test methods are referred to IEC 60092-504:2016.</td><td>- No abnormality is observed.
- The equipment operates satisfactory.</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

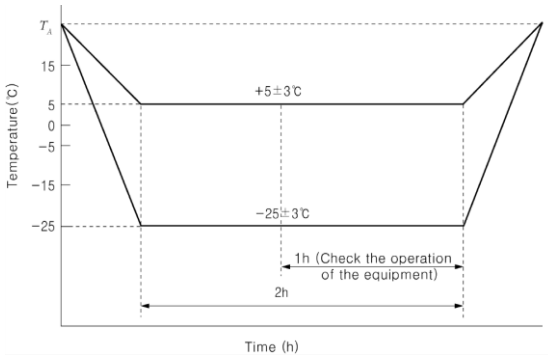
<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>10</td><td>Insulation resistance test</td><td>- Measure the insulation resistance between current carrying parts and between current parts and earth when measured with the following application voltage.
<table>
<tr><td>Rated voltage : Un (V)</td><td>Test voltage (D.C Voltage) (V)</td></tr>
<tr><td>Un ≤ 65</td><td>2 x Un, min. 24</td></tr>
<tr><td>Un > 65</td><td>500</td></tr>
</table>
- Measurements are carried out before and after; other series of environmental tests, damp heat test, cold test and salt mist test.
- For the equipment containing circuits in which the application of the test voltage is not desirable, the test voltage is applied after removing the circuits.
- For high voltage equipment, reference is made to IACS UR E11.
- insulation resistance test is to be carried out before and after: damp heat test, cold test, salt mist test and high voltage test;
- between all phases and earth; and where appropriate, between the phases.
Note: *Certain components e.g. for EMC protection may be required to be disconnected for this test*.</td><td>- The insulation resistance (MΩ) is not less than the value specified in the following.
<table>
<tr><td>Rated voltage</td><td>Before test</td><td>After test</td></tr>
<tr><td>Un ≤ 65</td><td>10</td><td>1,0</td></tr>
<tr><td>Un > 65</td><td>100</td><td>10</td></tr>
</table></td></tr>
<tr><td>11</td><td>High voltage test</td><td>- Apply the following test voltage, alternating of a frequency of 50 Hz or 60 Hz, between current carrying parts and between current-carrying parts connected and earth for 1 minute.
<table>
<tr><td>Rated voltage : Un (V)</td><td>Test voltage (V)</td></tr>
<tr><td>Un ≤ 65</td><td>2 x Un + 500</td></tr>
<tr><td>65 < Un ≤ 250</td><td>1500</td></tr>
<tr><td>250 < Un ≤ 500</td><td>2000</td></tr>
<tr><td>500 < Un ≤ 690</td><td>2500</td></tr>
</table>
- For the equipment containing circuits in which the application of the test voltage is not desirable, the test voltage is applied after removing the circuits.
- For high voltage equipment, reference is made to IACS UR E11.</td><td></td></tr>
<tr><td>12</td><td>Cold test</td><td>- The test shall be carried out at 25 ±10 °C in atmospheric temperature.
- The equipment is switched off except for the operation test and apply the environmental condition of +5 ±3 °C for 2 hours. And check the operation of the equipment during the last hour at the test temperature and after recovery.
- For the equipment installed in open decks, etc., the environmental condition of -25 ±3 °C is applied for 2 hours.
- Insulation resistance measurements are carried out before and after cold test.
- Detailed test methods are referred to test Ab or test Ad of IEC 60068-2-1:2007
 

Fig 3.15 Program of cold test</td><td>- No abnormality is observed.
- The equipment operates satisfactory.</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>13</td><td>Salt mist test [2]</td><td>- The equipment is switched off except when its operation is checked. Apply four cycles of the environmental condition of spraying NaCl liquid (saline solution, 5 % NaCl, pH 6,5 ~ 7,2, 20 ±2 °C) for 2 hours and leaving for 7 days. Check the operation of the equipment during the 7th day of each cycle and after recovery.
- Damp chamber conditions for storage are to be maintained as follows;
- Temp.: 40 °C ±2 °C
- Relative humidity: 93% +2% -3%
The test is carried out according to the following procedure
- Insulation resistance and functional test before test
- Functional test on the 7th day of each cycle period
- Insulation resistance and functional test: 4 to 6 hours after recovery
- Detailed test methods are referred to Test kb of IEC 60068-2-52:2017.</td><td>- No abnormality is observed.
- The equipment operates satisfactory.</td></tr>
<tr><td>14</td><td>Electrostatic discharge immunity test.</td><td>- Check the operation of the equipment when the electrostatic discharge immunity test is carried out according to the following condition.
<table><tr><td>Contact Discharge</td><td>6 kV</td></tr><tr><td>Air Discharge</td><td>2 kV, 6 kV, 8 kV</td></tr><tr><td>Interval between single discharge</td><td>1 sec.</td></tr><tr><td>No. Of Pulses</td><td>10 per polarity</td></tr></table>- The test is to be confined to the points and surfaces that can normally be reached by the operator.
- Detailed test methods are referred to Level 3 of IEC 61000-4-2:2008.
- If an equipment is intended to receive radio signals for the purpose of radio communication (e.g. wifi router, remote radio controller), then the immunity limits at its communication frequency do not apply, subject to the provisions in Rules for Electrical Installations (Pt.1, Vol.IV) Sec. 10. E.2.</td><td>Performance Criterion B [2]</td></tr>
<tr><td>15</td><td>Radiated radio frequency immunity test</td><td>- Check the operation of the equipment when the radiated radio frequency immunity test is carried out according to the following condition.
<table><tr><td>Frequency range</td><td>80 MHz ~ 2 GHz</td></tr><tr><td>Modulation</td><td>80 % AM at 1000 Hz</td></tr><tr><td>Field strength</td><td>10 V/m</td></tr><tr><td>Frequency sweep rate</td><td>≤ 1,5 x 10-3 decades/ sec.
(or 1 %/ 3 sec.)</td></tr></table>- If for tests of equipment an input signal with a modulation frequency of 1,000 Hz is necessary, a modulation frequency (80 % AM) of 400 Hz may be chosen.
- The test is to be confined to the appliances exposed to direct radiation by transmitters at their place of installation.
- If an equipment is intended to receive radio signals for the purpose of radio communication (e.g. wifi router, remote radio controller), then the immunity limits at its communication frequency do not apply, subject to the requirements in Rules for Electrical Installations (Pt.1, Vol.IV) Sec.
- Detailed test methods are referred to Level 3 of IEC 61000-4-3:2020.</td><td>Performance Criterion A [3]</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

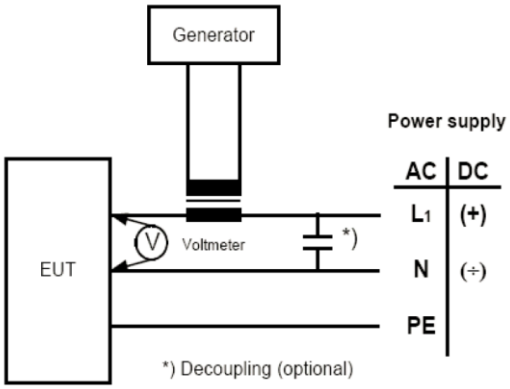
<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>16</td><td>Conducted low frequency immunity test</td><td>
- Check the operation of the equipment when the conducted low frequency immunity test is carried out according to the following condition. (values in round brackets are shown where the rated frequency of the equipment is 50 Hz)


Fig 3.16 Test set-up – Conducted Low Frequency Test
<table>
<tr><td>Frequency Range</td><td colspan="3">60 Hz ~ 12 kHz
(50 Hz~10 kHz)</td></tr>
<tr><td rowspan="4">Test Voltage</td><td rowspan="3">AC</td><td>10 % of supply voltage</td><td>60 Hz ~ 900 Hz
(50 Hz~750 Hz)</td></tr>
<tr><td>10 % to 1 % of supply voltage</td><td>900 Hz ~ 6 Hz
(750 Hz~5 kHz)</td></tr>
<tr><td>1 % of supply voltage</td><td>6 kHz ~ 12 kHz
(5 kHz~10 kHz)</td></tr>
<tr><td>DC</td><td>1 % of supply voltage
(at least 3 V)</td><td>50 Hz ~ 10 kHz</td></tr>
<tr><td rowspan="2">Maximum power</td><td>AC</td><td colspan="2">Min 3 V r.m.s, max 2 W.</td></tr>
<tr><td>DC</td><td colspan="2">max 2 W</td></tr>
</table>
- In case of marine navigational and radiocommunication equipment and systems, this test can be exempted.
</td><td>Performance Criterion A [3]</td></tr>
<tr><td>17</td><td>Conducted high frequency immunity test</td><td>
- Check the operation of the equipment when the conducted high frequency immunity test is carried out according to the following condition.
<table>
<tr><td>Frequency range</td><td>150 kHz ~ 80 MHz</td></tr>
<tr><td>Modulation</td><td>80 % AM at 1000 Hz</td></tr>
<tr><td>Amplitude</td><td>3 V rms [4]</td></tr>
<tr><td>Frequency sweep rate</td><td>≤ 1,5 x 10^{-3} decades/ sec.
(or 1 %/ 3 sec.)</td></tr>
</table>
- If for tests of equipment an input signal with a modulation frequency of 1 kHz is necessary a modulation frequency (80 % AM) of 400 Hz should be chosen.
- Detailed test methods are referred to Level 2 of IEC 61000-4-6:2013.
</td><td>Performance Criterion A [3]</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>18</td><td>Burst/Fast transient immunity test</td><td>- Check the operation of the equipment when the burst fast transient immunity test is carried out according to the following condition.
<table>
<tr><td>Single pulse time</td><td>5 ns (10 ~ 90% value)</td></tr>
<tr><td>Single pulse width</td><td>50 ns (50 % value)</td></tr>
<tr><td rowspan="2">Amplitude (peak)</td><td>Line on power supply port/ earth : 2 kV</td></tr>
<tr><td>Line/line on I/O data control and signal lines : 1 kV</td></tr>
<tr><td>Pulse period</td><td>300 ms</td></tr>
<tr><td>Burst duration</td><td>15 ms</td></tr>
<tr><td>Duration</td><td>5 min./polarity</td></tr>
</table>
- Detailed test methods are referred to Level 3 of IEC 61000-4-4:2012.</td><td>Performance Criterion B [2]</td></tr>
<tr><td>19</td><td>Surge immunity test</td><td>- Check the operation of the equipment when the surge immunity test is carried out according to the following condition.
<table>
<tr><td colspan="3">Test applicable to AC and DC power ports</td></tr>
<tr><td rowspan="3">Open-circuit voltage</td><td>Pulse rise time</td><td>1,2 μs (10 ~ 90% value)</td></tr>
<tr><td>Pulse width</td><td>50 μs (50 % value)</td></tr>
<tr><td rowspan="2">Amplitude (peak)</td><td>Line/earth : 1 kV</td></tr>
<tr><td>Line/line : 0,5 kV</td></tr>
<tr><td rowspan="2">Short-circuit current</td><td>Pulse rise time</td><td>8 μs (front time)</td></tr>
<tr><td>Pulse width</td><td>20 μs (time to half value)</td></tr>
<tr><td colspan="2">Repetition rate</td><td>At least 1 pulse/min</td></tr>
<tr><td colspan="2">No. Of pulse</td><td>5 per polarity</td></tr>
</table>
- Detailed test methods are referred to Level 2 of IEC 61000-4-5:2017.</td><td>Performance Criterion B [2]</td></tr>
<tr><td>20</td><td>Radiated emission test</td><td>- Radiated emission test is to be carried out according to the following.
For limits below 1000 MHz
<table>
<tr><td colspan="2">For equipment installed in the bridge and deck zone</td></tr>
<tr><td>Frequency range</td><td>Limits</td></tr>
<tr><td>150 kHz~ 300 kHz</td><td>80 ~ 52 dB μV / m</td></tr>
<tr><td>300 kHz ~ 30 MHz</td><td>52 ~ 34 dB μV / m</td></tr>
<tr><td>30 MHz ~ 1000 MHz</td><td>54 dB μV / m</td></tr>
<tr><td>156 MHz ~ 165 MHz</td><td>24 dB μV / m</td></tr>
<tr><td colspan="2">For equipment installed in the bridge in a zone other than bridge and deck zone</td></tr>
<tr><td>Frequency range</td><td>Limits</td></tr>
<tr><td>150 kHz~ 300 kHz</td><td>80 ~ 50 dB μV / m</td></tr>
<tr><td>30 MHz ~ 100 MHz</td><td>60 ~ 54 dB μV / m</td></tr>
<tr><td>100 MHz ~ 1000MHz</td><td>54 dB μV / m</td></tr>
<tr><td>156 MHz ~ 165 MHz</td><td>24 dB μV / m</td></tr>
</table>
For limits above 1000 MHz
<table>
<tr><td>Frequency range</td><td>Limits</td></tr>
<tr><td>1000 MHz ~ 6000MHz</td><td>54 dB μV / m</td></tr>
</table>
- Distance between equipment and antenna is to be 3 m.
- For the frequency band 156 MHz to 165 MHz the measurement shall be repeated with a receiver bandwidth of 9 kHz (as per IEC 60945:2002).</td><td>Radiated emission is to be within limits in the table.</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>20</td><td>Radiated emission test</td><td>- Alternatively the radiation limit at a distance of 3 m from the enclosure port over the frequency 156 MHz to 165 MHz shall be 30 dB micro-V/m Peak (as per IEC 60945:2002)
- Equipment intended to transmit radio signals for the purpose of radio communication (e.g. wifi router, remote radio controller) may be exempted from limit, within its communication frequency range, subject to the provisions in Rules for Electrical Installations (Pt.1, Vol.IV) Sec. 10. E.2.
- Detailed test methods are referred to CISPR 16-2-3:2016, IEC 60945:2002 for 156-165 MHz</td><td>Radiated emission is to be within limits in the table.</td></tr>
<tr><td>21</td><td>Conducted emission test</td><td>- Conducted emission test is to be carried out according to the following.
For equipment installed in the bridge and deck zone
Frequency range | Limits
10 kHz~ 150 kHz | 96 ~ 50 dB µV / m
150 kHz ~ 350 kHz | 60 ~ 50 dB µV / m
350 kHz ~ 30 MHz | 50 dB µV / m
For equipment installed in the bridge in a zone other than bridge and deck zone
Frequency range | Limits
10 kHz~ 150 kHz | 120 ~ 69 dB µV / m
150 kHz ~ 500 kHz | 79 dB µV / m
500 kHz ~ 30 MHz | 73 dB µV / m
- Test applicable to AC and DC power ports
- Detailed test methods are referred to CISPR 16-2, 1</td><td>Conducted emission is to be within limits in the table.</td></tr>
<tr><td>22</td><td>Flame resistance test</td><td>- Flame resistance test is to be carried out according to the following condition.
Flame application | 5 times 15 sec. each
Interval between each application | 15 sec. or 1 time 30 sec.
- The test is performed with the EUT or housing of the EUT applying needle-flame test method.
- Detailed test methods are referred to IEC 60092-101:2018 or IEC 60695-11-5:2016</td><td>- The burnt out or damaged part of the specimen by not more than 60 mm long.
- No flame, no incandescence or
- In the event of a flame or incandescence being present, it shall extinguish itself within 30 s of the removal of the needle flame without full combustion of the test specimen.
- Any dripping material shall extinguish itself in such a way as not to ignite a wrapping tissue. The drip height is 200 mm ± 5 mm.</td></tr>
<tr><td>23</td><td>Pressure test</td><td>- Apply the pneumatic or hydraulic pressure of 1,5 times the designed pressure.</td><td>No abnormality is observed.</td></tr>
</table>

Note:

1 Salt mist test is to be carried out for equipment installed in weather exposed areas.

2 Performance Criterion B: The Equipment Under Test is to continue to operate as intended after the tests. No degradation of performance or loss of function is allowed as defined in the technical specification published by the manufacturer.
During the test, degradation or loss of function or performance which is self-recoverable is however allowed but no change of actual operating state or stored data is allowed.

3 Performance Criterion A: The EUT is to continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed as defined in the technical specification published by the manufacturer.

4 For equipment installed on the bridge and deck zone, the test levels shall be increased to 10 Vrms for spot frequencies in accordance with IEC 60945 at 2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22, 25 MHz.

W. Equipment related to Ventilation Systems in Oil Tankers

1. General

1.1 Application

The requirements of this Sub-section apply to tests and inspection for the type approval of equipment related to ventilation systems in oil tankers in accordance with the requirements in Rules for Machinery Installations (Pt.1, Vol.III) Sec.15, B.5 and Rules for Ships Carrying Dangerous Chemical in Bulk (Pt.1, Vol.X) Sec. 12.12.1.

1.2 Definitions

The terms used in this Sub-section are defined as follows:

1.2.1 PV valve is a device designed to maintain pressure and vacuum in a closed container within pre-set in limit conformity.

1.2.2 Flame screen is a device utilizing wire mesh to prevent the passage of unconfined flames in conformity.

1.2.3 Flame arrester is a device to prevent the passage of flame by elements based on the principle of quenching in conformity.

1.2.4 Detonation flame arrester is a device to prevent the passage of flame generated in association with a detonation in the line pipe in conformity.

1.2.5 High velocity device is a device to prevent the passage of flame consisting of a mechanical valve which adjust the opening available for flow in accordance with the pressure at inlet of the valve in such a way that the efflux velocity cannot be less than 30 m/s in conformity.

1.2.6 Flame speed is the speed at which a flame propagates along a pipe or the other system.

1.2.7 Flashback is the transmission of a flame through a device.

1.2.8 High level alarm system is a device which alarms of excessive rises in the liquid cargo level to guard liquid rising in the venting system to the height which would exceed the designed head of cargo tanks in conformity.

1.2.9 Pressure monitoring system is a device to prevent over-pressure and or under-pressure during cargo loading and ballasting or discharging operations, and to monitor the tank pressure and to actuate an alarm when the tank pressure reaches to a set pressure.

2. PV (Pressure Vacuum) Valve

2.1 Materials and construction

Materials and construction of PV valve are to comply with the requirements given in Table 3.35 Materials and construction of PV valve.

Table 3.35 Materials and construction of PV valve

Kinds	Requirements
Materials	(A) The device housing, and other parts or bolted used for pressure retention, shall be constructed of materials suitable for the intended service and listed in a recognized national or international standard.

Table 3.35 Materials and construction of PV valve *(continued)*

Kinds	Requirements
Materials	(B) Housings, discs, spindles, seals, springs, gaskets, seals and all other integral parts, including parts with coatings to prevent corrosion, shall be made of materials resistant to attack by seawater and the liquids and vapours contained in the tank being protected. (C) Springs plated with corrosion-resistant material are not acceptable. (D) Non-metallic materials, other than gaskets and seals, shall not be used in the construction of pressure-retaining components of the device. (E) Resilient seals may be installed only if the device is still capable of effectively performing its function when the seals are partially or completely damaged or burned. (F) Non-metallic gaskets shall be made of non-combustible material suitable for the service intended. (G) Materials for connecting pressure/vacuum valves to their respective piping systems to which they are connected. (H) The materials for all parts not identified above shall be suitable for their intended purpose. (I) The possibility of galvanic corrosion shall be considered in the selection of materials.
Structure	(A) Device housings shall be gastight in the primary pressure zone upstream of the main valve seat to prevent the escape of vapours. (B) Housings, elements and seal gasket materials shall be capable of withstanding of the maximum and minimum pressures and temperatures to which the device may be exposed under normal operating conditions and shall be capable of withstanding the hydrostatic pressure specified in Table 3.36 of Sub-Section W.2.2. (C) Where welded construction is used for pressure-retaining components, welded-joint design details, welding and welders shall be in accordance with the relevant Rules for Welding (Pt.1, Vol.VI) and appropriate non-destructive testing shall be carried out. (D) When pressure/vacuum valves are designed to allow for inspection, cleaning, repair or removal of internal elements for replacement without removing the entire device form the system, the design shall not allow the valve to be incorrectly reassembled following disassembly for inspection, cleaning or repair. (E) Pressure/vacuum valves shall be designed such that condensed vapour drains from the device and does not impair the efficiency of the device. The design shall also prevent the accumulation of water inside the device and subsequent blockage due to freezing. (F) Where design does not permit complete drainage of condensed vapours through its connection to the tank, the housing shall be fitted with a plugged drain opening on the side of the atmospheric outlet of not less than 13 mm. The drain shall not allow vapour to escape unless the drain is equipped with suitable means to prevent the passage of flame and meets all requirements for efflux velocity and direction. (G) All fastenings essential to the operation of the device shall be protected against loosening. (H) Devices shall be designed and constructed to minimize the effect of fouling under normal operating conditions. The design shall be such that the device can be examined for any build-up of residue due to vapour condensation that might impair the operation of the device. (I) Devices shall be capable of operating over the full range of ambient temperatures anticipated. Devices shall also be capable of operating in freezing conditions and when covered by a layer of ice, the al- lowed thickness of which shall be stated by the manufacturer in the operating manual. Devices shall be capable of operating at whatever surface temperature is developed by heating arrangements. (J) End-of-line devices shall be constructed to direct the efflux vertically upward under all flow rates. (K) A manual means shall be provided to verify that valve lifts easily and cannot remain in the open position. (L) Valve discs shall be guided by a suitable means to prevent binding and ensure proper self-closing (seating), taking into account the possible build-up of condensed vapours passing through the valve during loading, when maintenance is carried out in accordance with the manufacturer's requirements. Valve discs shall normally close against the valve seat by metal-to-metal contact. Resilient-seating seals may be provided in the design is such that the disc closed tight against the seat in case the seals are destroyed, damaged or otherwise carried away. Valve discs may be solid or made hollow so that weight material may be added to vary the lifting pressure. If hollow discs are employed, a watertight bolted cover shall be fitted to encase the weight material. The lifting pressure shall not be varied by personnel other than the manufacturer without prior approval by

Table 3.35 Materials and construction of PV valve *(continued)*

Kinds	Requirements
Structure	the administration. A clear indication, visible from the outside of the valve, shall be employed to indicate the position of the valve. (M) Valves may be actuated by non-metallic diaphragms except where failure would result in unrestricted flow of tank vapours to the atmosphere or in an increase in the pressure or vacuum at which the valve normally releases (N) Relief pressure adjusted mechanisms shall be permanently secured by lockwire, locknuts or other suitable means to prevent devices from becoming misadjusted due to handling, installation or vibration.

2.2 Type tests

2.2.1 Test product

The test products used in the type test are to be of each configuration and dimension given in the application.

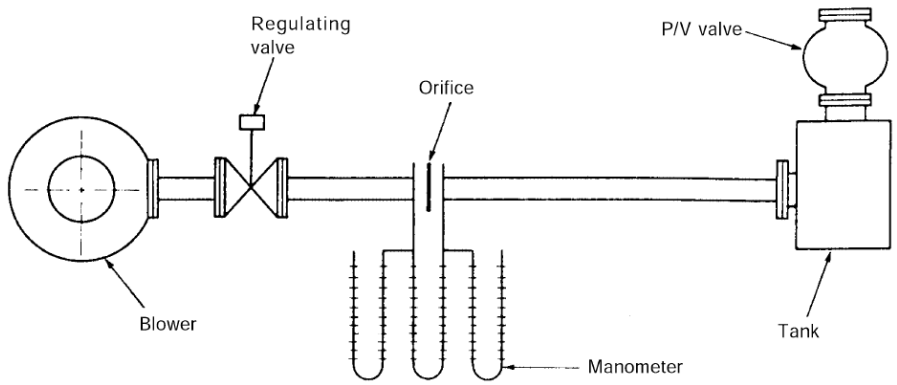
2.2.2 Details of tests and examinations

Type test and inspection of PV valve are to be in accordance with the requirements given in Table 3.36.

Table 3.36 Type test and inspection of PV valve

Test item	Test method
Construction inspection	The materials, construction and dimension of the device shall be confirmed.
Corrosion test	A corrosion test shall be conducted. In this test, a complete device, including a section of pipe similar to that to which the device will be fitted, shall be exposed to a 5 % sodium chloride solution spray at a temperature of 25° C (41°F) for a period of 240 h, and allowed to dry for 48 h. Following this exposure, all movable parts shall operate properly and there shall be no corrosion deposits that cannot be washed off.
Hydrostatic pressure test	The pressure-retaining boundary of the device shall be subjected to a hydrostatic-pressure test of at least 150 % of maximum rated pressure (MRP) or a minimum pressure of 345 kPa gauge (50psig), whichever is greater, for ten minutes without rupturing, leaking or showing permanent distortion.
Performance characteristics	Performance characteristics as declared by the manufacturer, such as flow under both positive and negative pressures, operating sensitivity flow resistance and velocity, shall be demonstrated by appropriate tests. Flow testing shall be conducted in accordance with the flow test below.
Pneumatic test	Each finished device shall be pneumatically tested at 70 kPa either using a submersion test or a soap test for a duration of three minutes to ensure there is no leakage.
Flow tests	(a) The capacity data shall be presented in the form of curves or tables that give the volume of flow through both vacuum and pressure ports and that cover the full range between the opening pressure (or vacuum) and the pressure (or vacuum) at which the ports are fully open, and the valve is flowing at its maximum anticipated rate. The capacity data for pilot-operated vents or devices that open fully at a set pressure (or vacuum) may be expressed as a flow coefficient that is the ratio of the flow through the vent to the flow through a theoretically perfect nozzle of the same diameter. Sufficient measurements shall be made a t pressures in the vicinity of the opening points, particularly at 1,1, 1,2 and 1,5 times the opening pressure and at 1,5 and 2,0 times the opening point on vacuum, to establish clearly the flow capacity at these points. (b) The capacity data shall indicate the points of initial opening and final closing of the venting device. (c) The capacity data shall be expressed in terms of cubic metres of air per hour at a temperature of 0°C and a pressure of 1,015 hPa (d) Pressures shall be expressed in hectopascals; however, auxiliary scales shall be expressed in millimetres of water, and other units of measurement may also be included if desired.

Table 3.36 Type test and inspection of PV valve *(continued)*

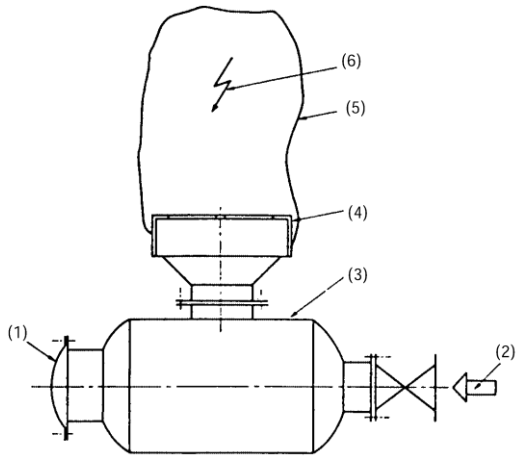
Test item	Test method
Flow tests	 Fig 3.17 Example of Testing Equipment for PV Valve

3. Devices to Prevent the Passage of Flame

3.1 General

3.1.1 Materials and strength, construction and dimension, and tests and inspections of a flame screen, a flame arrester, a detonation flame arrester and a high velocity vent are to be in accordance with the requirements in the following 3.2 through 3.3.

3.1.2 For flame screens, after carrying out a corrosion test and a hydraulic test, a flashback test and a general inspection are to be carried out. The test component is not to be exchanged for each test requested and is to have the most inappropriate gap dimension expected in the service of the product. An example of testing equipment for the flashback test is shown in Fig 3.18.



(1) Diaphragm (2) Explosive vapour-air mixture inlet
(3) Tank (4) Flame arrester
(5) Plastic bag (ordinary circumference 2 m, length 2.5 m and thickness 0.05 mm)
(6) Ignition device
*For information about explosive vapour mixture, refer to *IEC* 60079-1

Fig 3.18 Example of Testing Equipment for Flame Arrester

3.1.3 For flame arresters, after carrying out a corrosion test and a hydraulic test, a flashback test, an endurance burning test and a general inspection are to be carried out.

3.1.4 For detonation flame arresters, after carrying out a corrosion test and a hydraulic test, a detonation test, an endurance burning test and a general inspection are to be carried out. The test component is not to be exchanged for each test requested and is to have the most inappropriate gap dimension expected in the service of the product. An example of testing equipment for the detonation test is shown in Fig 3.19.

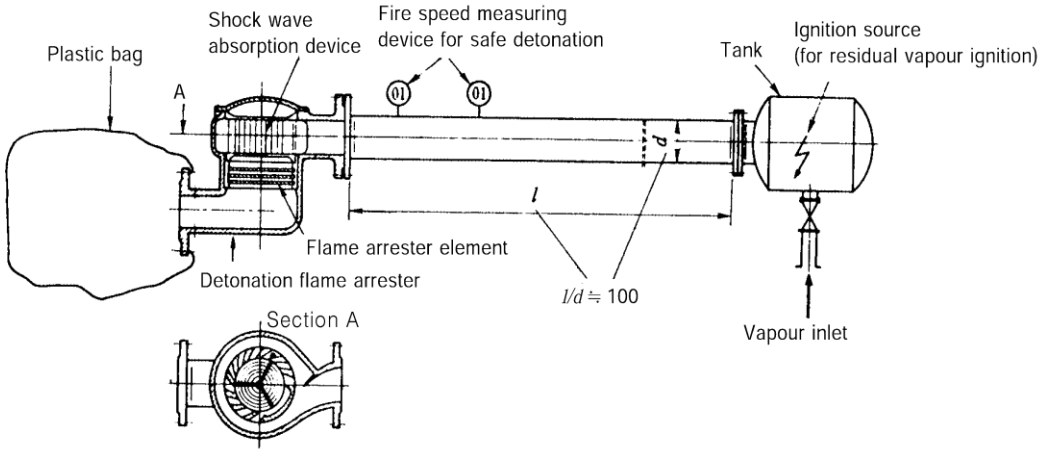


Fig 3.19 Example of Testing Equipment for Detonation Flame Arrester

3.1.5 For high velocity devices, after carrying out a corrosion test and a hydraulic test, a flow volume test, a flashback test, an endurance burning test and a general inspection are to be carried out. The test component is not to be exchanged for each test requested and is to have the most inappropriate gap dimension expected in the service of the product. Examples of testing equipment for the flashback test, and the flow volume test and the endurance burning test are shown in Fig 3.20.

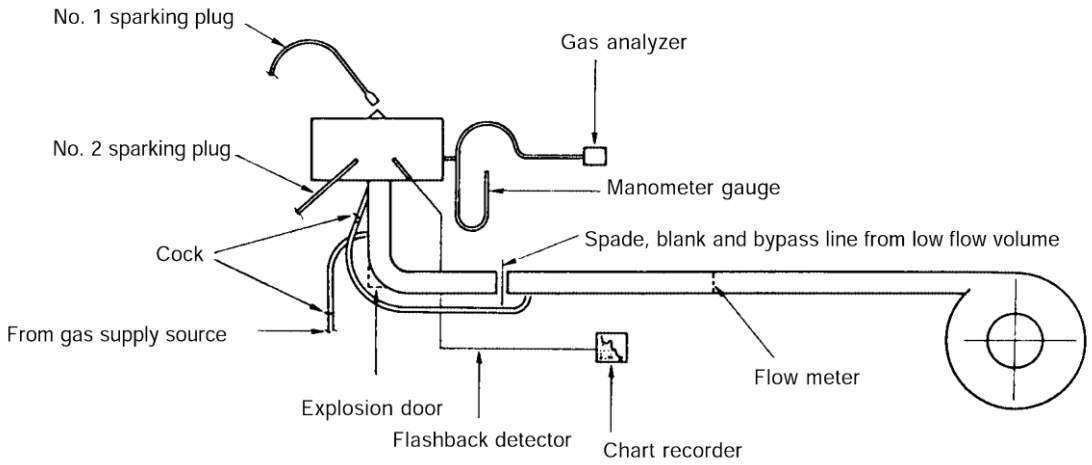


Fig 3.20 Example of Testing Equipment for High Speed Discharger (For flashback test)

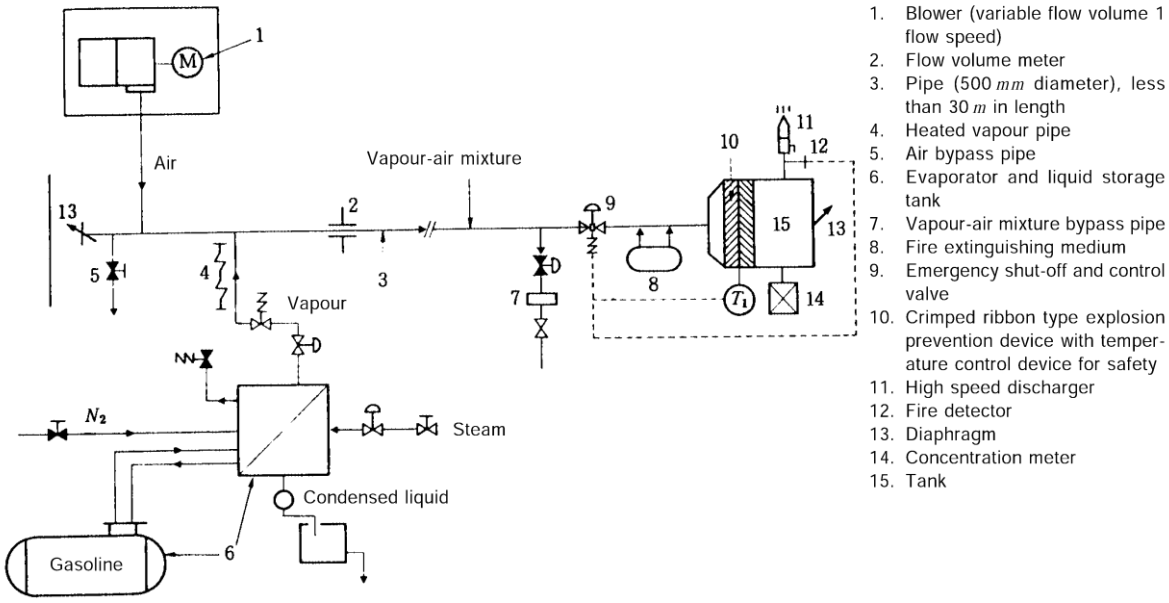


Fig 3.21 Example of Testing Equipment for High Speed Discharger

3.2 Materials and structure

Materials and structure of a flame screen, a flame arrester, a detonation flame arrester and a high velocity vent are to comply with the requirements given in Table 3.37.

Table 3.37 Materials and structure for devices to prevent the passage of flame

Kinds		Requirements
Material		(A) The casing or housing of devices should meet similar standards of strength, heat resistance and corrosion resistance as the pipe to which they are attached. (B) Elements, gaskets and seals should be of material resistant to both seawater and the cargoes carried. (C) The casing and element and gasket materials should be capable of withstanding the highest pressure and temperature to which the device may be exposed under both normal and specified fire test conditions.
Structure	General	(A) The design of devices should allow for ease of inspection and removal of internal elements for replacement, cleaning or repair. (B) Devices should allow for efficient drainage of moisture without impairing their efficiency to prevent the passage of flame. (C) Fastenings essential to the operation of the device, i.e. screws, etc., should be protected against loosening. (D) Devices should be designed and constructed to minimize the effect of fouling under normal operating conditions. (E) All flat joints of the housing should be machined true and should provide for a joint having an adequate metal-to-metal contact. (F) Resilient seals may be installed only if their design is such that if the seals are partially or completely damaged or burned, the device is still capable of effectively preventing the passage of flame. (G) End-of-line devices should be so constructed as to direct the efflux vertically upwards. (H) Devices should be capable of operating in freezing conditions. (I) Devices are to be protected against mechanical damage. (J) Performance characteristics, such as the flow rates under both positive and negative pressure, operating sensitivity, flow resistance and velocity should be demonstrated by appropriate tests. In this case, the presence of the Surveyor may be dispensed with.

Table 3.37 Materials and structure for devices to prevent the passage of flame *(continued)*

Kinds		Requirements
Structure	Flame screen, flame arrester and detonation flame arrester	(A) The design of devices should allow for ease of inspection and removal of internal elements for replacement, cleaning or repair. (B) The clear area through the element is to be at least 1,5 times the cross-sectional area of the line. (C) The elements are to be secured in the casing in such a way that flame cannot pass between the element and casing.
	High velocity devices	(A) High velocity devices are to have a width of the contact area of the valve seat of at least 5 mm. (B) Means should be provided to check that any valve lifts easily without remaining in the open position. (C) In the case of high velocity vents, the possibility of inadvertent detrimental hammering.

3.3 Type tests

3.3.1 Test product

The test products used in the type test are to be of each configuration and dimension given in the application.

3.3.2 Details of test and examinations

Type test and inspection of a flame screen, a flame arrester, a detonation flame arrester and a high velocity vent are to be in accordance with the requirements given in Table 3.38.

Table 3.38 Type test and inspection for devices to prevent the passage of flame

Kind	Test item	Test method
1. General		(a) The following characteristics should be recorded, as appropriate, throughout the tests: (i) concentration of fuel in the gas mixture (ii) temperature of the test gas mixture at inflow of the device (iii) flow rates of the test gas mixtures when applicable. (b) Flame passage should be observed by recording, e.g., temperature, pressure, or light emission by suitable sensors on the protected side of the device; alternatively, flame passage may be recorded on video tape. (c) If any device is provided with heating arrangements so that its surface temperature exceeds 85°C, then it should be tested in accordance with 2 through 6 of this Table at the highest operating temperature. (d) End of line devices which are intended for exclusive use at openings of inerted cargo tanks which are appropriate with the requirements of Rules for Electrical Installations (Pt.1, Vol.IV) Sec. 15, A need not be tested against endurance burning in this case, flashback may be dispensed with. (e) For ships other than those, 500 GT or above, engaged in the international voyages, the continuous combustion test for flame arrests, the flash back test and the continuous combustion test for high velocity devices may be omitted. (f) After the relevant tests, the device should not show mechanical damage that affects its original performance.
2. Flame arresters located at openings to the atmosphere.	General	The test rig should consist of an apparatus producing an explosive mixture, a small tank with a diaphragm, a flanged prototype of the flame arrester, a plastic bag and a firing source in three positions. Where end-of-line devices are fitted with cowls, weather hoods and deflectors, etc., these attachments should be fitted for the tests.
	Flashback test	(i) The tank, flame arrester assembly and the plastic bag enveloping the prototype flame arrester should be filled so that this volume contains the most easily ignitable propane/air mixture. However, devices are to be tested with ethylene or test media with MESG not

Table 3.38 Type test and inspection for devices to prevent the passage of flame *(continued)*

Kind	Test item	Test method
2. Flame arresters located at openings to the atmosphere	Flashback test	more than 0,65 mm for Apparatus Group IIB on chemical tankers and with hydrogen or test media with MESG not more than 0,28mm for Apparatus Group IIC on chemical tankers, according to the apparatus group assigned as per column i'' of Rules for Ships Carrying Dangerous Chemical in Bulk (Pt.1, Vol.X) Sec. 17. (ii) Three ignition sources should be installed along the axis of the bag, one close to the flame arrester, another as far away as possible therefrom, and the third at the midpoint between these two. (iii) These three sources should be fired in succession, twice in each of the three positions. (iv) Devices should not be capable of being bypassed or blocked open unless they are tested in the bypassed or blocked open position. (v) The temperature of the test gas should be within the range of 15 °C to 40 °C.
	Endurance burning test	Following tests are to be carried out to ascertain that no flashback occurs. (i) Without the plastic bag the flame arrester is to be so installed that the mixture emission is vertical. (ii) Endurance burning is to be achieved by using the most easily ignitable gasoline vapour/air mixture with the aid of a continuously operated pilot flame. (iii) By varying the flow rate, the flame arrester is to be heated until the highest obtainable temperature on the cargo tank side is reached. This temperature is to be maintained for a period of 10 minutes, after which the flow is to be stopped and the conditions are to be observed. The highest obtainable temperature may be considered to have been reached when the rate rise of temperature does not exceed 0,5°C per minute over a ten-minute period. If difficulty arises in establishing stationary temperature conditions (at elevated temperatures), endurance burning, by using the flow rate which produced the maximum temperature during the foregoing test sequence, is to be continued for a period of two hours from the time the above-mentioned flow rate has been established.
3. Tests for flame arresters located in-line	General	The following tests are to be carried out to ascertain that no flashback occurs. In these tests, the flame arrester is to be tested with the inclusion of all pipes, tees, bends, cowls, weather hoods, etc. which may be fitted between the device and atmosphere.
	Flashback test	A flashback test is to be carried out in accordance with 2. of this Table. In this test, the plastic bag is to be fitted at the outlet to atmosphere.
	Endurance burning test	An endurance burning test is to be carried out in accordance with 2. of this Table. In this test, the flame arrester is to be so installed as to reflect its final orientation.
4. Tests for detonation flame arresters located in-line	General	The following tests are to be carried out using the test apparatus which consists of an apparatus producing an explosive mixture, a tank, a plastic bag, a pipe of suitable length and of the same diameter as the flange of the detonation flame arrester, ignition device and a measuring instrument of flame speed, and it is to be ascertained that no flashback occurs, and no part of the flame arrester is damaged or shows permanent deformation.
	Detonation test	(i) A detonation flame arrester is to be installed at one end of a pipe, and a plastic bag is to be affixed on the other end of the detonation flame arrester. (ii) The tank, the plastic bag, the pipes and the detonation flame arrester are to be filled with the most easily ignitable propane/air mixture. However, devices are to be tested with ethylene or test media with MESG not more than 0,65mm for Apparatus Group IIB on chemical tankers and with hydrogen or test media with MESG not more than 0,28mm for Apparatus Group IIC on chemical tankers, according to the apparatus group assigned as per column i'' of Rules for Ships Carrying Dangerous Chemical in Bulk (Pt.1, Vol.X) Sec. 17 (iii) They are to be ignited in the tank and three detonation tests are to be carried out. The velocity of the flame measured near the detonation flame arrester is to have a value of that for stable detonations.
	Endurance burning test	In case where the distance requirement in the endurance burning test, 3. of this Table cannot be met, an endurance burning test is to be carried out in addition to the requirements in the detonation test.
5. Tests for flame screens	Flashback test	A flashback test is to be carried out in accordance with 2. or 3. of this Table depending on the installed position of the flame screen.

Table 3.38 Type test and inspection for devices to prevent the passage of flame *(continued)*

Kind	Test item	Test method
6. Tests for high velocity devices	Flow condition test	A flow condition test is to be carried out with high velocity vents using compressed air or gas at agreed flow rates, and the following is to be measured and recorded. (i) The flow rate. Where air or gas other than vapours of cargoes with which the vent is to be used is employed in the test, the flow rates achieved are to be corrected to reflect the vapour density of such cargoes. (ii) The pressure before the vent opens. The pressure in the test tank on which the device is located is not to rise at a rate greater than 10 kPa/m in. (iii) The pressure at which the vent opens. (iv) The pressure at which the vent closes. (v) The efflux velocity at the outlet which is not to be less than 30m/s at any time when the valve is open.
	Flashback test	The following tests are to be carried out using the test apparatus producing explosive mixture, flowmeter, ignition device and diaphragm, and it is to be ascertained that no flash-back occurs. (i) The test rig and the high velocity device are filled with the most easily ignitable gasoline vapour, hexane vapour or propane/air mixture. The mixture is to be ignited with the aid of a permanent pilot flame at the outlet. A flashback test is to be carried out with the device in the upright position and then inclined at 10° from the vertical. For some device designs further tests with the device inclined in more than one direction may be necessary. (ii) In each of these tests specified in (i), the flow is to be reduced until the device closes and the flame is extinguished, and each is to be carried out at least 50 times.
	Endurance burning test	The following tests are to be carried out using the test apparatus producing explosive mixture, blower, tank with a diaphragm, safety device and flowmeter, and it is to be ascertained that is no flashback occurs. (i) An endurance burning test is to be carried out in accordance with 2. of this Table. (ii) Following the test specified in (a), the main flame is to be extinguished and then, with the pilot flame burning or the spark igniter discharging, small quantity of the most easily ignitable mixture is to be allowed to e scape for a period of 10 minutes maintaining a pressure below the value of 90 % of the valves opening setting. (iii) For the purpose of this test, soft seals and seats are to be removed.
7. Corrosion test		A corrosion test is to be carried out. In this test a complete device including a section of the pipe to which the device may be fitted is to be exposed to a 5 % sodium chloride solution spray at a temperature of 25℃ for a period of 240 hours, and allowed to dry for 48 hours. Following the test all movable parts are to operate properly and there is to be no corrosion deposits which cannot be washed out. This test is to be carried out before carrying out the tests specified in 2. through 6. of this Table.
8. Hydraulic test		For the casing of a device, a hydraulic test at the same test pressure as the pipe to which the device is attached. This test is to be carried out before carrying out the tests specified in 2. through 6. of this Table. (a) End of line device of all sizes: 90 kPa (b) In-line device up to 200 mm pipe diameter: 1500 kPa (c) In-line device above 200 mm and up to 300mm: 1800 kPa (d) In-line device above 300 mm pipe diameter: to the satisfaction of BKI
9. Finished condition inspection		The materials, construction and dimensions of the device are to be ascertained.

4. High level alarms

Performance, construction, tests and inspections of a high-level alarm are to be in accordance with requirements given in Table 3.39.

Table 3.39 Performance, construction, tests and inspections of a high-level alarm

Item	Requirements
Performance and construction	(A) The deviation between the indicated level and the actual one is to be within 25mm or less. (B) The liquid level can be indicated within a time lag of 3 seconds following the actual liquid level fluctuation. (C) The device is to be capable of withstanding motions, vibrations and inclinations of a ship.

Table 3.39 Performance, construction, tests and inspections of a high-level alarm *(continued)*

Item	Requirements
Performance and construction	(D) Electrical installations of the device are to comply with the requirements in relevant Rules. (E) Due consideration is to be paid against the generation of static electricity. (F) The device is to be capable of withstanding the highest pressure and temperature to which the device may be exposed under normal condition, and is to be of material resistant both sea water and cargoes carried. (G) The construction of a device is to be in accordance with the following requirements: (H) The design is to allow for ease of repair. (I) The fastenings are to be protected against loosening. (H) The operational error is to be demonstrated by an appropriate test. (I) The alarms are to be visible and audible, and to be capable of identifying the tank in which the liquid level rises. (J) The audible alarm is to be capable of being stopped manually.
Type tests	High level alarms are to comply with the requirements specified in V.3. of this Guidance.

5. Pressure monitoring system

Construction, strength, test and inspections of a pressure monitoring system are to be in accordance with the requirements given in Table 3.40.

Table 3.40 Construction, strength, test and inspections of a pressure monitoring system

Item	Requirements
Performance and construction	(A) A pressure monitoring system is to comply with the requirements specified in V.2. (B) In addition to the requirements specified in (A), a pressure monitoring system is to be in accordance with followings: (a) The alarms are to be visible and audible, and to be capable of identifying the tank which is the condition of over-pressure or under-pressure. (b) The audible alarm is to be capable of being stopped manually.
Type tests	(A) The details of tests are to be in accordance with the requirements specified in V.3. (B) In addition to the requirements specified in (A), a pressure monitoring system is to be in accordance with followings: (a) The operational errors are to be in ranges from 0 % to -10 % of the set pressure on the pressure side and from +10 % to 0 % of the set pressure on the vacuum side. (b) The pressure can be measured within a time lag of 3 seconds following the actual pressure fluctuation.

X. Securing Device

1. Application

1.1 The requirements in this sub section apply to tests and inspection for the type approval of securing devices, which will be approved by BKI for the safe carriage of cargoes, in accordance with the requirements in the Rules for Stowage and Lashing of Containers (Pt.4, Vol.I).

1.2 Raw forgings or castings are to be approved their manufacturing process by BKI in accordance with the requirements in the Rules for Materials (Pt.1, Vol.V).

2. Type tests

2.1 Type tests to determine the breaking or proof loads are to be carried out on at least two samples of each item used in the securing system. The relationship between minimum design breaking load and safe working load is to be as indicated in Table 3.41.

Table 3.41 Design Braking Loads and Proof Loads

Item			Min. design breaking load		Min. proof load	
			SWL ≤ 40	SWL > 40	SWL ≤ 40	SWL > 40
Lashings	Wire ripe		3 × SWL	-	-	-
	Rod	mild steel	3 × SWL		1,5 × SWL	
		higher tensile steel	2 × SWL		1,5 × SWL	
	Chain	mild steel	3 × SWL		-	
		higher tensile steel	2,5 × SWL			
Fittings and securing devices			2 × SWL	SWL + 40 t	1,5 × SWL	SWL + 20 t

Notes:
1. Higher tensile steel is defined for this purpose as steel having a yield stress not less than 315 N/mm^2 (32 kg/mm^2).
2. Breaking and proof loads for lashings of material other than steel will be considered.

2.2 The Surveyor is to be satisfied that the design and materials of the fitting are in accordance with the approved plans. The mode of load application is to represent as closely as possible the in service operational modes. Jigs are to be employed where necessary in order that satisfactory simulation is obtained. For guidance purposes, test modes which are required for the more commonly used fittings including vehicle securing device are shown in Table 3.42.

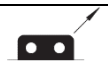
2.3 In the interests of standardization of the strength of container securing fittings and lashings, safe working loads in accordance with column 4 of Table 3.42 are recommended.

2.4 For acceptance, no permanent deformation (other than that due to initial embedding of component parts) is to be induced by test loads up to the proof load given in Table 3.41.

2.5 Where one of the test samples fails before the design breaking load is reached this can be accepted, provided:

1) The failure load is not less than 95 percent of the design breaking load.
2) An additional sample is tested satisfactorily.
3) The average failure load of the three samples is equal to or greater than the design breaking load.

Table 3.42 Test Loads and Test Modes

Type	Test Arrangement		WL Usual Working Load [kN]	TL Test Load [kN]	min BL Breaking Load [kN]
Lashing rod			230	288	460
Lashing Chain			80	100	200
Lashing Steel wire rope			200	250	450
Turnbuckle			230	288	460
Twistlock (single)/ Midlock [1]			210	263	420
Twistlock (single)/ Midlock [1]			250	313	500
Stacker			210	263	420
Doublestacker		Deck	200	250	400
		Hold	560	620	730
Flush socket			250	313	500
Pedestal socket [2]			250	313	500
Pedestal socket [2]			210	263	420
"D"-Ring			230	288	460
Lashing Plate			230	288	460
Penguin Book			230	288	460
TP Bridge fitting			210	263	420
Buttress		Betw.	650	715	850
		Top tier	250	275	325
Dove Tail Twistlock		Tensile	200	250	400
		Shear	210	263	420
Linkage Plate			150	188	300
General note	Deck		WL	1,25 WL	2,0 WL
	Hold		WL	1,1 WL	1,33 WL
The loads above are valid for Ro-Ro lashing elements also. Lashing belts are also tested with factor 2,0 BL/SWL.					

Notes:

[1] Load requirement for fully automatic locks are the same as for twist locks. Additionally, required is testing in a test jig, where pressure, shear and lifting forces

[2] Pedestal sockets shall be tested additionally for an SWL of 1000 kN pressure.

Y. Fire Protection Materials

1. Application

The requirement of this Sub Section applies to test and inspection for the approval of fire protection materials specified in Table 3.43 according to the requirements of the Rules for Machinery Installations (Pt. 1, Vol.III) Sec 12.

Table 3.43 Kinds and application of fire protection materials

Kinds	Application
Non-combustible material	(1) Non-combustible materials is a material which neither burns nor gives off flammable vapour in sufficient quantity for self-ignition when heated to approximately 750°C, this being determined in accordance with the Fire Test Procedure Code. (2) The kinds of test for non-combustible materials are to be the 'Test method for non-combustible material', the procedure of which is to be as specified in 4.1 (3) The materials specified below are to be regraded as non-combustible materials for which no approval by BKI is required. (A) Sheet glass, glass rock, clay, ceramics, and glass fiber (B) Metals (except magnesium and magnesium alloys) (C) Sand, gravel, expanded vermiculite, slag (expanded or foam slag), diatomaceous earth, Portland cement using pearlite or pumice as aggregates, gypsum, and magnesite concrete (D) Needle punched glass fiber products containing 2,5% or less of lubricant
"A" Class division	(1) "A" class divisions are those divisions formed by bulkheads and decks which comply with the following criteria: (A) They are constructed of steel or other equivalent material; (B) They are suitably stiffned; (C) They are insulated with approved non-combustible materials such that the average temperature of the unexposed side will not rise more than 140°C above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180°C above the original temperature, within the time listed below: Class “A-60” 60 min Class “A-30” 30 min Class “A-15” 15 min Class “A-0” 0 min (D) They are constructed as to be capable of preventing the passage of smoke and flame to the end of the one-hour standard fire test; and (E) BKI has required a test of a prototype bulkhead or deck in accordance with the Fire Test Procedures Code to ensure that it meets the requirements above for integrity and temperature rise. (F) They are used for bulkheads, decks, doors, cable penetrations, etc. (2) The kinds of test for “A” class divisions are to be “fire tests of A class divisions," the procedures of which are to be as specified in 4.2 (3) The materials constituting “A” class divisions are all to be non-combustible materials specified in the Rules for Materials (Pt.1, Vol.V). In applying for approval, documents proving that the constituent materials are non-combustible (the certificate of BKI or the test results recognized by BKI) are to be submitted in addition to the results of fire tests for the constituent materials
"B" Class division	(1) "B" class divisions are those division formed by bulkheads, decks, celling or linings which comply with the following criteria: (A) They are constructed of approved non-combustible materials and all materials used in the construction and erection of “B” class\division are non-combustible, with the exception that combustible veneers may be permitted provided they meet other appropriate requirements of this Section (B) They have an insulation value such that the average temperature of the unexposed side will not more than 140°C above the original temperature, nor will the temperature at any one point, including any joint, rise more than 225°C above the original temperature

Table 3.43 Kinds and application of fire protection materials *(continued)*

Kinds	Application
"B" Class divisions	within the time listed below: Class "B-15" 15 min Class "B-0" 0 min (C) They are 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 (D) BKI has required a test of a prototype division in accordance with the Fire Test Procedures Code to ensure it meets the above requirements for integrity and temperature rise. They are used for bulkheads, doors, continuous ceilings, cable penetrations, etc. (2) The kinds and procedure of tests for 'B' class divisions are to be "fire tests of B class divisions" the procedures of which are to be as specified in 4.2 (3) The materials constituting "B" class divisions are to comply with the requirements specified in the Rules for Materials (Pt.1, Vol.V). In applying for approval, documents proving that the constituent materials are non-combustible (the certificate of BKI or the test results recognized by BKI) are to be submitted in addition to the results of fire tests for the constituent materials
Fire retardant base materials	(1) Fire retardant base materials are the combustible materials used for internal divisions, and linings, draft stops, ceilings and their associated ground sills in corridors and stairway enclosures within accommodation and service spaces of a ship adopting Method III C or II C specified in the Rules for Machinery Installations (Pt.1, Vol.III) Sec. 12. (2) The kinds of test for fire retardant materials are to be test for surface flammability, smoke and toxicity test, the procedures of which are to be in accordance with the requirements specified in 4.3 and 4.4, respectively
Fire retardant veneers	(1) Fire retardant veneers are the combustible veneer materials applied on internal exposed surfaces and on the surfaces in consealed or inaccessible spaces in a ship except floor. (2) Fire retardant veneers applied on non-combustible bulkheads, linings, and ceilings within accommodation spaces and service areas are to be not more than 2,5 mm in thickness. In corridors, stairway enclosures, and control stations, fire retardant veneers are to be not more than 1,5 mm in thickness. (3) Notwithstanding the requirements (2) above, if the calorific value of fire retardant veneers measured by bomb method (refer to Appendix 1) does not exceed 45 MJ/m^2, the limit of thickness specified in (2) may not be observed. (4) The kinds and test procedures are similar to those specified in 4.3 and 4.4 (5) In applying the requirements in (4) above for PVC films, test for surface flammability is to be conducted without insulation materials, and smoke and toxicity test is to be conducted including insulation materials
Fire retardant floor coverings	(1) Floor coverings are other layers in the floor construction above the deck plating except primary deck coverings. (2) The kinds of test for fire retardant floor coverings are to test for surface flammability, smoke and toxicity test. The procedures of which are to be in accordance with the requirements specified in 4.3 and 4.4
Primary deck covering	(1) Primary deck coverings are the first layer of a floor construction which is applied directly on top of the deck plating and is inclusive of any primary coat, anti corrosive compound or adhesive which is necessary to provide protection or adhesion to the deck plating. (2) The kinds of test for the primary deck coverings are to be of the test for the primary deck coverings and the testing procedure is to be in accordance with the requirements specified in 4.4 and 4.5

Table 3.43 Kinds and application of fire protection materials *(continued)*

Kinds	Application
Fire retardant coating	(1) Fire retardant coatings are the finishing materials applied on the internal exposed surface of a ship. (2) The approval of fire retardant coatings is to be made to actual coating systems (combination of under coat and top coat) on the basis of the coatings classified according to the kinds of synthetic resins used. (3) The classes of fire retardant coatings are as follows: (A) Alkyd resin coating (B) Chlorinated rubber coating (C) Tar epoxy resin coating (D) Denatured epoxy resin coating (E) Pure epoxy resin coating (F) Urethane resin coating (G) Emulsion coating (H) Water gross coating (I) Poly-vinyl chloride resin coating (J) Pure silicone coating (K) Others (4) The kinds and test procedures are to be in accordance with 4.3 and 4.4 correspondingly.
Vertically supported textiles and films (including vertically hanging curtains and draperies}	(1) The test method for vertically supported textiles and films (including vertically hanging curtains and draperies) having the resistance to propagation of flame (hereinafter called curtains, etc) is to be in accordance with the requirements in 4.6. (2) After flame time means the time during which the material continues to burn after the ignition source has been removed or extinguished. (3) Sustained ignition means after flame time of 5 seconds or more. (4) After glow means persistence of a material after cessation of flaming or after the ignition source has been removed. (5) Surface flash means the rapid flash of a flame across the surface pile finish and often leaving the base fabric in an essentially undamaged condition
Upholstered furniture	(1) The test method for upholstered furniture having the resistance to propagation of flame is to be in accordance with the requirements in 4.7. (2) Progressive smouldering is an exothermic oxidation not accompanied by flaming which is self-propagating, i.e. independent of the ignition source. It may or may not be accompanied by incandescence
Bedding components	(1) The test method for bedding components such as blankets, quilts, bedspreads, pillows and mattresses, including thin, light mattresses used on top of other mattresses having the resistance to propagation of flame is to be in accordance with the requirements in 4.8. (2) Mattress is product in the form of a resilient material (for instance, polyurethane foam or light fibre fill) or of padding materials in combination with steel springs (spring mattress), enveloped by a cover. (3) Quilt and pillow are products of padding materials (down/feather or textile fibre) enveloped by a textile fabric. (4) Ticking is fabric enveloping the resilient material in a mattress. (5) Ignitability is a measure of the ease with which a material or a product can be ignited so as to flame or progressively smoulder. (6) Ignition source is source of energy which is used to ignite combustible materials or products. (7) Flaming is undergoing combustion in the gaseous phase, usually with emission of light. (8) Smouldering is an exothermic reaction taking place in a material without flaming, with or without emission of light. (9) Progressive smouldering is smouldering which continues after the ignition source is extinguished or removed
Fire door control system	The test method for control system of fire door which is required to be able to operate in case of fire is to be in accordance with the requirements in 4.9.

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to these specified in A.2.

1) Kinds of materials (names and trade names of the materials specified in 1.
2) Outline of testing facilities (This may be omitted if the tests are carried out by an organization which BKI considers appropriate for the purpose)
3) Details of test specimen (including joint construction, points of temperature measurement, fixing method of periphery, etc.)

3. Type test

3.1 The type tests are to be carried out by the procedures specified in 4. or by those regarded to be equivalent by BKI in the presence of the Surveyor. The witness by the Surveyor may be omitted, however, if the type tests are conducted by any official organizations which BKI considers appropriate.

3.2 The test specified in 3.1 may be omitted if the material is subjected to the tests specified in 3.1 in an organization which BKI considers appropriate and having a certificate or test records. BKI may require additional tests, however, if it considers necessary.

3.3 For other established test procedures and acceptance criteria other than those specified in 4. the approval expiry period is as follows.

3.3.1 BKI may issue type approval certificates of products tested in accordance with procedures adopted in IMO Res. MSC 61(67), provided the tests were conducted no later than one year after entry into force of IMO Res. MSC 307(88).

3.3.2 BKI may issue type approval of a product tested in accordance with procedures adopted in IMO Res. MSC 61(67) without retesting, provided that the test report is not more than 15 years old and that no alteration of components or construction has been made to the product.

4. Test methods

4.1 Test method for non-combustible material

Test method for non-combustible material is to be in accordance with the requirements given in Table 3.44. (Refer to FTP Code, Annex 1, Part 1 and IMO Res. MSC 307(88) & ISO 1182.

Table 3.44 Test method for non-combustible material

Item	Requirements
Test specimens	(A) The test specimen shall be taken from a sample which is sufficiently large to be representative of the product. (B) The specimens are to be cylindrical and each is to have a diameter of 45 $^{+0}_{-2}$ mm, a height of 50 ± 3 mm and a volume of 80 ± 5 cm^3. (C) For homogeneous products, five specimens shall be made. For non-homogeneous products, ten specimens shall be mad
Preparation of specimen	(A) If the thickness of the material is different from 50 ± 3 mm, specimens of the height of 50 ± 3 mm shall be made by using a sufficient number of layers of the material and/or by adjustment of the material thickness. (B) For non-homogeneous materials, the specimen of height of 50 ± 3 mm shall be constructed such that all layers are represented in the specimen in proportion to their presence, by volume, in the original specimen. (C) The layers shall occupy a horizontal position in the specimen holder and shall be held together firmly, without significant compression, by means of two fine steel wires, of maximum diameter 0,5 mm, to prevent air gaps between layers. The specimens of loose fill materials shall be representative in appearance, density, etc., as in use.

Table 3.44 Test method for non-combustible material *(continued)*

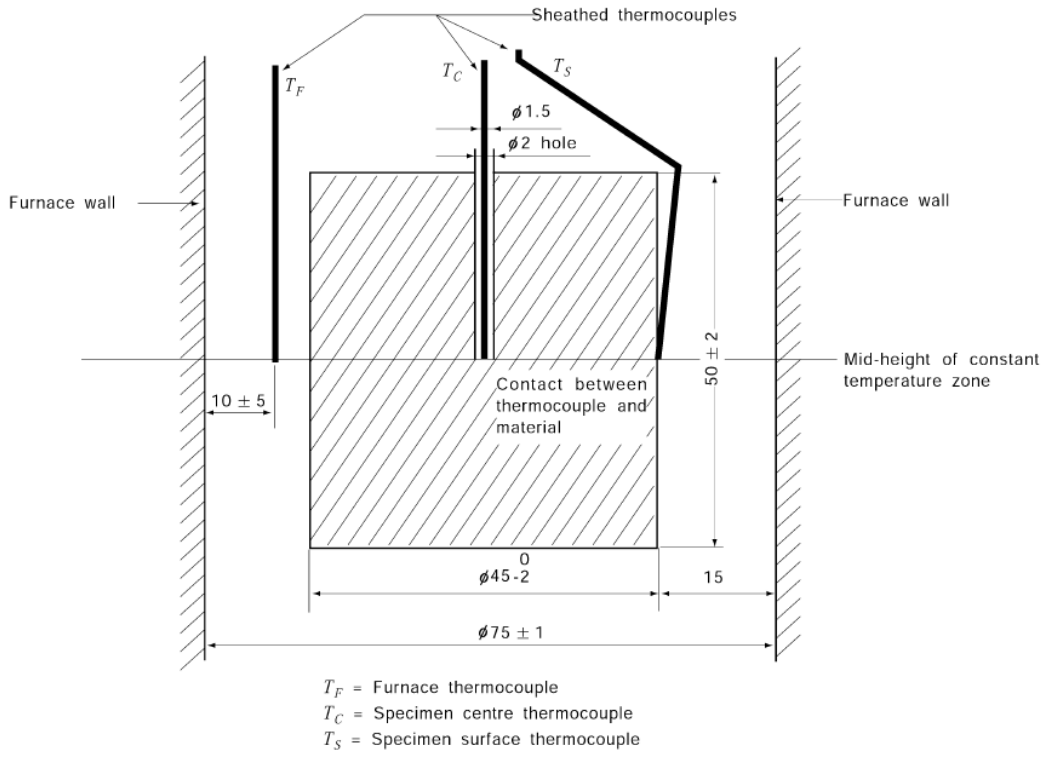
Item	Requirements
Preparation of specimen	(D) When a specimen is composed of a number of layers, the overall density should be as close as possible to that of the product provided by the manufacture
Conditioning	The specimens are to be conditioned in a ventilated oven maintained at 60 ± 5 °C, for between 20 hours and 24 hours, and cooled to ambient temperature in a desiccator prior to the testing. The mass of each specimen is to be determined to an accuracy of 0,01 g prior to test.
Observa-tions during test	(A) Record the mass before and after test for each specimen tested and note any observations relating to the behaviour of the specimen during the test including during insertion into the apparatus. (B) Note the occurrence of any sustained flaming and record the duration of each flaming. Sustained flaming is to be taken as the continuous presence of flame caused by the specimen lasting 5 seconds or longer. (C) Some specimens exhibit only a steady blue-coloured luminous gas zone; this shall not be considered as flaming but be noted under "observations during test" in the test report. (D) Record the following temperatures, as measured by the thermocouples; (a) the initial furnace temperature, Ti (furnace) : the average temperature over the final 10 min of the stabilization period) (b) the maximum furnace temperature T_m (furnace) and the maximum specimen surface temperature T_m (surface) : the discrete values at maximum temperature anywhere over the entire test period; and (c) the final furnace temperature T_f (furnace) and the final specimen surface temperature T_f (surface) : the average temperature over the final 1 min of the test period 
Expression of results	(A) Calculation of averages (a) For homogeneous products, calculate the averages for Mass loss (B) to Average temperature rise (E) for the five speciment. temperature rise (E) for each set of five specimens in the same orientation. The results for each orientation shall be presented separately, but they shall not be combined. (b) For non-homogeneous products, calculate the averages for Mass loss (B) to Average Classification shall be based on the most onerous orientation such that all the averages for each set of five specimens shall meet the requirements in "Classification of materials"

Table 3.44 Test method for non-combustible material *(continued)*

Item	Requirements
Expression of results	(B) Mass loss (a) Calculate and record the mass loss in percentage for each of the five specimens, expressed as a percentage of the initial mass of the specimen, measured as specified in "Observations during test (A)". (b) Calculate the average mass loss in percentage, which is the average of mass loss of the five specimens. (C) Flaming (a) Calculate and record the total duration of sustained flaming, in seconds, for each of the five specimens measured as "Observations during test (B)". (b) Calculate the average duration of sustained flaming, which is the average of total duration of sustained flaming of the five specimens, (D) Temperature rise Calculate and record the following temperature rise in °C for each of the five specimens recorded by the thermocouples as specified in "Observations during test (C)". (a) Furnace temperature rise: T_r *(furnace)* = T_m *(furnace)* – T_f *(furnace)* (b) Specimen surface temperature rise: T_r *(surface)* = T_m *(surface)* – T_f *(surface)* (E) Average temperature rise Calculate the average furnace temperature rise Tave r (furnace) and the average specimen surface temperature rise Tave r (surface) from the values obtained by (D) Temperature rise
Classification of materials	A material is to be deemed non-combustible if all the following criteria are satisfied. (A) The average furnace thermocouples temperature rise as calculated is not to exceed 30°C; (B) The average surface thermocouples temperature rise as calculated is not to exceed 30°C; (C) The mean duration of sustained flaming as calculated is not to exceed 10 second; and (D) The average mass loss as calculated is not to exceed 50 %
Others	Details of test for non-combustible materials not specially mentioned in 4. 1 are to comply with FTP Code, Annex 1, Part 1.

4.2 Fire test of “A” and “B” class divisions

(refer to FTP Code, Annex 1, Part 3 and IMO Res. MSC 307(88))

4.2.1 General

1) The dimensions of the structural cores of the test specimens given in 4.2.2 below are intended for structural cores of stiffened flat plates of steel or aluminium alloy. BKI may require tests to be carried out on specimens having structural cores of materials other than steel or aluminium alloy if such materials are more representative of the construction to be used on board ships.

2) “A“ class divisions which consist of uninsulated steel bulkheads or decks of suitable scantlings and without openings can be deemed to satisfy the requirements for ”A-0“ class divisions, i.e. to satisfy the requirements for the passage of smoke and flame, without the need for testing. All other divisions, including “A-0“class divisions with a structural core of aluminium, are required to be tested.

3) Results obtained on an insulating material used in conjunction with an 'A' class division may be applied to constructions incorporating heavier scantling than those tested and providing the orientation of the construction is the same, i.e. results from bulkhead tests are not to be applied to decks and vice versa.

4) Constructions are to be tested without paint or other superimposed finish, provided that where they are only produced with a superimposed finish, and subject to the agreement of BKI, they may be tested as produced. Such constructions may be required to be tested with a superimposed finish if such a finish is considered by BKI to have a detrimental effect on the performance of the construction in the test.

5) The construction to be tested are to be, as far as possible, representative of that to be used on board ships, including the materials and method of assembly.

6) Non-combustible materials used in the construction of the specimen are not to be more than 24 months old from the date of the performance of the fire resistance test. If not, tests are to be conducted specified in 4.1 above.

7) Adhesives used in A or B Class divisions should be low flame spread

8) The thickness of insulation on the stiffeners need not be same as that of the steel plate.

9) Doors, windows and other division penetrations intended to be installed in fire divisions made of material other than steel shall correspond to prototypes tested on a division made of such material.

10) "B" class constructions shall be tested without finished. For constructions where this is not possible, the finishes may be included in the "B" class test specimen, and shall be included in the non-combustibility test of the construction.

4.2.2 Nature of test specimens is to be as specified in Table 3.45.

Table 3.45 Fire test specimens of “A” and “B” class divisions

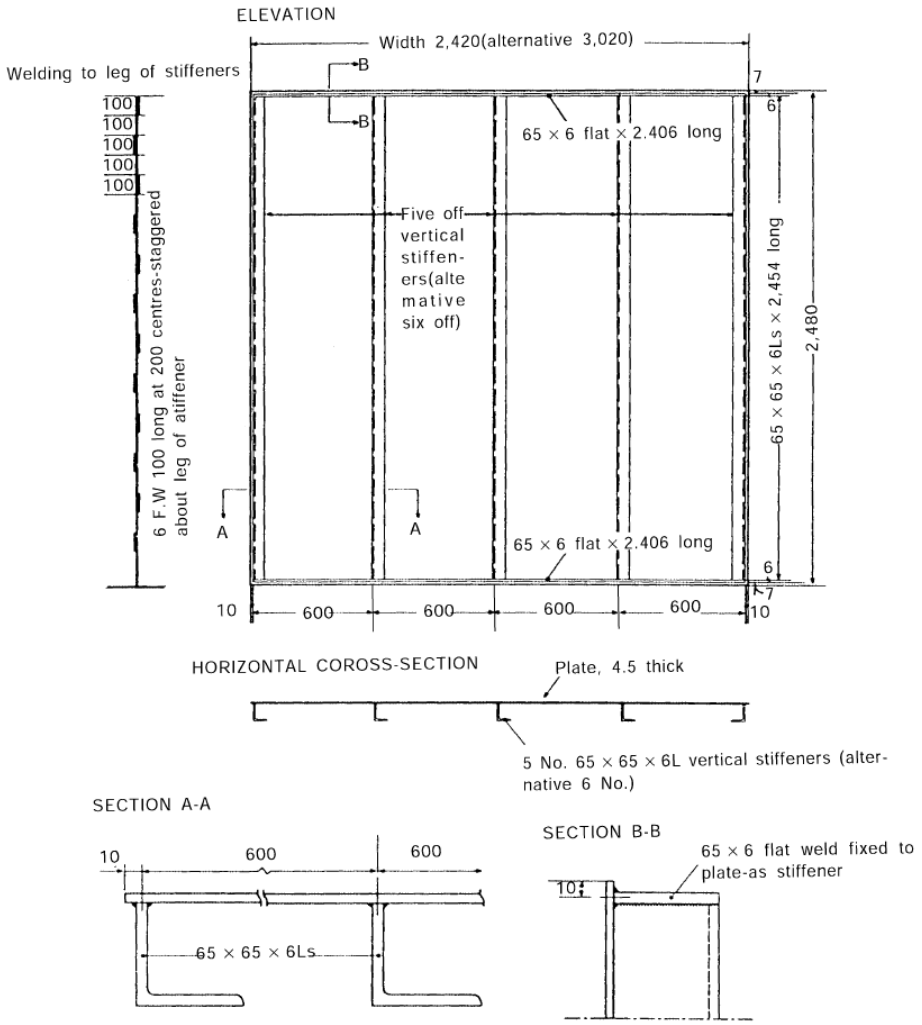
Kinds	Item	Requirements
“A“ class bulkheads	Dimensions	(1) The minimum overall dimensions of test specimen, including the perimeter details at the top, bottom and vertical edges, are 2440 mm width and 2500 mm height. (a) When the maximum overall height in practice is less than that given above, then the test specimen shall be of the maximum height to be used in practice. (b) The minimum bulkhead panel height shall be a standard height of the manufactured panel with a dimension of 2400 mm. (2) The overall dimensions of the structural core are to be 20 mm less in both the width and the height than the overall dimensions of the specimen, and the other dimensions of the structural core are to be as follows: (A) thickness of plating: - steel 4,5 ± 0,5 mm - aluminium 6,0 ± 0,5 mm (B) stiffeners spaced at 600 mm: - steel 65 ± 5 mm × 65 ± 5 mm × 6 ± 1mm - aluminium 100 ± 5 mm × 75 ± 5 mm × 9 ± 1 mm (3) The width of the structural core may be greater than the specified dimensions providing that the additional width is in increments of 600 mm to maintain the stiffener centres and the relationship between the stiffeners and the perimeter detail. (4) Any joints in the plating are to be full welded, at least from one side. The dimensions of the structural core and the details around the perimeter of the specimen are to be as illustrated in Fig 3.22 and Fig 3.23.  Fig 3.22 Structural Steel Core for "A" Class Bulkhead and "B"

Table 3.45 Fire test specimens of "A" and "B" class divisions *(continued)*

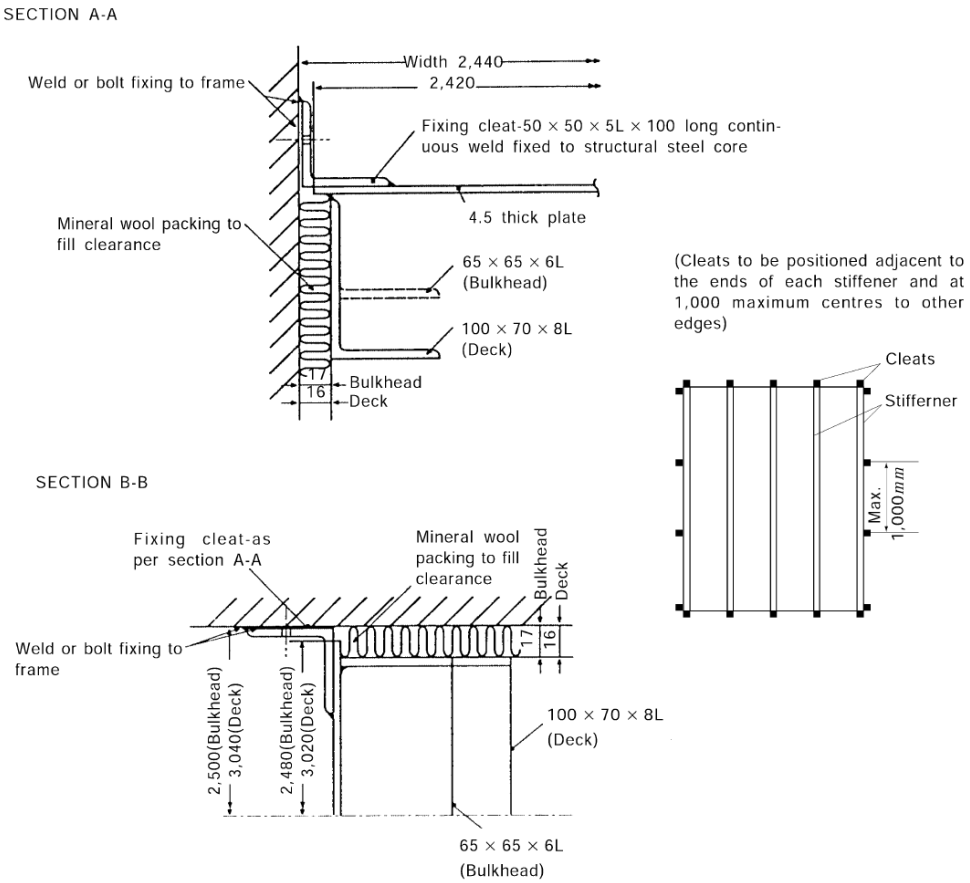
Kinds	Item	Requirements
"A" class bulkheads	Dimensions	 Fig 3.23 Connection between Restraint Frame and Structural Steel Core
	Construction	(1) Where insulation is provided by panels (e.g. a "B" class lining), then the test specimen is to be designed such that at least one of the panels is of full width and this, or these, are to be positioned such that both its/their longitudinal edges are jointed to an adjacent panel and are not secured to the restraint frame. (2) The overall dimensions of the panel insulation system, including the perimeter details at all the edges, are to be 20 mm greater in each direction than the equivalent dimensions of the structural core.
"A" class decks	Dimensions	(1) The minimum overall dimensions of test specimen, including the perimeter details at all the edges, are 2440 mm width and 3040 mm length. (2) The overall dimensions of the structural core are to be 20 mm less in both the width and the length than the overall dimensions of the specimen, and the other dimensions of the structural core are to be as follows: (A) thickness of plating: - steel 4,5 ± 0,5 mm - aluminium 6,0 ± 0,5 mm (B) stiffeners spaced at 600 mm: - steel 100 ± 5 mm × 70 ± 5 mm × 8 ± 1 mm - aluminium 150 ± 5 mm × 100 ± 5 mm × 9 ± 1 mm (3) The width of the structural core may be greater than the specified dimensions providing that the additional width is in increments of 600 mm to maintain the stiffener centres and the relationship between the stiffeners and the perimeter detail. (4) Any joints in the plating are to be full welded, at least from one side. The dimensions of the structural core and the details around the perimeter of the specimen are to be as illustrated in Fig 3.23 and Fig 3.24..

Table 3.45 Fire test specimens of "A" and "B" class divisions *(continued)*

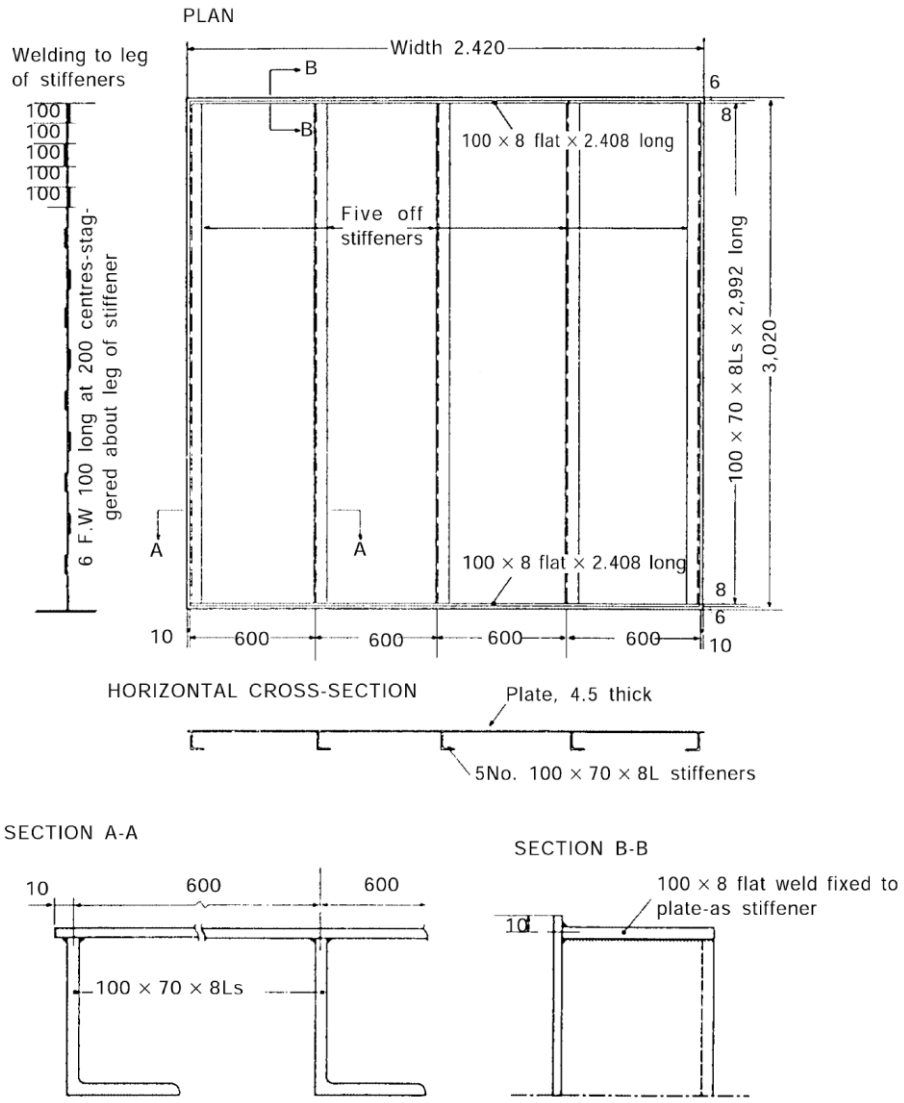
Kinds	Item	Requirements
"A" class decks	Dimensions	 Fig 3.24 Structural Steel Core for "A" Class deck and "B" Class Ceiling
	Construction	(1) Where insulation is provided by panels (e.g. a "B" class ceiling), then the test specimen is to be designed such that at least one of the panels is of full width and this, or these, are to be positioned such that both its/their longitudinal edges are jointed to an adjacent panel and are not secured to the restraint frame. (2) The overall dimensions of the panel insulation system, including the perimeter details at all the edges, are to be 20 mm greater in each direction than the equivalent dimensions of the structural core.
"A" class doors	Dimensions	The test specimen is to incorporate the maximum size (in terms of both the width and the height) of door leaf of leaves for which approval is to be sought. The maximum size of a door which can be tested will be determined by the requirement to retain certain dimensions of the structural core. (1) Door furniture such as hinges, locks, latches, shoot bolts, handles, etc. are to be constructed of materials having melting points of not less than 950°C unless it can be shown by the fire test that materials having melting points below 950°C do not adversely affect the performance of the door.

Table 3.45 Fire test specimens of "A" and "B" class divisions *(continued)*

Kinds	Item	Requirements
"A" class doors	Design	(2) The door leaf and frame are to be mounted as appropriate into a 'A' class bulkhead of compatible construction, thereby reflecting an actual end use situation. The bulkhead is to have dimension as specified in the dimension of 'A' class bulkhead above. The bulkhead is to be of a construction approved by BKI as having at least a similar classification to that required by the door. No additional stiffening shall be provided to the structurual core unless provided as part of the door frame. The method of fixing the door frame to the bulkhead is to be as used in practice. The door is to be positioned such that there is a minimum width of the bulkhead of 300 mm to each vertical side of the door and a minimum distance of 100 mm from the top edge of the bulkhead. If the method of fixing the door frame in a test is made by bolts, BKI may also accept welding as a method of fixing the door frame without further tests. (3) The door is to be positioned such that there is a minimum width of the bulkhead of 300 mm to each vertical side of the door and a minimum distance of 100 mm from the top edge of the bulkhead. If the method of fixing the door frame in a test is made by bolts, BKI may also accept welding as a method of fixing the door frame without further tests. (4) For doors mounted in a three-sided frame, the door shall be mounted with a bottom gap of between 12 mm and 25 mm between the bottom of the door and the test frame. (5) The door is to be mounted into the bulkhead such that the side expected to give the in ferior performance will be exposed to the heating condition of the test. A hinged door is to be tested with the door leaf opening away from the heating conditions unless BKI deems otherwise. For sliding doors, it is not possible to state generally from which side the door is to be tested to give the inferior performance. It will, therefore, be necessary to conduct two separate tests, one with the door mounted to the exposed face and one with the door mounted to the unexposed face of the bulkhead (6) For a door which incorporates a ventilation opening within its construction, the ventilation grille(s) is (are) to be open at the commencement of the test. Temperature measurements on such a door are not to be made over the face of the grille(s). (7) Lift landing doors can be expected to be exposed to fire from the corridor side only, and they shall be exposed to fire test heating conditions from that side only. (8) Tests performed with double leaf doors will not be accepted as approval documentation for single leaf doors. (9) Double leaf doors should be tested with equally sized door leaves unless the door is intended to have unequally sized leaves.
"B" class bulkheads	Dimensions	(1) The minimum overall dimensions of test specimen, including the perimeter details at the top, bottom and vertical edges, are 2440 mm width and 2500 mm height. When the maximum overall height in practice is to be less than given above, then the test specimen is to be of the maximum height to be used in practice. (2) The minimum bulkhead panel height shall be a standard height of the manufactured panel with a dimension of 2400 mm.
	Construction	Where the construction incorporates panels, the specimen is to be constructed such that at least one of the panels is of full width and this, or these, is to be positioned such that both its/their longitudinal edges are jointed to an adjacent panel and are not secured to the restraint frame.
"B" class decks	Dimensions	The minimum overall dimensions of test specimen, including the perimeter details at all the edges, are 2440 mm width and 3040 mm length. When the maximum dimension in practice is to be less than given above, then the test specimen is to be of the maximum size to be used in practice.

Table 3.45 Fire test specimens of “A” and “B” class divisions *(continued)*

Kinds	Item	Requirements
“B“ class decks	Construction	Where the construction incorporates panels, the specimen is to be constructed such that at least one of the panels is of full width and this, or these, is to be positioned such that both its/their longitudinal edges are jointed to an adjacent panel and are not secured to the restraint frame.
“B“ class door	Dimensions	The test specimen is to incorporate the maximum size (in terms of both the width and the height) of door leaf of leaves for which approval is to be sought. The maximum size of a door which can be tested will be determined by the requirement to retain certain dimensions of the bulkhead.
	Design	(1) Door furniture such as hinges, locks, latches, shoot bolts, handles, etc. are to be constructed of materials having melting points of not less than 850°C unless it can be shown by the fire test that materials having melting points below 850°C do not adversely affect the performance of the door. (2) The door leaf and frame are to be mounted as appropriate into a 'B' class bulkhead of compatible construction, thereby reflecting an actual end use situation. The bulkhead is to have dimension as specified in the dimension of 'B' class bulkhead above. The bulkhead is to be of a construction approved by BKI as having at least a similar classification to that required by the door. The method of fixing the door frame to the bulkhead is to be as used in practice. (3) The bulkhead shall be of a construction approved by BKI as having at least a similar classification to that required by the door, and approval shall be limited to the type of construction in which the door was tested. (4) The method of fixing the door frame to the bulkhead shall be as used in practice. If the method of fixing the door frame in a test is made by bolts, BKI may also accept welding as a method of fixing the door frame without further tests. (5) For doors mounted in a three-sided frame, the door shall be mounted with a bottom gap of between 12 mm and 25 mm between the bottom of the door and the test frame. (6) The door is to be positioned such that there is a minimum width of the bulkhead of 300 mm to each vertical side of the door and a minimum distance of 100 mm from the top edge of the bulkhead. (7) The door is to be mounted into the bulkhead such that the side expected to give the inferior performance will be exposed to the heating condition of the test. A hinged door is to be tested with the door leaf opening away from the heating conditions unless BKI deems otherwise. For sliding doors, it is not possible to state generally from which side the door is to be tested to give the inferior performance. It will, therefore, be necessary to conduct two separate tests, one with the door mounted to the exposed face and one with the door mounted to the unexposed face of the bulkhead (8) For a door which incorporates a ventilation opening within its construction, the ventilation grille(s) is (are) to be open at the commencement of the test. Temperature measurements on such a door are not to be made over the face of the grille(s).
“B“ class linings	Dimensions	(1) The minimum overall dimensions of test specimen, including the perimeter details at the top, bottom and vertical edges, are 2440 mm width and 2500 mm height. When the maximum overall height in practice is to be less than that given above, then the test specimen shall be of the maximum height to be used in practice. (2) The minimum bulkhead panel height shall be a standard height of the manufactured panel with a dimension of 2400 mm.
	Design	(1) The lining is to be positioned alongside a structural core constructed in accordance with the dimension of 'A' class bulkhead above. The design of the lining is to be such that it facilitates its assembly with the limited access provided by the proximity of the structural core, i.e. it is to be mounted with the structural core in place. (2) During a test on an “A” class bulkhead which utilizes membrane protection along its exposed side, e.g. a 'B' class lining, it is possible also to evaluate the

Table 3.45 Fire test specimens of "A" and "B" class divisions *(continued)*

Kinds	Item	Requirements
"B" class linings	Design	performance of the lining with a view to classification providing that the necessary thermocouples are attached to the lining and proving that the necessary integrity measurements are made. (3) The specimen is to be constructed such that at least one of the panels is of full width and this, or these, is to be positioned such that both its/their longitudinal edges are jointed to an adjacent panel and are not secured to the restraint frame.
"B" class ceilings	Dimensions	(1) The minimum overall dimensions of test specimen, including the perimeter details at the top, bottom and vertical edges, are 2440 mm width and 3040 mm length. (2) When the maximum dimensions in practice are less than those given above then the test specimen shall be of the maximum size to be used in practice, and the tested width shall be reported.
	Design	(1) The ceiling is to be positioned below a structural core constructed in accordance with the dimension of 'A' class deck above. (2) The design of the ceiling is to be such that it facilitates its assembly with the limited access provided by the proximity of the structural core, i.e. it is to be mounted with the structural core in place. (3) During a test on an "A" class deck which utilizes membrane protection along its underside, e.g. a 'B' class ceiling, it is possible also to evaluate the performance of the ceiling with a view to classification providing that the necessary thermocouples are attached to the ceiling and proving that the necessary integrity measurements are made. (4) If the ceiling incorporates panels, the specimen is to include example of both the lateral and longitudinal joints between the panels. (5) If the specimen is to simulate a ceiling where the maximum length of the panels is greater than the length of the specimen, then a joint is to be positioned at a distance of approximately 600 mm from one of the shorter ends of the test specimen. (6) The specimen is to be constructed such that at least one of the panels is of full width and this, or these, is to be positioned such that both its/their longitudinal edges are jointed to an adjacent panel and are not secured to the restraint frame.
Windows	General	Window is taken to include windows, side scuttles and any other glazed opening provided for light transmission or vision purposes in "A" class bulkheads. Windows in "A" class doors are considered to be part of the door and they are to be tested within the appropriate door.
	Dimensions	(1) The test is to be conducted on the window of the maximum size (in terms of both the width and the height) for which approval is sought. (2) The test shall be conducted on a window of the maximum size (in terms of both the height and the width) and the type of the glass pane and/or the minimum thickness of the glass pane or panes/and gaps, if appropriate, for which approval is sought. Test results obtained on this configuration shall, by analogy, allow approval of windows of the same type, with lesser dimensions in terms of height and width and with the same or greater thickness.
	Design	The bulkhead which includes the window is to be insulated to class 'A-60' on the stiffened face, which is to be the face exposed to the heating conditions of the test. There may be special applications of windows where BKI considers it appropriate to test the window with the insulation of the bulkhead to the unexposed face of the structural core, or within bulkheads other than class 'A-60'. The window is to be positioned within the bulkhead, shown in Fig 3.23, at that height which is intended for practical application. When this is not known, the window is to be positioned with the top of its frame as close as possible, but not closer than 300 mm, to the top of the bulkhead.

Table 3.45 Fire test specimens of "A" and "B" class divisions *(continued)*

<table>
<tr><th>Kinds</th><th>Item</th><th>Requirements</th></tr>
<tr><td rowspan="2">Fire Dampers</td><td>Dimensions</td><td>The maximum sizes (in terms of both the width and the height, or the diameter) of each type of fire damper for which approval is sought are to be tested in both vertical and horizontal orientation.</td></tr>
<tr><td>Design</td><td>(1) A bulkhead which includes the damper is to be constructed in accordance with the dimension of 'A' class bulkhead above and is to be insulated to class "A-60" on the stiffened face, which is to be the face which is not exposed to the heating conditions of the test. A deck which includes the damper is to be constructed in accordance with (B) (a) above and is to be insulated to lass "A-60" on the stiffened face, which is to be the face which is exposed to the heating conditions of the test.
(2) Fire dampers are to be incorporated into or fixed to coaming or spigots, which are to be welded or bolted into the structural core.
The length on the unexposed side = (450 mm or a needed insulation length for a damper under test) (L_{unexp}) + 50 mm.
The thickness of the coaming or spigot shall be as follows :
<table>
<tr><th>Width* or diameter of the duct</th><th>Minimum thickness of coaming or spigot</th></tr>
<tr><td>Up to and including 300 mm</td><td>3 mm</td></tr>
<tr><td>760 mm and over</td><td>3 mm</td></tr>
</table>
* Width means the greater of the two cross-sectional dimensions.
For widths or diameters of ducts in excess of 300 mm but less than 760 mm, the thickness of the coaming or spigot is to be obtained by interpolation. The coaming or spigot are to be insulated as shown in Fig 3.25.
(3) The coamings or spigots (including insulation) are to be positioned only in the top half of a bulkhead but are to be no closer than 200 mm from the edges of a bulkhead or a deck. Where more than one damper is to be tested simultaneously in a division, the separation between adjacent coamings or spigots (including insulation) are not to be less than 200 mm. When more than one damper is included in a bulkhead, the top edges of all dampers are to be, as far as possible, at the same height.
(4) The fire dampers are to be positioned on the exposed face of the bulkhead or deck, at a distance of at least 225 mm from the structural core, with their operative controls also on that side of the division. When a damper is mounted in the bulkhead the fuse element should be situated at the lowest level of the damper as in practice.
(5) Fire dampers which are operated automatically shall be in the open position at the start of the test and shall be closed by an automatic device. The damper shall be in the closed position within 2 min after the commencement of the test. If the fire damper shall be deemed to have failed and the test shall be discontinued.</td></tr>
</table>

Table 3.45 Fire test specimens of "A" and "B" class divisions *(continued)*

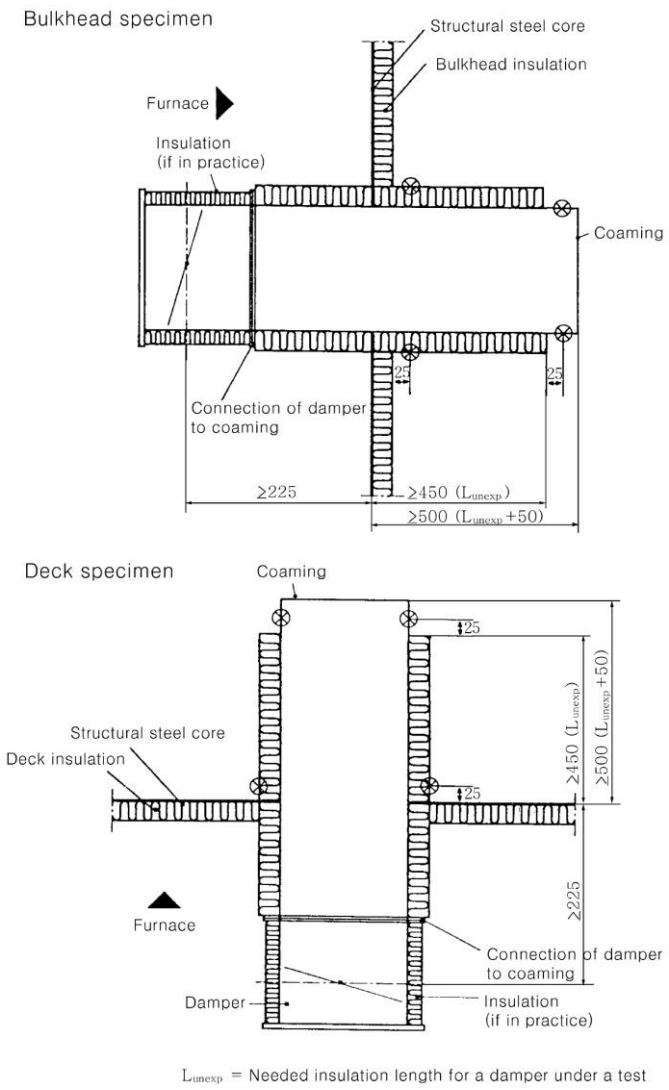
Kinds	Item	Requirements
Fire Dampers	Design	 Fig 3.25 Fire Dampers: Insulation on Test Specimens and Position of Unexposed-face Thermocouples (6) Fire dampers which are operated with a manual system shall be closed at the test time of 1 min.
Pipe and duct penetrations	Dimensions	The maximum and minimum sizes (in terms of both the width and the height, or diameter) of each type of pipe penetration for which approval is sought are to be tested in both vertical and horizontal orientation.
	Design	(1) A bulkhead which includes the pipe penetration is to be constructed in accordance with (A) (a) above and is to be insulated to class "A-60" on the stiffened face, which is to be the face which is not exposed to the heating conditions of the test. A deck which includes the pipe penetration is to be constructed in accordance with the dimension of 'A' class deck above and is to be insulated to class "A-60" on the stiffened face, which is to be the face which is exposed to the heating conditions of the test. (a) "A-0" class pipe penetrations are recommended to be performed in an uninsulated ("A-0") bulkhead/deck. If the pipe penetrations are tested as an "A-60" class penetrations, any insulation fitted (on the penetration itself and 200 mm around) will be required to be fitted also for class "A-0".

Table 3.45 Fire test specimens of "A" and "B" class divisions *(continued)*

Kinds	Item	Requirements
Pipe and duct penetrations	Design	(2) The pipe penetrations are to be positioned only in the top half of a bulkhead but are not to be closer than 200 mm from the edges of a bulkhead or a deck. Where more than one pipe penetration is to be tested simultaneously in a division, the separation between adjacent penetrations is not to be less than 200 mm. Both measurements are to relate to the distance to the nearest part of the penetration system, including any insulation which is part of the system. (3) Each pipe passing through a penetration is to project 500 ± 50 mm beyond the exposed end of the penetration and 500 ± 50 mm beyond the unexposed end of the penetration. The exposed end of the pipe is to be blanked off, using an appropriate methodology to ensure that any fire penetration into the pipe does not occur via the end of the pipe in advance of it occurring through the exposed perimeter of the pipe. (4) Each pipe is to be firmly supported and fixed independent of the bulkhead or deck on the unexposed side of the test specimen, e.g. by a framework mounted from the restraint frame. The support and fixing of the pipe are to restrain it from movement during the test. (5) When the deck penetration is fitted on an exposed side or is fitted symmetrically, general application will be given. When the deck penetration is fitted on an unexposed side, the approval will limit the penetration to the tested orientation. When the bulkhead penetration is fitted symmetrically, approval would be given for general application. For bulkhead penetrations with an exposed or unexposed fitted frame, one test for each fitting is required in order for obtaining approval for general application. (6) Sealing of pipe and duct penetrations: there shall be no visible openings before the start of the fire test.
Cable transits	Dimensions	The maximum and minimum sizes (in terms of both the width and the height, or diameter) of each type of pipe penetration for which approval is sought are to be tested in both vertical and horizontal orientation.
	Design	(1) A bulkhead which includes the cable transit is to be constructed in accordance with the dimension of 'A' class bulkhead above and is to be insulated to class "A-60" on the stiffened face, which is to be the face which is not exposed to the heating conditions of the test. A deck which includes the cable transit is to be constructed in accordance with the dimension of 'A' class deck above and is to be insulated to class 'A-60' on the stiffened face, which is to be the face which is exposed to the heating conditions of the test. (a) "A-0"class cable transits are recommended to be performed in an uninsulated ("A-0") bulkhead/deck. If the cable transits are tested as an "A-60" class penetrations, any insulation fitted (on the cable transits itself and 200 mm around) will be required to be fitted also for class "A-0". (2) The cable transits are to be positioned only in the top half of a bulkhead but are not to be closer than 200 mm from the edges of a bulkhead or a deck. Where more than one cable transit is to be tested simultaneously in a division, the separation between adjacent penetrations is not to be less than 200 mm. Both measurements are to relate to the distance to the nearest part of the penetration system, including any insulation which is part of the system. (3) Notwithstanding the above, the distance between transits is to be sufficient to ensure that the transits do not influence each other during the test, except that this requirement does not apply to mulitransits which are intended to be positioned adjacent to one another. (4) The cables are to project 500 ± 50 mm beyond the transit on the exposed side of the division and 500 ± 50 mm on the unexposed side. Each cable shall be firmly supported and fixed independent of the bulkhead or deck on the unexposed side of the test specimen, e.g., by a framework mounted from the restraint frame. The support and fixing of the cables shall restrain them from movement during the test.

Table 3.45 Fire test specimens of "A" and "B" class divisions *(continued)*

Kinds	Item	Requirements
Cable transits	Design	(5) Cable transits shall be fitted to the bulkhead or deck in accordance with the manufacturer's specifications. The cables and sealing compounds or blocks shall be incorporated into the transits with the bulkhead and deck panels places respectively in vertical and horizontal positions. Any insulation shall be applied to the cables and transits with the panels in the same respective positions. (6) The transit(s) is to be tested incorporating a range of different types of cables (e.g. in terms of number and type of conductor, type of sheathing, type of insulation material, size) and is to provide an assembly which represents a practical situation which may be found on ships. The test results obtained from a given configuration are generally valid for the tested types of cables of size equal to or smaller than tested. (7) Tests shall be conducted for the maximum and minimum fill based on the inside cross-sectional area at each transit. The distance between the adjacent cables shall be the minimum specified by the manufacturer, and the cables should be placed close to the centre of the transit. (8) When the deck cable transit is fitted on an exposed side or is fitted symmetrically, general application will be given. When the deck cable transit is fitted on the unexposed side, the approval will limit the penetration to the tested orientation. When the bulkhead cable transit is fitted symmetrically, approval would be given for general application. For bulkhead cable transit with exposed or unexposed fitted frame, one test for each fitting is required in order for obtaining approval for general application. (9) Sealing of cable transits shall have no visible opening before the start of the fire test.
Continuous "B" class divisions	Continuous 'B' class ceilings	The ceilings are to be tested in accordance with "B" class ceilings above except that the ceiling is to be mounted on the horizontal furnace so that at least 150 mm high "B" class bulkheads are mounted on the furnace and the ceiling is fixed to these partial bulkheads by using the joining method as is intended to be used in practice. Such ceilings and the joining methods are to be evaluated as required for ceilings in accordance with "B" class ceilings above and accordingly they are to be classified as "continuous "B" class ceilings".
	Continuous "B" class linings	A lining which has been evaluated in accordance with "B" class linings above to be a "B" ("B-0", "B-15", as applicable on basis of the lining test) class lining may be considered forming 'continuous "B" ("B-0" or "B-15", as applicable) class lining' in conjunction with a 'continuous "B" ("B-0' or "B-15", as applicable) class ceiling' and with the joining method used in the test without further testing the lining.
	Continuous "B" class construction	An enclosed construction installed on an "A" class deck and formed by 'continuous "B" ("B-0" or "B-15", as applicable) class lining' and 'continuous "B" ("B-0" or "B-15", as applicable) class ceiling' is to be considered forming 'continuous 'B' class construction".

4.2.3 Examination of the test specimens

1) BKI is to verify the conformity of the test specimen with the drawings and method of assembly provided by the applicant and any area of discrepancy is to be resolved prior to commencement of the test.

2) Door clearances

   Following mounting of the door and immediately prior to test, BKI is to measure the actual clearances between the door leaf and the doorframe, and additionally for a double leaf door between the adjacent door leaves. The clearances are to be measured for each door leaf at two positions along the top and bottom edges and at three positions along each vertical edge.

3) Door operation

Similarly, immediately prior to test, BKI is to check the operability of the door by opening the door leaf by a distance of at least 300 mm. The door leaf is to then be closed, either automatically, if such a closing device is provided, or manually. The door may be latched for the test but is not to be locked, and no devices for latching or locking are to be included which are not normally incorporated in practice.

4.2.4 Observations during the test

Observations during the test is to be as specified in Table 3.46.

Table 3.46 Observation of “A” and “B” class divisions

Item	Observation
Flaming on unexposed face	The occurrence and duration of any flaming on the unexposed surface, together with the location of the flaming, are to be recorded. In case where it is difficult to indentify whether or not there are flames then the cotton-wool pad is to be applied to the area of such disputed flaming to establish whether ignition of the pad can be initiated.
Cotton-wool pad	(a) Tests with the cotton-wool pad are used to indicate whether cracks and openings in the test specimen are such that they could lead to the passage of hot gases sufficient to cause ignition of combustible materials. (b) A cotton-wool pad is employed by placing the frame within which it is mounted against the surface of the test specimen, adjacent to the opening or flaming under examination, for a period of 30 seconds, or until ignition (defined as glowing or flaming) of the cotton-wool pad occurs (if this happens before the elapse of the 30 seconds period). A cotton-wool pad is to be used only once.
Gap gauges	(a) Tests with the gap gauges are used to indicate whether cracks and openings in the test specimen are of such dimensions that they could lead to the passage of hot gases sufficient to cause ignition of combustible materials. (b) The gap gauges are to be used at intervals which will be determined by the apparent rate of the specimen deterioration. Two gap gauges are to be employed, in turn, and without undue force to determine: - whether the 6 mm gap gauge can be passed through the specimen such that the gauge projects into the furnace, and can be moved a distance of 150 mm along the gap, or - whether the 25 mm gap gauge can be passed through the specimen such that the gauge projects into the surface. (c) If gaps in "A" or "B" class divisions are fully or partly sealed by intumescent materials, the gap gauge test shall be performed as if no intumescent material is present. (d) For doors mounted in a three-sided frame, the change of gap at the bottom of the door as measured by a horizontally-held gap gauge shall not increase by more than 12 mm along the bottom edge of the door. 12 mm gap gauge can be used for the purpose of examining the increase of such gap. The edges of the door above the horizontal plane along the bottom of the door should be checked in the same manner as the fou-sided framed door. * If the door is mounted with a 13 mm gap, the 25 mm gap gauge may be used to determine an unacceptable change in gap.
Deformation	The deflection of an “A”or "B" class test specimen, and additionally in the case of a door the maximum displacement of each corner of the door leaf relative to the door frame, are to be recorded during the test. These deflections are to be measured with an accuracy of 2 mm.
General behaviour	If quantities of smoke are emitted from the unexposed face, this is to be noted in the report.

4.2.5 Duration of testing

Duration of testing is to be as specified in Table 3.47.

Table 3.47 Duration of testing of "A" and "B" class divisions

Item	Duration of testing
"A" class divisions	For all "A" class divisions, including those with doors, the test is to continue for minimum 60 minutes. When the specimen is of an "A" class division, with a structural steel core which is imperforate (e.g. without door), and where insulation is provided to the exposed face only (i.e. the structural steel core is the unexposed face of the construction), it is permitted to terminate the test prior to 60 minutes once the unexposed face temperature rise limits have been exceeded.
"B" class divisions	For all "B" class divisions, including those with doors, the test is to continue for minimum 30 minutes.
Termination of the test	The test may be terminated for one or more of the following reasons: (1) safety of personnel or impending damage to equipment; (2) attainment of selected criteria; or (3) request of the sponsor. The test may be continued after failure under subparagraph (2) above to obtain additional data.

4.2.6 Performance criteria

Performance criteria is to be as specified in Table 3.48.

Table 3.48 Performance criteria of "A" and "B" class divisions

Item	Kinds	Performance criteria
Insulation	"A" class divisions, including "A" class doors	The average unexposed face temperature rise is not to be more than 140 °C, and the temperature rise recorded by any of the individual unexposed face thermocouples is not to be more than 180 °C during the periods given below for each classification: class "A-60" 60 minutes class "A-30" 30 minutes class "A-15" 15 minutes class "A-0" 0 minutes
	"B" class divisions, including "B" class doors	The average unexposed face temperature rise is not to be more than 140 °C, and the temperature rise recorded by any of the individual unexposed face thermocouples is not to be more than 225°C during the periods given below for each classification: class "B-15" 15 minutes class "B-0" 0 minutes
Integrity	General	For all "A" and "B" class divisions, including "A" and "B" class doors, the following requirements are to be satisfied for the minimum test duration relevant to the classification. "A" and "B" class doors are not required to be able to be opened or closed, during or after the specified test duration.
	Flaming	There are to be no flaming on the unexposed face
	Cotton-wool pad	There are to be no ignition, i.e. flaming or glowing, of the cotton-wool pad when applied in accordance with Table 3.46 above or when used to assist evaluation of flaming in accordance with Table 3.46 above.
	Gap gauges	Gap gauges: it is not to be possible to enter the gap gauges into any opening in the specimen in the manner described in Table 3.46 above.
Structural core temperature		In the case of load-bearing divisions of aluminium alloy, the average temperature of the structural core obtained by the thermocouples is not to rise more than 200 °C above its initial temperature at any time during the minimum test duration relevant to the classification described in 4.2.5 above. Where the structural core is of a material other than steel or aluminium alloy, BKI is to decide the rise in temperature which is not to be exceeded during the test duration.

Table 3.48 Performance criteria of "A" and "B" class divisions *(continued)*

Item	Kinds	Performance criteria
Continuous "B" class ceilings and linings		Where ceilings or linings are required to be continuous "B" class ceilings or linings, they may be tested and evaluated in accordance with Appendix 4, Part 3, Annex 1 of the FTP Code.
Additional requirements		(1) The specimen of the "A" and "B" class constructions shall be constructed from non-combustible materials. (A) adhesives and vapour barriers used in the construction of the specimen are not required to be non-combustible; however, they shall have low flame-spread characteristics; (B) sealing materials used in penetration systems; (C) seals for gas-, water- and weather-tight doors; (D) seals for windows; and (E) filling material within glazing systems. (a) Adhesives and sealing materials used in testing of penetration sysstems shall be used in the actual structure. Materials mentioned in paragraphs (A) ~ (E) may be installed in constructions of the specimen. Such inclusions shall be stated in the test report. (b) The material used in the test shall not be replaced by any other materials that have not been tested in accordance with FTP Code and/or accepted by BKI. (2) Thermal radiation through windows (A) Where thermal radiation through windows is required to be limited by BKI, the window assembly may be tested and evaluated in accordance with Appendix 3 of the FTP Code. (B) The cotton-wool pad need not be used on the unexposed face after the period relevant to the insulation classification of the product.

4.2.7 A fire door of marginally larger dimensions

Method of evaluation and testing about fire doors larger than the standard specimen size (2,440 mm wide and 2,500 mm high) as specified in part 3 of the FTP Code is to comply with the following requirements.

1) If such doors can be accommodated into a larger test furnace, it is recommended to conduct a test with the full-size specimen of the door; or
2) It is recommended to use the following method for evaluation of the fire performance of the door and approval of the door may be used.

A) Fire doors of marginally larger dimensions

A fire door of marginally larger dimensions than a fire door tested in accordance with the FTP Code may be individually assessed and accepted for a specific project with the same classification, provided all of the following are met:

a) Dimensions (width, height) are not more than 15 % above those of the fire door tested in accordance with the FTP Code
b) The surface area of the door is not more than 10 % above that of the fire door tested in accordance with the FTP Code
c) The door design does not deviate in any other aspect from the fire door tested in accordance with the FTP Code.
d) The tested door has successfully satisfied both insulation and integrity criteria for the following times, as appropriate

Class divisions	Insulation (min)	Integrity (min)
B-0	0	36
B-15	18	36
A-0	0	68
A-15	18	68
A-30	36	68
A-60	68	68

B) Fire doors larger than those in the above A), but not exceeding 50 % in surface area of a fire door tested in accordance with the FTP Code.

a) An engineering assessment can be used to extrapolate the fire test results of a fire door tested in accordance with the FTP Code to apply to a door larger than those in the above A), but not exceeding 50 % in surface area of a fire door tested in accordance with the FTP Code.

b) Such an assessment can be accepted for verification, only if the dimensions of the door in question are greater than the maximum permitted and the results from tested door have been found satisfactory in accordance with Annex 1, Part 3 of the FTP Code.

c) The methodology used to extrapolate the fire tests results shall include the following three steps

i) Standard fire test of the “specimen” to obtain reference temperature and structural displacements. Such a “specimen” may be either

– A door already certified through the fire test which is identical in design to the door to be analysed (fire test to include additional instrumentation as per paragraph d) v) or
– A specially-built specimen where the finite element method is to be performed to extrapolate the results of a specimen for a door having a size exceeding the maximum size allowed by the furnace of the testing laboratory; the specimen should be a mock-up of the door in question, but having a size that fits in the furnace.

ii) Finite element analysis in paragraph f), of the “specimen” to calibrate the thermal and mechanical boundary conditions of the FEM model, which are adjusted until the numerical and experimental temperature and displacement distribution compare satisfactorily

iii) Finite element analysis in paragraph e), of the door in question carried out using the model calibrated as per paragraph g), assuming that the differences in the geometry and dimensions between the actual door and the specimen door do not significantly influence the results.

d) In order for the analysis to be carried out, the following information should be submitted

i) Detailed drawings of the door, the door frame and the closure and locking devices including clearances and interferences.

ii) Test report of the prototype used to extrapolate the results.

iii) Mechanical characteristics of all materials used for the construction of the door and its insulation

– Young’ module
– Yield strength
– Density

iv) Thermal properties

– Thermal expansion coefficient
– Thermal conductivity
– Specific heat.

v) Since the properties in the above iii) and iv) are temperature dependent, it is necessary that the required data be given as a function of the temperature range foreseen for the fire tests. Where it is not possible to obtain experimental data, an engineering evaluation shall be submitted with the supporting documentation for the proposed curves of variation of mechanical and thermal characteristics as a function of the temperature in the considered range.

e) Method of analysis

The comparison of the fire resistance of doors having larger geometry shall be carried out in two steps:

i) Evaluation of the heat transmission through the specimen thickness and of the temperature on the unexposed specimen surface.

ii) Evaluation of the strength characteristics and of the displacements of the structural members of the specimen.

f) Heat transmission analysis

i) By carrying out finite element calculations, the histories over time of the heat transmission within the structural assembly are computed and the temperature is compared with the temperature experienced by the assembly represented in the standard fire test.

ii) Based on suitable data for the temperature-dependent variables, an iterative procedure is used for the evaluation of thermal-mechanic properties.

iii) The thermal boundary conditions of convecting and radiative type are:

$$q_c = h_c(T_S - T_\infty) \quad \text{and} \quad q_r = \sigma_\varepsilon(T_S^4 - T_\infty^4)$$

where:

q_c and q_r : Convective and radiative heat flux, respectively

h_c : Convective heat transfer coefficient

σ : Stefan-Boltzmann constant

ε : Emissivity coefficient

T_S : Surface temperature

T_∞ : Furnace or ambient temperature

iv) The two equations can be included in an equivalent boundary condition:

$$q = H_{eq}(\sigma\varepsilon, T_S, T_\infty)(T_S - T_\infty)$$

The equivalent coefficient Heq depends on the unknown surface temperature. However, it can be calculated as part of the finite element analysis using an emissivity coefficient appropriately calibrated with the fire test results.

v) The equivalent heat transfer coefficient can be assumed to be constant on the single exposed surface, as the furnace assembly built in accordance with the FTP Code gives uniformity of the temperature and heat flux within the furnace.

vi) Alternatively, the temperature distribution measured on the specimen of the standard fire test can be directly applied on the finite element structural model taking into account the same time histories.

g) Structural analysis

i) Using the results of the heat transmission analysis and information on temperature dependent material properties, the thermal stresses and deformations on the geometry are evaluated. When modelling the structural assembly, attention should be paid to using a sufficient number of elements to account for the non-uniform temperature distribution within the member and to catch the non-linear temperature-dependent behaviour.

ii) Once the model is prepared, the analysis is to be carried out stepwise. For each element, the incremental strain or deformation caused by a temperature increase is calculated and a new stress level is obtained based on the stress strain relationship applicable for that particular temperature increase.

iii) The mechanical boundary conditions are to be congruent in order to represent the real interaction of the door with the external frame for the overall length of the test.

C) Larger fire doors exceeding 50% in surface area of a fire door tested in accordance with the FTP Code

a) For larger doors exceeding 50 % in surface area of a fire door tested in accordance with the FTP Code, a full analysis is to be performed as per SOLAS regulation II-2/17.

b) The approach shall be based on the results of the fire test of the door having the maximum dimensions permitted according to the procedure described in the above B).

4.2.8 Others

Details of test for “A” and “B” class divisions not specially mentioned in 4.2 are to comply with FTP Code, Annex 1, Part 3.

4.3 Test for surface flammability

Test for surface flammability are to comply with requirements specified in Table 3.49 (refer to FTP Code, Annex 1, Part 5 and IMO Res. MSC. 370(88)).

Table 3.49 Surface flammability test

Item	Test method
Application	Where a product is required to have a surface with low flame-spread characteristic, the product is to comply with the requirements below.
Test specimens	(A) Number required (a) Specimens required: At least six specimens shall be provided for each different exposed surface. (b) Required number for the test: Three specimens shall be tested for each different exposed surface of the product evaluated and applied. (B) Dimension (a) The specimens are to be 155 $^{+0}_{-5}$ mm wide by 800 $^{+0}_{-5}$ mm long, and be representative of the product. (b) Specimen thickness: materials and composites of normal thickness 50 mm or less are to be tested using their full thickness. For materials and composites of normal thickness greater than 50 mm, the required specimens are to be obtained by cutting away the unexposed face to reduce the thickness to 50 $^{+3}_{-0}$ mm. (C) Substrate (a) Substrate of surface material and floorcoverings Materials and composite materials shall be tested using their full thickness, attaching them, by means of an adhesive if appropriate, to the substrate to which they will be attached in practice. The test specimen shall reflect actual application. (b) Substrate of primary deck covering

Table 3.49 Surface flammability test *(continued)*

Item	Test method
	The specimens shall be applied to a steel plate having a thickness of $3\ ^{+0,3}_{-0,3}$ mm. The specimens shall have a nominal thicknes; the components and construction of the primary deck covering shall reflect actual application. (D) Composite materials (a) Assembly is to be as specified in (B) above. However, where thin materials or composites are used in the fabrication of an assembly, the presence of an air gap and/or the nature of any underlying construction may significantly affect the flammability characteristics of the exposed surface. The influence of the underlying layers is to be recognized and care taken to ensure that the test result obtained on any assembly is relevant to its use in practice. (b) Vapour barriers used in conjunction with installation shall be tested without any other components that will shield the barrier being tested from the radiant panel. The substrate of the specimen shall reflect actual application on ships. (E) Metallic facings If a bright metallic faced specimen is to be tested, it shall be tested as it is. (F) Marking specimens A line is to be marked centrally down the length of the face to be tested of each specimen. Caution is to be exercised to avoid the use of a line which would influence specimen performance. (G) Conditioning of specimens Before test, the specimens are to be conditioned to constant moisture content, at a temperature of 23 ± 2°C, and a relative humidity of 50 ± 5 %. Constant moisture content is considered to be reached when, following two successive weighing operations, carried out at an interval of 24 hours, the measured masses do not differ by more than 0,1% of the mass of the specimen
Duration of test	The test is to be terminated, the specimen removed, and the dummy specimen in its holder reinserted when any one of the following is applicable: (A) the specimen fails to ignite after a 10 minutes' exposure; (B) 3 minutes have passed since all flaming from the specimen ceased or 10 min. exposure, whichever is longer.
Conditions of retest	(A) In the event of failure, during test of one or more specimens, to secure complete flame spread times or a reasonable heat release curve, the data secured are to be rejected and a new test or tests performed. Such failures might involve, but not be limited to, incomplete observational data or malfunction of data logging equipment. Excessive stack signal baseline drift is also to require further equipment stabilization and retest. (B) If a specimen shows extensive loss of incompletely burned material during test, at least one additional specimen, restrained in the testing frame by poultry netting, is to be tested and the data secured to be reported separately. (C) The following procedures shall be taken in relation to the behavior of the specimen during the test. (a) if the pilot flame extinguishes: report occurrence and reject data and repeat test; or (b) if the specimen breaks up and falls out of the specimen holder, report the behavior, but classify on basis of worst performance with and without specimen restraint in the above (B)
Observations during the test	In addition to the recording of the experimental data, observations are to be made and recorded on the behaviour of the specimen including but not limited to flashing, unstable flame front, sparks, glowing, charring, melting, flaming drips, disintegration of the specimen, fissures, fusion, change in form.

Table 3.49 Surface flammability test *(continued)*

<table>
<tr><th colspan="2">Item</th><th>Test method</th></tr>
<tr><td rowspan="6">Derived fire characteristics</td><td>General</td><td>Experimental results are to be reported in terms of the thermal baseline of the output from the thermocouple circuit and measurements of incident heat flux measured with a dummy specimen in place. The results are not to be adjusted to compensate for changes in the thermal output of the radiant panel and the pilot flame during the conduct of the test. The following data are to be derived from the test results.</td></tr>
<tr><td>Heat for ignition</td><td>The product of the time from initial specimen exposure until the flame front reaches the 150 mm position and the flux level at this position, this latter obtained in prior calibration of the apparatus.</td></tr>
<tr><td>Heat for sustained burning</td><td>The product of time from the start of exposure of a specimen to the arrival of the flame front at a specified position and the incident flux corresponding to that position measured on a non-combustible calibration board. This shall be calculated for each station starting at the 150 mm station, but it shall not be calculated for a given station unless the flame propagates more than halfway to the next station as viewed along the centreline of the specimen.</td></tr>
<tr><td>Average heat for sustained burning</td><td>(A) An average of the values for the characteristic defined in the above measured at different stations, the first 150 mm and then at subsequent stations at 50 mm intervals through the final station or the 400 mm station, whichever is the lower.
(B) For each specimen where the flame front does not reach the 175 mm position, the heat of sustained burning in not defined. If the heat of sustained burning is not defined for one specimen, Qsb is calculated using the data from the other two specimens. If the heat of sustained burning is not defined for two specimens, Qsb is calculated using the data from the third specimen. If the heat of sustained burning is not defined for all three specimens, Qsb is undefined and the criterion of Qsb is deemed to have been met.</td></tr>
<tr><td>Critical flux at extinguishment</td><td>A list of the values of this characteristic for the specimens tested and the average of these values.</td></tr>
<tr><td>Heat release of the speciment</td><td>Both a heat release time curve and a listing of the peak and total integrated heat release are to be secured from the experimental data.
(A) The total heat release is given by integration of the positive part of the heat release rate during the test period.
(B) The peak heat release rate is the maximum of the heat release rate during the test period.</td></tr>
<tr><td colspan="2">Classification</td><td>Materials giving average values for all of the surface flammability criteria that comply with the values as listed in Table below, are considered to meet the requirement for low flame spread in compliance with the relevant regulations in chapter II-2 of the International Convention for the Safety of Life at Sea, 1974
<table>
<tr><th></th><th>Bulkhead, wall and ceiling linings</th><th>Floor coverings</th><th>Primary deck coverings</th></tr>
<tr><td>CFE (Kw/m^2)</td><td>≥ 20,0</td><td>≥ 7,0</td><td>≥ 7,0</td></tr>
<tr><td>Q_{sb} (Mj/m^2)</td><td>≥ 1,5</td><td>≥ 0,25</td><td>≥ 0,25</td></tr>
<tr><td>Q_t (Mj)</td><td>≤ 0,7</td><td>≤ 2,0</td><td>≤ 2,0</td></tr>
<tr><td>Q_p(kW)</td><td>≤ 4,0</td><td>≤ 10,0</td><td>≤ 10,0</td></tr>
<tr><td>Burning droplets</td><td>Not produced</td><td>No more that 10</td><td>Not produced</td></tr>
<tr><td colspan="4">Where, CFE = Critical flux at extinguishment, Q sb = Heat for sustained burning
Q t = Total heat release, Q p = Peak heat release rate</td></tr>
</table></td></tr>
<tr><td colspan="2">Other reference</td><td>Surface materials are to comply with 4.4 below.</td></tr>
<tr><td colspan="2">Others</td><td>Details of test for surface flammability not specially mentioned in 4.3 are to comply with FTP Code, Annex 1, Part 5.</td></tr>
</table>

4.4 Smoke and toxicity test

Smoke and toxicity test are to comply with the requirements specified in Table 3.50 (refer to FTP Code, Annex 1, Part 2 and Part 5, Annex 4).

Table 3.50 Smoke and toxicity test

Item		Test method
Application		Where a material is required not to be capable of producing excessive quantities of smoke and toxic products or not to give rise to toxic hazards at evaluated temperatures, the material is to comply with the requirements below.
Test specimen		Preparation of test specimen is to be in accordance with the practice outlined in IMO FTP Code, Annex 1, Part 5, Appendix 4.
Test conditions		Irradiance to the specimen during the test shall be kept constant. Three specimens are to be tested under each of the following conditions: (A) irradiance of 25 Kw / m^2 in the presence of pilot flame; (B) irradiance of 25 Kw / m^2 in the absence of pilot flame; and (C) irradiance of 50 Kw / m^2 in the absence of pilot flame;
Duration of tests	Smoke	The initial test at each test condition shall last for 20 min. to verify the possible existence of a second minimum transmittance value. If the minimum transmittance value is shown by the initial test to occur within the first 10 min. then subsequent tests for that test condition may have an exposure of 10 min. Otherwise, the tests shall last 20 min.
	Toxicity	Continue the smoke density test until a 20 min. period has elapsed.
Classification criteria	Smoke	An average *(D_m)* of the maximum of specific optical density of smoke *(D_{smax})* of three tests at each test condition is to be calculated. - for materials used as surface of bulkheads, linings or ceilings, the D_m is not to exceed 200 in any test condition; - for materials used as primary deck covering, the D_m is not to exceed 400 in any test condition; - for materials used as floor covering, the D_m is not to exceed 500 in any test condition; and - for plastic pipes and electric cables, the D_m is not to exceed 400 in any test condition.
	Toxicity	The average value of the maximum value of the gas concentration measured at each test condition is not to exceed the follow limits: - CO 1450 ppm - HBr 600 ppm - HCl 600ppm - HCN 140 ppm - HF 600 ppm - SO2 120 ppm (200 ppm for floor coverings) - NOx 350 ppm
Additional requirements		Paints, floor coverings, primary deck coverings, varnishes and other finishes used on exposed interior surfaces are also to be applicable to the above 4.3, Surface flammability test
Others		Details of test for smoke and toxicity test not specially mentioned in 4.4 are to comply with FTP Code, Annex 1, Part 2.

4.5 Test of curtains, etc.

Test of curtains etc. are to comply with the requirements specified in Table 3.51 (refer to FTP Code, Annex 1, Part 7 and IMO Res. MSC. 307 (88)).

Table 3.51 Test of curtains, etc.

Item	Test method
Application	Where draperies, curtains and other supported textile materials are required to have qualities of resistance to the propagation of flame, not inferior to those of wool of mass 0,8 kg/m^2, they shall comply with the requirements below.

Table 3.51 Test of curtains, etc. *(continued)*

Item		Test method
Test specimen	Preparation	The specimens are to be as representative as possible of the material provided and are to exclude salvages. At least ten specimens are to be cut, each measuring 220 mm × 170 mm, five in the direction of the warp, five in the direction of the weft. Where the fabric has differing surfaces on the two sides enough samples are to be cut for both surfaces to be tested. Using a template 220 mm × 170 mm, with holes approximately of 5 mm diameter located on the template at the position of the pins on the frame, each specimen is to be laid flat on a bench and premarked /punctured, to ensure a repeatable and reproductive tension of the specimen, after mounting on the frame.
	Conditioning	The specimens are to be conditioned at 20 ± 5°C and 65 ± 5 % relative humidity for not less than 24 hours before test. Each specimens are to be removed from the conditioning atmosphere and either tested within 3 min. or placed in a sealed container until required.
	Exposure procedures	If the material have not permanent fire-retardant treatment or is not inherently flameproof, one of the exposure procedures detailed in Appendix 3 of IMO Res. MSC. 307(88) may be applied to at least ten further specimens.
Observations during the test		(A) Afterglow times and any evidence of surface flash are to be noted. If afterglow is observed to occur during a test, the specimen is to be allowed to remain in place until all glowing has ceased. The extent of char is also measured in accordance with Appendix 2 of IMO Res. MSC. 307(88). (B) To investigate if burning drops of thermoplastic materials are capable of igniting combustible materials on the base of the apparatus, cotton wool is to be laid to a depth of 10 mm over the base plate, immediately below the specimen holder. Note is to be made of any ignition or glowing of the cotton wool.
Criteria		(A) Products which show any of the following characteristics shall be considered unsuitable for us as curtains, draperies, or free-hanging fabric product for use in rooms containing furniture and furnishings of restricted fire risk as defined in SOLAS II-2/3.40 (a) An afterflame time greater than 5 seconds for any of the 10 or more specimens tested with surface application of the pilot flame. (b) Burn-through to any edge of any of the 10 or more specimens tested with surface application of the pilot flame. (c) Ignition of cotton wool below the specimen in any of the 10 or more specimens tested. (d) An average char length in excess of 150 mm observed in any of the batches of fire specimen tested by either surface or edge ignition. (e) The occurrence of a surface flash propagating more than 100 mm from the point of ignition with or without charring of the base fabric. (B) If, following analysis of the experimental data from tests of a fabric, it is found that either or both of the batches of five specimens cut in both warp and weft directions fail to meet one or more of the criteria specified in (a), (b), (c) and (e) of (A) above because of poor performance of only one of the five specimens tested, one complete retest of a similar batch is permitted. Failure of the second batch to meet any of the criteria is to provide the basis for rejection of the fabric for use.
Additionally requirements		The tests are to be made by using specimens of the final product (e.g. with colour treatment). In cases where only the colours change, a new test is not necessary. However, in cases where the basis product or the treatment procedure change, a new test is required.
Others		Details of test for curtains, etc. not specially mentioned in 4.5 are to comply with FTP Code, Annex 1, Part 7.

4.6 Test for upholstered furniture

Test for upholstered furniture are to comply with the requirements specified in Table 3.52 (refer to FTP Code, Annex 1, Part 8 and IMO Res. MSC. 307(88)).

Table 3.52 Test for upholstered furniture

Item		Test method
Application		Where upholstered furniture are required to have qualities of resistance to the ignition and propagation of flame, the upholstered furniture are to comply with the requirements below.
Test pieces	General	The test piece materials are to be representative of the cover, filling and any other components to be used in the final assembly.
	Cover material and fabric interliner	The cover size needed for each test is 800 ± 10 mm × 650 ± 10 mm. The long dimensions are to be cut parallel to the selvage. The cover may be constructed from smaller pieces of material provided that the resulting seams are not located within 100 mm of the area likely to be affected by the test. Where a fabric interliner is used, it is to be cut to the same dimensions and in the same orientation as the cover for fitting to the test rig under the cover.
	Upholstery filling	Two pieces, one 450 ± 5 mm × 300 ± 5 mm × 75 ± 2 mm thick, and the other 450 ± 5 mm × 150 ± 5 mm × 75 ± 2 mm thick are required for each test.
Atmosphere for conditioning and testing	Conditioning	The materials to be tested and the cigarettes are to be conditioned immediately before the test for 72 hours in indoor ambient conditions and then for at least 16 hours in an atmosphere having a temperature of 23 ± 2°C and a relative humidity of 50 ± 5 %.
	Testing	For testing, a substantially draught-free environment, having a temperature of 20 ± 5°C and relative humidity of 20 % to 70 %, is to be used.
Criteria	Smouldering cigarette test	(a) If progressive smouldering of flaming of the upholstery components is observed at any time within a period of 1 hour of the placement of the cigarette, extinguish the test pieces and record a fail result for the smouldering cigarette test. (b) If progressive smouldering or flaming is not observed within the 1 hour period, or if the cigarette fails to smoulder its complete length, repeat the test with a new cigarette placed in a fresh position not less than 50 mm from any previous test damage. If progressive smouldering or flaming is not observed in this retest, or if the cigarette fails to smoulder its complete length, record a pass result for the smouldering cigarette test unless the test piece fails the final examination specified in the final examination below.
	Butane flame test	(a) Allow the gas to burn for a period of 20 ± 1 seconds, then terminate by carefully removing the burner tube from the test pieces. Observe for flaming or progressive smouldering in the interior and/or cover. Disregard flames, afterglow, smoking or smouldering that cease within 120 seconds of the removal of the burner tube. If flaming or progressive smouldering of the upholstery components is observed, extinguish the test pieces. Record a fail result for the butane flame ignition source test. (b) If progressive smouldering or flaming is not observed, repeat the test at a fresh position not less than 50 mm from any previous test damage. If flaming or progressive smouldering is not observed in this retest, record a pass result for the butane flame ignition source test unless the test piece fails the final examination specified in the final examination below.
	Final examination	Where the tests specified in the smouldering cigarette test and butane flame test above are passed, immediately after completion of the test programme on the assembly, dismantle and examine it internally for progressive smouldering. If this is present, extinguish thetest piece and record a fail result for the relevant test source.

Table 3.52 Test for upholstered furniture *(continued)*

Item	Test method
Additionally requirements	The tests are to be made by using specimens of the final product (e.g. with colour treatment). In cases where only the colours change, a new test is not necessary. However, in cases where the basis product or the treatment procedure change, a new test is required.
Others	Details of test for upholstered furniture not specially mentioned in 4.6 are to comply with FTP Code, Annex 1, Part 8.

4.7 Bedding components

Test for Bedding components are to comply with the requirements specified in Table 3.53 (refer to FTP Code, Annex 1, Part 9 and IMO Res. MSC. 307 (88)).

Table 3.53 Test for bedding components

Item		Test method
Application		Where bedding components are required to have qualities of resistance to the ignition and propagation of flame, the bedding components are to comply with the requirements below.
Specimens	General	The specimens are to be representative of the whole product to be tested. If possible, the specimens are to be taken in such a way that ignition can also be started along seams and their intersections. The top side is exposed. Where there is doubt as to which side is the top side, the test is to be carried out on both sides. Four additionally specimens are then needed.
	Mattresses	Sufficient material is to be available for making at least for specimens with dimensions 450 mm × 350 mm in full nominal thickness. The cover is to envelop the mattress completely without wrinkles and is to be secured underneath (for instance with steel pins). For testing of mattresses with removable covers, sufficient material is to be available for the making of at least eight specimens, four with and four without the mattress cover, with dimensions 450 mm × 350 mm in full nominal thickness.
	Pillows	Four samples in full size are to be available.
	Other than mattresses and pillows	Four specimens each of size 450 mm × 350 mm are to be cut from each sample.
Preparation of specimens		If the blankets, quilts, pillows, thin light mattresses or removable covers are sold as flame retardant, they are to be tested after three cleaning treatments carried out according to instructions given by the manufacturer, the commercial detergent or in accordance with a procedure described in International Standard ISO 6330.
Conditioning		The materials to be tested, the cigarette used as ignition sources, the insulating cotton wool pads are to be conditioned immediately before testing for 72 hours in indoor ambient conditions and then for at least 16 hours in an atmosphere having a temperature of 23 ± 2°C and 50 ± 5% relative humidity.
Testing		The test is carried out indoors, in an environment essentially free of air currents. The room temperature is to be 20 ± 5°C and 20 to 70% relative humidity.
Criteria for ignitability	Progressive smouldering	All the types of behaviour described below are considered to be progressive smouldering ignition: (a) any test specimen that procedures externally detectable amounts of smoke, heat or glowing after a period of 1 hour following the application of the ignition source; (b) any test specimen that displays escalating combustion behaviour, so that it is unsafe to continue the test and requires forcible extinction; (c) any test specimen that smoulders until it is essentially consumed within the duration of the test; (d) any test specimen that smoulders to the extremities of the specimen, viz. to either side or to the full thickness of the specimen, within the duration of the test. However, all materials having a thickness of 25 mm or less, such as light

Table 3.53 Test for bedding components *(continued)*

Item		Test method
Criteria for ignitability	Progressive smouldering	mattresses, quilts and blankets are allowed to smoulder to the full thickness of the specimen; (e) any test specimen that, on final examination, shows evidence of smouldering other than discoloration more than 25 mm in any horizontal direction from the nearest part of the original position of the edge of cotton wool pad and open flame ignition source.
	Flaming ignition	(a) Mattresses All the types of behaviour described below are considered to be flaming ignition: - the occurrence of any flames initiated by a smouldering ignition source; - any test specimen that continues to flame for more than 150 seconds after removal of the igniting flame; - any test specimen that displays escalating combustion behaviour, so that it is unsafe to continue the test and requires forcible extinction; - any test specimen that burns until more than 66 % consumed with 150 seconds after removal of the ignition flame; - any test specimen that burns to the extremities of the specimen, viz. to either side or to the full thickness of the specimen, within the duration of the test. (b) Blankets, quilts, pillows and thin light mattresses All the types of behaviour described below are considered to be flaming ignition: - the occurrence of any flames initiated by a smouldering ignition source; - any test specimen that continues to flame for more than 150 seconds after removal of the igniting flame; - any test specimen that displays escalating combustion behaviour, so that it is unsafe to continue the test and requires forcible extinction; - any test specimen that burns until more than 66 % consumed with 150 seconds after removal of the ignition flame; - any test specimen that burns to either side of the specimen within the duration of the test.
	Classification	The bedding component is classified as not readily ignitable if it show no progressive smouldering ignition or flaming ignition as specified above
Additionally requirements		The tests are to be made by using specimens of the final product (e.g. with colour treatment). In cases where only the colours change, a new test is not necessary. However, in cases where the basis product or the treatment procedure change, a new test is required.
Others		Details of test for bedding components not specially mentioned in 4.7 are to comply with FTP Code, Annex 1, Part 9.

4.8 Test for fire door control systems

Test for fire door control systems are to comply with the requirements specified in Table 3.54 (refer to FTP Code, Annex 1, Part 4 and IMO Res. MSC. 307(88)).

Table 3.54 Test for fire door control systems

Item	Test method
Application	Where a control system of fire door is required to be able to operate in case of fire, the system is to comply with the requirements below.
Fire test procedure and classification criteria	Fire test procedure and classification criteria are to comply with FTP Code, Annex 1, Part 4.
Additional requirements	Insulation materials used in connection with a fire door control system are to comply with 4.1 above.
Others	Details of test for fire door control systems not specially mentioned in 4.8 are to comply with FTP Code, Annex 1, Part 4

APPENDIX 1. BOMB METHOD

1. Test specimens

Three test specimens of approximately 1 g are to be cut out from the test material and the surface area of each test specimen is to be measured accurately. The test specimens are to be dried for more than one hour in a dryer at a temperature of 105°C and then be stored in a desiccator.

2. Equipment, instruments, reagents, combustion improvers and operations. A Nenken-A type flowmeter (insulation system) and a Nenken-B type flowmeter (insulation system) specified in ISO 1928 (Determination of calorific value of coal and coke) or those having the equivalent characteristics are to be used as equipment and instruments for the test. The reagent, combustion improver and operating method are also to conform to the requirements of ISO 1928 (Determination of calorific value of coal and coke).

3. Calculation of calorific value

The calorific value is to be calculated to the second decimal place and rounded off the first decimal place from the following formula.

$$\text{Calorific value}\,(M_J/m^2) = \frac{(\text{Temperature rise °C x (internal cylinder water(g) + water equiva - lent (g))})}{\text{surface area of test sample}\,(m^2)} \times 4{,}186 \times 10^{-6}$$

The average value of calorific values of the three specimens are to be used as the calorific value of the specimens.

4. Manufacturer approval

The manufacturer is to be subjected to Manufacturer approval in accordance with Section 6.

Z. Materials for Refrigerated Chambers and Oil-Impervious Composition

1. Application

1.1 The requirements in this Sub Section apply to tests and inspection for the type approval of materials intended to be used for insulating the refrigerated chambers and oil-impervious composition provided for the surface oil tanks adjacent refrigerated chambers in accordance with the requirements of Rules for Referigrating Installation (Pt.1, Vol.VIII) Sec.1. M.

1.2 For materials for refrigerated chambers of ships carrying liquefied gases in bulk in accordance with the requirements of Rules for Ships Carriying Liquied Gases in Bulk (Pt.1, Vol.IX) Sec.4, the requirements of this Sub Section are correspondingly applied.

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

1) Process of manufacture
2) Installation procedures on board (including precautions for working if any)
3) Painting procedures of oil-impervious covering
4) Packaging and marks (labels, symbol, etc.)
5) Physical properties of products assured by the manufacturer
6) Storage method of products
7) Service records

3. Type test

3.1 General

3.1.1 The type tests specified in 3.2 or 3.3 are to be carried out in the presence of BKI Surveyor where the submitted documents are considered acceptable.

3.1.2 Applicants are to submit the test plan describing the test place, testing procedure, etc., in advance.

3.1.3 It is recommended that the above test plan is submitted with application form letter.

3.1.4 Test samples are to be picked out, in general, from the products by the direction of the Surveyor upon the survey at confirmation survey.

3.1.5 The test record are to be submitted in electronic format to BKI.

3.1.6 The type tests may be omitted when the test is carried out at a recognized testing organization and the test records are to be submitted to BKI.

3.2 Insulation materials

3.2.1 The items represented by mark O in Table 3.55 are to be tested for the insulation materials. However, materials not given in the table are to be considered in each case.

3.2.2 Testing procedure and acceptance criteria

The testing procedures are to be in accordance with the requirements of recognize standards, and acceptance criteria are to be as belows.

Table 3.55 Type test items of insulation materials

Main materials	Thermal conductivity	Density	Bending strength	Compressive strength	Water absorption	Water content	Combustion test	Others
Mineral wool	○	○						Heat shrinkage, Particle content
Glass wool	○	○	○					Heat shrinkage
Calcium silicate	○	○	○					Water repellency and shrinkage
Foam polystyrene	○	○	○	○	○		○	Water vapor permeability
Pearlite	○	○	○					Water repellency and shrinkage
Rigid foam urethane	○	○	○	○	○		○	Water vapor permeability and rust test

A) Acceptance criteria for mineral wool is to be as specified in Table 3.56.

Table 3.56 Test items and acceptance criteria for mineral wool

Kind			Density		Thermal conductivity (W/m・K) (Ave. temp. 70 ±5℃)	Heat shrinkage (℃)	Diameter of fibre μm	Particle content (%)
			Kg/m³	allowance				
Mineral wool			40~150		Max. 0,044	Min. 650	Max. 7	Max. 4
Insulation board	No.1		71~100	-15%	Max. 0,044	Min. 600	-	-
	No.2		101~160		Max. 0,043			
	No.3		161~300		Max. 0,044			
Felt			40~70		Max. 0,049	Min. 400		
Insulation band	No.1		71~100		Max. 0,052	Min. 600		
	No.2		101~160		Max. 0,049			
Blanket	No.1	a	40~70		Max. 0,049	Min. 400		
		b	71~100		Max. 0,044	Min. 600		
	No.2		101~160		Max. 0,043			
Insulation pipe cover			40~200		Max. 0,044			

B) Acceptance criteria for glass wool is to be as specified in Table 3.57.

Table 3.57 Test items and acceptance criteria for glass wool

Kind			Density		Thermal conductivity (W/m.K) (Ave. temperature 70±5°C)	Heat shrinkage °C
			Kg/m³	allowance		
Glass wool	No.2		-	-	Max. 0,042	Min. 400
	No.3		-	-	Max. 0,049	
Insulation board	No.2	24k	24	+3, -2	Max. 0,049	Min. 300
		32k	32	±4	Max. 0,046	
		40k	40	+4 -3	Max. 0,044	Min. 350
		48k	48	+4, -3	Max. 0,043	
		64k	64	±6	Max. 0,042	Min. 400
		80k	80	±7		
		96k	96	+9, -8		
		120k	120	±12		
	No.3	80k	80	±7	Max. 0,047	Min. 400
		96k	96	+9, -8		
		120k	120	±12		
Blanket	No.2	a	24~40		Max. 0,048	Min. 350
		b	41~120		Max. 0,043	Min. 400
Insulation band	No.2	a	22~36		Max. 0,052	Min. 300
		b	37~52			Min. 350
		c	58~132			Min. 400
Insulation pipe cover			40~90		Max. 0,043	Min. 350

C) Acceptance criteria for calcium silicate is to be as specified in Table 3.58.

Table 3.58 Test items and acceptance criteria for calcium silicate

Kind	Density Kg/m³	Thermal conductivity (W/m.K) (Ave. temperature 70±5°C)	Bending strength N/cm²	Shrinkage %	Water repellency [2] %
Board No.1-13 Pipe Cover No.1-13	Max. 130 [1]	Max. 0,049	Min. 20	Max. 2,0 free from spitting and/or twisting	Min. 98,0
Board No.2-17 Pipe Cover No.2-17	Max. 170	Max. 0,055	Min. 20		
Board No.1-22 Pipe Cover No.1-22	Max. 220	Max. 0,062	Min. 30		
Board No.2-22 Pipe Cover No.2-22		Max. 0,062	Min. 30		

Notes
[1] In case where the thickness of insulation board No.1-13 and pipe cover No.1-13 is not more than 30mm, density can be max. 155 kg/m³
[2] Not to be applied if water repellency is not required.

D) Acceptance criteria for foam polystyrene is to be as specified in Table 3.59 and Table 3.60

a) Insulation board and pipe cover made by polystyrene bead.

Table 3.59 Test items and acceptance criteria for polystyrene bead

Kind		Density Kg/m^3	Thermal conductivity (W/m.K) (Ave. temperature 20±5°C)		Bending strength N/cm^2	Compressive strength N/cm^2	Water absorption g/100 cm^2	Combustion test	Water Vapor Permeability [1] ng/m^2.s.Pa.
			Class 1	Class 2					
Insulation board	No.1	Min. 30	Max. 0,036	Max. 0,031	Min.35	Min.16	Max. 1	Flame is to be extinguished without remains within 3 minutes. And not to burn over the combustion limit line.	Max. 146
	No.2	Min. 25	Max. 0,037	Max. 0,032	Min.30	Min.12			Max. 208
	No.3	Min. 20	Max. 0,040	Max. 0,033	Min.22	Min.8	Max. 1		Max. 250
	No.4	Min. 15	Max. 0,043	Max. 0,034	Min.15	Min.5	Max. 1,5		Max. 292
Insulation board	No.1	Min. 35	Max. 0,036	Max. 0,031	Min.30	-	t ∠ 30mm : Max. 2, t ≥ 30 mm : Max. 1		-
	No.2	Min. 30	Max. 0,036	Max. 0,032	Min.25				
	No.3	Min. 25	Max. 0,037	Max. 0,033	Min.20				
Note: [1] To be measured per 25 mm in thickness for reference.									

b) Insulation board and pipe cover made by polystyrene extrusion.

Table 3.60 Test items and acceptance criteria for polystyrene extrusion

Kind		Pressure test N/cm^2	Bending strength N/cm^2	Thermal conductivity (W/m.K) (Ave. temperature 70±5°C)	Combustion test	Water Vapor Permeability [1] ng/m^2.s.Pa
Insulation board	Special	Min. 25	Min. 45	Max. 0,027	Flame is to be extinguished without remains within 3 minutes. And not to burn over the combustion limit line.	Max. 146
	No.1	Min. 18	Min. 35	Max. 0,028		
	No.2	Min. 14	Min. 30	Max. 0,029		
	No.3	Min. 10	Min. 25	Max. 0,031		
Note: [1] To be measured per 25 mm in thickness for reference.						

E) Acceptance criteria for Pearlite is to be as specified in Table 3.61.

Table 3.61 Test items and acceptance criteria for pearlite

Kind	Density Kg/m^3	Thermal conductivity (W/m.K) (Ave. temperature 70±5°C)	Bending strength N/cm^2	Shrinkage %	Water repellency %
Insulation board (pipe cover) No.1	Max. 200	Max. 0,062	Min. 25	Max. 2,0	Min. 98
Insulation board (pipe cover) No.2	Max. 155	Max. 0,055	Min. 20	Max. 2,0	
High temp. insulation board (pipe cover) No. 1	Max. 250	Max. 0,072	Min. 25	Max. 2,0	Min. 98
High temp. insulation board (pipe cover) No. 2	Max. 185	Max. 0,056	Min. 20	Max. 2,0	

F) Acceptance criteria for Rigid foam urethane is to be as specified in Table 3.62.

Table 3.62 Test items and acceptance criteria for rigid foam urethane

Kind			Density Kg/m^3	Thermal conductivity (W/m.K) (Ave. temp. 20±5°C)	Bending strength N/cm^2	Pressure test N/cm^2	Water absorption g/100 cm^2	Combustion test	Water Vapour Permeability [1] ng/m^2.s.Pa	Rust test
Insulation board	Grade 1	No.1	Min.45	Max. 0,024	Min. 35	Min. 30	Max. 3,0	Burning time is to be within 120 sec. and length is not more than 60mm.	Max. 145	[2]
		No.2	Min.35	Max. 0,024	Min. 25	Min. 20			Max. 185	
		No.3	Min.25	Max. 0,025	Min. 15	Min. 10			Max. 225	
	Grade 2	No.1	Min.45	Max. 0,023	Min. 35	Min. 15		-	Max. 40	
		No.2	Min.35	Max. 0,023	Min. 25	Min. 10			Max. 40	
		No.3	Min.25	Max. 0,024	Min. 15	Min. 8			Max. 40	
Insulation pipe cover		No.1	Min.45	Max. 0,024	Min. 35	Min. 30		-	Max. 145	
		No.2	Min.35	Max. 0,024	Min. 25	Min. 20			Max. 185	
		No.3	Min.25	Max. 0,025	Min. 15	Min. 10			Max. 225	

Note
[1] To be measured per 25 mm in thickness for reference.
[2] Weight loss is to be not more than the weight loss of specimen without flame retardant. However, this value is used as for reference.

3.2.3 Test items and test methods of materials for refrigerated chambers of ships carrying liquefied gases in bulk are to be in accordance with the requirements in Rules for Ships Carriying Liquied Gases in Bulk (Pt.1, Vol.IX) Sec.6.

3.3 Oil-impervious covering

3.3.1 Tank top covering

The test items and testing procedure given in Table 3.63 are to be carried out for the tank top covering.

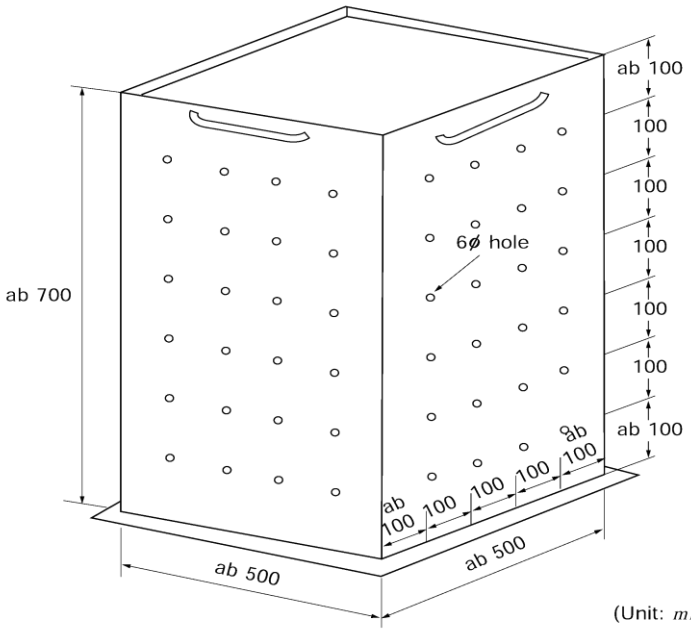
3.3.2 Additional tests

The tests are to be carried out in accordance with requirements specified in Table 3.63 In addition to these tests, the tests given in Table 3.64 are to be carried out for the tank side covering.

Table 3.63 Type Test Items and Testing Procedure for Tank Top Covering for Oil Tanks

Test item	Test procedures
Odor test	The inner surface of an appropriate container is to be coated with the covering and the outer surface is to be warmed up and kept at 65°C by hot water, etc. It is to be verified whether or not harmful odor is generated.
Bending strength	To be in accordance with ASTM C78 (Testing method for flexural strength of concrete (Using simple beam with third-point loading))
Compression strength	To be in accordance with ASTM C873 (Testing method for compressive strength of concrete cylinders cast in place in cylindrical molds)
Oil absorption test	Test piece of tank top covering (30 cm × 30 cm) is to be immersed for 24 hours in heavy oil at 65°C and measure the increase of weight. 15% or less of weight increasing is acceptable.
Oil tightness test	The tank top covering is to be coated on the top of steel container where 20 holes of 6 mm diameters are drilled with 100 mm pitch. 0,2 MPa oil pressure is to be applied to the inner surface and be kept for 24 hours. It is to be verified that no oil permeates through the 6 mm holes.
Combustion test	To be in accordance with the combustion test in 3.2.2.

Table 3.64 Approval Test Items and Testing Procedure for Tank Side Covering

Item	Method
Vibration test	
	After the oil tightness test, the container is to be vibrated for 4 hours. (Vibration conditions of approximately 8 Hz frequency and about 0,10 to 0,50 mm half amplitude are to be maintained. After the vibration test, heavy oil is filled up in the container and left for 17 hours. It is to be verified that no leakage of oil and no peeling off of covering occurred.
Hammering test	The inside of the test container is to be patted with a 5 kg hand hammer, and it is to be verified that no crack and no peeling off occurred.
Adhesion test	A test sample is to be bundles up from the surface of the tank and detached by scraper to check adhesion hardness and permeation of fuel oil.
Heating test	The internal surface of the tank is to be heated as follows to check the dissolution conditions of the test sample and the adhesive condition using a scraper. Heating time: 3 minutes Heating temperature: 600 °C Heating area: Approximately 100 mm in diameter

AA. Materials of Reinforced Plastic

1. Application

The requirements of this Sub-section apply to tests and inspections for the type approval of the raw materials (reinforcements, thermosetting resins and core materials for sandwich construction) to be used for FRP ships conforming to the requirements of Rules for Non-Metallic Materials (Pt.1, Vol.XIV), Rules for High Speed Craft (Pt.3, Vol.III), Rules for Fibreglass Reinforced Plastics Ships (Pt.3, Vol.V), and Guidance for FRP and Wooden Fishing Vessels up to 24 m (Pt.3, Vol.A).

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

2.1 General Requirements

- Product description
- Safety data sheet
- Storage and processing instructions
- A declaration in writing by the applicant that the tested materials comply with those for which the approval is requested, and that the sample is manufactured in accordance with the Rules and Guidance of Biro Klasifikasi Indonesia.
- Copy of the test certificate of a recognized testing body, i.e. an accredited testing laboratory or a notified testing body.

2.2 Thermosetting resins

The data listed in Table 3.65 is to be provided by the manufacturer for each thermosetting resin.

Table 3.65 Data requirements for thermosetting resins

Data	Type of resin	
	Unsaturated Polyester [2]	Epoxy
Specific gravity of liquid resin	○	○
Viscosity	○	○
Gel time	○	○
Appearance	○	○
Mineral content [1]	○	○
Volatile content	○	–
Acid value	○	–
Epoxide content	–	○

Note:

[1] This is to be the total filler in the system, including thixotrope, filler, pigments, etc., and is to be expressed in parts by weight per hundred parts of pure resin.

[2] Vinylesters are to be treated as equivalent to polyesters.

2.3 Reinforcements

The data specified in Rules for Non-Metallic Material (Pt.1, Vol.XIV) Ch.1 Sec.2 is to be provided, where applicable, for each type of reinforcement.

2.4 Core materials

- The following data is to be provided for each type of core material:
- Type of material.
- Density.
- Description (block, scrim mounted, grooved).
- Thickness and tolerance.
- Sheet/block dimensions.
- Surface treatment.
- Full application procedure for use of the product.

3. Type tests

The test items and test methods are to comply with the following requirements and the Flame spread (Fire durability) test in Table 3.14, O.3. of the Guidance, as necessary.

3.1 Testing procedures

3.1.1 General

1) The test laboratory is to equip the test facilities so that they can perform the testing in accordance with the requirements in this Sub-section and are to be recognized by BKI Alternatively, testing may be carried out by the manufacturer subject to these tests being witnessed by the Surveyor.
2) The accuracy of test machines is to be within ±1 % and test machines are to be recalibrated at approximately annual intervals. A record of all calibrations is to be kept available in the test laboratory.

3.1.2 Preparation of test samples

1) Samples of thermosetting resins are to be prepared using the curing system recommended by the manufacturer and identical with that used for the finished product.
2) The post curing conditions for samples of thermosetting resins are to be as recommended by the manufacturer and identical with those used for the finished product.
3) Where curing of the product is intended to take place at room temperature, the sample is to be allowed to cure at minimum temperature (20 °C) for 12 hours followed by a post-cure at 40 °C for 16 hours (polyester resins) or 16 h at 50 °C (epoxy resins).

3.1.3 Preparation of test specimens

1) The test specimen is to be prepared in accordance with the appropriate ISO standard and the requirements of this Sub-section.
2) Precautions are to be taken during machining to ensure that the temperature rise in the specimen is kept to a minimum.

3.1.4 Testing

1) Strain measurement are to be made by the use of a suitable extensometer or strain gauge.
2) The number of test specimens from each sample to be tested is to be in accordance with the Rules for Non-Metallic Materials (Pt.1, Vol.XIV). However, comparable standards of other countries are also acceptable after agreement with BKI Head Office in each individual case.

3) The minimum properties required by BKI for the tests shall be fulfilled by all specimens.

4) If a test specimen fails because of faulty preparation or incorrect operation of the testing machine it is to be discarded and replaced by a new specimen.

5) In the case of inadequate test results of individual specimens, attention shall be paid to the following (for a basic number of 6 tests):
   - If one or two specimens yield inadequate results, the tests shall be repeated with twice as many specimens.
   - If the test results are inadequate for three or more specimens, the test can be repeated on newly produced specimens, provided that BKI agrees to this.
   - If even one sample yields inadequate results while repeat-testing, then approval is not possible.

3.1.5 Reporting of results

1) All load/displacement graphs and tabulated results are to be reported, including mean values and the calculated standard deviation.

2) Full details of the sample and specimen preparation are to be provided including (where applicable):
   - Catalyst/accelerator or curing agent types and mix ratio.
   - Weights of resins, and/or reinforcements used.
   - Casting/laminate dimensions.
   - Number of layers of reinforcement used.
   - Curing/post-curing conditions.

3.2 Thermosetting resins

3.2.1 Cast samples are to be prepared in accordance with the manufacturer's recommendations and are to be cured and post-cured in a manner consistent with the intended use. Where post-cure conditions equivalent to ambient-cure conditions apply, see 3.1.2 2) and 3)

3.2.2 The curing system used and the ratio of curing agent (or catalyst) to resin are to be recorded.

3.2.3 The following are to be determined using these samples:

1) Tensile strength (stress at maximum load) and stress at break.
2) Tensile strain at maximum load.
3) Tensile secant modulus at 0,05 per cent and 0,25 per cent strain respectively.
4) Temperature of deflection under load.
5) Water absorption.
6) Volume shrinkage after cure.
7) Specific gravity of cast resin.

3.2.4 For gel coat resins the stress at break and modulus of elasticity in flexure are to be determined.

3.2.5 Test methods and acceptance criteria for cast thermosetting resins are to comply with Table 3.66.

3.3 Reinforcements

3.3.1 Tests of the mechanical properties are to be made on laminate samples containing the reinforcement and prepared as follows:

1) An approved resin of suitable type is to be used;

2) A minimum of three layers of the reinforcement is to be laid with parallel ply to give a laminate not less than 4 mm thick;

3) The weights of resin and reinforcement used are to be recorded together with the measured thickness of the laminate, including the measured weight per unit area of the reinforcement used;

4) For glass reinforcements, the glass/resin ratios, by weight, as shown in Table 3.67 are to be used;

5) For reinforcement type other than glass, a fibre volume fraction, as shown in Table 3.68, is to be used.

Table 3.66 Tests on cast thermosetting resin specimens

Test	Standard	Acceptance criteria
Tensile properties	ISO 527-2 (test speed: 1 % strain / min, Specimen 1B)	To comply with the requirements of Rules for Non-Metallic Material (Pt.1, Vol.XIV).
Flexural properties	ISO 178 (test speed: 1 % strain / min)	
Water absorption	ISO 62 (Method 1)	
Temperature of deflection under load	ISO 75-2 (Method A)	
Interlaminar shear strength test (4)	ISO 14130	22-13,5Gc [N/mm^2] (Min 15) Gc: glass fraction by weight

Notes:

(1) ISO 62: where resins are intended for use under ambient conditions to avoid additional post-curing, the requirement in ISO 62 for pre-drying the test specimen at 50 °C is to be omitted. The test result is to be expressed as mg of water.

(2) ISO 527-2: tensile properties are to be measured using extensometer.

(3) Testing method other than those given in this Table is to be in accordance with the requirements as deemed appropriate by BKI.

(4) Interlaminar shear strength test is to be applied to the polyester containing wax or other material that deteriorate bonding.

Table 3.67 Glass fraction by weight for different reinforcement types

Reinforcement type	Glass fraction (nominal values)
Unidirectional	0,60
Chopped strand mat	0,30
Woven roving	0,50
Woven cloth	0,50
Composite roving (1)	0,45
±45°/Triaxial/Quadriaxial parallel(2D) plied roving	0,50

Note:

(1) Continuous fibre reinforcement with attached chopped strand mat.

3.3.2 Rovings intended for filament winding are to be tested as unidirectional rovings.

3.3.3 The laminate is to be tested in air in the directions indicated by Table 3.69.

Table 3.68 Fibre fraction by volume for different reinforcement types

Reinforcement type	Fibre fraction by volume (nominal values)
Unidirectional	0,41
Chopped strand mat	0,17
Woven roving	0,32
Woven cloth	0,32
Composite roving	0,28
±45°/Triaxial/Quadriaxial parallel(2D) plied roving	0,32

Note: The volume content may be converted to weight fractions by use of the formula:

$W_F = V_F D_F / (D_F V_F + D_R V_R)$

where:

W_F : Fibre fraction by weight, D_F : density of fibre

D_R : density of cured resin, V_F : fibre fraction by volume

V_R : resin fraction by volume

Table 3.69 Fibre orientations in reinforced test specimens

Type of reinforcement	Test orientations
Unidirectional	0°
Chopped strand mat, Gun roving	any direction
Woven roving, Woven cloth. Composite roving	0° and 90°
±45° parallel plied roving	0°, 45°, 90° and -45°
Triaxial plied roving	
Quadriaxial plied roving	

3.3.4 The following tests are to be made on the samples:

1) Tensile strength (stress at maximum load).
2) Tensile strain at break.
3) Tensile secant modulus at 0,05 per cent and 0,25 per cent strain respectively.
4) Flexural strength (stress at maximum load).
5) Modulus of elasticity in flexure.
6) Fibre content.

3.3.5 The test methods and acceptance criteria applied to laminate specimens of reinforcement are to comply with Table 3.70.

Table 3.70 Test methods and acceptance criteria of reinforcement specimens

Test	Standard	Acceptance criteria
Tensile properties	ISO 527-4 (test speed: 1 % strain / min, Specimens Types II or III)	To comply with the requirements of Rules for Non-Metallic Material (Pt.1, Vol.XIV).
Flexural properties	ISO 14125 (test speed: 1 % strain / min, Method A)	
Glass content	ISO 1172	

Notes:

(1) ISO 527-4: tensile properties are to be measured using extensometer.

(2) Tensile modulus values are to be determined using an extensometer which may be removed for strain to failure.

(3) Testing method other than those given in this Table is to be in accordance with the requirements as deemed appropriate by BKI.

3.4 Core materials

3.4.1 Initially the core shear strength and modulus are to be determined by ISO 1922–981 or ASTM C273. Test sandwich panels are then to be prepared and subjected to four-point flexural tests to determine the apparent shear properties according to ASTM C393 (short beam) at two representative thicknesses (i.e. 15 mm and 30 mm). Testing is to be carried out at ambient temperature and at 70 °C. The following requirements are to be observed:

1) Each skin is to be identical and have a thickness not greater than 21 per cent of the nominal core thickness. For hand laid constructions, each skin is to comprise a lightweight chopped strand mat reinforcement (300 g/m^2) consolidated at a glass content, by weight, of 0,3 against the core, plus the required number of woven reinforcements consolidated, using an isophthalic polyester resin, to give a minimum glass content, by weight, of 0,5.
2) The method of construction of the sandwich laminate is to reflect the core material manufacturer' instructions for use, i.e. application of bonding paste, surface primer or any other recommended system.
3) Curing conditions are to be in accordance with 3.1.2, 2) and 3).
4) The dimensions of the test samples should be based on the requirements of ASTM C393 Paragraph 5.1, and the ratio parameters as indicated in ASTM C393 Paragraph 5.2, using a proportional limit stress (F) for the woven roving skins of 130 N/mm^2 and a span (a2) of not less than 400 mm.

3.4.2 For each type of test sample the following data are to be reported, together with the submission of a representative test sample showing the mode of failure for each density of core material:

1) Skin and core thickness, and core type and density.
2) Resin/catalyst/accelerator ratio.
3) Skin construction, including types and weight of reinforcements, resin(s), etc.
4) Details of production method and curing conditions (temperature and times).
5) Where additional preparation of the foam is involved, for example the use of primers or bonding pastes, full details are to be provided.
6) Actual span between base supports for each type of test sample.

3.4.3 Specific requirements for end-grain balsa

1) The following tests are to be carried out on the virgin material, both parallel to and perpendicular to the grain. The density of the virgin material is also to be tested.
   A) Compressive strength (stress at maximum load).
   B) Compressive modulus of elasticity.
   C) Tensile strength (stress at maximum load).
2) Where the balsa is mounted on a carrier material (e.g. scrim), any adhesive used is to be of a type compatible with the proposed resin system.
3) The test methods and acceptance criteria for end-grain balsa are to comply with Table 3.71.

Table 3.71 Test methods and acceptance criteria of end-grain balsa

Test	Standard	Acceptance criteria
Density Tensile properties Compressive properties Shear properties	• ISO 845 • ASTM C297-61 (Test speed=Thickness/10 mm/min) • ISO 844 (Test speed=Thickness/10 mm/min) • ISO 1922 (Test speed=Thickness/1 mm/min)	To comply with the requirements Rules for Fiberglass Reinforced Plastics Ships (Pt.3, Vol.V).

3.4.4 Specific requirements for rigid foams (PVC, Polyurethane and other types)

1) The following test are to be carried out for each type of foam:
   A) Density.
   B) Tensile strength (stress at maximum load).
   C) Tensile modulus of elasticity.
   D) Compressive strength (stress at maximum load).
   E) Compressive modulus of elasticity.
2) Additionally, the compressive properties (see 1), D) and E)) are to be determined at a minimum of five points over the temperature range ambient to maximum recommended service or 70 °C, whichever is the greater.
3) The test methods and acceptance criteria for rigid foams are to comply with Table 3.71.

4. The test for each FRP ship is to be conducted in accordance with the requirements in Rules for Fiberglass Reinforced Plastics Ships (Pt.3, Vol.V).

AB. Water Level Detection and Alarm System

1. Application

The requirements in this Sub-section apply to tests and inspections for the type approval of water level detector and visual and audible alarm system (hereinafter called detector system) in accordance with the requirements of Rules for Electrical Installation (Pt.1, Vol.IV) Sec.18.

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

1) Specifications of the detector system including any limitation regarding the type of cargoes for the guarantee of performance
2) Construction drawings and explanatory documents of the working principle of the detector system
3) Technical documents of the detector system including the manual specified in Rules for Electrical Installation (Pt.1, Vol.IV) Sec.18.

3. Construction and Function

The construction and the function of the detector system is to satisfy the following requirements.

1) To be able to adequately withstand ship vibration, ship motions, trim and heel.
2) To be able to withstand the most severe pressure and temperature expected during working conditions and, for parts in contact with the liquid, to have adequate compatibility between the device and the liquid considered.
3) The construction in addition to the above is also to be as follows:
   A) To be such that maintenance and inspection can be carried out easily and safely
   B) To have appropriate devices installed to prevent metal fittings from coming loose.
4) The construction and function specified in Rules for Electrical Installation (Pt.1, Vol.IV) Sec. 18 are to be provided.
5) For the systems provided with override devices, the function specified in Rules for Electrical Installation (Pt.1, Vol.IV) Sec. 18, B.4.2.

4. Type test

4.1 The approval test is to include the following items 4.1.1 through 4.1.5 depending on the application and the type of the detector system.

4.1.1 In addition to conformity with the requirements in 3., confirmation of whether the test sample complies with the designated specifications for finishing, construction, dimensions and parts or not

4.1.2 Pressure test of the test specimen for a period in accordance with the following 1) through 3). The test pressure is to be a design pressure but not less than the pressure equivalent to sea-water head of maximum depth of the space where the parts are fitted.

1) The submerged test period for electrical components intended to be installed in ballast tanks and cargo tanks used as ballast tanks is to be not less than 20 days.
2) The submerged test period for electrical components intended to be installed in dry spaces and cargo holds not intended to be used as ballast tanks is to be not less than 24 hours.
3) Where a detector and/or cable connecting device (e.g. junction box, etc) is installed in a space adjacent to a cargo hold (e.g. lower stool, etc.) and the space is considered to be flooded under damage stability calculations, the detectors and equipment are to satisfy the requirements of IP68

for a water head equal to the hold depth for a period of 20 days or 24 hours on the basis of whether or not the cargo hold is intended to be used as a ballast tank as described in a) and b) above.

4.1.3 Confirmation whether the test sample performs as specified or not, under the regular installed condition, inclining conditions of 22,5 degrees in transverse direction and 10 degrees in longitudinal direction at the following temperature:

1) Parts installed outside the cargo hold: normal temperature
2) Parts installed inside the cargo hold: maximum and minimum working temperature (Where this temperature is expected within the range between 0°C and 60°C, room temperature may be used)

4.1.4 For the detector system installed in cargo holds, confirmation whether the test specimen detects seawater as specified or not, by merging in a test mixture of fine materials of each intended cargo in seawater (a solution of sodium chloride having a specific gravity of 1,025 g/cm^3 may be accepted as an alternative to seawater) in accordance with the followings:

1) The test container for the cargo/water mixture is to be dimensioned so that its height and volume are such that the sensor and any filtration fitted can be totally submerged for the repeated functionality tests.
2) The sensor and any filtration fitted that are to be arranged in the container as they would be installed in accordance with the installation instructions submitted.
3) The pressure in the test mixture container is to be not more than 0,02 MPa at the sensor and any filter arrangement. The pressure may be realized by pressurization or by using a container of sufficient height.
4) When the test mixture is pumped into the test mixture container, the test mixture is to be kept in homogenized condition during the test and the effect of the pumping is not to affect the operation of the sensor and filter arrangements.
5) The concentration of fine materials in a test mixture is to be of minimum 50 % by weight. In general, the type of test mixture may be limited to the followings. The smallest and largest particle size together with the density of the dry mixture used in this test is to be ascertained and recorded in the test records and the manuals required by Rules for Electrical Installation (Pt.1, Vol.IV) Sec.18.B.4.2.
   A) Minimum one type of fine mineral (dust of iron ore, coal, sand, etc. with particle size of, in general, less than 0,1 mm)
   B) Minimum one type of grain (barleycorn, wheat, corn, etc. with particle size of, in general, greater than 3 mm)
6) The cargo/water mixture is to be pumped into the test container to a predetermined level that submerges the detector and the operation of the alarm observed.
7) The test container is then to be drained and the de-activation of the alarm condition observed.
8) The test container and sensor with any filter arrangement are to be allowed to dry without physical intervention.
9) A sequence from immersion to detection is to be repeated minimum 10 times (a period of one sequence of the test is not to be less than 30 seconds as a standard) without cleaning any filtration arrangements.
10) Satisfactory alarm activation and de-activation at each of the ten consecutive tests will demonstrate satisfactory type testing.

4.1.5 For the electrical parts of the devices, testing as given in the following 1) through 10). However, the type tests are to comply with the requirements in W.4.2 and, in case the explosion-protected construction is required, type tests also are to comply with the requirements in Rules for Electrical Installations (Pt.1, Vol.IV).

1) Electrical power supply failure test
2) Power supply variation test
3) Dry heat test
4) Damp heat test
5) Cold test (for water ingress detectors)
6) Vibration test.
7) Insulation resistance test
8) High voltage test
9) Inclinations tests (if the detectors contain moving parts).
10) EMC tests (if the detector is capable of producing electromagnetic noise)

4.2 Additional tests other than those of 1. may be requested, where deemed necessary by BKI.

AC. Protective Coating Systems for Ballast Tanks

1. Application

1.1 The requirements of this Sub-section apply to tests and inspection for the type approval of protective coating systems in accordance with the requirements in the Rules for Hull (Pt.1, Vol.II) Sec.38.

1.2 Winter and summer type coating are considered different unless infrared (IR) identification and specific gravity (SG) demonstrates that they are the same. Winter type epoxy is required separate prequalification test including shop primer compatibility test according to 6. of this sub section.

2. Data to be submitted

2.1 The following approval data are to be submitted to BKI (electronically) in addition to those specified in A.2.

2.1.1 Copy of Technical Data Sheet, including:

1) Product name and identification mark and/or number;
2) Materials, components and composition of the coating system, colours;
3) Minimum and maximum dry film thickness;
4) Application methods, tools and/or machines;
5) Condition of surface to be coated (de-rusting grade, cleanness, profile, etc.); and
6) Environmental limitations (temperature and humidity);
7) Dry-to recoat times and walk-on time

2.1.2 Compatibility of shop primer with protective coating system (if any)

2.1.3 Inspection and acceptance criteria of protective coating system

2.1.4 Procedures for repair of protective coating system

2.2 The coating manufacturer should provide to BKI the following information;

1) A detailed list of the production facilities.
2) Names and location of raw material suppliers will be clearly stated.
3) A detailed list of the test standards and equipment to be used, (Scope of approval).
4) Details of quality control procedures employed.
5) Details of any sub-contracting agreements.
6) List of quality manuals, test procedures and instructions, records, etc.
7) Copy of any relevant certificates with their issue number and/or date e.g. Quality Management System certification
8) Other documents which BKI considers necessary

3. Data review and plant audit

3.1 BKI shall performed the data review and plant audit specified in the Rules for Approval Manufacturers and Service Suppliers (Pt.1, Vol.XI) Sec.1. to assure the manufacturing process (including that of subcontractor's works) and quality assurance of the pro tective coating systems.

3.2 With the exception of early ‘scale up’ from lab to full production, adjustment outside the limitations listed in the QC instruction referred to below is not acceptable, unless justified by trials during

the coating system's development programme, or subsequent testing. Any such adjustments must be agreed by the formulating technical centre.

3.3 If formulation adjustment is envisaged during the production process the maximum allowable limits will be approved by the formulating technical centre and clearly stated in the QC working procedures.

3.4 The manufacturer's quality control system will ensure that all current production is the same formulation as that supplied for the Type Approval Certificate. Formulation change is not permissible without testing in accordance with the test procedures in 4.3 or 4.4 and the issue of a Type Approval Certificate by BKI.

3.5 Batch records including all QC test results such as viscosity, specific gravity and airless spray characteristics will be accurately recorded. Details of any additions will also be included.

3.6 Whenever possible, raw material supply and lot details for each coating batch will be traceable. Exceptions may be where bulk supply such as solvents and pre-dissolved solid epoxies are stored in tanks, in which case it may only be possible to record the supplier's blend.

3.7 Dates, batch numbers and quantities supplied to each coating contract will be clearly recorded.

3.8 All raw material supply must be accompanied the supplier's 'Certificate of Conformance'. The certificate will include all requirements listed in the coating manufacturer's QC system.

3.9 In the absence of a raw material supplier's certificate of conformance, the coating manufacturer must verify conformance to all requirements listed in the coating manufacturer's QC system.

3.10 Drums must be clearly marked with the details as described on the 'Type Approval Certificate'.

3.11 Product Technical Data Sheets must comply with all the PSPC requirements. The QC system will ensure that all Product Technical Data Sheets are current.

3.12 QC procedures of the originating technical centre will verify that all production units comply with the above stipulations and that all raw material supply is approved by the technical centre.

4. Performance standard

4.1 Protective coating systems are in principal, to be an epoxy-based system. All systems that are not an epoxy-based system applied according to these requirements are defined as an alternative system.

4.2 A multi-coat system with each coat of contrasting colour is recommended. The top coat shall be of a light colour (a colour that reflects light to an extent that a simple flash light (hand torch) will make inspection easy and fast. Normally light grey, buff, off-white, swimming pool blue/green, etc. easily distinguishable from rust.) in order to facilitate in-service inspection.

4.3 Protective coatings for dedicated seawater ballast tanks shall satisfied the approval tests specified in 6.2 and 6.3 and protective coatings for double-side spaces of bulk carriers shall satisfied the approval test specified in 6.3.

4.4 Epoxy-based systems which have documented field exposure for 5 years with a final coating condition of not less than "GOOD" may be accepted. In this case, field exposure for 5 years shall be satisfied following conditions.

4.4.1 Coating manufacturer's records, which shall at least include the information indicated in followings, shall be examined to confirm coating system has 5 years field exposure, and the current product is the same as that being assessed.

1) Original application records

2) Original coating specification
3) Original technical data sheet,
4) Current formulation's unique identification (Code or number)
5) If the mixing ratio of base and curing agent has changed, a statement from the manufacturer confirming that the composition mixed product is the same as the original composition. This shall be accompanied by an explanation of the modifications made.
6) Current technical data sheet for the current production site
7) SG and IR identification of original product
8) SG and IR identification of the current product
9) If original SG and IR cannot be provided, then a statement from the manufacturer confirming the readings for the current product are the same as those of the original.

4.4.2 A joint (BKI and coating manufacturer) survey of all ballast tanks of a selected vessel is to be carried out for the purpose of verification of compliance with the requirements of 4.4.1 and 4.4.5. The coating manufacturer's representative is to be qualified to NACE Coating Inspector Level 2 or FROSIO Inspector Level III or equivalent as verified by the Administration.

4.4.3 The selected vessel is to have ballast tanks in regular use, of which:

1) At least one tank approx 2,000 m^3
2) At least one tank shall be adjacent to heated tank and
3) At least one tank underdeck exposed to sun.

4.4.4 In the case that the selected vessel does not meet the requirements in 4.4.3 above then the limitations shall be clearly stated on the type approval certificate. For example, the coating cannot be used in tanks adjacent to heated tanks or underdeck or tanks with volume greater than the size surveyed.

4.4.5 All ballast tanks shall be in "GOOD" condition excluding mechanical damages, without touch up or repair in the prior 5 years. "Good" is defined as: Condition with spot rusting on less than 3% of the area under consideration without visible failure of the coating. Rusting at edges or welds, must be on less than 20 % of edges or welds in the area under consideration. Examples of how to report coating conditions with respect to areas under consideration should be as those given in IACS Recommendation 87, Appendix 1.

4.5 In the case that a manufacturer wishes to have products which are manufactured in different locations under the same name, then infrared (IR) identification and specific gravity shall be used to demonstrate that they are the same coating, or individual approval tests will be required for the paint manufactured in each location.

4.6 Epoxy based system Coatings Systems with existing satisfactory Marintek test reports minimum level B1 including relevant IR identification and SG, issued before 8 December 2006 can be accepted. If original SG and IR documentation cannot be provided, then a statement shall be provided by the coating manufacturer confirming that the readings for the current product are the same as those of the original.

4.7 Such coatings shall be applied in accordance with IMO Resolution MSC.215(82)Table 1 rather than the application conditions used during the approval test which may differ from the PSPC, unless these are more stringent than Section 3. AC., for example if the NDFT is higher or high pressure water washing and or sweep blasting of the shop primer is used. In such cases these limiting conditions shall be added to the type approval certificate and shall be followed during coating application in the shipyard.

5. Test Laboratory

The test laboratory where testing is carried out in accordance with the requirements in 4.3. are to equip the test facilities so that they can perform the testing in accordance with the requirements in this Instruction and are to be data reviewed and audited in accordance with the require ments in the Rules of Approval Manufacturers and Service Suppliers (Pt.1, Vol.XI) Sec.3 by BKI.

6. Type test

6.1 Application of protective coating system

6.1.1 There shall be a minimum of two stripe coats and two spray coats, except that the second stripe coat, by way of welded seams only, may be reduced in scope where it is proven that the NDFT can be met by the coats applied, in order to avoid unnecessary over-thickness.

6.1.2 Stripe coats shall be applied by brush or roller.

6.1.3 Each main coating layer shall be appropriately cured before application of the next coat, in accordance with coating manufacturer's recommendations.

6.1.4 Surface contaminants such as rust, grease, dust, salt, oil, etc., shall be removed prior to painting with proper method according to the paint manufacturer's recommendation. Abrasive inclusions embedded in the coating shall be removed. Job specifications shall include the dry-to-recoat times and walk-on time given by the manufacturer.

6.1.5 NDFT 320 μm with 90/10 rule (A 90/10 rule means that 90 % of all thickness measurements shall be greater than, or equal to, NDFT and none of the remaining 10 % measurements shall be below 0,9 x NDFT) for epoxy-based coatings; other systems to coating manufacturer's specifications.

6.1.6 For the coating pre-qualification test, the measured average DFT (dry film thickness) on each prepared test panels shall not exceed NDFT (nominal dry film thickness) of 320 μm plus 20 % unless a paint manufacturer specified a NDFT greater than 320 μm.

6.1.7 In the case that a paint manufacturer specified a NDFT greater than 320 μm, the average DFT shall not exceed the specified NDFT plus 20 % and the coating system shall be certified to the specified NDFT if the system passes the tests according to 4.3. The measured DFT shall meet the "90/10" rule and the maximum DFT shall be below the maximum DFT value specified by the manufacturer.

6.1.8 Care shall be taken to avoid increasing the thickness in an exaggerated way. Wet film thickness shall be regularly checked during application.

6.1.9 Thinner shall be limited to those types and quantities recommended by the manufacturer.

6.2 Test on Simulated Ballast Tank Conditions

6.2.1 Test condition

Test on simulated ballast tank conditions shall satisfy each of the following conditions:

1) The test shall be carried out for 180 days.
2) There are to be 5 test panels.
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. (see Fig 3.26)

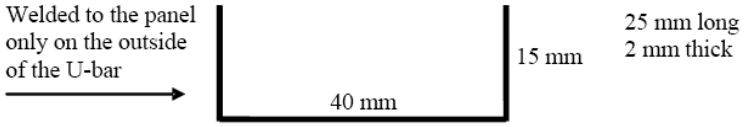


Fig 3.26 Welding of U-bar

4) Coating systems are to be applied on test panels according to 6.1. Shop primer (zinc containing inhibitor free zinc silicate based or equivalent) 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 useful life system. To facilitate innovation, alternative preparation, coating systems and dry film thicknesses may be used when clearly defined.
5) The reverse side of the test piece shall be painted appropriately, in order not to affect the test results.
6) 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. (see Fig 3.27).

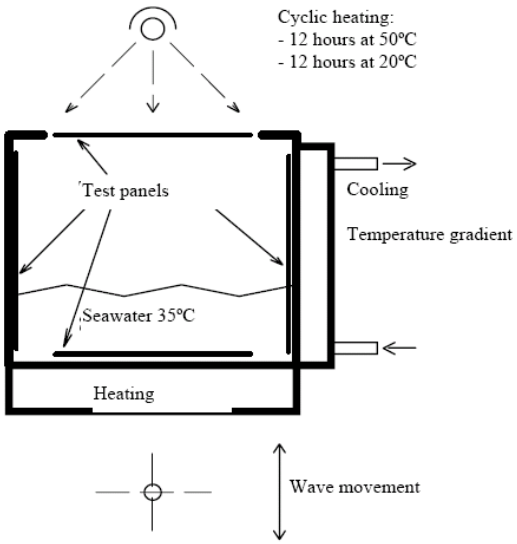


Fig 3.27 Wave tank for testing of ballast tank coatings

7) **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.
8) **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.
9) **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.

10) **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.

11) **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.

6.2.2 Test results

1) Prior to the testing, the following measured data of the coating system shall be reported:
   A) Infrared (IR) identification of the base and hardener components of the coating;
   B) Specific gravity of the base and hardener components of the paint (refer to ISO 2811-1/4); and
   C) Number of pinholes, low voltage detector at 90 V.
2) After the testing, the following measured data shall be reported:
   A) Blisters and rust (refer ISO 4628-2 and ISO 4628-3);
   B) Dry film thickness (DFT) (use of a template) (9 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.);
   C) Adhesion value (refer to ISO 4624);
   D) Flexibility modified according to panel thickness (refer to ASTM D 4145, 3 mm steel, 300 µm coating, 150 mm cylindrical mandrel gives 2 % elongation) for information only;
   E) Cathodic protection weight loss/current demand/disbondment from artificial holiday; and
   F) 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.

6.2.3 Acceptance criteria

1) The test results based on 6.2.2 shall satisfy the criteria specified in Tabel 3.72.
2) Epoxy-based systems shall satisfy the criteria for epoxy-based systems and alternative systems shall satisfy the criteria for alternative systems as indicated in 6.2.4.

6.2.4 Test report

The test report shall include the following information:

1) Name of the manufacturer;
2) Date of tests;
3) Product name/identification of both paint and primer;
4) Batch number;
5) Data of surface preparation on steel panels, including the following:
   A) Surface treatment;
   B) Water soluble salts limit;
   C) Dust; and
   D) Abrasive inclusions;

Table 3.72 Acceptance criteria for the test on Simulated Ballast Tank Conditions

Item	Acceptance criteria for epoxy-based systems	Acceptance criteria for alternative systems
Blisters on panel	No blisters	No blisters
Rust on panel	Ri 0 (0%)	Ri 0 (0%)
Number of pinholes	0	0
Adhesive failure	> 3.5 MPa Adhesive failure between substrate and coating or between coats for 60% or more of the areas.	> 5 MPa Adhesive failure between substrate and coating or between coats for 60% or more of the areas.
Cohesive failure	> 3 MPa Cohesive failure in coating for 40% or more of the area.	> 5 MPa Cohesive failure in coating for 40% or more of the area.
Cathodic protection; current demand calculated from weight loss	< 5 mA/m^2	< 5 mA/m^2
Cathodic protection; disbondment from artificial holiday	< 8 mm	< 5 mm
Undercutting from scribe	< 8 mm	< 5 mm
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.

6) Application data of coating system, including the following:
   A) Shop primed;
   B) Number of coats;
   C) Recoat interval (both of actual specimen data and manufacturer's requirement / recommendation.)
   D) Dry film thickness (DFT) prior to testing (both of actual specimen data and manufacturer's requirement/recommendation);
   E) Thinner; (both of actual specimen data and manufacturer's requirement/recommendation);
   F) Humidity (both of actual specimen data and manufacturer's requirement/recommendation);
   G) Air temperature (both of actual specimen data and manufacturer's requirement/ recommendation);
   H) Steel temperature;
7) Test results according to 6.2.2; and
8) Judgment according to 6.2.3

6.3 Condensation Chamber Test

6.3.1 Test condition

Condensation chamber test shall be conducted in accordance with the ISO 6270-1 and shall satisfy each of the following conditions (see Fig 3.28):

1) The exposure time is 180 days.
2) There are to be 2 test panels.
3) The size of each test panel is 150 mm x 150 mm x 3 mm.
4) Coating system are to be applied on test panels according to 6.1 of this Instruction. 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.

5) The reverse side of the test piece shall be painted appropriately, in order not to affect the test results.

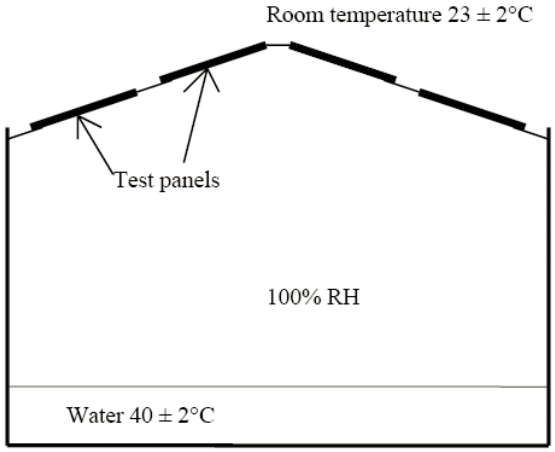


Fig 3.28 Condensation chamber

6.3.2 Test results

According to 6.2 1) and 2) (except for 6.2 2), E) and F))

6.3.3 Acceptance criteria

1) The test results based on 6.3.2 shall satisfy the criteria specified in Table 3.73.
2) Epoxy-based systems shall satisfy the criteria for epoxy-based systems and alternative systems shall satisfy the criteria for alternative systems as indicated in Table 3.73.

6.3.4 Test report

According to 6.2.4.

Table 3.73 Acceptance criteria for the Condensation Chamber Test

Item	Acceptance criteria for epoxy-based systems	Acceptance criteria for alternative systems
Blisters on panel	No blisters	No blisters
Rust on panel	Ri 0 (0%)	Ri 0 (0%)
Number of pinholes	0	0
Adhesive failure	> 3,5 MPa Adhesive failure between substrate and coating or between coats for 60% or more of the areas.	> 5 MPa Adhesive failure between substrate and coating or between coats for 60% or more of the areas.
Cohesive failure	> 3 MPa Cohesive failure in coating for 40% or more of the area.	> 5 MPa Cohesive failure in coating for 40% or more of the area.

6.4 Equivalent laboratory test

Type approval of a coating system is normally to be carried out in accordance with 6.2 and/or 6.3 above. However, BKI may accept an equivalent laboratory test method comprised of a single test or number of tests combined as a test procedure, subject to the following acceptance requirements:

6.4.1 The test method/programme shall be based on recognized national or international standards, well established with proven experience.

6.4.2 The equivalent test program is to adequately address the technical intent of the tests required in 6.2 and/or 6.3 above.

6.4.3 Test results of samples tested in accordance with the equivalent test methods are, wherever possible, to be compared against the acceptance criteria specified in 6.2 and/or 6.3 above. Where this is not possible due to the parameters of the equivalent test method used, the acceptance criteria of the equivalent test method standard are to be selected that provide the closest equivalent to those in 6.2 and/or 6.3 above.

6.4.4 Test laboratories shall comply with 5.

6.4.5 Epoxy based coating systems approved by such an equivalent test method shall be applied in the shipyard in accordance with all the surface preparation and application requirements specified in 1 above.

7. Type Approval Certificates

7.1 If the type tests specified in AC.4.3 or 5 years field exposure specified in AC.4.4 or Marintek test specified in 4.6 are satisfactory, a Type Approval Certificate will be issued to include both the epoxy and the shop primer.

7.2 In case where 5 years field exposure test specified in AC.4.4 are performed, The Type Approval Certificate shall reference the joint survey report specified in AC.4.4.(2)

7.3 In case where 5 years field exposure test specified in AC. 4.4 are performed, If the applied NDFT is greater than required in AC.6.1.(5), the applied NDFT will be the minimum to be applied during construction. This will be reported prominently on the Type Approval Certificate.

7.4 In case where the epoxy has been tested without shop primer on bare prepared steel with satisfactory, a Type Approval Certificate will be issued. The Type Approval Certificate will just record the epoxy.

7.5 The Type Approval Certificate is invalid if the formulation of either the epoxy or the shop primer is changed. It is the responsibility of the manufacturer to inform class immediately of any changes to the formulation.

7.6 In case where Marintek test specified in AC.4.6 are performed, the certificate shall record the report reference and the shop primer used. The Type Approval Certificate shall allow the use of the epoxy based system either with the named shop primer, unless there is evidence to indicate that it is unsuitable, or on bare prepared steel.

8. Compatability of shop primer

8.1 If a zinc silicate shop primer has passed the type test as part of an epoxy coating system, it may be used in combination with other approved epoxy coatings provided that the compatibility has been confirmed by the test in accordance with 6.2.1 8) without wave movement.

8.2 In case where same epoxy coating system is to be applied on the different shop primers, each combination to be type tested in accordance with 4. However, if each shop primer has already passed the type test as part of an epoxy coating system, the compatibility of shop primer can be confirmed by the test in accordance with 1. above.

8.3 If the test or tests specified above 1. are satisfactory, a Type Approval Certificate will be issued. In this instance, the Type Approval Certificate will include the details of the epoxy and a list of all shop primers with which it has been tested that have passed these requirements.

9. Dealing after approval

9.1 The protective coating systems satisfied for the tests specified in 4.3 are to be allowed the use of the epoxy with all the named shop primers or on bare prepared steel.

9.2 The protective coating systems satisfied for the tests without shop primer according to 7.4 are to be allowed the use of the epoxy on bare prepared steel only.

9.3 In all cases of approval by 5 years field exposure test specified in 4.4, the shop primer shall be removed prior to application of the approved epoxy based system coating, unless it can be confirmed that the shop primer applied during construction, is identical in formulation to that applied in the selected vessel used as a basis of the approval.

10. Alternative systems

10.1 All systems that are not applied according to IMO PSPC (IMO Resolution 215(82)) 4.4 are defined as an alternative system.

10.2 Acceptance of alternative systems will be subject to documented evidence that they ensure acorrosion prevention performance at least equivalent to that indicated in IMO PSPC (IMO Resolution 215(82)).

10.3 The documented evidence shall consist of satisfactory performance corresponding to a target useful life of 15 years in either actual field exposure for 5 years with final coating condition not less than "GOOD" or laboratory testing according to 4.3.

AD. LED Lighting Fittings and Fluorescent Lighting Fittings of Electronic Ballast Stabilizer Type

1. Application and General

LED lighting fittings and fluorescent lighting fittings of electronic ballast stabilizer type installed in navigation bridge are to comply with the requirements of the Rules for Electrical Installations (Pt.1, Vol.IV) Sec.11 and IEC 60092-306 as well as this Guidance.

2. Data to be submitted

The manufacturer wishing to obtain the type approval of LED lighting fittings and fluorescent lighting fittings of electronic ballast stabilizer type is to submit the data required in A.2 to BKI.

3. Type test

Type tests are to be carried out in accordance with Table 3.74 and supplementary tests may be required where deemed necessary by BKI. Type tests may be partly or wholly omitted, subject to the approval by BKI, in cases where the manufacturer submits the test reports issued by an authorized test laboratory in accordance with the standard approved by BKI.

Table 3.74 Type test items

No.	Item	Test method		Remark
1	Visual inspection	No.1	Table 3.34 of Sec.3, V	-
2	Performance Test	No.2		-
3	Electrical power supply failure test	No.3		-
4	Electrical power supply variation test	No.4		-
5	Dry heat test	No.6		-
6	Damp heat test	No.7		-
7	Vibration test	No.8		-
8	Insulation resistance test	No.10		-
9	High voltage test	No.11		-
10	Cold test	No.12		-
11	EMC tests	No.14-21		-
12	Flame resistance test	No.22		-
13	Salt mist test	No.13		for LED lightings installed in open deck
14	Mechanical strength test	IEC 60092-306		-
15	Temperature rising test	IEC 60092-306		-
16	IP test	IEC 60529		Please refer to Rules for Electrical Installations (Pt.1, Vol.IV) Sec. 5 Table 1.10 regarding the required IP grade
17	Explosion-Proof test	IEC 60079 Series		for LED lightings installed in hazardous areas

AE. Corrosion Resistant Steels

1. Application

1.1 The requirements of this Sub-section apply to tests and inspection for the type approval of Corrosion Resistant Steel in accordance with the requirements in Rules for Materials (Pt.1, Vol.V) Sec.4.

1.2 Corrosion Resistant Steel is to be graded and approved its manufacturing process in accordance with Section 2.B.1 of this Guidance.

1.3 For each corrosion designation, Corrosion resistant steel shall be verified by the corrosion testing specified in this Sub-section.

1.4 The Surveyor is to be present, as a rule, when the test samples for the approval test are being identified and for approval tests.

2. Data to be submitted

The following approval data are to be submitted in electronic format to BKI in addition to those specified in A.2

- Corrosion test plan and details of equipment and test environments.
- Technical data related to product assessment criteria for confirming corrosion resistance
- The technical background explaining how the variation in added and controlled elements improves corrosion resistance (The manufacturer will establish a relationship of all the chemical elements which affect the corrosion resistance, the chemical elements added or controlled to achieve this are to be specifically verified for acceptance. Verification is to be based on the ladle analysis of the steel.)
- The grades, the brand name and maximum thickness of corrosion resistant steel to be approved. Designations for corrosion resistant steels are given in Table 3.75.
- The welding processes and the brand name of the welding consumables to be used for approval.

Table 3.75 Designations for Corrosion Resistant Steels

Type of steel	Location where steel is effective	Corrosion Resistant Designation
Rolled steel for hull	For strength deck, ullage space	RCU
	For inner bottom	RCB
	For both strength deck and inner bottom plating	RCW

3. Data review and approval of test plan

3.1 The test program submitted by the manufacturer is to be reviewed by BKI, if found satisfactory, it will be approved and returned to the manufacturer for acceptance prior to tests being carried out. Tests that need to be witnessed by the Surveyor will be identified.

3.2 Method for selection of test samples is to satisfy the following:

1) The numbers of test samples are to comply with 5.
2) The number of casts and test samples selected are to be sufficient to make it possible to confirm the validity of interaction effects and/or the control range (upper limit, lower limit) of the elements which are added or intentionally controlled, for improving the corrosion resistance. Where agreed, this may be supported with data submitted by the manufacturer.

3.3 In addition to 3.2 2) above, BKI may require additional tests in the following cases. Considerations for additional tests may include but not be limited to:

1) When BKI determines that the control range is set by the theoretical analysis of each element based on existing data, the number of corrosion resistance tests conducted in accordance with Appendix of MSC.289(87) is too few to adequately confirm the validity of the control range of chemical composition;
2) When BKI determines that the data of the corrosion resistance test result obtained for setting the control range of chemical composition varies too widely;
3) When BKI determines that the validity of the corrosion resistance test result for setting the control range of chemical composition is insufficient, or has some flaws;
4) When BKI's surveyor has not attended the corrosion resistance tests for setting the control range of chemical composition, and the BKI determines that additional testing is necessary in order to confirm the validity of the test result data; and
5) When BKI determines that it is necessary, for reasons other than cases 1) to 4) above.

Remarks:

The chemical composition of the corrosion resistant steel is to be within the range specified for rolled steel for hull. Elements to be added for improving the corrosion resistance and for which content is not specified are to be generally within 1% in total.

4. Test Laboratory

4.1 The test laboratory where testing is carried out in accordance with the requirements in 5. are to equip the test facilities so that they can perform the testing in accordance with the requirements in this sub section and are to be data reviewed and audited in accordance with the requirements in Rules for Approval Manufacturers and Service Suppliers (Pt.1, Vol.XI) Sec.1 (except for 1.6).

4.2 Where a Surveyor of BKI is present at specified stages to witness the approval tests. The BKI's approval is not needed for the testing laboratory.

4.3 In the case where BKI is not present at specified stages to witness the approval tests, the testing laboratory is to be approved by BKI.

5. Approval Test

5.1 Test on simulated upper deck conditions

5.1.1 Test condition

Tests on simulated upper deck conditions in cargo oil tank (COT) shall satisfy each of the following conditions:

1) Corrosion resistant steel and conventional steel shall be tested at the same time.
2) The chemical composition of conventional steel shall comply with the requirements of Table 3.76. The mechanical properties of the test specimen should be representative of steel used in its intended shipboard application.
3) The tests for corrosion resistant steel shall be carried out for 21, 49, 77 and 98 days. The tests for conventional steel shall be carried out for 98 days. The tests for welded joints shall be carried out for 98 days.
4) There are to be five test pieces for each test period.
5) The size of each test piece is 25±1mm x 60±1mm x 5±0,5mm (see Fig 3.28). The surface to be tested is to be taken from a position within 2 mm of one rolled surface. This surface is to be ground to bare steel and polished with an emery paper #600.

Table 3.76 Chemical composition for conventional steel (%)

C	Mn	Si	P	S
0,13~0,17	1,00~1,20	0,15~0,35	0,010~0,020	0,002~0,008
Al (acid soluble, min.)	**Nb, max.**	**V, max.**	**Ti, max.**	**Nb+V+Ti, max.**
0,015	0,02	0,10	0,02	0,12
Cu, max.	**Cr, max.**	**Ni, max.**	**Mo, max.**	**Other, max.**
0,1	0,1	0,1	0,02	0,02 (each)

Notes;
1. To be based on ladle analysis given in the mill certificate.
2. Steel complying with a national standard that meets the requirements of this Table is also acceptable.

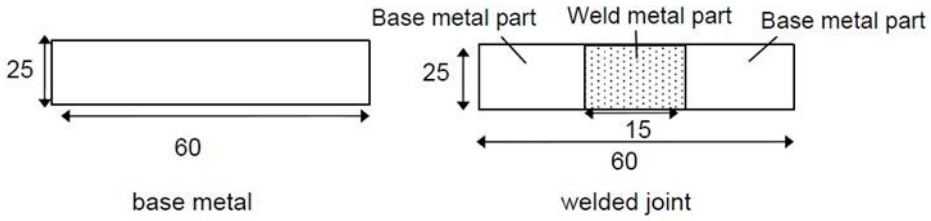


Fig 3.29 Test piece

6) For welded samples, a test assembly is to be made from the same steel cast as the base material test in (e) but may be from a plate of different thickness. The assembly is to be welded using the process and consumable to be approved for use with the base material. The size of the test piece for a welded joint is 25±1mm x 60±1mm x 5±0,5mm, including 15±5mm width of the weld metal part (excluding heat affected zone). This surface is to be ground to bare steel and polished to 600 grit finish.

7) The surface of the test piece, except for the tested surface, shall be protected from corrosive environment in order not to affect the test results.

8) The test apparatus consists of a double chamber, and the temperature of the outer chamber is to be controlled.

9) All the base material specimens should be located in one tank. Fig 3.29 only shows locations of 20 specimens. The tank can be designed to hold 25 or more specimens; alternatively, specimens can be added and removed as necessary so that the appropriate time periods are achieved within the total timescale of 98 days.

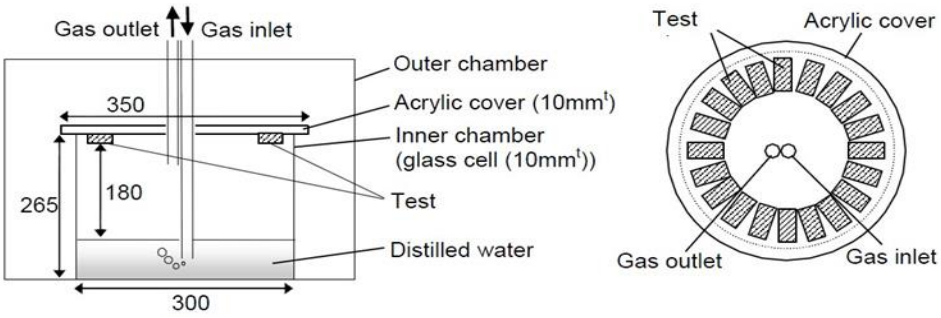


Fig 3.30 An example of simulated corrosion test apparatus for upper deck

10) Welded specimens may be tested with the parent material tests or tested separately against 5 conventional steel specimens.

11) Since certain factors such as control and measurement of temperature and size of chamber may affect the corrosion rate achieved, it should be confirmed that the corrosion rate of conventional

steel in the conditions and equipment of the test, satisfies the rate criteria, before carrying out corrosion test for evaluation of corrosion resistant steel.

12) To remove specimens, the chamber is to be purged with 100% nitrogen gas while the specimens are in the high temperature region until the specimens are dry.

13) Simulating the condition of the actual upper deck, the test cycle runs with distilled water and simulated COT gas (4±1% O_2, 13±2% CO_2, 100±10ppm SO_2, 500±50ppm H_2S, 83±2% N_2). A sufficient distance between the surface of the test piece and the distilled water is to be kept avoiding splashing of distilled water. The minimum gas flow rate is 100 cc per minute for the first 24 hours and 20 cc per minute after 24 hours.

14) The test pieces shall be heated for 19±2 h at 50±2°C and 3±2 h at 25±2°C and the transition time is to be at least 1 h. The time for 1 cycle is 24 h. The temperature of the dis- tilled water is to be kept at not higher than 36°C, while the temperature of the test pieces is 50°C.

15) The cycling pattern of specimen temperature and temperature of distilled water should be controlled such that each cycle is as identical as possible throughout the whole corrosion test period. These temperatures must be recorded. See Fig 3.30.

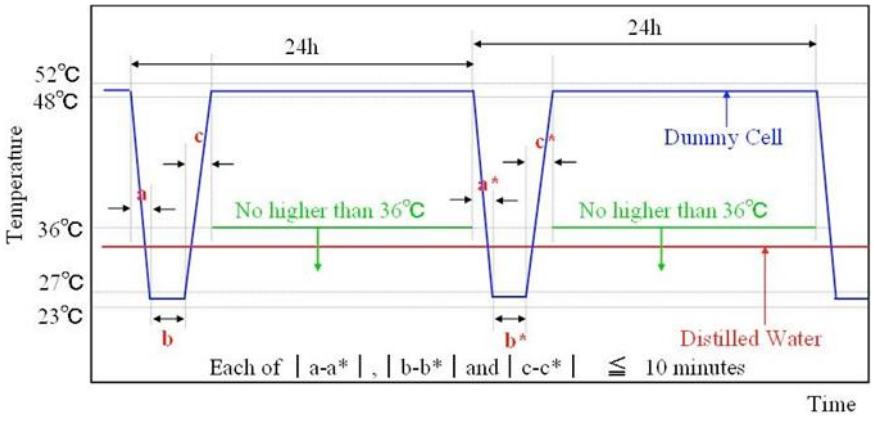


Fig 3.31 Schematic view of temperature controlling accuracy of specimens and distilled water during corrosion test

16) The transition time, a, a*, c and c* in Fig 3.31 is the time from when the cooling and heating commences until the lower or upper temperature is reached, see Fig 3.32 The transition of each cycle is to be as identical as possible throughout the whole corrosion test period. The temperature of both the specimens and the water is to be continuously recorded throughout the test.

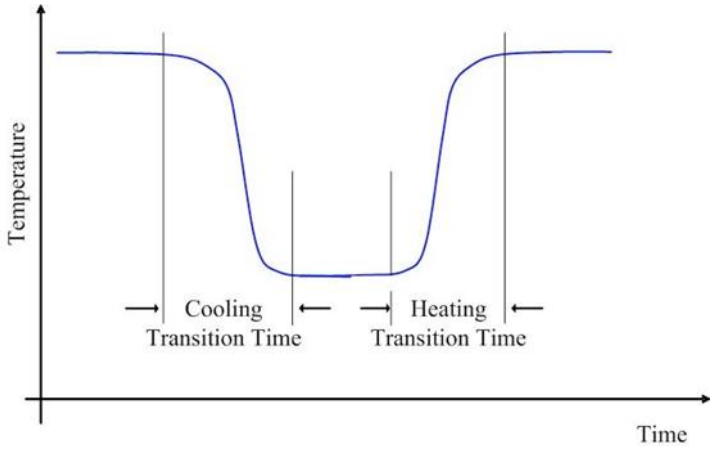


Fig 3.32 Transition time definition

5.1.2 Test results of base metal

1) Prior to the testing, the following measured data shall be reported:
   A) Size and weight of the test piece
2) After the testing, the following measured data shall be reported:
   A) Weight loss (difference between initial weight and weight after testing) of conventional steel (W_C) and corrosion resistant steel (W_{21}, W_{49}, W_{77} and W_{98});
3) Specimens are to be weighed to an accuracy of ±1 mg.
4) Corrosion loss of conventional steel ($CL_{C)}$ and corrosion resistant steel (CL_{21}, CL_{49}, CL_{77} and $CL_{98)}$, calculated by the following formulae:

$$CL_C(mm) = \frac{10 \times W_C}{S \times D} \qquad CL_C(mm) = \frac{10 \times W_{21}}{S \times D} \qquad CL_C(mm) = \frac{10 \times W_{49}}{S \times D}$$

$$CL_{77}(mm) = \frac{10 \times W_{77}}{S \times D} \qquad CL_{98}(mm) = \frac{10 \times W_{98}}{S \times D}$$

Where by:

W_C : weight loss of conventional steel (g) (average of five test pieces)

W_{21} : weight loss of corrosion resistant steel after 21 days (g) (average of five test pieces)

W_{49} : weight loss of corrosion resistant steel after 49 days (g) (average of five test pieces)

W_{77} : weight loss of corrosion resistant steel after 77 days (g) (average of five test pieces)

W_{98} : weight loss of corrosion resistant steel after 98 days (g) (average of five test pieces)

S : surface area (cm^2)

D : density (g/cm^3)

5) The test is considered to be carried out appropriately if CLc is between 0,05 and 0,11 (corrosion rate is between 0,2 and 0,4 mm/year).
6) Where the calculated corrosion loss of conventional steel is less than 0,05 mm/year, the concentration of H2S may be increased in the simulated cargo oil tank gas. All tests will be carried out at this increased level.
7) At least 3 values of individual weight loss of conventional steel should be in the range of maximum X and minimum Y measured in grams.

$X = (0{,}11 \times S \times D)/10$

$Y = (0{,}05 \times S \times D)/10$

Where by:

S = Surface area (cm^2)

D = Density (g/cm^3)

8) Coefficients A and B of corrosion resistant steel, calculated from the test results for 21, 49, 77 and 98 days by least square method. Corrosion loss of corrosion resistant steel is described as follows:

$CL = A \times t^B$

A (mm), and

B = coefficient

t = test period (days)

9) Estimated corrosion loss after 25 years (ECL) calculated by the following formula:

$$ECL\ (mm) = A \times (25 \times 365)^{B}$$

5.1.3 Test results of welded joint

The surface boundary between base metal and weld shall be observed and evaluation of discontinuous surface to be in accordance with requirements in 5.3.

5.1.4 Acceptance criteria

The test results based on provisions of 5.1.2 and 5.1.4 above shall satisfy the following criteria:

1) ECL(mm) ≤ 2 (for base metal)
2) No discontinuous surface (e.g., step) between the base metal and weld metal (for welded joint)

5.1.5 Test report

The test report shall include the following information:

1) Name of the manufacturer
2) Date of tests
3) Chemical composition and corrosion resistant process of steel
4) Test results according to 5.1.2 and 5.1.3 above
5) Judgement according to 5.1.4 above

5.2 Test on simulated inner bottom conditions

5.2.1 Test condition

Tests on simulated inner bottom conditions in cargo oil tanks (COT) should satisfy each of the following conditions:

1) The test shall be carried out for 72 hour for base metal, and 168 hour for welded joint.
2) There are to be at least five test pieces of corrosion resistant steel for base metal and welded joint, respectively. For comparison, at least five test pieces of base metal of conventional steel should be tested in the same condition.
3) The conventional steel used should also meet the requirements of Table 3.76. The mechanical properties of the test specimen should be representative of steel used in its intended shipboard application.
4) Base material is to be prepared such that one surface is to be taken from a position within 2 mm of one rolled surface. The size of each test piece is 25±1mm x 60±1mm x 5±0,5mm. All surfaces are to be ground to bare steel and polished with an emery paper #600, except a hole for hanging (see Fig. 3.33).

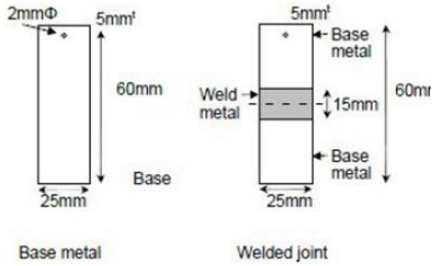


Fig 3.33 Test piece

5) For welded samples, a test assembly is to be made from the same steel cast as the base material test in (d) but may be from a plate of different thickness. The assembly is to be welded using the process and consumable to be approved for use with the base material. The size of the test piece for a welded joint is 25±1mm x 60±1mm x 5±0,5mm, including 15±5mm width of the weld metal part (excluding heat affected zone). This surface is to be ground to bare steel and polished to 600 grit finish.

6) The samples are hung in a solution from a fishing line (0,3 mm to 0,4 mm in diameter, made of nylon) to avoid crevicelike and/or localized corrosion. An example of a corrosion test configuration is shown in Fig 3.34.

7) The test solution contains 10 mass% NaCl and its pH is 0,85 adjusted by HCl solution. The test solution should be changed to a new one every 24 h to minimize pH change of the test solution. The volume of the solution is more than 20 cc/cm^2 (surface area of test piece). The temperature of the test solution is to be kept at 30 ± 2°C.

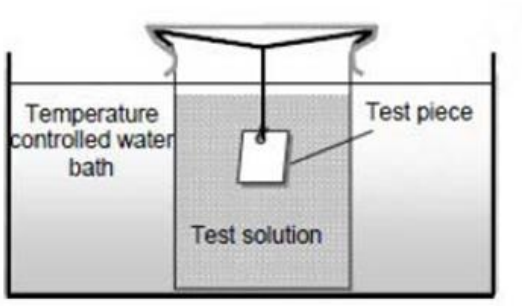


Fig 3.34 Simulated corrosion test apparatus for inner bottom

5.2.2 Test results of base metal

1) Prior to the testing, the following data shall be measured and reported:
   A) Size and weight of test piece.
2) After the testing, the following measured data shall be reported:
   A) Weight loss (difference between initial weight and weight after testing)
3) Specimens are to be weighed to an accuracy of ± 1 mg.
4) Corrosion rate (C.R.) calculated by the following formula:

$$\text{C.R.(mm/year)} = \frac{365\,(\text{days}) \times 24\,(\text{hours}) \times W \times 10}{S \times 72\,(\text{hours}) \times D}$$

Where by:

W: Weight loss (g), S: Surface area (cm^2), D: Density (g/cm^3)

5) To identify specimen which hold crevice and/or localized corrosion, the C.R. is to be plot- ted on a normal distribution statistic chart. One specimen that has a corrosion rate deviating from the average corrosion rate by more than +25% may be eliminated from the results, provided that the cause of the accelerated corrosion is demonstrated to be due to localized corrosion around the hanging hole and/or stamp (e.g. crevice corrosion, pitting corrosion, etc.). C.R. data which deviate from the normal statistical distribution must be eliminated from the test results. An example is shown in Fig 3.35 for reference.

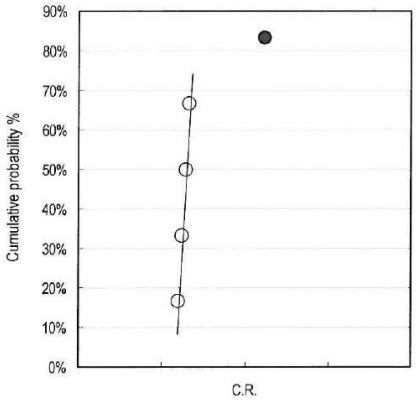


Fig 3.35 An example of plot of C.R.s on a normal distribution chart

(In this case C.R. data ● should be abandoned and eliminated.)

6) Calculation of average of C.R.'s data (C.R. ave)

5.2.3 Test results of welded joint

The surface boundary between base metal and weld shall be observed and evaluation of discontinuous surface to be in accordance with requirements in 5.3.

5.2.4 Acceptance criterion

The test results based on 5.2.2 and 5.2.3 above shall satisfy the following criteria:

1) C.R.ave (mm/ year) ≤ 1,0 (for base metal)
2) No discontinuous surface (e.g., step) between the base metal and weld metal (for welded joint)

5.2.5 Test report

The test report shall include the following information:

1) Name of the manufacturer
2) Date of tests
3) Chemical composition and corrosion resistant process of steel
4) Test results according to 5.2.2 and 5.2.3 above
5) Judgement according to 5.24 above

5.3 Interpretation of weld discontinuity

5.3.1 Preparation of samples after corrosion test

1) All five samples are to be prepared as follows.

2) Two full thickness specimens approximately 20 mm long x 5 mm wide are to be sectioned with their principle axis perpendicular to the weld fusion line. Each specimen is to be located such that the weld fusion line is located approximately at its mid length. See Fig 3.36.

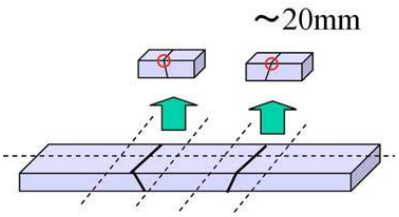


Fig 3.36 Sectioning plan

3) The specimens are to be mounted in resin to allow polishing of the cross section. The specimens are to be etched in Nital after polishing to reveal the fusion boundary.

4) A photomicrograph is to be taken at a magnification of approximately 1000 X.

5.3.2 Evaluation of depth step

1) On the photomicrograph, construct a line A-B, perpendicular to the corrosion surface through the point where fusion line and the surface cross. See Fig 3.37.

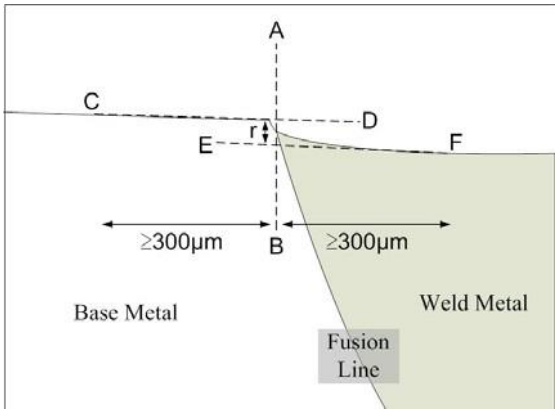


Fig 3.37 Determination of corrosion depth on photomicrograph

2) Construct two parallel lines C-D and E-F one representing the higher level, the other the lower level. Each line is to be constructed over a distance of ≥ 300 μm from line A-B on the base metal and weld metal side, respectively.

3) Measure the distance r mm between the intersection point at line A-B and each average surface line on the photomicrograph.

4) If the intersection point at line A-B and average surface line of welded metal part is above that of base metal part, then the existence of step should be neglected for this sample.

5) Calculate the depth of discontinuous step R in μm from the actual photomicrograph magnification M as follows.

$$R(\mu m) = \frac{r(mm) \times 1000}{M}$$

5.3.3 Evaluation of step angle

1) Evaluation for angle of step is unnecessary if the depth of step calculated on both samples see 5.3.2 above, are not greater than 30 μm or if either step exceeds 50 μm for a single specimen. Otherwise the angle of step is to be calculated as follows.
2) Produce a photomicrograph at a magnification of approximately 250 times, see Fig 3.38.

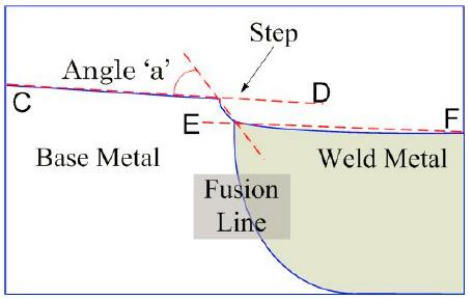


Fig 3.38 Calculation of step angle

3) Draw an average surface line C-D for base metal part and E-F for weld metal part.
4) Find the closest intersection point with the step of the base metal surface profile and the constructed line C-D and the closest intersection point with the step for weld metal constructed line E-F respectively, and connect those two intersection points.
5) Measure the angle 'a' in degrees given by the line C-D and the connected line described in 4) above.

5.3.4 Acceptance Criteria

1) If the depth of both steps is less than or equal to 30 μm then the measurement of angle is unnecessary, and the sample is considered to be acceptable.
2) If the depth of steps on both photomicrographs are less than or equal to 50 μm and in addition if both the measured angles are less than or equal to 15 degrees, then the sample is considered to be acceptable.
3) If either of the conditions described in 1) or 2) above are not in compliance, the sample is considered to contain a "discontinuous surface" and fails the test.
4) Welds should be evaluated as "without discontinuous surface" when all 5 corrosion test samples are considered acceptable.

6. Type Approval Certificates

6.1 After completion of the approval test, the manufacturer is to produce the report of the approval test and submit it to BKI.

6.2 BKI is to issue a Type Approval Certificate, where deemed appropriate by BKI on the basis of the submitted test reports after completion of the type test.

6.3 The Type Approval Certificate for approved corrosion resistant steel is to include the following items:

1) Brand name, manufacturer and certificate number
2) Steel grade and area of application designation
3) Chemical composition range (including additive and/or controlling element percentages to improve corrosion resistance)
4) Maximum thickness

5) Steelmaking process
6) Casting process
7) Delivery condition
8) Brand of welding consumables and welding method
9) Period of validity of approval

6.4 Validity and renewal of approval certificate are to be in accordance with Section 3, A.8. of this Guidance.

7. Changes in the approved contents

7.1 Where the scope of approval changes, for example for additions to the applicable welding consumables, the effects of these changes are to be subjected to corrosion resistance tests for the welded joints.

AF. Protective Coating Systems for Cargo Oil Tanks

1. Application

The requirements of this Sub-section apply to tests and inspection for the type approval of protective coating systems in accordance with the requirements in Rules for Hull (Pt.1, Vol.II), Sec. 38.

2. Data to be submitted

2.1 The following approval data are to be submitted to BKI (electronically) in addition to those specified in A.2.

1) Copy of Technical Data Sheet, including:
   A) Product name and identification mark and/or number;
   B) Materials, components and composition of the coating system, colours;
   C) Minimum and maximum dry film thickness;
   D) Application methods, tools and/or machines;
   E) Condition of surface to be coated (de-rusting grade, cleanness, profile, etc.); and
   F) Environmental limitations (temperature and humidity);
   G) Dry-to recoat times and walk-on time.
2) Compatibility of shop primer with protective coating system (if any).
3) Inspection and acceptance criteria of protective coating system.
4) Procedures for repair of protective coating system.

2.2.1 The coating manufacturer should provide to BKI the following information;

1) A detailed list of the production facilities.
2) Names and location of raw material suppliers will be clearly stated.
3) A detailed list of the test standards and equipment to be used, (Scope of approval).
4) Details of quality control procedures employed.
5) Details of any sub-contracting agreements.
6) List of quality manuals, test procedures and instructions, records, etc.
7) Copy of any relevant certificates with their issue number and/or date e.g. Quality Management System certification.
8) Material Safety Data Sheet

3. Data review and plant audit

3.1 BKI shall perform the data review and plant audit specified in the Rules for Approval Manufacturers and Service Suppliers (Pt.1, Vol.XI) Sec. 1 to assure the manufacturing process (including that of subcontractor's works) and quality assurance of the protective coating systems.

3.2 With the exception of early ‘scale up’ from lab to full production, adjustment outside the limitations listed in the Quality Control (QC) instruction referred to below is not acceptable.

3.3 Unless justified by trials during the coating system’s development program, or subsequent testing. Any such adjustments must be agreed by the formulating technical centre. If formulation adjustment is envisaged during the production process the maximum allowable limits will be approved by the formulating technical centre and clearly stated in the QC working procedures.

3.4 The manufacturer's quality control system will ensure that all current production is the same formulation as that supplied for the Type Approval Certificate. Formulation change is not permissible without testing in accordance with the test procedures in this Sub-section and the issue of a Type Approval Certificate by BKI.

3.5 Batch records including all QC test results such as viscosity, specific gravity and airless spray characteristics will be accurately recorded. Details of any additions will also be included.

3.6 Whenever possible, raw material supply and lot details for each coating batch will be traceable. Exceptions may be where bulk supply such as solvents and pre-dissolved solid epoxies are stored in tanks, in which case it may only be possible to record the supplier's blend.

3.7 Dates, batch numbers and quantities supplied to each coating contract will be clearly recorded.

3.8 All raw material supply must be accompanied the supplier's 'Certificate of Conformance'. The certificate will include all requirements listed in the coating manufacturer's QC system.

3.9 In the absence of a raw material supplier's certificate of conformance, the coating manufacturer must verify conformance to all requirements listed in the coating manufacturer's QC system.

3.10 Drums must be clearly marked with the details as described on the 'Type Approval Certificate'.

3.11 Technical Data Sheets must comply with all the PSPC requirements. The QC system will ensure that all Product Technical Data Sheets are current.

3.12 QC procedures of the originating technical centre will verify that all production units comply with the above stipulations and that all raw material supply is approved by the technical centre.

4. Performance standard

4.1 Protective coating systems are, in principal, to be an epoxy-based system. All systems that are not an epoxy-based system applied according to these requirements are defined as an alternative system.

4.2 A multi-coat system with each coat of contrasting colour is recommended. The top coat shall be of a light colour (a colour that reflects light to an extent that a simple flash light (hand torch) will make inspection easy and fast. Normally light grey, buff, off-white, swimming pool blue/green, etc. easily distinguishable from rust) in order to facilitate in-service inspection.

4.3 Protective coatings for Cargo Oil Tanks of Crude Oil Tankers shall satisfy the approval tests specified in 6.2 and 6.3.

4.4 Epoxy-based systems which have documented field exposure for 5 years with a final coating condition of not less than "GOOD" may be accepted. In this case, field exposure for 5 years shall be satisfied following conditions.

4.4.1 Coating manufacturer's records should include the information indicated in followings and should be examined to confirm coating system has 5 years field exposure, and the current product is the same as that being assessed.

1) Original application records
2) Original coating specification
3) Original technical data sheet,
4) Current formulation's unique identification (Code or number)
5) If the mixing ratio of base and curing agent has changed, a statement from the manufacturer confirming that the composition of the mixed product is the same as the original composition. This should be accompanied by an explanation of the modifications made.

6) Current technical data sheet for the current production site
7) SG (Specific Gravity) and IR (Infra-Red) identification of original product
8) SG and IR identification of the current product
9) If original SG and IR cannot be provided, then a statement from the manufacturer confirming the readings for the current product are the same as those of the original.

4.4.2 Either class survey records should be reviewed, or a joint (coating manufacturer and BKI) survey of cargo tanks of a selected vessel should be carried out, to verify compliance with the requirements of 4.4.1 and 4.4.5. The reporting of the coating condition in both cases shall be in accordance with the principles given in section 4 of MSC.1/Circ.1399. The coating manufacturer's representative is to be qualified to NACE Coating Inspector Level 2 or FROSIO Inspector Level III or equivalent as verified by the Administration.

4.4.3 The selected vessel should have cargo tanks in regular use, of which:

1) At least one tank is exposed to minimum temperature of 60°C ± 3°C
2) For field exposure, the ship should be trading in varied trade routes and carrying substantial varieties of crude oils including highest temperature and lowest pH limits to provide a realistic sample: for example, three ships on three different trade areas with different varieties of crude cargoes.

4.4.4 In the case that the selected vessel does not meet the requirements in 4.4.3 then the limitations on lowest pH and highest temperature of crude oils carried should be clearly stated on the type approval certificate.

4.4.5 All cargo tanks should be in "GOOD" condition excluding mechanical damages, without touch up or repair in the prior 5 years. "Good" is defined as: Condition with spot rusting on less than 3% of the area under consideration without visible failure of the coating. Rusting at edges or welds, must be on less than 20% of edges or welds in the area under consideration. "Area under consideration" is the area defined as per PSPC-COT 4.4 and 4.5. In evaluating the figures given in the definition, an under-deck area and an inner bottom area are to be treated separately.

4.5 In the case that a manufacturer wishes to have products which are manufactured in different locations under the same name, then infrared (IR) identification and specific gravity shall be used to demonstrate that they are the same coating, or individual approval tests will be required for the paint manufactured in each location.

5. Test Laboratory

The test laboratory where testing is carried out in accordance with the requirements in 4.3 is to equip the test facilities so that they can perform the testing in accordance with the requirements in this sub section and are to be accredited by any of followings;

- Komite Akreditasi Nasional (KAN)
- International Laboratory Accreditation Cooperation (ILAC) or equivalent qualification
- ISO 9000 Quality Management System

6. Type test

6.1 General

6.1.1 Application of protective coating system

1) There shall be a minimum of two stripe coats and two spray coats, except that the second stripe coat, by way of welded seams only, may be reduced in scope where it is proven that the NDFT can be met by the coats applied, in order to avoid unnecessary over-thickness.
2) Stripe coats should be applied as a coherent film showing good film formation and no visible defects. The application method employed should insure that all areas that require stripe coating are properly coated by brush or roller. A roller may be used for scallops, ratholes etc., but not for edges and welds.
3) Each main coating layer shall be appropriately cured before application of the next coat, in accordance with coating manufacturer's recommendations.
4) Surface contaminants such as rust, grease, dust, salt, oil, etc., shall be removed prior to painting with proper method according to the paint manufacturer's recommendation. Abrasive inclusions embedded in the coating shall be removed. Job specifications shall include the dry-to-recoat times and walk-on time given by the manufacturer.
5) NDFT 320 µm with 90/10 rule (A 90/10 rule means that 90% of all thickness measurements shall be greater than, or equal to, NDFT and none of the remaining 10% measurements shall be below 0,9 x NDFT) for epoxy-based coatings; other systems to coating manufacturer's specifications.
6) Maximum total dry film thickness according to manufacturer's detailed specifications.
7) Care shall be taken to avoid increasing the thickness in an exaggerated way. Wet film thickness shall be regularly checked during application for quality control. It is accepted to be carried out by the Builder. Measurement of DFT shall be done as part of the inspection required in PSPC-COT 6.
8) Thinner shall be limited to those types and quantities recommended by the manufacturer.

6.1.2 Test gas composition

The test gas is based on the composition of the vapour phase in crude oil tanks and is to comply with the Table 3.77.

Table 3.77 Test gas composition

Test gas	composition	Remark
N_2	83 ± 2%	Volume of dry gas
CO_2	13 ± 2%	Volume of dry gas
O_2	4 ± 1%	Volume of dry gas
SO_2	300 ± 20 ppm	
H_2S	200 ± 20 ppm	

6.1.3 Test liquid

1) Start with distillate Marine Fuel, DMA Grade density at 15 °C: maximum 890 kg/m^3, viscosity of maximum 6 mm^2/s at 40 °C (refer to ISO 8217) ;
2) Add naphthenic acid up to an acid number of 2,5±0,1 mg KOH/g (refer to ISO 6618) ;
3) Add benzene/ toluene (1:1 ratio) up to a total of 8,0±0,2% w/w of the DMA;
4) Add artificial seawater (refer to ASTM D1141) up to a total of 5,0±0,2% w/w to the mixture;
5) Add H_2S dissolved in a liquid carrier (in order to get 5±1 ppm w/w H_2S in the total test liquid) ;
6) Thoroughly mix the above constituents immediately prior to use; and

7) Once the mixture is completed, it should be tested to confirm the mixture is compliant with the test mixture concentrations.

8) To prevent the risk of H_2S release into the test facility, it is recommended to use a stock solution for steps 1) to 4), then fill the test containers and complete the test solution with steps 5) and 6).

6.2 Gastight cabinet test

6.2.1 Test condition

The vapour test shall be carried out in a gastight cabinet. The dimensions and design of the air tight gas cabinet are not critical, provided the requirements of subparagraphs 6) to 10) below are met.

1) The exposure time is 90 days.

2) Testing shall be carried out using duplicate panels; a third panel shall be prepared and stored at ambient conditions to act as a reference panel during final evaluation of the test panels.

3) The size of each test panel is 150 mm x 100 mm x 3 mm.

4) The panels shall be treated according to 6.1.1 above.

5) The zinc silicate shop primer, when used, shall 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 shall be reported, and the judgement issued for that specific system. The reverse side and edges of the test piece shall be coated appropriately, in order not to influence the test results.

6) Inside the gastight cabinet, a trough shall be present. This trough shall be filled with 2 ± 0,2 l of water. The water in the trough shall be drained and renewed prior to each time the test gas is refreshed.

7) The vapour spaces inside the gastight cabinet shall be filled with a mixture of test gas as per 6.1.2 above. The cabinet atmosphere shall be maintained over the period of the test. When the gas is outside the scope of the test method, it shall be refreshed. The monitoring frequency and method, and the date and time for refreshing the test gas, shall be in the test report.

8) The atmosphere in the test cabinet shall at all times be 95 ± 5% relative humidity.

9) Temperature of the test atmosphere shall be 60 ± 3 °C.

10) A stand for the test panels shall be made of a suitable inert material to hold the panels vertically spaced at least 20 mm between panels. The stand shall be positioned in the cabinet to ensure the lower edge of the panels is at least 200 mm above the height of the water and at least 100 mm from the walls of the cabinet. If two shelves are in the cabinet, care shall be taken to ensure solution does not drip on to the lower panels.

6.2.2 Test results

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, shall be reported:
   A) Infrared (IR) identification of the base and hardener components of the coating;
   B) Specific gravity (refer to ISO 2811-1/4) of the base and hardener components of the paint; and
   C) Mean dry film thickness (DFT) (by using a template). (Six equally distributed measuring points are used on panels size 150mm x 100mm.)

2) After completion of the test duration, the panels shall be removed from the cabinet and rinsed with warm tap water. The panels shall be dried by blotting with absorbent paper and, then, evaluated for rust and blistering within 24 hours of the end of the test.

3) After testing, the following measured data shall be reported:
   A) Blisters and rust. (refer to ISO 4628-2 and ISO 4628-3)

6.2.3 Acceptance criteria

1) The test results based on 6.2.2 above shall satisfy the following criteria, the poorest performing of the duplicate test panels shall be used in the report:

Item	Acceptance criteria for epoxy-based system	Acceptance criteria for alternative system
Blisters on panel	No blister	No blister
Rust on panel	Ri 0 (0%)	Ri 0 (0%)

2) When evaluating test panels, blistering or rusting within 5 mm of the panel edge shall be ignored.

6.2.4 Test report

The test report shall include the following information:

1) Coating manufacturers' name and manufacturing site;
2) Dates of test;
3) Product name/identification of each coat and, where applicable, zinc silicate shop primer;
4) Batch numbers of each component of each product;
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:
   A) Surface treatment, or treatment of weathered shop primer, and any other important information on treatment influencing the performance; and
   B) Water soluble salt level measured on the steel prior to application of the shop primer (refer to ISO 8502)
6) Details of coating system, including the following:
   A) Zinc silicate shop primer if relevant, its secondary surface pre-treatment and condition under which applied, weathering period;
   B) Number of coats, including the shop primer and thickness of each;
   C) Mean dry film thickness (DFT) prior to testing
   D) Thinner if used;
   E) Humidity;
   F) Air temperature;
   G) Steel temperature;
7) Details of schedule for refreshing the test gas;
8) Test results according to 6.2.2 and;
9) Results according to 6.2.3.

6.3 Immersion test

6.3.1 Test condition

1) The exposure time is 180 days.
2) The test liquid should be made as per 6.1.3 above.
3) The test liquid should 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 setup, 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.

4) The temperature of the test liquid should be 60 ± 2 °C and should be uniform and maintained constant with recognized methods such as water or oil bath or air circulation oven capable of keeping the immersion liquid within the required temperature range.
5) Test panels shall be positioned vertically and fully immersed during the test.
6) Testing shall be carried out using duplicate panels.
7) Inert spacers which do not cover the test area shall be used to separate test panels.
8) The size of each test panel is 150 mm x 100 mm x 3 mm.
9) The panels shall be treated according to 6.1.1 above.
10) The zinc silicate shop primer, when used, shall 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 shall be reported, and the judgment issued for that specific system. The reverse side, and edges, of the test piece shall be coated appropriately, in order not to influence the test results.
11) After the full immersion test period is completed the panels shall be removed from the test liquid and wiped with dry clean cloth before evaluation of the panels.
12) Evaluation of the test panels shall be done within 24 hours after completion of the test.

6.3.2 Test results

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, shall be reported:
   A) infrared (IR) identification of the base and hardener components of the coating;
   B) specific gravity of the base and hardener components of the paint (refer to ISO 2811-1/4);
   C) mean dry film thickness (DFT) (by using a template). (Six equally distributed measuring points are used on panels size 150mm x 100mm.)
2) After testing, the following measured data shall be reported:
   A) blisters and rust (refer to ISO 4628-2 and ISO 4628-3)

6.3.3 Acceptance criteria

1) The test results based on 6.3.2 above shall satisfy the following criteria, the poorest performing of the duplicate test panels shall be used in the report:

Item	Acceptance criteria for epoxy-based system	Acceptance criteria for alternative system
Blisters on panel	No blister	No blister
Rust on panel	Ri 0 (0%)	Ri 0 (0%)

2) When evaluating test panels, blistering or rusting within 5 mm of the panel edge should be ignored.

6.3.4 Test report

The test report shall include the following information:

1) Coating manufacturers' name and manufacturing site;
2) Dates of test;
3) Product name/identification of each coat and, where applicable, zinc silicate shop primer;
4) Batch numbers of each component of each product;

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:
   A) Surface treatment, or treatment of weathered shop primer, and any other important information on treatment influencing the performance; and
   B) Water soluble salt level measured on the steel prior to application of the shop primer (refer to ISO 8502)
6) Details of coating system, including the following:
   A) Zinc silicate shop primer if relevant, its secondary surface pretreatment and condition under which applied, weathering period;
   B) Number of coats, including the shop primer and thickness of each;
   C) Mean dry film thickness (DFT) prior to testing
   D) Thinner if used;
   E) Humidity;
   F) Air temperature;
   G) Steel temperature;
7) Test results according to 6.3.2 above; and
8) Results according to 6.3.3 above.

7. Type Approval Certificates

7.1 If the type tests specified in 4.3 or 5 years field exposure test specified in 4.4. are satisfactory, a Type Approval Certificate will be issued to include both the epoxy and the shop primer.

7.2 In case where 5 years field exposure test specified in 4.4. are performed, The Type Approval Certificate shall reference the joint survey report specified in 4.4.2.

7.3 In case where 5 years field exposure test specified in 4.4 are performed, if the applied NDFT is greater than 320 μm, the applied NDFT will be the minimum to be applied during construction. This will be reported prominently on the Type Approval Certificate.

7.4 In case where the epoxy has been tested without shop primer on bare prepared steel with satisfactory, a Type Approval Certificate will be issued. The Type Approval Certificate will just record the epoxy.

7.5 The Type Approval Certificate is invalid if the formulation of either the epoxy or the shop primer is changed. It is the responsibility of the manufacturer to inform class immediately of any changes to the formulation. For coating manufacturer, failure to inform BKI of an alteration to the formulation will lead to cancellation of the certificates for that manufacturer's products.

8. Compatability of shop primer

8.1 If a zinc silicate shop primer has passed the type test as part of an epoxy coating system, it may be used in combination with other approved epoxy coatings provided that the compatibility has been confirmed by the immersion test of 6.3. or test in accordance with AC. in this Guidance.

8.2 In case where same epoxy coating system is to be applied on the different shop primers, each combination to be type tested in accordance with 4. However, if each shop primer has already passed the type test as part of an epoxy coating system, the compatibility of shop primer can be confirmed by the test in accordance with 8.1 above.

8.3 If the test or tests specified above 8.1 are satisfactory, a Type Approval Certificate will be issued. In this instance, the Type Approval Certificate will include the details of the epoxy and a list of all shop primers with which it has been tested that have passed these requirements.

9. Dealing after approval

9.1 The protective coating systems satisfied for the tests specified in 4.3 are to be allowed the use of the epoxy with all the named shop primers or on bare prepared steel.

9.2 The protective coating systems satisfied for the tests without shop primer according to 7.4 are to be allowed the use of the epoxy on bare prepared steel only.

9.3 In all cases of approval by 5 years field exposure test specified in 4.4, the shop primer shall be removed prior to application of the approved epoxy based system coating, unless it can be confirmed that the shop primer applied during construction, is identical in formulation to that applied in the selected vessel used as a basis of the approval.

10. Alternative systems

10.1 All systems that are not applied according to IMO PSPC (IMO Resolution 288(87)) 4.6 are defined as an alternative system.

10.2 Acceptance of alternative systems will be subject to documented evidence that they ensure a corrosion prevention performance at least equivalent to that indicated in IMO PSPC.

10.3 The documented evidence shall consist of satisfactory performance corresponding to a target useful in either actual field exposure of continuous trading with crude oil cargoes for 5 years with final coating condition not less than "GOOD" or testing according to this Section.

AG. Fiber Reinforced Plastic Gratings

1. Application

1.1 The requirements of this Sub-section apply to tests and inspection for the type approval of fiber reinforced plastic (hereinafter refer to FRP) gratings used in gangway for safe access to tanker bows in accordance with the requirements in Rules for Hull (Pt.1, Vol.II) Sec. 24.A.7.

1.2 In case where gratings used in lieu of steel gratings other than FRP gratings, the requirements of this Sub-section can be applied.

1.3 The manufacturers wishing to obtain the approval of BKI for FRP gratings used in service location specified in Table 3.78 other than gangway are to comply with the requirements of this Sub-section.

2. Documents to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

1) Dimensions of gratings
2) Design temperature
3) Installation locations and serviceable life
4) The level of fire integrity
5) Electrostatic property
6) Installation instructions (including precautions to be taken at work site, repair procedures and criteria for determining whether repairs are necessary or not)
7) Details of marking
8) Drawings and supporting documentation
   A) Certificates and reports for relevant tests previously carried out
   B) Details of relevant standards
   C) All relevant design drawings, catalogues, data sheets, calculations and functional descriptions
   D) Fully detailed sectional assembly drawings showing gratings
9) Materials
   A) The resin type
   B) The reinforcement type
   C) A detailed statement of all reinforcements employed in cases where a reference number for the filament winding process is not specified
   D) Full information regarding the type of gel-coat or thermoplastic liner employed during construction, as appropriate.
   E) Cure/post-cure conditions. The cure and post cure temperatures and times employ resin/reinforcement ratio.
   F) Winding angle and orientation
10) Packing and marking methods
11) Process of manufacture
12) Service records
13) The outline of company and data on major manufacturing facilities
14) Data of quality control system
15) Documents on types of joints and working procedures

16) Details on the bonding procedures
   A) Bonding method and materialused
   B) Joints and tools with fixtures
   C) Cure temperature
   D) Dimensional requirements and tolerance
   E) Test acceptance criteria upon completion of the assembly

3. Type tests

3.1 General

3.1.1 The type tests specified in 3.2, 3.3, 3.4, and 3.5 are to be carried out in the presence of the Surveyor where the submitted documents are considered acceptable.

3.1.2 Applicants are to submit the test plan describing the test place, testing procedure, etc., in advance.

3.1.3 It is recommended that the above test plan is submitted with application form letter.

3.1.4 Test samples are to be picked out, in general, from the products by the direction of the Surveyor upon the survey at confirmation survey.

3.1.5 A copy of the test record (electronically) are to be submitted to BKI.

3.1.6 The type tests may be omitted when the test is carried out at a recognized testing organization and the test records are to be submitted to BKI.

3.2 Fire integrity test

The service and locations for fire integrity test are to comply with the requirements specified in Table 3.78. The definitions and test procedures for L1, L2, and L3 are also to be as follows.

3.2.1 Definitions

1) Level 1 (L1): FRP gratings meeting the L1 performance criteria are intended to be satisfactory for use in escape routes or access for fire-fighting, emergency operation or rescue, after having been exposed to a significant hydrocarbon or cellulosic fire incident. In addition, they are also acceptable for the services and functions described for levels L2 and L3.
2) Level 2 (L2): FRP gratings meeting the L2 performance criteria are intended to be satisfactory for use in open deck areas where groups of people are likely to assemble such as temporary safe refuge or lifeboat embarkation areas. In addition, they are also acceptable for the services and functions described for level L3.
3) Level 3 (L3): FRP gratings meeting the L3 performance criteria are intended to be satisfactory for use in egress routes and any areas that may require access for fire-fighting, rescue or emergency operations during exposure to or shortly after exposure to a transitory hydrocarbon or cellulosic fire.

3.2.2 Level 1 - To be qualified as L1, the FRP gratings shall meet the requirements for qualification as level 3 and level 2, and in addition shall be subjected to the following test procedures:

1) Three FRP grating specimens, after being subjected to the level 2 testing, shall be unloaded and prepared for impact testing in the manner specified for horizontal specimens in ASTM E 695 (Standard Method of Measuring Resistance of Wall, Floor, and Roof Construction to Impact Loading). The test specimens shall be secured as required in section 8.3 of ASTM E 695 except that the span shall be 200 mm less than the specimen length. A lead shot bag of 40 kg mass shall be dropped once

from a height of 2 m such that the point of impact is in the center of the span. The specimens shall then be uniformly loaded as required by the level 2 test procedures.

2) The test will be considered successful if all three specimens remain intact after being subjected to the impact test and the level 2 loading test. Failure will be indicated by collapse of one or more of the gratings.

Table 3.78 Level for fire integrity

Location	Service	Fire Integrity
Machinery Spaces	Walkways or areas which may be used for escape, or access for firefighting, emergency operation or rescue	L1(1)
	Personnel walkways, catwalks, ladders, platforms or access areas other than those described above	L3
Cargo Pump Rooms	All personnel walkways, catwalks, ladders, platforms or access areas	L1
Cargo Holds	Walksways or areas which may be used for escape, or access for firefighting, emergency operation or rescue	L1
	Personnel walkways, catwalks, ladders, platforms or access areas other than those described above	–
Cargo Tanks	All personnel walkways, catwalks, ladders, platforms or access areas	–(2)
Fuel Oil Tanks	All personnel walkways, catwalks, ladders, platforms or access areas	–(2)
Ballast Water Tanks	All personnel walkways, catwalks, ladders, platforms or access areas	–(3)
Cofferdams, void spaces, double bottoms, pipe tunnels, etc.	All personnel walkways, catwalks, ladders, platforms or access areas	–(3)
Accommodation, service, and control spaces	All personnel walkways, catwalks, ladders, platforms or access areas	L1
Lifeboat embarkation or temporary safe refuge stations in open deck areas	All personnel walkways, catwalks, ladders, platforms or access areas	L2
Open Deck or semi-enclosed areas	Walkways or areas which may be used for escape, or access for firefighting, emergency operation or rescue The areas to comply with the requirements of 1.1	L3(4)
	Personnel walkways, catwalks, ladders, platforms or access areas other than those described above	–

Notes:

(1) If the machinery space does not contain any internal combustion machinery, other oil burning, oil heating, or oil pumping units, fuel oil filling stations, or other potential hydrocarbon fire sources and has not more than 2,5 kg/m^2 of combustible storage, grating of L3 integrity may be used in lieu of L1.

(2) If these spaces are normally entered when underway, gratings of L1 integrity shall be required.

(3) If these spaces are normally entered when underway, gratings of L3 integrity shall be required.

(4) Vessels fitted with deck foam firefighting systems require gratings of L1 integrity for foam system operational areas and access routes.

3.2.3 Level 2 - To be qualified as L2, the FRP gratings shall meet the requirements for qualification as level 3, and in addition shall be subjected to the following test procedures:

1) On the FRP grating specimen and the steel grating specimen subjected to the level 3 post-loaded testing, the specimen shall be gradually loaded in increments not to exceed 20 kg, placed in such a manner as to represent a uniformly distributed loaded across the span.

2) The test will be considered successful if the FRP grating remains intact at a load greater than or equal to a uniform 4,5 kN/m^2 or greater than or equal to the steel grating failure loading, whichever is less. Failure will be indicated by collapse of the grate.

3.2.4 Level 3 - To be qualified as L3, the FRP gratings should be subjected to the following fire test procedures for both the post-loaded and pre-loaded tests and conditions:

1) A fire test will be conducted in accordance with ASTM E 119 (Standard Test Method for Tests of Building Construction and Materials). Two tests shall be conducted in the ASTM E 119 furnace for each FRP grating design. The first fire test shall be conducted with the specimens under the specified load (pre-loaded) and the second fire test will be conducted on unloaded specimens (post-loaded). The time-temperature curve shall be the standard for ASTM E 119 or the ISO equivalent.
2) Each test specimen shall be 300 ~ 350 mm wide to allow for the differences in the spacing of longitudinal supporting members. The length of each test specimen shall be the length of the maximum span to be seen in service plus 200 mm. Four test specimens shall be prepared as described above; two of the proposed FRP gratings and two of a similar steel grating that would be used in the same location constructed to the applicable regulations and standards. And steel gratings rated at a minimum of 4,5kN/m^2 uniform loading with a 1,67 factor of safety are acceptable.
3) The pre-loaded test shall consist of the following:
   A) One steel grating specimen and one FRP grating specimen shall be placed adjacent to one another in the furnace simply supported on two I-beams with a minimum flange width of 100 mm at an elevation of at least a half of the furnace height or a minimum of 300 mm above the burners;
   B) The specimens shall be placed on the I-beams such that 100 mm of each side of the specimen rests on each of the two I-beams;
   C) A static load represented by a 40 kg mass shall be placed in the center span of the test specimens;
   D) The 40 kg mass load shall consist of a steel container filled with sand, the base of which shall be square with an area of 0,09 m^2.
   E) Arrangements shall be made to measure the deflection at the center of the span of each of the loaded specimens during the test with a degree of accuracy of ± 5 mm.
   F) The two specimens shall be subjected to the time-temperature curve specified in the ASTM E 119;
   G) Deflection of the two loaded test specimens shall be measured throughout the duration of the fire test and the average furnace temperature shall be recorded when each of the two specimens has deflected a distance of L/10 (failure point) from the horizontal where L is equal to the maximum unsupported span of the specimens; and
   H) The test will be considered successful if the difference between the average furnace temperature at the time of failure of the steel grating and the average furnace temperature at the time of failure of the FRP grating is less than 100°C (180°F).
4) The post-loaded test shall consist of the following:
   A) One steel grating specimen and one FRP grating specimen shall be placed adjacent to one another in the furnace simply supported on two I-beams with a minimum flange width of 100 mm at an elevation of at least a half of the furnace height;
   B) The specimens shall be placed on the I-beams such that 100 mm of each side of the specimen rests on each of the two I-beams;
   C) The two specimens shall be subjected to the time-temperature curve specified in the ASTM E 119 for a duration of 60 minutes;

D) At the end of the 60minutes the specimens will be allowed to cool and shall then be subjected to a static load represented by the 40 kg mass specified in the pre-loaded test above, placed in the center span of the test specimens; and

E) The test will be considered successful if the FRP grating specimen is intact at the end of the test and does not collapse under the 40 kg mass load.

3.3 Fire retardance test

All FRP gratings should be fire retardant; this can be demonstrated by testing to ASTM E 84 (Standard Test Method for the Surface Burning Characteristics of Building Materials) with a flame spread rating not to exceed 25 or by meeting the requirements in 3.4.1 or 3.4.2 below.

3.4 Flame spread and surface flammability test

All FRP gratings, except those fitted on open decks and within tanks, cofferdams, void spaces, pipe tunnels and ducts, should have low flame spread and surface flammability characteristics as determined by one of the following test procedures. FRP gratings to comply with the requirements of 1.1 should have low flame spread and surface flammability characteristics as determined by 3.4.2 of the following test procedures:

3.4.1 When testing to ASTM E 84 for flame spread characteristics, the flame spread rating is not to exceed 20; or

3.4.2 The test for surface flammability is to comply with the requirements specified in Table 3.49 Sub-section Y of this Guidance (refer to FTP Code, Annex 1, Part 5 and IMO Res. MSC. 307(88)). The criteria established for materials used for bulkheads, linings, or ceilings are to be complies with.

3.5 Smoke and toxicity test

FRP gratings within accommodation, service and control spaces, should have low smoke characteristics as determined by one of the following test procedures. FRP gratings to comply with the requirements of 1.1 should have low smoke and toxicity characteristics as determined by 3.5.2 of the following test procedures:

3.5.1 When testing to ASTM E 84 for smoke characteristics, the smoke developed rating is not to exceed 10; or

3.5.2 Smoke and toxicity test are to comply with the requirements specified in Table 3.50 of this Guidance (refer to FTP Code, Annex 1, Part 2 and Part 5, Annex 4). The criteria established for materials used for bulkheads, linings, or ceilings are to be complies with.

AH. Use of Gas Detection Equipment

1. Application

1.1 The requirements in this sub-section apply to the flammable or toxic gas detection equipment of fixed type and portable type provided for gas detection in accordance with the requirements in Rules for Machinery Installations (Pt.1, Vol.III) Sec. 15. B.10 and C.7, Rules for Ships Carrying Liquefied Gases in Bulk (Pt.1, Vol.IX) Sec.3.13.6, Rules for Ships Carrying Dangerous Chemicals in Bulk (Pt.1, Vol.X) Sec. 13.13.2. However, where the tests are conducted for individual fixed type gas detection equipment, no approval may be required for its use.

1.2 In cases where application of the requirements in this sub-section is difficult, they are to be dealt with in each case.

2. Documents to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

1) Approval test plan (the place of test and scheduled date of test are to be entered)
2) Outline plans
3) Sectional assembly
4) Installation procedure
5) Instruction manual
6) Strength calculation sheets of structural members (thermal stress calculations are to be included where deemed necessary)
7) List of spare parts
8) List of cargoes suitable for detection and detecting ability
9) Data relating to the compatibility of the materials used for the gas detection equipment with the cargoes
10) General instruction manual including the periodical inspection and maintenance.
11) Other plans and documents deemed necessary by BKI depending on the type of the equipment, etc.

3. Preliminary Examination

3.1 Approval of Test Plan

BKI examines the approval test plan submitted under the requirements of 2.2), and where deemed appropriate, the plan is approved and returned to the applicant. When BKI examines the documents prescribed in 2. and considers appropriate, a part of the test items may be omitted.

3.2 Confirmation of Manufacturing and Quality Control Procedure

When deemed necessary, BKI may request an on-site investigation of the manufacturer.

4. Type Test

4.1 Materials

The materials of the detection equipment are to have corrosion resistance or to be subjected to corrosion-resisting processing. Particularly, those parts liable to be exposed to cargo vapour are to be suitable for use in the atmosphere of these vapours.

4.2 Construction

4.2.1 The detection equipment is to be provided with an indication device capable of clearly showing that the equipment is in service when it is in operation.

4.2.2 The detection equipment, which is used in a flammable atmosphere, is to have necessary explosion proof performance.

4.2.3 In the detection equipment provided with a suction pump, the capacity of such a pump is to be sufficient to draw detecting object mixture gas in a volume sufficient for detection and measurement.

4.2.4 Sampling heads are to be arranged by taking into account the properties of the detecting object mixture gas.

4.2.5 The sampling lines from each sampling head to the detection device are to be independent with each other.

4.2.6 Means are to be provided so that gas detection can be made automatically at least once every 30 minutes for each sampling head.

4.2.7 The gas detection equipment is to be provided with a function to display location of the sampling head under detection and to identify the alarm point when alarm is issued.

4.2.8 For the gas detection equipment serving to detect one sampling point and portable gas detection equipment, the requirements in 4.2.5 to 4.2.7 do not apply.

4.3 Gas Concentration Indicator

4.3.1 Each gas detection equipment, except for cases specifically approved by BKI, is to be provided with gas concentration indicator conforming to the following requirements 4.3.2 to 4.3.4.

4.3.2 The flammable gas detection equipment is to be capable of indicating gas concentration, at least, up to the lower explosive limit (the same definition of "flammability limits"as given in Rules for Ships Carrying Liquefied Gases in Bulk (Pt.1, Vol.IX) and hereinafter referred to as "LEL"). However, the flammable gas detection equipment provided in cargo containment systems other than independent tanks is to be also capable of indicating the gas concentration up to 100% in volume.

4.3.3 The toxic gas detection equipment is to be capable of indicating gas concentration, at least, up to twice the threshold limiting value (hereinafter referred to as "TLV").

4.3.4 Notwithstanding the requirements in 4.3.2 and 4.3.3, BKI may accept the lower indicating range in consideration of the construction and the purpose of use of the gas detection equipment. However, it is to be capable of indicating, at least, up to the concentration corresponding to the preset alarm value.

4.4 Alarm Systems

4.4.1 The gas detection equipment is to be provided with audible and visible alarm systems capable of issuing alarms when the setting value is exceeded.

4.4.2 The setting values of alarm are to be changeable as necessary, and they are to be readily recognizable.

4.4.3 The setting value of alarm of the flammable gas detection equipment is to be not more than 30% LEL.

4.4.4 The setting value of alarm of the toxic gas detection equipment is, as a rule, to be not more than the TLV

4.4.5 The alarm systems are to be in accordance with the following requirements 1) through 4):

1) Alarms are to continue until resetting is caused even when the gas concentration assumes a value lower than the setting value of alarm.
2) Audible alarms are to be so arranged that temporary alarm stop can be made.
3) Alarms are to resume when the gas concentration of other sampling point exceeds the setting value of alarm even when audible alarms are temporarily in a state of alarm stop.
4) The alarm system is to be capable of issuing alarm in the event of failure of the system such as loss of power supply and parting of wiring. The visible alarm issued in such an event is to be capable of being distinguished from those issued in cases as given in 4.4.1.

4.4.6 For portable system, alarm function may not be provided, but means are to be provided to verify the effectiveness of the batteries.

4.5 Performance

4.5.1 The detection equipment is to be capable of functioning in the environmental conditions of ships including varying temperature and humidity, vibrations and ship motions generally conceivable in ships.

4.5.2 For the detection equipment of suction type, no significant effects are to be given on the indicating accuracy and alarming accuracy, or means are to be provided to compensate or correct these differences in temperature or humidity even when differences in temperature or humidity are caused between the sampling heads and detection equipment.

4.5.3 The detection equipment is to be capable of becoming ready for detection with least possible delay time when the power supply switch is turned on.

4.5.4 The accuracy of the gas concentration indicator is to conform to the following requirements 1) or 2):

1) Flammable gas detection equipment
   A) For the equipment with a full scale value exceeding 50% LEL or volume, the error is to be ± 5% of the full scale or ± 10% of the concentration of the detected gas, whichever is the greater.
   B) For the equipment with a full-scale value not exceeding 50% LEL or volume, the error is to be ±10% of the full-scale value or ± 20% of the concentration of the detected gas, whichever is the greater.
   C) A gas concentration corresponding to 20% LEL in either range is to be capable of being indicated with an error not exceeding ± 20%.
2) Toxic gas detection equipment

   The accuracy is determined individually considering property of the detected gas, the specification of the detection equipment, etc. In General, it is to be within +30% and -10% of TLV.

4.5.5 The alarming error is to be within ± 25% of the alarm set value. However, in the toxic gas detection equipment, the alarming error is to be within +15% and -30% respectively.

4.6 Test Standards

4.6.1 Visual inspection

In visual inspection, it is to be verified that the construction, materials and dimensions are as specified on the drawings and specifications.

4.6.2 Performance test

On all the vapours to be detected, the following tests 1) through 7) are to be conducted. However, in the flammable gas detection equipment, when approved by BKI, the number of test gas may be reduced, or replacement test gas may be used in the test. The concentration of the gas used in the test is to be analysed by gas chromatography or similar other equally effective method.

1) Verification of indicating accuracy

   It is to be verified that the indicating accuracy at least at three different concentrations of vapour adequately set conforms to that stated in the specification. In cases where ranges of measurement can be altered, verification is to be made for each range.

2) Verification of alarming accuracy

   By gradually raising the concentration of a vapour, it is to be verified that the concentration when alarm is issued is within the allowable range of error. In cases where points of alarm set can be altered, verification is to be made at least at three set points.

3) Verification of reproducibility

   Tests identical with 1) and 2) are to be conducted with drawing of the gas and air repeated alternately at proper intervals. In the case of the portable gas detection equipment, making and breaking of power supply are to be included in the test.

4) Verification of response performance

   By introducing the test gas, the period before the indication of gas concentration reaches 90% of the value of final indication is to be measured. Further, a test gas with a concentration corresponding to 115% of the alarm set value is to be induced whereby the period before issuing an alarm is to be measured. In either case, the period is to be not more than 30 seconds. However, the period may be modified to not more than 1 minute in case where the vapour pressure of the test gas at a temperature of 37,8 °C is not more than 0,28 MPa, and to not more than 3 minutes in the case of toxic gas detection equipment. In the case of portable type, the pointer is to start moving in 3 seconds.

5) Verification of operation of alarm system

   It is to be verified that the alarm system functions properly for each cause of alarm.

6) Verification of initiation of operation

   The test specified in 2) is to be conducted after an elapse of the period given in the specification on the detection equipment which had been placed in normal operation once, then break the power supply and make it after it was left for 24 hours.

7) Verification of suction pump capacity

   It is to be verified that the capacity of the suction pump satisfied the specification.

4.6.3 Environmental Tests

1) The detection equipment is to be subjected to the tests specified in 4.6.2 1) and 2) under the environment given in the following A) through E) and pass the testing requirements. In the case of the fixed type gas detection equipment, the following test B) may be omitted:
   A) Psychrometric test
   B) Drop test
   C) Vibration test
   D) Inclining test
   E) Power supply variation test
2) The testing procedures of each test are to be in accordance with the following requirements:

A) Psychrometric test

The detection equipment is to be placed in a thermostatic tank of which environmental conditions are adjusted to 90 ~ 95% of humidity and 50 ± 2°C of temperature, and then left for 8 hours. The temperature of the thermostatic tank is to be adjusted to -10 ± 2°C with the humidity left unadjusted, and then left for another 8 hours. This cycle is to be repeated 3 times.

B) Drop test

With the outer protective casing of the gas detection equipment removed (excluding those used with the case fitted), the test object is to be dropped freely in various directions excluding the faces incorporating lenses and glasses onto the floor laid with a 50 mm thick sheet of cedar on top from a height of 100 mm.

C) Vibration test

The gas detection equipment is to be fixed in the vibration testing machine and vibrations with a frequency in a range from 5 to 16 Hz (double amplitude: 2 mm) and another frequency in a range from 16 to 60 Hz (acceleration: 1G) are to be applied in the vertical, horizontal transverse and longitudinal directions for 30 minutes in each direction (tests are to be progressed from low vibration to high vibration at 10 minutes' cycle and again from low to high). However, for the fixed type gas detection equipment, the requirements in 3.5 of JIS F 0807 "General Rules for Environmental Test on Automatic Control for Marine Use" or in equivalent standards are to be complied with.

D) Inclining test

The requirements in 3.6 of JIS F 0807 or in equivalent standards are to be complied with.

E) Power supply variation test

The requirements in 3.7 of JIS F 0807 or in equivalent standards are to be complied with.

4.6.4 Tests for explosion-proof performance

The requirements in IEC 60079 (Electrical apparatus for explosive atmosphere) or in equivalent standards are to be complied with.

4.7 Shipboard Inspection

In the case of the fixed type gas detection equipment, operating test is to be conducted after completion of all the piping systems and accessories on board the ship. In this time, at least issuing alarm is to be verified to draw the test gas from each sampling headers.

4.8 Witness of Tests

As a rule, the approval tests are to be carried out at the present of BKI Surveyor. However, attendance of BKI Surveyor may not be necessary in case the said tests are carried out at a recognized official organization deemed appropriate by BKI.

4.9 Test Records

4.9.1 After completion of the approval test, the manufacturer is to prepare a record of the approval test and is to submit to BKI after verification by the attending surveyor.

4.9.2 Where the provision of 4.8 applies, the verification by the surveyor may not be required for the test record prepared by the recognized organization.

4.9.3 The records relating to quality control implemented during the production of the test specimen are to be attached to the record of the approval test in 4.9.1 above.

5. Handling after Approval

5.1 Tests and Inspection on the Individual Product

Tests and inspection at the manufacturing plant of gas detection equipment which have been obtained the approval may be limited to those specified in the approval certificate notwithstanding the relevant requirement of the Rules and their Guidance.

5.2 Marking and Maintenance/Inspection

5.2.1 The gas detection equipment is to be marked with the following items 1) through 5):

1) Name of manufacturer, date of manufacture and type number
2) In the case of explosion-proof construction, the type and explosion-proof performance
3) The type of detectable gas and measuring range
4) Rated voltage and frequency (or type and number of batteries)
5) Alarm set values

5.2.2 The gas detection equipment is to be provided with instruction manuals and where necessary, correction tables or equations for temperature corrections.

5.2.3 The details of periodical inspection and maintenance checks necessary for the maintenance of the performance of the detection equipment are to be noted in the instruction manual. Further, record books of periodical inspection and maintenance checks, also necessary test gases and associated fittings are to be provided.

AI. Sewage Treatment Plant and Sewage Comminuting and Disinfecting System

1. General

1.1 Scope

The requirements of this sub section apply to testing and inspection for the approval of use of a sewage treatment plant (hereinafter referred to as a plant in this sub section) and a sewage comminuting and disinfecting system (hereinafter referred to as a system in this sub section) on ships in accordance with the requirements of the Rules for Machinery Installations (Pt.1, Vol.III) Sec.11. T.

2. Application

2.1 Application Form

The manufacturer, who intends to obtain the approval of use, is to submit an application form filled in with necessary data and information to BKI (Head Office).

2.2 Documents

2.2.1 The following reference data are to be submitted together with the application form specified in 2.1 to BKI, in addition to those specified in A.2

- Records of manufacture and delivery of the product
- Construction drawings with all dimensions necessary for evaluation of the product
- Manuals for installation, operation and maintenance of the product
- Approval test plan (provided with the place and scheduled date of test)
- Test records (if any preliminary test is carried out)
- Other documents which are considered necessary by BKI

2.2.2 Notwithstanding the requirements in 1. above, submission of part or all of the documents may be omitted if the manufacturer had previously obtained the approval from BKI in the past, and the duplicated items are included therein.

3. Confirmation Survey of Manufacturing Factory

BKI may carry out confirmation survey on facilities, manufacturing techniques, product quality control and internal inspection of the manufacturing factory based on the data specified in 2. in order to verify the factory's ability of manufacturing product of stable quality.

4. Approval Tests for Sewage Treatment Plant

4.1 Items of Prototype Test

Items of prototype test are as follows:

1) Effluent test
2) Operation test
3) Tilt and vibration test
4) Other tests as considered necessary by BKI

4.2 Effluent Test

4.2.1 The influent is to be fresh sewage consisting of faecal matter, urine, toilet paper and flush water. Primary sewage sludge has been added as necessary to attain a minimum total suspended solids concentration appropriate for the number of persons and hydraulic loading for which the sewage treatment plant will be certified. In any case, the influent concentration of total suspended solids is not to be less than 500 mg/l.

4.2.2 The duration of the test period is to be a minimum of 10 days after steady-state conditions have been reached by the equipment under test.

4.2.3 The plant is to be installed in accordance with the manufacturer s specification and in a manner which facilitates the collection of samples.

4.2.4 Influent and effluent samples respectively are to be taken at least 4 times per day. A total of at least 40 samples are to be taken. A statistical analysis is to be performed on each sample and the testing data is to be recorded.

4.2.5 Any disinfectant residual in samples should be neutralized when the sample is collected. In cases where Chlorine is used as a disinfectant, the Chlorine concentration and pH should be measured prior to neutralization.

4.2.6 The effluent is to be inspected as follows:

1) Thermotolerant Coliform

   The thermotolerant coliform count of the samples of effluents taken during the test period is not to exceed 100 thermotolerant coliforms/100 ml as determined by the membrane filter (ISO 9308-1:1990), multiple tube fermentation (ISO 9308-2:1990) or any other internationally accepted equivalent test standard.

2) Total Suspended Solids (TSS)

   The analytical procedure is to be as follows: filtrating a representative sample through a 0,45 m filter membrane, drying at 105^0 C and weighing; or centrifuging a representative sample (for at least five minutes with mean acceleration of 2800-3200 G), drying at 105 °C and weighing; or evaluating a representative sample according to some other internationally accepted equivalent test standard. The influent concentration of total suspended solids is to be no less than 500 mg/l and the effluent concentration of total suspended solids is not to exceed 35 Qi (Influent)/Qe (Effluent) mg/l.

3) 5-day Biochemical Oxygen Demand (BOD5)

   Analytical procedures are to be in accordance with ISO 5815-1:2003 or other internationally accepted equivalent test standards, and the influent 5-day Biochemical Oxygen Demand (BOD5) is not to be less than 225 mg/l and the effluent 5-day Biochemical Oxygen Demand (BOD5) is not to exceed 25 Qi (Influent)/Qe (Effluent) mg/l.

4) Chemical Oxygen Demand (COD)

   Analytical procedures are to be in accordance with ISO 15705:2002 or other internationally accepted equivalent test standards, and the effluent Chemical Oxygen Demand (COD) is not to exceed 125 Qi (Influent)/Qe (Effluent) mg/l.

5) pH

   Analytical procedures are to be in accordance with ISO 10523:2008 or the equivalent, and the pH of the effluent samples taken during the test period are to be between 6 and 8,5.

6) In cases where Chlorine or its compounds are used as a disinfectant, Free Residual Chlorine Concentration Analytical procedures are to be in accordance with ISO 7393-3:1990 or the equivalent, and the effluent Free Residual Chlorine Concentration is not to exceed 0,5 mg/l.

7) Any Evaporation Residue ISO 759:1981 Volatile Solids, Volatile Suspended Solids, Evaporation Residue on Ignition Transparency, Total Phosphorous ISO 6878:2004/ ISO 15681-2:2003/ ISO 15681-1:2003), Organic Carbon ISO 8245:19:99, Standard Plate Count Bacteria Analytical procedures are to be in accordance with ISO 9999:2007 or the equivalent.

4.2.7 In the case of thermolerant coliforms, zero values should be replaced with a value of 1 thermotolerant coliform/100 ml to allow the calculation of the geometric mean. In the case of Total Suspended Solids (TSS), 5-day Biochemical Oxygen Demand (BOD_5) and Chemical Oxygen Demand (COD), values below the detection limit should be replaced with values half the detection limit to allow the calculation of the geometric mean.

4.2.8 A sewage treatment plant installed on a passenger ship intending to discharge sewage effluent in special areas shall be additionally meet as follows:

1) Nitrogen and phosphorus removal standard

The geometric mean of the total nitrogen and phosphorus content of the samples of effluent taken during the test period should not exceed:

A) Total nitrogen: 20 Qi (Influent)/Qe (Effluent) mg/l or at least 70 per cent reduction. Where the total nitrogen means the sum of total Kjeldahl nitrogen (organic and ammoniacal nitrogen) nitrate-nitrogen and nitrite-nitrogen and reduction in relation to the load of the influent.

B) Total phosphorus: 1,0 Qi (Influent)/Qe (Effluent) mg/l or at least 80 per cent reduction (reduction in relation to the load of the influent).

C) The method of testing shall be ISO 29441:2010 for total nitrogen and ISO 6878:2004 for total phosphorus or other internationally accepted equivalent test standard.

4.3 Performance Test

Performance tests are to be carried out over the range of temperature and salinity specified by the manufacturers that operating characteristics are satisfactory.

4.4 Tilt and Vibration Test

4.4.1 It is to be confirmed that no abnormality is observed when the plant is at an operating condition under 22,5 degrees' static inclination. For large plants, this test may be substituted for an ideal test on the drawings by inclining the highest water level up to 22,5 degrees.

4.4.2 Control and sensor components used for the plant are to be subject to the vibration test of which conditions are specified in Table 3.79 and Table 3.80.

Table 3.79 Resonance Test Condition

Amplitude or Acceleration	Frequency	Sweep time	Directions	Cycles	Total test time
2 mm	2 Hz~13,2 Hz	10 minutes	3 axis directions	3 cycles for each directions	1,5 hours
±0,7g	13,2 Hz~80Hz	Ditto	Ditto	Ditto	Ditto

Table 3.80 Endurance Test Condition

	Amplitude or Acceleration	Frequency	Directions	Cycles	Total test time
When resonance points exist on the test specified in Table 3.79	Same Amplitude or Acceleration of the test specified in Table 3.79	Resonance points	3 axis directions	1 cycles for each directions	4,5 hours

Table 3.80 Endurance Test Condition *(continued)*

	Amplitude or Acceleration	Frequency	Directions	Cycles	Total test time
When resonance points do not exist on the test specified in Table 3.79	2 mm	13,2 Hz	Ditto	Ditto	Ditto

5 Approval Tests for Sewage Comminuting and Disinfecting System

5.1

The system is to be installed in accordance with 4.2.3.

5.2 Vibration test

It is to be confirmed that no abnormality is observed during the vibration test of which conditions are specified in Table 3.79 and Table 3.80.

5.3 Function tests

1) Visual inspection
2) Capacity test

   The treating capacity is to be confirmed not less than the flow rate provided in the manufacturer's specification by measuring the influent specified in 4.2.1 being delivered continuously at minimum pressure or minimum flow rate specified by the manufacturers.
3) Hydrostatic test

   For the seal of the shaft, a hydrostatic test is carried out at 10 kPa for 10 minutes.
4) Operation test

   It is to be confirmed that the system is in good working condition wherein no abnormality is observed and no solidity of 25 mm or more in size is contained in the effluent, and no uncomminuted influent is left in the system by the operation using the influent specified in 4.2.1. At the same time, the disinfecting system is to be operated to confirm its disinfecting function that the faecal coliform counted by the method specified in 4.2.6.1) is not to exceed 3000 faecal coliforms/ml M.P.N.
5) Overload protection test

   It is to be confirmed that the power cannot be supplied when the system is started under the condition the cutting blade is fixed and that the system cannot be started automatically when the power supply is restored upon the blade being released. No abnormality is to be observed during the test.
6) Noise test

   After the system is rigidly fixed, the noise level is to be measured in normal operating condition without any influent. The noise level is to be 80 dB (A) or less at a distance of 1 m or more.
7) Insulation resistance test

   The insulation resistance test between current-carrying parts entirely connected each other and the earth and between current-carrying parts of each opposite polarity or phase are not to be less than 10 MΩ upon applying at least DC 500 V.
8) High voltage test

   The high voltage test is to be carried out at the following voltage for one minute between current-carrying parts entirely connected each other and the earth and between current-carrying parts of each opposite polarity or phase. Instruments and auxiliary apparatus, if any, may be disconnected during the test:

   – For rated voltage of 60 V or less: 500 V
   – For rated voltage exceeding 60 V: 1000 V + twice the rated voltage (minimum 1500 V)

9) Power supply fluctuation test

It is to be confirmed that no abnormality is observed, and no solidity is contained in the effluent, and no uncomminuted influent is left in the system by the operation using the influent specified in 4.2.1 when the power supply is kept fluctuating from +10% to -10% of the rated power. For electrical power supply, both the rated voltage and the rated frequency are to be fluctuated from +10% to -10% and +5% to -5% respectively.

5.4 Other tests as considered necessary by BKI.

6. Approval

6.1 Test Records

The manufacturer is to prepare records of the approval test after completion of the test, to obtain verification by BKI's attending surveyor and to submit them, in duplicate, to BKI.

7. Examinations for Products

For each component of a plant/system supplied to an individual ship after obtaining approval by BKI, the following tests and examinations are to be carried out under the presence of the Surveyor in order to confirm that the products have been manufactured in the same specification as those used for the approval test of the plant/system. However, where the quality management system of the manufactures who produce each component of the plant/system is one to the satisfaction of BKI, the frequency of the Surveyor's attendance for the examination of the product may be reduced.

1) Visual inspection
2) Dimensional inspection and examination of construction
3) Performance tests of the safety devices, alarms and inter-locking device
4) Insulation resistance test specified in 4.4.2.2) or 5.1.3.7)
5) High voltage test specified in 5.1.3.8) (to be also applied to a plant)
6) Hydrostatic tests at the pressure of 2 times for the design pressure for tanks subject to internal pressure and at the pressure of 0,25 MPa above the top of the tank for the other tanks (to be applied to a plant only)
7) Other tests as considered necessary by BKI

8. Announcement of Approval

The plant/system approved by BKI are to be marked with the following.

1) Type and model of the product
2) Mark to prove that the product is approved by BKI. It may be marked simply by BKI.
3) Name of the manufacturer
4) Approval number
5) Year and month of manufacture

AJ. Sealing Systems of Bulkhead and Deck Penetration

1. General

1.1 Application

The requirements in this sub section apply to sealing systems in cable installations for the purpose of sealing bulkhead and deck penetrations and other fire protection constructions in accordance with SOLAS 1974, (Chapter II-2, Part A, Reg. 9.3), and Fire test of "A" and "B" class divisions (refer to FTP Code, Annex 1, Part 3 and IMO Res. MSC 307(88)). In addition, requirements relating to gas and watertightness are specified.

In general, these sealing functions are performed by sealing compounds or packing systems. In conjunction with the present requirements the following shall also be applicable with Rules for Electrical Installations (Pt.1, Vol.IV) and sub section A.

1.2 Definition

1.2.1 Sealing systems are constructions consisting of different components and conforming to the requirements of these sub section governing the sealing of penetrations in bulkheads, decks and other fire protection structures. They generally consist of a metal case, sealing compound and additional auxiliary means possibly required.

1.2.2 Auxiliary means are means which are used to seal the open sides of penetrations (cable exit openings). Auxiliary means also serve the purpose of ensuring the tightness and minimum spacing between the cables and the penetration casing required for applying the sealing compound.

1.2.3 Packing systems are modular sealing systems. They generally consist of a compression frame, packing modules, anchorage and intermediate plates, and a terminal seal with compression screw.

1.2.4 The compound filling or sealing length is the length within a cable penetration which is needed to meet the requirements laid down in these sub section.

1.2.5 Sealing compounds are flowable products consisting of one or more components. When cured, the compound acts as the moulded sealing element of the sealing system.

1.2.6 Sealing compound systems are sealing systems realized by means of sealing compounds. They generally consist of the penetration casing, the auxiliary means for sealing the ends and maintaining the spacing, and the sealing compound.

2. Data to be submitted

The following documents are to be submitted to BKI:

1) Application for type testing.
2) Specification of the materials used.
3) Details regarding the materials used and the envisaged range of application.
4) Manufacturer's guarantee of the compatibility of the sealing system with the cables used
5) Assembly and working instructions.
6) Drawings of the test specimen with indication of dimensions, sealing length required, type and cross section of the cables and method of insulation.
7) Test programme of tests to be performed in accordance with 4.
8) After final examination the test report is to be submitted to BKI.

9) BKI reserves the right of demanding re-tests to be performed or additional proofs to be furnished in individual cases.

3. Requirements

3.1 General

3.1.1 The sealing system shall not impair the strength, tightness and fire resistance of the hull structure. Systems must possess sufficient mechanical strength, and be protected against corrosion.

3.1.2 With regard to their fire behaviour and watertightness, sealing systems must meet the requirements of 4.

Where watertightness is not proved, sealing systems shall be admitted for use above the continuous bulkhead deck only and below this deck within watertight compartments only.

Where proof of gastightness is applied for, the relevant requirements set out in Table 3.81, gastightness are to be observed.

3.1.3 Sealing systems, including the auxiliary means employed, must also be compatible with the cables used, i.e. the cables shall not undergo any changes affecting, for example, their swelling behaviour or causing embrittlement, corrosion sheath decomposition or premature ageing.

Parts of sealing systems coming into direct contact with the cables should be chemically approximately neutral (pH range: 6,5 - 8,5).

Where no special specifications are laid down for the cables, compatibility is to be ensured at least in regard to cables manufactured in accordance with the following standards:

- IEC 92-350
- IEC 92-351
- IEC 92-353
- IEC 92-359
- IEC 92-375
- IEC 92-376
- JIS 3410
- DIN 89158, 89159, 89160

3.1.4 Approval is not given to any individual components of sealing systems, but only to complete systems with any auxiliary means which may be required.

3.1.5 Prior to the use of sealing systems, the user is to be supplied with clear instructions for their assembly and application. On board installation and workmanship are to be in compliance with the relevant requirements of the type tested and certified system.

3.2 Compound Fillings

3.2.1 Application and expansion behavior

Sealing compounds shall remain flowable and workable for a sufficient period, and their expansion behaviour shall be such that no damage is caused to the cables.

3.2.2 Curing time

Compounds are to be set within 24 hours, and within a period not exceeding 30 days shall be sufficiently cured to ensure that a constant weight is attained.

Sealing compounds together with the auxiliary means used, are to be so constructed as to ensure that the curing of the compound takes place within the stated period.

3.2.3 Water absorption

When cured sealing, compounds shall not be hygroscopic, and shall not crack, swell or dissolve under the action of water.

3.3 Auxiliary Means

By appropriate auxiliary means, it has to be ensure that a minimum spacing of about 5 mm is maintained between individual cables, and between the cables and the casing of the penetration. Auxiliary means are to be always be presented in combination with the components used in the sealing system (e.g. sealing compound) and on the individual tests mentioned previously. Auxiliary means shall not restrict the space for compound specified for the system. Auxiliary means shall be fire retardant and self-extinguishing.

Examples of auxiliary means:

- Packing material / insulating compounds.
- Putty.
- Intermediate layers of all kinds.
- Expansion elements

3.4 Packing Systems

The following requirements have to be met:

- Packing systems shall be simple to fit.
- Packing modules with suitably graded diameters matched to the ship's cable sizes shall be available.
- Packing modules are to have sufficient elasticity to ensure durable sealing action.
- They have to be water resistant.
- Intermediate and anchor plates of non-magnetic materials are to be used when laying single core AC cables.

3.5 Other Sealing Systems

Apart from the sealing compound and packing systems referred to above, systems using foams or other materials can be employed for cable penetration systems, provided that they comply with the requirements contained in 3. and 4.

4. Type Test

4.1 General

The tests are to be carried out according to Table 3.81. Following tests indicated in Table 3.81 are to be carried out in the presence of Surveyor.

Table 3.81 Kinds of test for sealing systems of bulkhead and deck penetration

Kinds	Item	Requirements
Fire Test	General	1. Fire tests for "A" and "B" class divisions are to be carried out in accordance with Y.4.2. 2. The products shall be tested and evaluated in accordance with the fire test procedure specified in Table 3.45, cable transit. 3. Beyond this, any additional requirements contained in this Table are applicable.
	Tests specimen	1. Dimensions The largest and smallest dimensions (width and height) of each type of cable penetration, for which approval is applied for, should be tested in horizontal and vertical position. 2. Construction a. Sealing systems for use in Type "A" bulkheads and decks: see Table 3.45, cable transit b. Sealing systems for use in Type "B" bulkheads and decks provided with cable penetrations are to be constructed in accordance with the requirements contained in Table 3.45, "B" class bulkheads and "B" class deck. For bulkheads the insulated side is to be the side not exposed to the fire, and for decks the insulated side is to be the side exposed to the fire. 3. Cabling of test specimen a. Different cable types and cross sections representative of those normally used on board ships should be chosen for the tests. b. The following aspects should be observed: – Insulation material (e.g. EPR, XLPE, PVC). – Material or outer sheath (e.g. CR, PVC, SHF_1 or SHF_2). – Cross section and number of cores of each cable. – Braided screen armouring. c. Test specimens should be furnished as listed in Table 3.82. Where this is not possible, comparable cabling is to be agreed with BKI. d. Following a conditioning period for sealing compounds of at least 30 days at room temperature, the penetrations to be tested will be subjected to the fire test. e. In the case of bulkhead penetrations the cables are to be so positioned in the penetration that the large diameters are at the bottom, while the small diameters are to the top. f. The ends of the cables introduced are to be sealed on the side not exposed to the fire, so that air or smoke will be prevented from passing through.
Watertightness test		Sealing systems in Type "A" bulkheads and decks are to be so constructed that, with the test arrangement shown in Fig 3.39 or Fig 3.40, they are capable of withstanding a hydraulic test pressure conforming to the conditions stated below (for exception see 3.1.2). The specimen shall be tested for a period of at least 30 minutes under hydraulic pressure equal to or greater than that corresponding to the actual location in the vessel in which the penetrations are to be installed, however, at least 1 bar. There should be no leakage through the prototype arrangement for the duration of the test. Subsequently, the penetration is exposed to a test pressure of 2,5 bar for a period of 30 minutes, during which a minimum leakage water quantity of 1 liter is permissible.
Gastightness test		Where proof of gastightness is applied for, the following tests are to be performed: – Bulkhead and deck penetrations are to be so constructed that, with the test arrangement shown in Fig 3.39 or Fig 3.40, they are capable of withstanding a pneumatic pressure test. – The specimen is exposed to a test pressure of 30 mbar for a period of 30 minutes, during which no gas must leak out on the free side.

4.2 Test Arrangement for Watertightness and Gastightness

4.2.1 The sealing system is to be prepared in accordance with manufacturer's installation and work instructions and cables are to be run through it as listed in, fire test, tests specimen, 3) and in Table 3.82.

4.2.2 The penetration length is determined in accordance with manufacturer's specifications.

4.2.3 Following a conditioning period for sealing compounds of at least 30 days and for packing systems of at least 24 hours, the penetration system will be subjected to the tightness test.

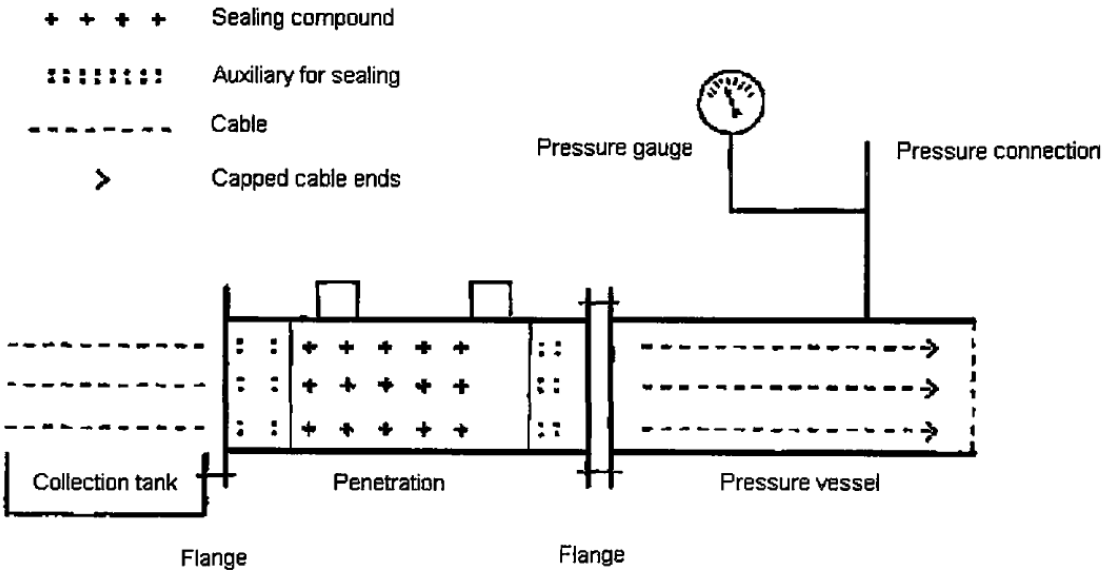


Fig 3.39 Arrangement for testing watertightness of a sealing compound system

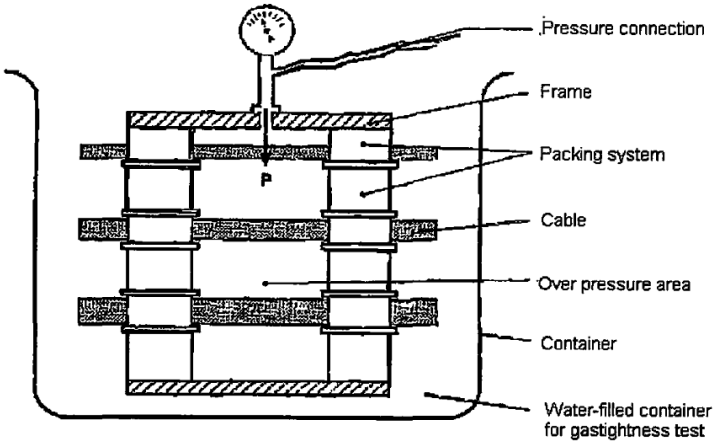


Fig 3.40 Arrangement for testing watertightness and gastightness of a packing system

Table 3.82 Cabling of bulkhead and deck penetrations for the fire test and for verifying gas and watertightness

Pos	Group	Insulation	Sheath	Cable Type No. of cores x cross section [mm²]	Dia. [mm]	Area [mm²]
1	1.2	XLPE	PVC	3 x 120		
2	1.1	XLPE	PVC	3 x 50		
3	1.1	PVC	PVC	3 x 4		
4	1.1	XLPE	PVC	37 x 2 x 0,75		
5	2.2	EPR	CR	1 x 150		
6	2.1	EPR	CR	1 x 160		
7	2.2	EPR	CR	3 x 25		
8	2.2	EPR	CR	14 x 2 x 0,5		
9	2.1	EPR	CR	27 x 1		

Table 3.82 Cabling of bulkhead and deck penetrations for the fire test and for verifying gas and watertightness *(continued)*

Pos	Group	Insulation	Sheath	Cable Type No. of cores x cross section [mm²]	Dia. [mm]	Area [mm²]
10	3.2	EPR	PVC	3 x 120		
11	3.2	EPR	PVC	3 x 50		
12	3.1	EPR	PVC	14 x 2 x 0,5		
13	4.2	EPR	Elastomere SHF_2	3 x 120		
14	4.1	EPR	Elastomere SHF_2	14 x 2 x 0,5		
15	4.2	XLPE	Thermoplast SHF_1	3 x 50		
16	4.1	XLPE	Thermoplast SHF_1	19 x 2,5		
17	4.2	HEPR	Thermoplast SHF_1	3 x 16		
18	4.1	HEPR	Thermoplast SHF_1	7 x 2 x 2,5		
19	4.2	HEPR	Elastomere SHF_2	3 x 50		

Group 1: cables with thermoplasl core Insulation and sheaths
1.1 cables with braided or metal screen or armouring
1.2 cables without metal screen or armouring
Group 2: Cables with elastomer core Insulation and sheaths
2.1 Cables with braided or metal screen or armouring
2.2 cables without metal screen or armouring
Group 3: Cables with elastomer core Insulation and thermoplast sheaths
3.1 cables with braided or metal screen armouring
3.2 cablas without metal screen or armouring
Group 4: Cables with halogen-free materiels
4.1 cables with halogen-free elaslDmerics
4.2 cables with halogen-free thermoplastic compounds
Note: The penetration area occupied by cablas should not be less than 30% and not exceed 40 %. A minimum of 30 % and a maximum of 40 % of the penetration area should be oacupied by cables.

AK. Outboard Engines

1. Application

The requirements of this Sub-Section apply to approval of marine outboard propulsion engines used for small craft up to 24 m hull length.

2. Data to be submitted

The following data and drawings are to be submitted in addition to those specified in A.2:

- Power transmission
- Propeller
- Result of bench test

3. Type tests

3.1 Type Testing

3.1.1 The type-testing of outboard engines is subject to the following requirements. Any exceptions require BKI's agreement.

The following parameters shall be measured while conducting type test programme according to 3.2:

- Barometric pressure, humidity and ambient temperature
- Engine speed or cycle frequency
- Engine brake torque
- Fuel consumption
- Lubricating oil pressure
- Temperature and pressure of exhaust gas leaving the engine

3.1.2 Engine manufacturer shall present brake power and specific fuel consumption calculations to BKI Surveyor with regards to above measurements

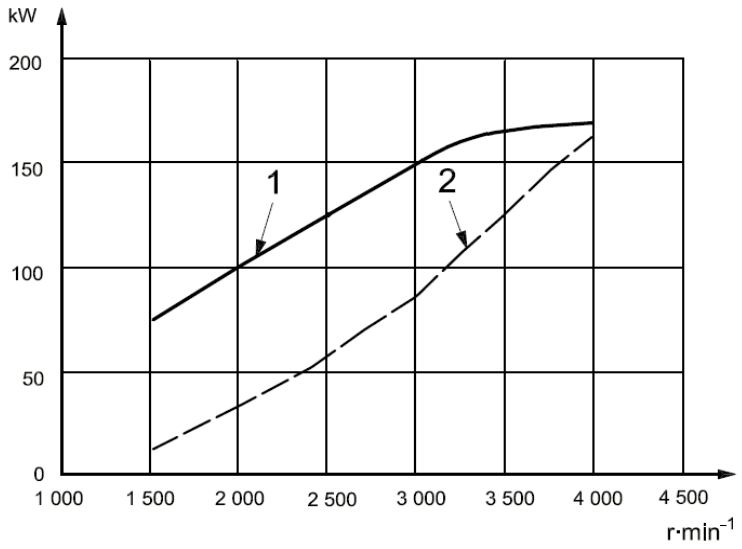
The following Functional tests are to be verified subsequent to Type test programme:

- The correct functioning of the reversing mechanism, built-in reverse reduction gear and couplings
- The ability of the starting system
- The ability of all malfunction protection and warning devices to respond correctly to the fault conditions in which they should operate (e.g. low lubricating oil pressure, high lubricating oil temperatures, high coolant temperatures, etc.)

3.2 Type Test Programme

Power measurement shall be taken at a sufficient number of engine speeds to completely define the power and torque curve between the lowest and the highest engine speeds recommended by the manufacturer (see example in Fig 3.41). The speed range shall include the point at which the engine produces its maximum power and torque.

The measurements shall in every case only be performed when steady state operation has been achieved.



Note : 1. Full load propeller shaft power

2. Propeller shaft power

Fig 3.41 Power – Speed Curve with Complete Propulsion Unit (ISO 8665)

3.3 Bench test

The work trials for bench test are to be carried out according to 3.2 of this section.

AL. Safety valves

1. Application

1.1 The requirements of this sub-section apply to test and inspection for approval of safety valves for the application on ships, onshore and offshore terminals, as well as LNG plants.

1.2 For these tests the definitions in the Rules for Machinery Installations (Pt.5, Vol.IV) Sec.13.C are to be considered additionally.

1.3 For safety valves of LNG tankers, the definitions in the Rules for Ships Carrying Liquefied Gas in Bulk (Pt.1, Vol.IX) are to be considered.

2. Type test

2.1 Test specimen

For the requirements and selection of test specimens the instructions of the ISO EN 4126 are to be considered. Otherwise the following instructions are valid:

- For a certain type series of a safety valve, consisting of seven or more nominal sizes, the tests are to be performed with three safety valves of different nominal size for each series. If the series consists of maximum six nominal sizes, the number of test specimens may be reduced to two.
- In case of extensions of safety value series, for which the tests of the preceding test specimens and nominal sizes are not more representative, further tests with a relevant number of test specimens are to be agreed.

2.2 Test item, test method and criteria

Testing requirements for safety valves is to be as indicated in Table 3.83. The tests to be performed will be defined case by case in accordance with the type and range of application.

Table 3.83 The outlines of testing of safety valves

Test item	Type test method	Criteria
Visual inspection	The test specimen will be inspected on conformity with: – the Rules and Guidelines of BKI – the manufacturer's specification – the drawings including material specifications – the specified standards	The equipment complies with the specification
Pressure test	**Hydrostatic pressure test** – The part of the valve from the inlet to the valve seating is to be tested with 1,5 times the maximum allowable working pressure defined by the manufacturer. The valve body at the outlet side is to be tested with 1,5 times the maximum back pressure defined by the manufacturer. – The relevant duration of test shall enable a visual inspection of the valve parts and surfaces. As far as the test duration is not defined according to ISO 4126 or according to another international standard recognized by BKI, the minimum duration of the pressure test has to be chosen according to Table below.	No permanent damages or other deficiencies at the parts exposed to pressure and no inadmissible leakages at the housing and at the closures

Table 3.83 The outlines of testing of safety valves *(continued)*

<table>
<tr><th>Test item</th><th>Type test method</th><th>Criteria</th></tr>
<tr><td>Pressure test</td><td>Minimum duration of the pressure test
<table>
<tr><th>Nominal size DN
[mm]</th><th>Duration of test
[minutes]</th></tr>
<tr><td>DN ≤ 100</td><td>10</td></tr>
<tr><td>100 < DN ≤ 300</td><td>15</td></tr>
<tr><td>300 < DN</td><td>20</td></tr>
</table>
Pneumatic pressure test
– The pressure test with compressed air or other suitable gases may be possible as an alternative to the hydrostatic pressure test with BKI approval and under the following conditions:
a) The design of the valve does not allow filling with water or another liquid.
b) The valve will be tested for operation conditions which do not tolerate even a little amount of water.
– For pneumatic pressure trials adequate precautionary and safety measures have to be taken, especially for protection of human life. For designs of safety valves with pneumatic pressure test the material has to be chosen in a way that the danger of brittle fracture under test conditions will be avoided.
The test procedure and the instructions for test duration and test pressure are to be chosen according to Hydrostatic pressure test</td><td>No permanent damages or other deficiencies at the parts exposed to pressure and no inadmissible leakages at the housing and at the closures</td></tr>
<tr><td>Test of seating tightness</td><td>The test for the tightness of the seating and the belonging leakage rates are to be performed according to the design standard of the safety valve as well as to the instructions of the manufacturer, the operator and the approval of BKI.</td><td>The tightness of the seating and the belonging leakage rates are in accordance with the definitions of BKI and the standard of the safety valve.</td></tr>
<tr><td>Test for determination of the function characteristic</td><td>Actuation pressure
The instructions of ISO 4126 have to be considered for the test of the actuation pressure. As actuation pressure for which the function characteristic is to be evaluated, the minimum and maximum actuation pressure for the actually installed spring is to be used.
Permissible tolerances
The permissible tolerances respectively limit values for the function characteristics are the following:
a) Actuation pressure: ± 3 % of the actuation pressure or ± 0,15 bar, the bigger value is valid
b) Lift: not less than the value defined by the manufacturer
c) Difference of opening pressure: the value defined by the manufacturer, but maximum 10 % of the actuation pressure or 0,1 bar, the bigger value is valid.
d) Difference of closing pressure: not bigger as the value defined by the manufacturer, but within the following limits:
For compressible media:
minimum 2,0 % (not valid for safety valves with proportional opening characteristic);
maximum 15 % or 0,3 bar, the bigger value is valid
For incompressible media:
minimum 2,5 % (not valid for safety valves with proportional opening characteristic);
maximum 20 % or 0,6 bar, the bigger value is valid</td><td>The actuation pressures and the belonging springs fulfil the instructions of the valve standard and the design criteria agreed between manufacturer and costumer approved by BKI</td></tr>
</table>

Table 3.83 The outlines of testing of safety valves *(continued)*

Test item	Type test method	Criteria
Test for determination of the function characteristic	e) The difference of the opening pressure and the difference of the closing pressure are to have for valves with lift limitation the same tolerances and limit values as for valves with not limited lift. f) The difference of the opening pressure and the difference of the closing pressure of safety valves with proportional opening characteristics have to be checked and shall be constant within the minimum and maximum value defined by the manufacturer for different lifting heights. A curve has to be established, showing the lift of the valve in relation to the difference of the opening pressure. Other tolerances may be chosen from an international standard for safety valves recognized by BKI respectively are to be approved by BKI. **Permissible tolerances for LNG Tanks on board of liquefied gas tankers** For safety valves on board of liquefied gas tankers the following tolerances are valid for the actuation pressure respectively the adjustment pressure to safeguard that the safety valve opens at the prescribed adjustment pressure: – 10 % for pressures from 0 to 1,5 bar – 6 % for pressures from 1,5 to 3,0 bar – 3 % for pressures from 3,0 bar and above See also the information in the Rules for Ships Carrying Liquefied Gas in Bulk (Pt.1, Vol.IX) Sec. 8. **Test media** The following test media are to be applied: a) Valves for air and other gases are to be tested with air or other non-toxic and non-flammable gases with known characteristics. b) Valves for toxic and flammable gases are to be tested with air or other non-toxic and non-flammable gases with known characteristics. c) Valves for steam are to be tested with superheated steam with minimum 10 °C superheating. d) Valves for any other vapours are to be tested with air or non-toxic and non-flammable gases with known characteristics. Valves for liquid operation are to be tested with water or another liquid with known characteristics.	The actuation pressures and the belonging springs fulfil the instructions of the valve standard and the design criteria agreed between manufacturer and costumer approved by BKI
Test for determination of the opening characteristic	Unless specified and approved by BKI, the requirements according to ISO EN 4126 are to be considered. Alternatively instructions of other international standards recognized by BKI may be applied.	The opening and lifting characteristics are according to the design requirements of the manufacturer and the valve standard approved by BKI
Cold shock tests	**Additional tests for safety valves for low temperature use/LNG as well as on liquefied gas tankers** 1) The test is to be performed with liquefied gas or liquid nitrogen at a test temperature equal or less than -160 °C under ambient pressure. 2) The valve has to be brought in a partially open condition and is to be filled within 5 minutes. 3) The valve shall remain filled with the test medium for at least 1 hour under test condition.	No crack for all part which are exposed to pressure

Table 3.83 The outlines of testing of safety valves *(continued)*

Test item	Type test method	Criteria
Test for the determination of the through flow characteristic	Unless specified otherwise by BKI the definitions for the test procedure according to ISO EN 4126 are to be considered. Alternatively instructions of other international standards recognized by BKI may be applied. The mechanical characteristics of the valve as satisfactory retaking of the seating, rattling, fluttering, sticking and/or disturbing vibrations are to be checked by visual and/or acoustic observations. All test results are to be documented in a test report.	The test results have to deliver the following characteristic data: - number of tests for each type and nominal diameter of the safety valve - actual outlet mass flow evaluated by the test - outlet figure according to theoretical mass flow
Salt mist test	Only for safety valves which are installed on the open deck, See Sub-section V test no.13	

AM. Fuel oil and oil filters

1. Application

The test requirements are only valid for filters with housings made of metals with a melting point < 925 °C as well as for filters with screwed filter elements respectively filter housings.

2. Type test

2.1 Test specimen

Two specimens of different size for each type and series are to be tested.

2.2 Test item, test method and criteria

Testing requirements for fuel oil and oil filters is to be as indicated in Table 3.84. The tests to be performed will be defined case by case in accordance with the type and range of application.

The tests to be performed case by case will be defined according to filter type and filter housing.

Table 3.84 The outlines of testing of fuel oil and oil filters

<table>
<tr><th>Test item</th><th>Type test method</th><th>Criteria</th></tr>
<tr><td>Visual inspection</td><td>The test specimen will be inspected on conformity with:
– the Rules and Guidelines of BKI
– the manufacturer's specification
– the drawings including material specifications
– the specified standards</td><td>The equipment complies with the specification</td></tr>
<tr><td>Vibration test</td><td>1. General information
a) The test specimens are to be tested in operationally connected and functional condition.
b) The tests are normally to be carried out in three mutually perpendicular levels to each other. The function of the test specimen is to be demonstrated during the vibration tests. At the beginning of the test, resonances at each level are to be determined.
c) If resonances at the test specimen are determined with an amplification factor Q [1] < 2, the test duration is 90 min at each level at a frequency of 30 Hz.
d) If resonances at the test specimen are determined with an amplification factor Q [1] ≥ 2, the test duration is 90 min at each resonance frequency.

The components are to be tested according to their intended mounting position with the following accelerations and amplitudes:

2. General vibration strain (curve 1 in Fig 3.42)
This characteristic curve applies to components and systems which, due to their mounting position, do not have to meet stringent requirements, see Table below.

General vibration strain
<table>
<tr><th>Frequency range</th><th>Amplitude</th><th>Acceleration</th></tr>
<tr><td>2 to 13,2 Hz</td><td>± 1,0 mm</td><td>-</td></tr>
<tr><td>13,2 to 100 Hz</td><td>-</td><td>0,7 g</td></tr>
<tr><td>Change of frequency</td><td colspan="2">max. 1 octave/minute [1]</td></tr>
<tr><td colspan="3">[1] Octave corresponds to a frequency interval where the upper limit is achieved by doubling the lower limit.</td></tr>
</table></td><td>Specified functions could be demonstrated, the results are within the specified tolerance limits and no damage which limits the function has been detected at the test specimen.</td></tr>
</table>

Table 3.84 The outlines of testing of fuel oil and oil filters *(continued)*

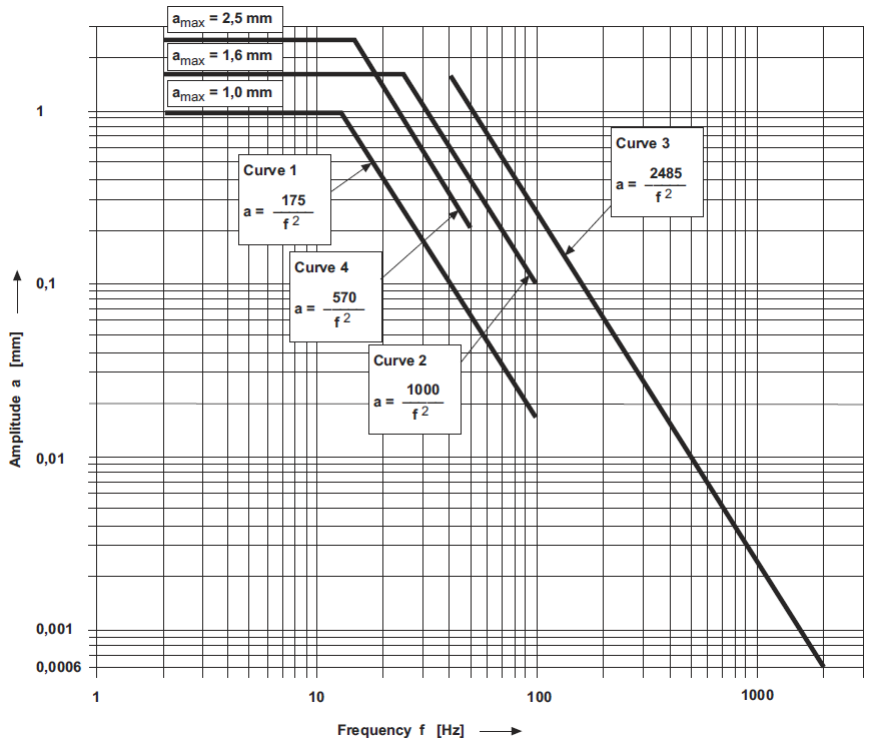
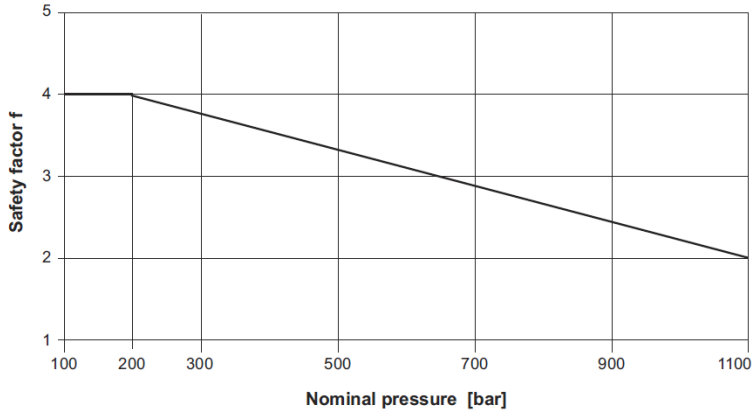
<table>
<tr><th>Test item</th><th>Type test method</th><th>Criteria</th></tr>
<tr><td>Vibration test</td><td>


Fig 3.42 Vibration curve
3. Increased vibration strain (curve 2 in Fig 3.42)
This characteristic curve applies to components and equipment mounted on diesel engines, aggregates, compressors or in steering gear compartment or which are operated under similar mounting conditions, see Table below.
Increased vibration strain
<table>
<tr><th>Frequency range</th><th>Amplitude</th><th>Acceleration</th></tr>
<tr><td>2 to 25 Hz</td><td>± 1,6 mm</td><td>-</td></tr>
<tr><td>25 to 100 Hz</td><td>-</td><td>4,0 g</td></tr>
<tr><td>Change of frequency</td><td colspan="2">max. 1 octave/minute [1]</td></tr>
<tr><td colspan="3">[1] Octave corresponds to a frequency interval where the upper limit is achieved by doubling the lower limit.</td></tr>
</table>
4. Extreme vibration strain (curve 3 in Fig 3.42)
This characteristic curve applies to components and equipment mounted on exhaust gas lines of medium speed and high speed diesel engines. As minimum strain the values in Table below are defined.
Extreme vibration strain
<table>
<tr><th>Frequency range</th><th>Amplitude</th><th>Acceleration</th></tr>
<tr><td>40 to 2000 Hz</td><td>600 °C</td><td>10,0 g</td></tr>
<tr><td>Change of frequency</td><td colspan="2">max. 1 octave/minute [1]</td></tr>
<tr><td colspan="3">[1] Octave corresponds to a frequency interval where the upper limit is achieved by doubling the lower limit.</td></tr>
</table>
</td><td>Specified functions could be demonstrated, the results are within the specified tolerance limits and no damage which limits the function has been detected at the test specimen.</td></tr>
</table>

Table 3.84 The outlines of testing of fuel oil and oil filters *(continued)*

Test item	Type test method	Criteria
Vibration test	5. Components having a mass M of more than 10 kg are to be designed for accelerations according to the relation 40 to M. However the minimum acceleration is to be 0,7 g. Following a vibration test in each case a functional test is to be carried out. 6. If exceeding vibration strain is to be expected at the installation location this has to be considered for the test.	
Flame resistance test	The test procedure is to be performed according to standards ISO 15540 respectively ISO 19921, the test stand shall be adequate to standards ISO 15541 respectively 19922. To these standards the following clarifications are necessary: a) If the test pressure (at minimum 5 bar) deviates from the nominal pressure, the final test for tightness has to be performed with the test pressure relevant for the product. This is for non-metallic hose lines 2 times, for non-metallic compensators 1,5 times and for mechanical joints 2 times the maximum allowable working pressure. b) The choice of the test specimens is to be performed according to the ISO standards mentioned above (for pipe lines ISO 15540, for connecting elements ISO 19921). c) A selection of representative nominal bores may be tested in order to evaluate the fire resistance of a series or range of mechanical joints of the same design. When a mechanical joint of a given nominal bore (D_n) is so tested then other mechanical joints falling in the range D_n to 2 x D_n (both inclusive) are considered accepted. d) Alternative test methods and/or test procedures considered to be at least equivalent may be accepted at the discretion of the BKI in cases where the test pieces are too large for the test bench and cannot be completely enclosed by the flames. e) Thermal insulation materials applied on couplings are to be non-combustible in dry condition and when subjected to oil spray. A non-combustibility test according to ISO 1182 is to be carried out. In addition, BKI reserve the following deviations to these standards: a) Test specimens and their preparation: The end fittings for the test specimens are to be defined by BKI. In principal the same types of end fittings are to be used as applied for the impulse test according to ISO 6803 respectively ISO 6802:1991 (E). b) Test specimens of compensators are to be presented for the test fully assembled according to the intended operating conditions equipped with flanges, screw connections, internal guiding pipes – if applicable, vacuum supporting rings, fastening elements, etc.	The test specimens meet after the test the requirements of the relevant standards. The results have to be documented by a test Certificate according to the test standards.
Burst pressure test	a) The same specimen may be used as for the tightness tests, if they have passed this first test. b) The specimen is to be loaded with stepless increase of pressure (abt. 10 % per minute) up to the test pressure. - Test pressure: nominal pressure x safety factor f - Safety factor f: test pressure / nominal pressure Below 200 bar nominal pressure: f = 4,0 Above 200 bar nominal pressure: f to be reduced according to Table 3.85 and as shown for overview in Fig 3.43.	The test is deemed to have past if the test pressure can be kept for the duration of test without observing leakages or cracks at the test specimen which can be visually detected. Light deformations may be accepted.

Table 3.84 The outlines of testing of fuel oil and oil filters *(continued)*

Test item	Type test method	Criteria
Burst pressure test	 Fig 3.43 Reduction of safety factor f for nominal pressures above 200 bar - Test medium: water or water-oil emulsion, vented Other media according to range of application - Duration of test: 5 minutes at maximum pressure - Test arrangement: For unrestrained pipe connections both pipe ends are to be fixed, for restrained pipe connections one pipe end has to be free movable.	The test is deemed to have past if the test pressure can be kept for the duration of test without observing leakages or cracks at the test specimen which can be visually detected. Light deformations may be accepted.
Function test	The function is to be tested according to the Rules Machinery Installations (Pt.1, Vol.III) Sec. 2.G	

[1] Q = relation of amplitudes a_G / a_E
a_G = acceleration amplitude of the test specimen
a_E = acceleration amplitude of the stimulation

Table 3.85 Reduced values of safety factors f for nominal pressures above 200 bar

Nominal pressure [bar]	Safety factor f [1] [-]	Nominal pressure [bar]	Safety factor f [1] [-]
207	4,0	670	2,97
210	3,99	680	2,95
220	3,97	690	2,92
230	3,95	700	2,90
240	3,93	710	2,88
250	3,90	720	2,86
260	3,88	730	2,83
270	3,86	740	2,81
280	3,84	750	2,79
290	3,81	760	2,77
300	3,79	770	2,74
310	3,77	780	2,72
320	3,75	790	2,70
330	3,73	800	2,68
340	3,70	810	2,66
350	3,68	820	2,63
360	3,66	830	2,61
370	3,64	840	2,59
380	3,61	850	2,57
390	3,59	860	2,54
400	3,57	870	2,52
410	3,55	880	2,50

Table 3.85 Reduced values of safety factors f for nominal pressures above 200 bar *(continued)*

Nominal pressure [bar]	Safety factor f [1] [-]	Nominal pressure [bar]	Safety factor f [1] [-]
420	3,53	890	2,48
430	3,50	900	2,45
440	3,48	910	2,43
450	3,46	920	2,41
460	3,44	930	2,39
470	3,41	940	2,37
480	3,39	950	2,34
490	3,37	960	2,32
500	3,35	970	2,30
510	3,32	980	2,28
520	3,30	990	2,25
530	3,28	1000	2,23
540	3,26	1010	2,21
550	3,24	1020	2,19
560	3,21	1030	2,16
570	3,19	1040	2,14
580	3,17	1050	2,12
590	3,15	1060	2,10
600	3,12	1070	2,08
610	3,10	1080	2,05
620	3,08	1090	2,03
630	3,06	1100	2,01
640	3,03	1104	2,00
650	3,01		
660	2,99		

[1] Intermediate values may be interpolated linearly.

AN. Hose fittings

1. Application

The requirements of this sub-section apply to test and inspection for hose fittings for the application on ships.

2. Type test

2.1 Test specimen

For the impulse test for each size of a series one test specimen has to be provided. For the flame resistance test three sizes of each series have to be selected as test specimen.

2.2 Test item, test method and criteria

Testing requirements for hose fittings to be as indicated in Table 3.86.

Table 3.86 The outlines of testing of hose fittings

Test item	Type test method	Criteria
Visual inspection	The test specimen will be inspected on conformity with: – the Rules and Guidelines of BKI – the manufacturer's specification – the drawings including material specifications – the specified standards	The equipment complies with the specification
Impulse test	The test has to be performed according to the standard ISO 6803-100 °C:1994.	
Fire resistance test	– The test has to be performed with three test specimens of different size and material (carbon steel and high quality steel). A combination of the materials in a test specimen is possible, however both parts of the test specimen have to be exposed to the flame. – The fittings are to be tested in exactly the same condition as provided for production, which means installation of the fitting on the peeled or unpeeled hose.	

AO. Flame protection covers for non-metallic hoses

1. Application

The requirements of this sub-section apply to test and inspection for flame protection covers for non-metallic hoses on ships.

2. Type test

2.1 Test specimen

Three hydraulic hose lines with textile weave, e.g. 1TE, 2TE, 3TE according to DIN EN 854 and installed flame protection cover are to be tested.

2.2 Test parameter

Following the flame resistance test a pressure test with two times the maximum allowable working pressure is to be performed. Holding time is 2 minutes.

2.3 Test item, test method and criteria

Testing requirements for flame protection covers for non-metallic hoses to be as indicated in Table 3.87.

Table 3.87 The outlines of testing of flame protection covers for non-metallic hoses

Test item	Type test method	Criteria
Visual inspection	The requirements for visual inspection are in accordance with Table 3.83 of fuel oil and oil filters	The equipment complies with the specification
Pressure test	The requirements for pressure test are in accordance with Table 3.83 of fuel oil and oil filters	
Fire/flame resistance test	The requirements for fire resistance test are in accordance with table Table 3.83 of fuel oil and oil filters	The test is deemed to have passed, if the flame resistance test was successful and no leakage occurs during the subsequent pressure test.

AP. Compensators of non-metallic materials

1. Application

The requirements of this sub-section apply to test and inspection for compensators of non-metallic materials on ships.

2. Type test

2.1 Test specimen

The tests are to be performed using at least three test specimens of different size for each series and type, as far as no different regulations are defined by BKI according to the operation conditions.

2.2 Test item, test method and criteria

Testing requirements for flame protection covers for compensators of non-metallic materials to be as indicated in Table 3.88.

Table 3.88 The outlines of testing of compensators of non-metallic materials

<table>
<tr><th>Test item</th><th>Type test method</th><th>Criteria</th></tr>
<tr><td>Visual inspection</td><td>The requirements for visual inspection are in accordance with table Table 3.83 of fuel oil and oil filters</td><td>The equipment complies with the specification</td></tr>
<tr><td>Pressure and Tightness test</td><td>A) Pressure test (strength test)
• Test pressure pp for pipes, valves, fittings:
1,5 x nominal pressure PN
• Velocity of pressure increase [bar/s]:
relatively slow resp. acc. to definition of manufacturer
• Test medium:
water or oil emulsion, vented air or other gases up to 6 bar, other media according to agreement
• Duration of test:
As far as not defined by BKI or relevant technical standards the following minimum test durations are valid:
Fittings, compensators and other components:
5 minutes
Disconnecting couplings with integrated valves according to Table below
Other test procedures may be recognized, as far as necessary, after verification by BKI.
Duration of tests for disconnecting couplings
<table>
<tr><th>Nominal size DN [mm]</th><th>Duration of test [minutes]</th></tr>
<tr><td>DN ≤ 100</td><td>10</td></tr>
<tr><td>100 < DN ≤ 300</td><td>15</td></tr>
<tr><td>300 < DN</td><td>20</td></tr>
</table>
B) Tightness test for houses of fittings and seat sealing
1. Test of tightness of the pressure loaded housing
The test has to be performed with gas or liquid, the choice of the test medium being the responsibility of the manufacturer.
• Test pressure:
1,5 x allowable working pressure (at room temperature), the nominal pressure at minimum. All connections to the housing have to be closed, the valve has to be brought to partly open position and the valve housing has to be filled with test medium.</td><td>The test is deemed to have past if no pressure decrease occurs and if no permanent deformations or other deficiencies can be visually observed at the pressure loaded parts of the test specimen.
Otherwise the test is to be repeated with two test specimens of the type and size which failed. If a test specimen
fails, the test is deemed finally not to have past.</td></tr>
</table>

Table 3.88 The outlines of testing of compensators of non-metallic materials *(continued)*

Test item	Type test method	Criteria
Pressure and Tightness test	• Course of test: Liquid as test medium: The valve housing is to be checked visually for external leakages. Gas as test medium: The valve housing is to be immersed in water and the rising of gas bubbles to the water surface has to be checked. No gas shall leak out. The upper side of the valve should be situated at maximum 50 mm below the water surface. • Duration of test: at minimum 10 minutes respectively according to a technical regulation recognized by BKI. 2. Test for testing seat tightness a) For the test of tightness of the seat the allowable leakage rate has to be agreed before the test between manufacturer and contractor and approved by BKI. b) The leakage rate is to be checked according to the requirements of BKI or another international valve standard recognized by BKI. c) The test has to be performed with gas or liquid, the choice being the responsibility of the manufacturer. If a valve is not designed for one flow direction only, the test has to be made for both flow directions. • Test pressure: 1,1 x maximum allowable working pressure respectively acc. to a standard approved by BKI • Test medium: Liquid or gas. The definition of the test medium is in the responsibility of the manufacturer. • Course of test: 1. Closing body, e.g. valve cone, gate valve, piston to be brought in closed position. 2. Hollow space at the entrance side to be filled with test medium. 3. Activate test pressure. 4. Evaluate leakage rate. • Duration of test: according to definition of manufacturer, at minimum 10 minutes ***Note:*** *Fittings with double seating or two independent seating areas may be tested by establishing the test pressure between the seating and checking each side of the closed fitting.*	The test is deemed to have past if the tightness test of the housing shows no leakage and at the tightness test of the seating the leakage rates measured during the test duration, which are defined in the requirements of BKI or other relevant international standards recognized by BKI, are not exceeded.
Burst pressure test	The requirements for burst pressure test are in accordance with Table 3.83 with 3 times the nominal pressure respectively maximum allowable working pressure	
Fire resistance test [1]	Test See test requirements for fire resistance test are in accordance with Table 3.83 of fuel oil and oil filters	The test is deemed to have passed, if the flame resistance test was successful and no leakage occurs during the subsequent pressure tests.
Ozone resistance	The tests are to be performed in accordance with the standards to be defined by the manufacturer and recognized by BKI.	

Table 3.88 The outlines of testing of compensators of non-metallic materials *(continued)*

Test item	Type test method	Criteria
Behaviour with Pressure liquids	The tests are to be performed in accordance with the standards to be defined by the manufacturer and recognized by BKI.	
Wearing behaviour of the outside layer	The tests are to be performed in accordance with the standards to be defined by the manufacturer and recognized by BKI.	
[1] Only for compensators in fuel oil, lubrication oil, hydraulic oil, bilge and seawater systems		

AQ. Compensators of metallic materials

1. Application

The product tests specified in Table 3.89 A) are applicable to metallic compensators installed in piping systems covered by Rules for Machinery Installations (Pt.1, Vol.III) Sec. 11.

For application in process pipes and cargo pipes of gas and chemical tankers as well as cryogenic and non-cryogenic gas piping systems of internal combustion engines and boilers, Table 3.89 B) applies.

2. Type test

2.1 Test specimen

The tests have to be performed for at least three different test specimens of different size for each series and type as far as BKI has not defined different requirements taking into account the intended application and operating conditions.

For metallic compensators intended to be used in process pipes and cargo pipes of gas and chemical tankers as well as cryogenic and non-cryogenic gas piping systems of internal combustion engines and boilers, the tests have to be performed for at least three different sizes of each type. Additional test specimens may be tested if deemed necessary according to the intended application and operating condition.

2.2 Test item, test method and criteria

Testing requirements for flame protection covers for compensators of metallic materials to be as indicated in Table 3.89.

Table 3.89 The outlines of testing of compensators of metallic materials

Test item	Type test method	Criteria
A) Metallic compensators for application in piping systems covered by Rules for Machinery Installations (Pt.1, Vol.III), Section 11		
Visual inspection	The requirements for fire resistance test are in accordance with Table 3.88 of compensators of non-metallic materials	The proof of sufficient flexibility and compressive stress is deemed to be established if the test specimen has passed the pressure and tightness test after the endurance test without deficiencies.
Pressure and Tightness Test [1]	The requirements for fire resistance test are in accordance with Table 3.88 of compensators of non-metallic materials	
Burst pressure test [1]	The requirements for fire resistance test are in accordance with Table 3.88 of compensators of non-metallic materials	
Endurance test	This test serves to demonstrate that the design of the bellow according to Expansion Joint Manufacturers Association (EJMA) or comparable standard ensures the compression strength and flexibility of the compensator under the influence of defined operating cycles and full pressure load. The test specimen is to be tested as follows: – number of load cycles: 1000 – test medium: water or water/oil emulsion – test pressure: nominal pressure	
B) Metallic compensators intended to be used in process pipes and cargo pipes of gas and chemical tankers as well as cryogenic and non-cryogenic gas piping systems of internal combustion engines and boilers.		
Visual inspection	The requirements for fire resistance test are in accordance with Table 3.88 of compensators of non-metallic materials	

Table 3.89 The outlines of testing of compensators of metallic materials *(continued)*

Test item	Type test method	Criteria
Tightness test	The requirements for fire resistance test are in accordance with Table 3.88 of compensators of non-metallic materials	
Pressure test	The test is to be carried out on a compensator complete with all the accessories (flanges, stays, articulations, etc.) at twice the design pressure at the extreme displacement conditions recommended by the Manufacturer. No permanent deformations are allowed. The minimum design pressure shall be 10 bar.	
Burst pressure test	The test is to be carried out on a compensator, not pre-compressed. It is to be pressure tested to a pressure not less than five times the design pressure without bursting. – The duration of the test is not to be less than 5 minutes. – The pressure tests are to be performed at the lowest design temperature. – For low temperature steels (Rules for Materials (Pt.1, Vol.V) Sec. 5.D) the pressure tests may be carried out at room temperature.	
Cycle test (thermal movements)	The test is to be performed on a complete expansion joint, which is to successfully withstand at least as many cycles, under the conditions of pressure, temperature, axial movement, rotational movement and transverse movement, as it will encounter in actual service. Testing at room temperature, when conservative, is permitted.	
Fatigue test (ship deformation)	The test is to be performed on a complete expansion joint, without internal pressure, by simulating the bellows movement corresponding to a compensated pipe length for at least 2 x 10^6 cycles at a frequency not higher than 5 cycles/second. The test is only required when, owing to the piping arrangement, ship deformation loads are actually experienced.	

[1] For compensators which are to be used in process and cargo pipes on gas and chemical tankers, the pressure and tightness test as well as the burst pressure test has to be performed at the lowest design pressure. The design pressure of the compensators is to be scheduled for at least 10 bar. The burst pressure has to correspond 5 times the nominal pressure.

AR. CO_2 hoses

1. Application

These test requirements are valid for the approval of hoses made of synthetic rubber. For the approval of other hose materials, as e.g. thermoplastic, special test requirements are to be defined.

In the case of hoses made of synthetic rubber an approval as hydraulic hose issued in advance is an assumption for the approval of a CO_2 hose. CO_2 hoses are to be designed for a working pressure of at least 100 bar.

2. Type test

2.1 Test specimen

From each hose type which shall be tested the smallest and the biggest dimension has to be manufactured according to manufacturer specification, including pricking and using the fittings to be used for operation of the CO_2 hose.

For the case of prick failures for each test specimen two spare specimens shall be available.

2.2 Test item, test method and criteria

Testing requirements for CO_2 hose to be as indicated in Table 3.90.

Table 3.90 The outlines of testing of CO_2 hoses

Test item	Type test method	Criteria
Visual inspection	The requirements for fire resistance test are in accordance with Table 3.86 of hose fittings	No cracks, swellings, bubbles and further deficiencies shall exist.
Burst pressure test	The requirements for fire resistance test are in accordance with Table 3.86 of hose fittings	
Prick procedure	By sufficient pricking it has to be ensured that gas escaping from the internal layer may escape through the external layer without creating bubbles or further deficiencies. The procedure has to ensure, that the needles of the pricking device do not damage the internal layer that means the prick procedure has to be made in controlled manner. For release of the prick procedure to be used the outer layer of the test specimens including the spare parts has to be perforated. After the pricking and integration of the hoses a visual inspection and pressure test is to be performed according to hose standard.	If leakage is detected after the test, an adequate modification of the prick procedure has to be done. Subsequently for each failed size two further test specimens are to be manufactured and have to be subjected again to a visual check and pressure test. Should leakage occur again, the applied prick procedure is to be modified respectively to be replaced by a new one.

Table 3.90 The outlines of testing of CO_2 hoses *(continued)*

Test item	Type test method	Criteria
Endurance test with liquid carbon dioxide	The test specimens are to be connected to one or more CO_2 cylinders, which are arranged standing with a total volume of at least 45 kg in U-form with the minimum permissible bending radius. For at least 24 hours they have to be exposed to liquid carbon dioxide with room temperature. After expiration of the test period the content of the cylinders is to be emptied via the test specimens within 30 minutes into the open. After warming up of the test specimens to room temperature, a visual inspection concerning eventually occurring damages of the internal and external layer has to take place.	The proof of suitability for the test medium is deemed to have passed if the test specimens show no cracks, swellings, bubbles and further deficiencies and if they remain tight over a test period of 2 minutes. The test pressure has to be equivalent to 2 times the maximum allowable working pressure of the hose line.
Bending fatigue test	After emptying, the hoses are to be bent immediately alternately by 180° over an adequate pattern keeping the minimum bending radius.	
Pressure test according to hose standard	After visual inspection, a pressure test with 2 times the maximum allowable working pressure is to be performed, in any way the test pressure shall be at least 200 bar.	

AS. Anti-fouling systems

1. Introduction

The procedures and requirements described in this Guidance are applicable for obtaining the BKI's type approval certificate based on requirements in:

- IMO AFS Convention: International Convention on the Control of Harmful Anti-Fouling Systems on Ships (2001)

  IMO Resolution MEPC. 195(61). Guidelines for Survey and Certification of Anti-Fouling Systems on Ships (2010)
- IMO Resolution MEPC. 208(62). Guidelines for Inspection of Anti-Fouling Systems on Ships (2011)

2. Scope

This Guidance gives a description of the procedures and requirements related to documentation, design and type testing applicable for type approval of anti-fouling systems.

The type approval comprises the anti-fouling system in liquid condition and in the condition when applied in full compliance with the manufacturer's recommendations (see 3). Quality control during surface preparation and/or application of the anti-fouling system is, however, not included in the type approval.

The BKI's type approval certificate will cover one grade of the actual product with the possibility to include variants. For an anti-fouling system this means:

- grade: full anti-fouling system, including one or more coats (as per system definition)
- variants: e.g. color variants or thinned variants.

A BKI type approval certificate is normally limited to one manufacturer at one production site.

3. Application

A type approval certificate in accordance with this Guidance will confirm compliance with the requirements in the regulations as specified in 1. The type approval certificate will not confirm compliance with requirements in other parts of the rules. In case additional requirements in other parts of the rules shall be covered by the type approval certificate, this shall be specified in the application for type approval and will be stated in the type approval certificate.

The BKI's rules do not require that anti-fouling systems shall be type approved, and type approval in accordance with this Guidance is therefore voluntary for anti-fouling systems to be applied on classed vessels.

4. Documentation

For type approval of anti-fouling systems the following additional documentation shall be submitted by the manufacturer at initial type approval, and updated at renewal (general requirements for documentation is given in A.2.3). The documentation shall be submitted as electronic files. The manufacturer shall keep one (1) copy of type approval documentation in their own file. The documentation that forms the basis for the type approval shall be easily available for the BKI's surveyors at the type approval applicant's premises.

Please number documentation according to below list to facilitate review:

1) type designation, i.e. product name (grade) with list of variants to be included in and stated on the type approval certificate
2) product description (product ID number, number and type of components, colour, consistence, etc.)

3) field of application and special limitations of the product

4) product specification or technical data sheet, materials safety data sheet, with relevant information such as:

- trade name of the anti-fouling system
- type of anti-fouling system, e.g. self-polishing, ablative, conventional, “non-stick” (silicone), etc.
- documentation that the organotin, if present, is harmless to organic life, i.e. does not act as a biocide
- binder type
- active ingredients with CAS-number
- packaging, storage
- solids content, thinners
- viscosity
- flash point
- service temperatures
- any other operational limitations
- safety and health data
- requirements for surface preparation
- application temperature range
- air humidity limitations
- application methods, equipment
- curing times versus temperatures
- dry film thickness per coat, and total number of coats
- repair or re-coating instructions.

5) description of fabrication [2]

6) description of quality control arrangement including copies of the relevant certificates with issue number and/or date (e.g. quality management system certification)[2]

7) test results with references to standards, methods etc. and relevant calibration certificates for equipment used in type tests (if applicable)

8) information regarding marking of the product or package[2]

9) in-service experience, if available

10) witnessed type test results shall be submitted when completed.

5. Design requirements

The anti-fouling system shall comply with the relevant requirements of this Guidance and the following publication:

- IMO AFS Convention: International Convention on the Control of Harmful Anti-Fouling Systems on Ships (2001).

6. Requirements to production and quality control arrangement

The manufacturer should have a quality system that meets ISO 9001 standards, or equivalent. If this quality standard is not fulfilled, the extent of type testing and assessments will be specially considered.

[2] Will be verified by initial assessment prior to the issuance of the type approval certificate

The quality control arrangement in production shall be checked with respect to:

- control of incoming materials
- scope of quality control, i.e. proof that test methods, test quantity and test equipment complies to the applicable standard (e.g ISO or other equivalent standards)
- traceability and marking system
- production records
- storage condition and procedure

The manufacturer shall check the production for either:

- content of total tin by analysis (ICP, AAS, XRF or similar), or
- content of organotin by raw material certificates or by analysis (GCMS or similar) and make a log for the analysis. This log shall be made available to the BKI during assessment.

7. Laboratory Testing

A condition for type approval is that total tin is less than 0,25% by weight in dry film, mixed and cured if plural components, as determined by laboratory tests as described in Table 3.91.

If the total tin content is tested to be higher than 0,25% by weight in dry film (mixed and cured if plural components), additional laboratory testing as described in Table 3.92 is required. Type approval certificate may be issued only provided that the tin or organotin compound present does not act as a biocide (TBT is a common organotin compound normally acting as a biocide).

One dry sample is sufficient for carrying out the tests (alternatively one wet sample), and may be collected and treated as follows:

- make a dry sample by applying some paint on a plastic sheet or similar, size about 10 × 10 cm
- let it dry for two days or more at 20°C or higher and cover it with some soft plastic material
- the paint shall be taken from a well-mixed paint container in the presence of the BKI's surveyor
- alternatively, a wet sample of about 100 ml may be collected, from the same paint container, in a tin can or bottle.

Table 3.91 Requirements for type testing of anti-fouling system - tin content only

Property	Test method [1)]	Number and selection of specimens	Acceptance criteria	Minimum level of verification	Frequency of verification
Total tin (Sn) [2)]	Inductively coupled plasma (ICP), atomic absorption (AAS), X-ray fluorescence (XRF), or similar	Minimum one representative sample	Maximum 0,25% by weight tin (Sn) [2)] in dry film (mixed and cured if plural components)	BKI Assessment	Initial, Renewal [3)]

[1)] Other test methods may be agreed upon with BKI prior to testing.
[2)] If tin is identified or present in higher level than 0,25% by weight total tin, the product must be tested as per Table 3.92.
[3)] Required testing at renewal will be considered and decided upon for each anti-fouling system.

Table 3.92 Requirements for type testing of anti-fouling system - if tin content too high

Property	Test method [1]	Number and selection of specimens	Acceptance criteria	Minimum level of verification	Frequency of verification
Tin (Sn) [3]	Gas chromatography-mass spectroscopy (GCMS), or similar	Minimum one representative sample	Action criterion maximum 0,25% by weight of TBT [4] calculated as tin (Sn) [3] in dry film (mixed and cured if plural components)	BKI Assessment	Initial, Renewal [2]

[1] Other methods may be agreed upon with BKI prior to testing.
[2] Required testing at renewal will be considered and decided upon for each anti-fouling system.
[3] If TBT is identified/present in higher level than 0,25% by weight, it must be documented that the TBT or organotin compound present is harmless to aquatic life, i.e. does not act as a biocide.
[4] A common organotin compound normally acting as a biocide is TBT, tributyltinoxide.

8. Requirements for marking of product

The package shall be marked. The marking shall at least include the following information:

- manufacturer's name and/or logo
- manufacturer's production address
- type designation
- type of Anti-Fouling System used, see 4, if relevant
- storage instruction
- production date
- batch number
- quality guarantee period, if any

The marking shall be carried out in such a way that it is visible, legible and indelible. The marking of product shall enable traceability to the type approval certificate.

AT. Life-Saving Appliances

1. Application

1.1 This sub-section applies to tests and inspections for type approval/approval of appliances or equipment with respect to the following:

1) Lifeboats;
2) Rescue boats;
3) Inflatable liferafts;
4) Launching appliances for lifeboats, rescue boats and liferafts;
5) Engines for lifeboats and rescue boats (including reduction and reversing gears);
6) Release mechanisms of lifeboats or rescue boats launched by falls other than free-fall lifeboats.

1.2 Components constituting any part of the appliances or equipment referred to in 1.1 may be type approved/approved in accordance with this sub-section whenever applications are submitted.

2. Lifeboats

2.1 Lifeboat Engines, Equipment, etc.

2.1.1 Lifeboat engines (including reduction and reversing gears) are to be in compliance with 6.

2.1.2 Among the lifeboat fittings and equipment, the following are to be of a type approved either by the flag government of the ship where they are carried, by contracting governments to the SOLAS Convention in force or by the organizations recognized by these governments:

1) Portable fire-extinguishing equipment;
2) High-pressure gas cylinders;
3) External lamps;
4) Internal lamps (in case either dry cell or sea water cell is used);
5) Lifeboat equipment:
   - Thermal protective aids;
   - Food rations;
   - De-salting apparatus;
   - First-aid outfits;
   - Rocket parachute flares;
   - Buoyant smoke signals;
   - Hand flares;
   - Searchlights;
6) Retro-reflective materials.

2.2 Type Approval

2.2.1 Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

1) Specifications;
2) General arrangement;

3) Hull construction;
4) Inherent buoyant material arrangement;
5) Arrangement of lifeboat fittings including fenders and lifelines;
6) Steering gear and rudder construction;
7) General arrangement of propelling machinery;
8) Propeller shaft arrangement;
9) Door arrangement and its details;
10) Seating arrangement;
11) Release mechanism;
12) Fitting of retro-reflective materials;
13) Wiring diagram;
14) List of materials used (including fire-retardancy data);
15) List of lifeboat equipment;
16) Self-contained air support system (for lifeboats with self-contained air support system and for fire-protected lifeboats);
17) Water spray piping system (for fire-protected lifeboats);
18) Lines of hull;
19) Laminating procedures and details of joints (for FRP lifeboats);
20) Structural strength calculations and data;
21) Buoyancy calculations for inherent buoyant materials;
22) Stability calculations and data;
23) Maintenance and inspection manuals;
24) Other drawings and documents which BKI deems necessary.

2.2.2 Type test

Type test is to consist of the following tests and inspections. The procedures for tests on material, strength and performance are to be in accordance with Annex A "Procedures for Prototype Tests for Type Approval and Production Tests of Lifeboats" or International Standards recognized by BKI :

1) Material tests:
   A) Material test for boat hulls and rigid covers;
   B) Material test for inherent buoyant materials;
2) External and construction inspections:
   A) External and construction inspection;
   B) Dimension measurement;
   C) Mass measurement;
   D) Freeboard measurement;
   E) Lifeboat equipment inspection;
   F) Marking inspection;
3) Strength and performance tests:
   A) Lifeboat overload test;
   B) Davit-launched lifeboat impact and drop test;
   C) Free-fall lifeboat free-fall test;

D) Lifeboat seating strength test;

E) Lifeboat seating space test;

a) Boarding and seating test

b) Non-skid finish inspection

F) Lifeboat freeboard and stability tests;

a) Flooded stability test

b) Freeboard test

G) Release mechanism test;

H) Lifeboat operation test;

a) Operation of lifeboat engine and fuel consumption test

b) Compass

c) Survival recovery test

I) Lifeboat towing and painter release test;

J) Other performance tests;

a) Test for bringing stretchers into the lifeboats

b) Emergency steering test

c) Watertightness test for battery casings

d) Charging test

e) Rowing test for davit-launched lifeboats

f) Effectiveness test for bailing means

K) Canopy erection test;

L) Additional tests for totally enclosed lifeboats;

a) Self-righting test

b) Operation test

c) Flooded capsizing test

M) Additional tests for lifeboats with a self-contained air support system;

a) Tests as specified in L) above

b) Air supply test

N) Additional tests for fire-protected lifeboats;

a) Tests as specified in M) above

b) Fire test

c) Water spray test

O) Measuring and evaluating acceleration forces.

2.3 Production Test

2.3.1 Inspection

A production test of each lifeboat unit is to consist of the examination of the implementation of the quality control system of the production site of the manufacturer and of the respective records, and of the following tests and inspections. The procedures for strength and performance tests are to be in accordance with Annex A or International Standards recognized by BKI:

1) External and construction inspections:

A) External and construction inspection;
B) Dimension measurement;
C) Mass measurement;
D) Freeboard measurement (in fully loaded condition);
E) Lifeboat equipment inspection;
F) Marking inspection.

2) Strength and performance tests:
A) Performance test of release mechanisms of davit launched lifeboats;
B) Operation test;
C) Release gear test.

2.3.2 Inspection for Markings

Lifeboats which have been subjected to the production test with satisfactory result are to be marked with the following markings in clear permanent characters at some appropriate location on each piece:

- Type approval number of BKI;
- Serial number of the manufacturer; and
- Date, month and year of the manufacture.

3. Rescue Boats

3.1 Application

These provisions are to apply to davit-launched rescue boats.

3.2 Rescue Boat Engines and Equipment

3.2.1 The rescue boat engines are to be in accordance with 6.

3.2.2 Among the rescue boat fittings and equipment, the following are to be of a type approved either by the flag government of the ship where they are carried, by contracting governments to the SOLAS Convention in force or by organizations recognized by these governments:

1) Rescue boat equipment:
- Thermal protective aids;
- First aid outfits;
- Search lights;

2) Retro-reflective materials.

3.3 Type Approval

3.3.1 Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2 and 2.2.1. 1) to 24), except 16) and 17) :

1) Air chamber structure and arrangement of inflated and combined rescue boats.
2) Air chamber/transom joining procedures of inflated rescue boats.
3) Hull and air chamber/transom joining procedures of combined rescue boats.

3.3.2 Type Test

A type test is to consist of the following tests and inspections. The procedures for tests on material, strength and performance are to be in accordance with Annex B or International Standards recognized by BKI:

1) Material test:
   A) Material test for boat hulls;
   B) Material test for rigid covers;
   C) Material test for buoyant materials.
2) Inflated rescue boats:
   A) Material test for boat hull.
3) Combined rescue boats:
   A) Material test for boat hull;
   B) Material test for buoyant materials.
4) External and construction inspections:
   A) External and construction inspection;
   B) Dimension measurement;
   C) Mass measurement;
   D) Freeboard measurement;
   E) Rescue boat equipment inspection;
   F) Marking inspection.
5) Strength and performance tests:
   A) Rigid rescue boats;
      a) Overload test
      b) Impact and drop tests
      c) Seating strength test
      d) Seating space test
      e) Non-skid finish inspection
      f) Freeboard and stability tests:
         i) Flooded rescue boat stability test
         ii) Freeboard measurement
      g) Release mechanism test
      h) Operation tests:
         i) Operation of lifeboat engine and fuel consumption test
         ii) Compass
         iii) Survival recovery test
      i) Towing and painter release test
      j) Toeing test
      k) Righting test
      l) Manoeuvrability test
      m) Other performance tests:
         i) Test for bringing stretchers into the rescue boats

ii) Emergency steering test
iii) Watertightness test of battery casings
iv) Charging test
v) Effectiveness test for bailing means

n) Detailed inspection

B) Inflated rescue boats;

a) Overload test
b) Impact test
c) Drop test
d) Seating strength test
e) Seating space test
f) Non-skid finish inspection
g) Loading test (Freeboard measurement)
h) Stability test
i) Damage test
j) Swamp test
k) Release mechanism test
l) Operation test:
i) Operation of lifeboat engine and fuel consumption test
ii) Compass
iii) Survival recovery test
m) Manoeuvrability test
n) Towing and painter release test
o) Righting test
p) Simulated heavy weather test
q) Mooring out test
r) Towing test
s) Other performance tests:
i) Test for bringing of stretchers into the rescue boat
ii) Emergency steering test
iii) Watertightness test for battery casings
iv) Charging test
v) Effectiveness test for bailing means
t) Detailed inspection

C) Combined rescue boats;

a) Overload test
b) Impact test
c) Drop test
d) Seating strength test
e) Seating space test
f) Non-skid finish inspection

g) Loading test (Freeboard measurement)
h) Stability test
i) Damage test
j) Swamp test
k) Release mechanism test
l) Operation test:
    i) Operation of lifeboat engine and fuel consumption test
    ii) Compass
    iii) Survival recovery test
m) Manoeuvrability and towing tests
n) Towing and painter release test
o) Righting test
p) Simulated heavy weather test
q) Mooring out test
r) Towing test
s) Other performance tests:
    i) Test for bringing of stretchers into the rescue boat
    ii) Emergency steering test
    iii) Watertightness test for battery casings
    iv) Charging test
    v) Effectiveness test for bailing means
t) Detailed inspection

D) Rigid fast rescue boats;
a) Overload test
b) Impact and drop test
c) Seating strength test
d) Seating space test
e) Non-skid finish inspection
f) Loading and stability test
g) Release mechanism test
h) Operation test:
    i) Operation of lifeboat engine and fuel consumption test
    ii) Compass
    iii) Survival recovery test
i) Towing and painter release test
j) Towing test
k) Righting test
l) Manoeuvrability test
m) Loading test
n) Other performance tests:
    i) Test for bringing of stretchers into the rescue boat

ii) Emergency steering test
iii) Watertightness test for battery casings
iv) Charging test
v) Effectiveness test for bailing means

o) Detailed inspection

E) Inflated fast rescue boat;

a) Impact test
b) Seating strength test
c) Non-skid finish inspection
d) Release mechanism test
e) Operation test:
i) Operation of lifeboat engine and fuel consumption test
ii) Compass
iii) Survival recovery test
f) Towing and painter release test
g) Righting test
h) Towing test
i) Seating space test
j) Manoeuvrability test
k) Drop test
l) Loading test
m) Stability test
n) Damage test
o) Simulated heavy weather test
p) Swamp test
q) Overload test
r) Mooring out test
s) Other performance tests:
i) Test for bringing of stretchers into the rescue boat
ii) Emergency steering test
iii) Watertightness test for battery casings
iv) Charging test
v) Effectiveness test for bailing means
t) Detailed inspection

F) Combined rescue boats.

a) Overload test
b) Impact test
c) Drop test
d) Seating strength test
e) Seating space test
f) Non-skid finish inspection

g) Loading test (Freeboard measurement)
h) Stability test
i) Damage test
j) Swamp test
k) Release mechanism test
l) Operation test:
    i) Operation of lifeboat engine and fuel consumption test
    ii) Compass
    iii) Survival recovery test
m) Manoeuvrability tests
n) Towing and painter release test
o) Righting test
p) Simulated heavy weather test
q) Mooring out test
r) Towing test
s) Other performance tests:
    i) Test for bringing of stretchers into the rescue boat
    ii) Emergency steering test
    iii) Watertightness test for battery casings
    iv) Charging test
    v) Effectiveness test for bailing means
t) Detailed inspection

3.4 Production Test

3.4.1 Inspection

A production test of each rescue boat unit is to consist of the examination of the implementation of the quality control system of the production site of the manufacturer and of the respective records, and of the following tests and inspections. The procedures for tests on strength and performance are to be in accordance with Annex B or International Standards recognized by BKI:

1) External and construction inspections:
    A) External and construction inspection;
    B) Dimension measurement;
    C) Mass measurement;
    D) Freeboard measurement (in fully loaded condition);
    E) Rescue boat equipment inspection;
    F) Marking inspection.
2) Strength and performance tests:
    A) Release mechanism test;
    B) Overload, pressure and tightness tests for inflated and combined rescue boats;
    C) Operation test;
    D) Functional test of release gear.

3.4.2 Inspection of Markings

Rescue boats which have been subjected to the production test with satisfactory result are to be marked with the following markings in clear permanent characters at some appropriate location on each piece:

- Type approval number of BKI;
- Serial number of the manufacturer; and
- Date, month and year of the manufacture.

4. Inflatable Liferafts

4.1 Liferaft Fittings and Equipment

4.1.1 Among the liferaft fittings and equipment, the following are to be of a type approved either by the flag government of the ship where they are carried, by contracting governments to the SOLAS Convention in force or by organizations recognized by these governments:

1) High pressure gas cylinders (including their valves);
2) External lamps;
3) Internal lamps;
4) Liferaft equipment:
   - Thermal protective aids;
   - Food rations;
   - De-salting apparatus;
   - First-aid outfits;
   - Rocket parachute flares;
   - Buoyant smoke signals;
   - Hand flares;
5) Retro-reflective materials;
6) Hydrostatic release units;
7) Weak links.

4.2 Type Approval

4.2.1 Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2:

1) Specifications;
2) General arrangements and construction (including air chamber construction, floor, canopy construction, water pocket details and joint details for boarding ramps/ladders);
3) Liferaft fitting arrangement;
4) Liferaft equipment stowage and arrangement;
5) Gas charging arrangement;
6) Float-free arrangement;
7) List of materials used;
8) Carrying capacity calculation sheet;
9) Container construction;

10) Maintenance and inspection manuals;

11) Other drawings and documents which are deemed necessary by BKI.

4.2.2 Type Tests

A type test is to consist of the following tests and inspections. The procedures for tests on material, strength and performance are to be in accordance with Annex C or International Standards recognized by BKI:

1) Material test:
   A) Test for materials for main buoyancy chambers, canopy supports, floors, floor buoyancy chambers and canopy.
2) External and construction inspections:
   A) External and construction inspection;
   B) Dimension measurement;
   C) Mass measurement;
   D) Liferaft equipment inspection;
   E) Marking inspection.
3) Strength and performance tests:
   A) Drop test;
   B) Jump test;
   C) Weight test;
   D) Towing test;
   E) Mooring out test;
   F) Painter system test;
   G) Loading and seating test;
   H) Boarding and closing arrangement test;
   I) Stability test;
   J) Manoeuvrability test;
   K) Swamp test;
   L) Canopy closure test;
   M) Buoyancy of float-free liferafts;
   N) Weak link test;
   O) Damage test;
   P) Righting test;
   Q) Inflation test;
   R) Pressure test;
   S) Seam strength test;
   T) Additional tests for davit-launched liferafts;
      a) Strength test of lifting components
      b) Impact test
      c) Drop test
      d) Boarding test
      e) Strength test

U) Additional tests applicable to automatically self-righting liferafts

V) Submergence test for automatically self-righting and canopied reversible liferafts

W) Wind velocity test

X) Tests for self-draining of floors of canopied reversible liferafts and automatically self-righting liferafts

Y) Other performance tests;

a) Air-charging test

b) Automatic lighting test

Z) Detailed inspection.

4.3 Production Test

4.3.1 Inspection

A production test of each inflatable liferaft is to consist of the examination of the implementation of the quality control system of the production site of the manufacturer and of the respective records, and of the following tests and inspections. The procedures for tests on strength and performance are to be in accordance with Annex C or International Standards recognized by BKI:

1) External and construction inspections:
   A) External and construction inspection;
   B) Dimension measurement;
   C) Mass measurement;
   D) Liferaft equipment inspection;
   E) Marking inspection;
2) Strength and performance tests:
   A) Inflation test (for inflatable liferafts selected by the Surveyor);
   B) Pressure and tightness test;
   C) 10% overload test for davit-launched liferafts.

4.3.2 Inspections of Markings

Inflatable liferafts which have been subjected to the production test with satisfactory result are to be marked with the following markings in clear permanent characters at some appropriate location on each piece:

- Type approval number of BKI;
- Serial number of the manufacturer; and
- Date, month and year of the manufacture.

5. Launching Appliances for Lifeboats, Rescue Boats and Liferafts

5.1 Davit-launched Liferaft Automatic Release Hooks, Electric Appliances and Hydraulic Oil System

5.1.1 Davit-launched liferaft automatic release hooks are to be of a type approved either by the flag government of the ship where they are carried, by contracting governments to the SOLAS Convention in force or by organizations recognized by these governments.

5.1.2 Electric appliances of the launching appliances are to be in accordance with the requirements of Rules for Electrical Installations (Pt.1, Vol.IV). Motors and control boards may however be accepted if it is

ascertained from the in-house test records of the respective manufacturers that they comply with the relevant requirements of Rules for Electrical Installations (Pt.1, Vol.IV) or equivalent thereto.

5.1.3 Special materials, and special pipes of which working pressure exceeds 1,6 MPa of the hydraulic oil pressure system of the launching appliances are to be of those approved either by BKI or by organizations who are deemed appropriate by BKI.

5.2 Type Approval

5.2.1 Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2:

1) Specifications;
2) General arrangement;
3) Construction (including main dimensions, materials and joint details);
4) Strength calculations;
5) Winch specifications, performance and control mechanism;
6) Handling and maintenance manuals;
7) Other drawings and documents which are deemed necessary by BKI.

5.2.2 Prototype test

A prototype test is to consist of the following tests and inspections. The procedures for tests on strength and performance are to be in accordance with Annex D or International Standards recognized by BKI.

1) External and construction inspections:
   A) External and construction inspection;
   B) Dimension measurement.
2) Strength and performance tests:
   A) Launching appliances of davits, etc.;
      a) Overload test
      b) Swing-out test
      c) Recovery operation test
      d) Brake test
      e) Recovery test by rescue boat winches
      f) Hand operation test of winches
      g) Overhaul inspection of winches
      h) Pressure test for hydraulic oil systems
      i) Test for ramps for free-fall lifeboats
      j) Test for adjustable ramps
   B) Launching appliances for fast rescue boats.

5.3 Production Test

5.3.1 Inspection

A production test of each launching appliance is to consist of the examination of the implementation of the quality control system of the production site of the manufacturer and of the respective records, and of the

following tests and inspections. The procedures for tests on strength and performance are to be in accordance with Annex D or International Standards recognized by BKI.

1) External and construction inspections:
   A) External and construction inspection;
   B) Dimension measurement;
2) Strength and performance tests:
   A) Launching appliances with davit falls and winches;
      a) Overload test
      b) Pressure test of hydraulic oil systems

5.3.2 Inspection of Markings

Launching appliances which have been subjected to the production test with satisfactory result are to be marked with the following markings in clear permanent characters at some appropriate location on each piece:

1) Type approval number of BKI;
2) Serial number of the manufacturer; and
3) Date, month and year of the manufacture.
4) Launching appliances including davits:
   – Maximum working load (L_{max});
   – Minimum working load (L_{min});
5) Winches:
   – Maximum working load (W_{max}).

6. Engines for Lifeboats and Rescue Boats (Including Reduction and Reversing Gears)

6.1 Type Approval

6.1.1 Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2:

1) Specifications;
2) Particulars;
3) General arrangement;
4) Sectional assembly plan;
5) Starting procedures;
6) List of materials used for main parts;
7) Engine installation plan / installation details;
8) Steering gear system of outboard motors;
9) Maintenance and inspection manuals;
10) Production records in past two years;
11) Other drawings and documents which are deemed necessary by BKI.

6.1.2 Prototype Test

A prototype test is to consist of the following tests and inspections. The procedure for performance test is to be in accordance with Annex E or International Standards recognized by BKI:

1) External and construction inspections:
   A) External and construction inspection;
   B) Dimension measurement;
   C) Mass measurement;
2) Performance tests:
   A) Internal combustion engines (including reduction and reversing gears) for lifeboats and rescue boats (excluding outboard motors);
      a) General performance tests
         i) Starting test
         ii) No-load, low-speed operation test
         iii) No-load, high-speed operation test (in case where no speed governor is provided.)
         iv) Load test
         v) Reversing operation/reverse operating test
         vi) Governor test (in case where a speed governor is provided.)
         vii) Charging test
         viii) Insulation resistance test
         ix) Endurance test
      b) Cold engine starting test
      c) Engine-out-of-water test
      d) Submerged engine test
      e) Additional tests for engines for self-righting partially enclosed, totally enclosed, lifeboats with a self-contained air support and fire-protected lifeboats
         i) Engine inversion test
      f) Overhaul inspection
   D) Outboard motors for rescue boats;
      a) General performance tests
         i) Starting test
         ii) No-load, low-speed operation test
         iii) No-load, high-speed test (in case where no speed governor is provided)
         iv) Full load test
         v) Minimum speed operating test
         vi) Reversing operation and reverse operating test
         vii) Governor test (in case where a speed governor is provided)
         viii) Quick speed changing test
         ix) Engine-out-of-water test
         x) Charging test
         xi) Insulation resistance test
         xii) Endurance test

b) Tests for rescue boats
   i) Running test
   ii) Water drench test
   iii) Hot start test
   iv) Manual start test
   v) Cold start test
c) Overhaul inspection

6.2 Production Test

6.2.1 Inspection

A production test of each engine unit is to consist of the examination of the implementation of the quality control system of the production site of the manufacturer and of the respective records, and of the following tests and inspections. The procedures for performance tests are to be in accordance with Annex E or International Standards recognized by BKI:

1) External and construction inspections:
   A) External and construction inspection;
   B) Dimension measurement;
   C) Mass measurement.
2) Performance tests:
   A) Internal combustion engines (including reduction and reversing gears) for lifeboats and rescue boats (excluding outboard motors);
      a) Starting test
      b) No-load, low-speed operating test
      c) No-load, high-speed operating (in case where no speed governor is provided.)
      d) Load test
      e) Reversing operation and reversing test
      f) Governor test (in case where a speed governor is provided.)
      g) Charging test
      h) Insulation resistance test
      i) Overhaul inspection
   B) Outboard motors for rescue boats:
      a) Starting test
      b) No-load, high-speed operating test (in case where no speed governors is provided.)
      c) Full load test
      d) Minimum speed operating test
      e) Reversing operation and reversing test
      f) Governor test (in case where a speed governor is provided.)
      g) Charging test
      h) Insulation resistance test
      i) Overhaul inspection

6.2.2 Inspection of Marking

Engines which have been subjected to the production test with satisfactory result are to be marked with the following markings in clear permanent characters at some appropriate location on each piece:

- Type approval number of BKI;
- Serial number of the manufacturer; and
- Date, month and year of the manufacture.
- Maximum continuous output and rotation

7. Release Mechanisms of Lifeboats or Rescue Boats Launched by Falls Other than Free-fall Lifeboats

7.1 Type Approval

7.1.1 Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2:

1) Specifications;
2) Construction (including main dimensions and materials);
3) Strength calculations;
4) Handling and maintenance manuals;
5) Other drawings and documents which are deemed necessary by BKI.

7.1.2 Prototype test

A prototype test is to consist of the following tests and inspections. The procedures for tests on strength and performance are to be in accordance with Annex F or International Standards recognized by BKI:

1) External and construction inspections:
   A) External and construction inspection;
   B) Dimension measurement.
2) Strength and performance tests:
   A) On-load release test;
   B) Off-load release test;
   C) Being towed release test;
   D) Resistance test;
   E) Repeated loading test;
   F) Release operation test;
   G) Loading test.

7.2 Production Test

7.2.1 Inspection

A production test of each release mechanism is to consist of the examination of the implementation of the quality control system of the production site of the manufacturer and of the respective records, and of the following tests and inspections. The procedures for strength and performance tests are to be in accordance with Annex F or International Standards recognized by BKI:

1) External and construction inspections:

A) External and construction inspection;

B) Dimension measurement.

2) Strength and performance tests:

A) Performance test;

B) Strength test.

7.2.2 Inspection of Markings

Release mechanisms which have been subjected to the production test with satisfactory result are to be marked with the following markings in clear permanent characters at some appropriate location on each piece:

- Type approval number of BKI;
- Serial number of the manufacturer; and
- Date, month and year of the manufacture.

AU. Ballast Water Management Systems

1. Introduction

The procedures and requirements described in this Guidance are applicable for obtaining BKI's type approval certificate based on requirements in:

- IMO BWM Convention: International convention for the control and management of ships' ballast water and sediments
- IMO Res. MEPC.300(72) Code for Approval of Ballast Water Management Systems (BWMS CODE)
- IMO Res. MEPC.169(57) Appendix: Procedure for approval of ballast water management systems that make use of active substances (G9),

2. Scope

This Guidance gives a description of the procedures and requirements related to documentation, design and type testing applicable for type approval of Ballast water management systems (BWMS).

This Guidance does not set the design requirements to the Ballast water management systems. Type approval is based on compliance with design requirements given in BKI rules and/or other regulations and standards. The Guidance describes the applicable design requirements and how to document compliance with the requirements in order to obtain a type approval certificate for the equipment. This includes, where relevant, technical requirements for how the type tests shall be performed.

3. Application

Type approval of equipment in accordance with this Guidance is not mandatory, but may be used as an alternative to case by case design approvals for equipment to be installed on BKI classed vessels.

A type approval certificate in accordance with this Guidance will confirm compliance with the requirements as specified in 1. The type approval certificate will not confirm compliance with requirements in other parts of the regulation. In case additional requirements in other parts of the regulation shall be covered by the type approval certificate, this shall be specified in the application for type approval and will be stated in the type approval certificate.

4. Data to be submitted

For type approval of Ballast water management systems, the following documentation shall be submitted. The following reference data are to be submitted to BKI in addition to those specified in A.2:

1) Main drawings of the system:
   - general arrangements
   - P&ID
   - electrical/electronic wiring diagrams
   - sampling points
2) Bill of materials
3) Technical manuals – including:
   - system process description
   - system process limitations
   - operational instructions
   - specification of main components

- maintenance instructions
- safety requirements
- installation specifications
- troubleshooting procedures
- commissioning procedure
- scaling documentation

4) Functional description

5) Corrosion tests

6) Land-based and shipboard test plans as required in IMO guideline G8 Appendix Part 2, Section 2.3 and Section 2.2:
   - quality management plan (QMP) addressing the quality control management structure and policies of the testing body (including subcontractors and outside laboratories). IMO guideline G8 Appendix Part 2, Section 2.1. The QMP may be included in the QAPP.
   - quality assurance project plan (QAPP) specifically produced for the BWMS to be approved. IMO guideline G8 Appendix Part 2, Section 2.1.
   - discharge permit for the land based test facility and the treated ballast water if required by national authorities.

5. Type Tests

The manufacturer of the equipment shall submit information regarding the design, construction, operation and functioning of the Ballast water management system in accordance with 4. and G8 Part 1 of the Appendix. This information shall be the basis for a first evaluation of suitability. Further assessment shall be performed to conclude if the system is making use of an active substance or not. Following the first evaluation, a function test shall be performed to verify operation according to technical manuals and compliance with the BKI rules.

The Ballast water management system shall be tested for type approval in accordance with the procedures described in G8 Parts 2 and 3 of the Appendix.

A type approval certificate will be issued based on compliance with the BKI rules and procedures for type approval in accordance with G8 Parts 2 and 3 of the Appendix.

Ballast water management systems that make use of active substances or preparations containing one or more active substance shall be approved by IMO. The objective of the approval is to determine the acceptability of the active substances or preparation concerning ship safety, human health and aquatic environment, as described in G9.

5.1 Design requirements

The Ballast water management systems shall comply with the relevant requirements of the following publications:

- Rules for Machinery Installations (Pt.1, Vol.III) Sec. 11 about piping systems, valves and pumps.
- Rules for Electrical Installations (Pt.1, Vol.IV)
- International convention for the control and management of ships' ballast water and sediments (IMO BWM Convention)
- Guidelines for approval of ballast water management systems (G8), Res. MEPC.174(58) Appendix
- Procedure for approval of ballast water management systems that make use of active substances (G9), Res. MEPC.169(57) Appendix.

5.2 Pre-test evaluation

The manufacturer of the equipment should submit information regarding the design, construction, operation and functioning of the Ballast Water Management System in accordance with G8 Part 1 of the Appendix and according to 4. This information should be the basis for a first evaluation of suitability.

The documentation evaluation is carried out to assess that the BWMS is in compliance with requirements as stated in 1.

5.3 Type testing

Each type of Ballast Water Management System shall be subject to the following prototype tests witnessed by a BKI surveyor:

- visual inspection verifying compliance with approved documentation
- functional test
- performance testing in shipboard and land based tests as described in G8 Parts 2 of the Appendix
- Environmental tests according to G8 Parts 3 of the Appendix.

BKI will perform an assessment of documentation of test results from shipboard and land based tests.

The Ballast water management system will be type approved with a specific rated capacity. However, the type approved system may be installed in parallel to increase the total capacity. Such increased capacity does not require re-approval provided that each module consists of the same components and has the same capacity as the system, which was initially granted a type approval.

Different sizes of BWMS shall be assessed based on scaling documentation. Type testing may be required on a case by case basis.

5.4 Makers certificate

The manufacturer shall furnish each BWMS with a certificate. The certificate shall contain:

- declaration that the design of the BWMS conforms to the basis for the type approval
- details of the shop where testing was carried out
- references

5.5 Requirements for marking of product

The product shall be marked. The marking shall at least include the following information:

- manufacturer's name and/or logo
- type and model designation
- treatment rated capacity
- serial number, if any.

The marking shall be carried out in such a way that it is visible, legible and indelible. The marking of product shall enable traceability to the type approval certificate.

AV. Type Approval of Sacrificial Anode Materials

1. General

This sub-section gives a description of the procedures and requirements related to documentation, design and type testing applicable for type approval of sacrificial anode materials.

This sub-section does not set the design requirements to the sacrificial anode materials. Type approval is based on compliance with design requirements given in the BKI rules and/or other regulations and standards. This sub-section describes how to document compliance with the requirements in order to obtain a type approval certificate for the equipment. This includes, where relevant, technical requirements for how the type tests shall be performed.

A type approval certificate is limited to one manufacturer at one production site.

The following test results will be printed in the type approval certificate:

- test duration
- electrochemical efficiency (Ah/kg) / (protective current capacity)
- closed circuit potential (mV) v.s. Ag/AgCl/seawater / (driving voltage)
- temperature range the approval is valid for.

Type tests as specified in 5. shall be carried out and verified in one of the following ways:

- at a recognized and independent laboratory or a laboratory accepted by BKI
- at the manufacturer's premises in the presence of BKI Surveyor.

2. Application

A type approval certificate in accordance in this sub-section will confirm compliance with the requirements specified in Guidance for the Corrosion Protection and Coating Systems (Pt.1, Vol.G) and other related BKI Rules.

3. Data to be submitted

For type approval of sacrificial anode materials the following documentation shall be submitted by the manufacturer at initial type approval and updated, at renewal. The documentation shall be submitted as electronic files. The documentation that forms the basis for the type approval shall be easily available for BKI Surveyor at the applicant's premises.

The following reference data are to be submitted to BKI in addition to those specified in A.2.

1) type designation, i.e. product/trade names to be included in and stated on the type approval certificate
2) basis for approval. I.e. applicable rules and standards which the sacrificial anode alloy shall comply with.
3) product description/specification: a description or data sheet that gives a satisfactory characterization of the anode alloy. The data sheet is at least to include information on:
   - trade name
   - alloy type and grade (see Guidance for the Corrosion Protection and Coating Systems (Pt.1, Vol.G) Tables 8.3 and 8.4).
   - chemical composition including contents (minimum and maximum) of all alloying and impurity elements affecting anode performance

- closed circuit potential/driving potential to polarize the cathode
- electrochemical efficiency in Ah/kg of the sacrificial anode alloy materials as regards protective
- current capacity.

4) field of application and special limitations of the product to be stated in the type approval certificate
5) test results with references to standards, methods, calibration certificates of instruments used in testing, etc.
6) information regarding marking of the product or packaging [3]
7) in-service experience, from use in same or similar operating environment, if available

4. General Requirements

4.1 Design requirements

The chemical composition, closed circuit petential and protective current capacity of sacrificial anode materials shall comply with the relevant requirements in Guidance for the Corrosion Protection and Coating System (Pt.1, Vol.G).

4.2 Requirements to production and quality control arrangement

The manufacturer should have a quality system that meets ISO 9001 standards, or equivalent. If this quality standard is not fulfilled, the extent of type testing and assessments will be specially considered.

The quality control arrangement will particularly be checked with respect to:

- control and identification of incoming raw materials
- test equipment, test methods, test samples and reference to standards used
- treatment of anode inserts and cables
- quality control tests on chemical composition
- weight and dimensional control
- surface condition of produced anodes
- traceability and marking system
- production test reports/records
- production record
- system for issuing material certificates
- storage condition and procedure
- etc.

5 Type tests

Representative samples of the sacrificial anode alloy shall be selected from production or storage by surveyor during initial assessment for further type testing. Further details regarding the number and shape of samples to be collected is given in 5.1.

Type testing is required in order to obtain the electrochemical efficiency of the sacrificial anode alloy material as regards protective current capacity (Ah/kg).

[3] to be verified by surveyor during type testing

The type testing is based on galvanostatic testing immersed in synthetic seawater according to a recognised test procedure, e.g. NACE TM0190. Other test procedures may be used subject to an agreement with BKI prior to testing. Anode operating potential, current capacity and anode efficiency shall be documented.

The chemical composition of the test samples shall be checked to ensure that it is according to the specification.

5.1 Test procedures

5.1.1 Electrochemical testing

The detailed description of the test parameters shall be referred to NACE TM0190 or other recognized standards. The assigned test laboratory shall submit their test procedures to the BKI for review prior to starting the testing.

5.1.2 Chemical composition

Two samples from each heat shall be taken for chemical analysis. The samples shall be taken in the beginning and at the end of casting from the pouring stream. For smaller alloying furnaces (max. 500 kg), one sample per heat may be sufficient and shall be taken in the beginning of casting from the pouring stream. The samples shall be analyzed to verify the required chemical composition.

5.1.3 Physical properties

The detailed description of the test parameters shall be referred to EN 12496, Annex A or other recognized standards.

6. Marking of product

The anodes shall be marked. The marking shall at least include the following information:

- anode type and denomination (full product name or short version of product name) to be stamped on each anode
- the manufacturer’s name or trade mark shall be traceable either from the above anode type denomination or from a separate stamp
- production batch number/ identification
- production date, if applicable.

The marking shall be carried out in such a way that it is visible, legible and indelible. The marking of product shall enable traceability to BKI type approval certificate.

Section 4 Design Approval

A. General 4–1
B. Loading Computer and Stability Programs 4–3
C. Container Lashing Calculation Program 4–3

A. General

1. Application

1.1 The requirements in this Section apply to the procedure for the approval of the drawings and documents submitted in advance to BKI designating the construction, dimensions, materials, specifications, etc., as the standardized design for machinery and equipment required to obtain approval by submitting drawings to BKI in accordance with the requirements in. Rules for Machinery Installations (Pt.1, Vol.III), Rules for Electrical Installations (Pt.1, Vol.IV), Rules for Refrigeration (Pt.1, Vol.VIII) and Guidelines for Loading Gear on Seagoing Ships and Offshore Installations (Pt.6, Vol.9).

1.2 The drawings other than those specified in the Rules may, where deemed appropriate by BKI, be approved upon the request of applicant. In this case, the requirements in this Section are correspondingly applied.

1.3 Machinery and equipment specified in Rules for Machinery Installations (Pt.1, Vol.III), Rules for Electrical Installations (Pt.1, Vol.IV), Rules for Refrigeration (Pt.1, Vol.VIII) and Guidelines for Loading Gear on Seagoing Ships and Offshore Installations (Pt.6, Vol.9) are to be as follows:

1.3.1 Rules for Machinery Installations (Pt.1, Vol.III)

- Prime movers: Diesel engines, steam turbines, turbochargers
- Power transmission gears: Reduction gears, reversing gears, flexible couplings
- Shaftings: Propellers
- Boilers: Boilers, exhaust gas economizers, thermal oil installations
- Pressure vessels: Air tanks, heating devices of fuel oil, other heat exchangers, etc.
- Essential auxiliaries: Pumps, air compressors, steering gears, windlass, winch, blowers, oil hydraulic motors, etc.

1.3.2 Rules for Electrical Installations (Pt.1, Vol.IV)

- Electrical equipment: Generators, motors
- Control systems: Remote control devices of main engine, control devices of boiler, etc.

1.3.3 Rules for Refrigeration (Pt.1, Vol.VIII) and Guidelines for Loading Gear on Seagoing Ships and Offshore Installations (Pt.6, Vol.9).

- Refrigerating installations: Compressors, pressure vessels
- Cargo handling arrangements: Construction drawings of cargo handling arrangements

2. Approval application

2.1 The manufacturers wishing to obtain design approval are to submit a copy of the application of design approval and for approval, the drawings and documents shall be submitted in electronic version (soft copy).

2.2 Relevant drawings (fully detailed sectional assembly, drawings for main component parts) and documents as bellows.

- Product specifications
- All product details, catalogues, data sheets, calculations and functional descriptions, parts list, etc. (if any)
- Application and operational limitation
- Drawings showing the interaction between the main components. (if any)
- Name and version No of software to be installed and Quality Assurance Plan (if any)
- Installation and operation manual (if necessary)
- Marking methods

2.3 When the alteration of the specification, construction, etc. is to be made on the machinery and equipment which have been granted the design approval, the manufacturer is to submit the application of alteration to BKI together with the detailed drawings and documents of the alteration.

3. Approval assessment

3.1 The machinery and equipment specified in 1.1 are to be assessed in accordance with the corresponding requirements in the Rules and the Guidance. And, in particular, the reliability and the endurability are to be investigated considering the existing damages, etc., on the same or similar type.

3.2 The machinery and equipment approved in accordance with 1.2 are to be assessed by applying the corresponding requirements in the Rules and the Guidance.

3.3 The assessment of Certificates issued by other Classification Society or an inspection organization recognized by BKI may be partially or wholly omitted. However, for this, the drawings and documents related to approval by other Classification Society or an inspection organization are to be submitted.

4. Notification and announcement of approval

4.1 BKI is to issue a Design Approval Certificate to the applicant, where deemed appropriate by BKI on the basis of the submitted drawings and documents after completion of the approval assessment.

4.2 BKI announces the manufacturers who have been granted the design approval in the booklet of "List of Approved Manufacturer & Type Approved Products".

5. Validity and renewal of approval certificate

5.1 The design approval certificate will be valid within five (5) years from the date of issue.

5.2 The manufacturer who intends to have a continuation of the approval is to submit an application to BKI three (3) months before the expiry date together with the contents of alteration if there is any alteration to the design.

5.3 At the request of the manufacturer, BKI may extend the validity of approval certificate within the period of three (3) months after expiry of the validity. In this case, the renewed approval certificate will be valid within five (5) years from the expiry date of old approval certificate.

6. Suspension or withdrawal of approval

6.1 BKI can withdraw the design approval, in case any of the following cases.

1) When the machinery and equipment no longer conform to the given requirements due to amendments or establishment of conventions, laws, rules and regulations.
2) When serious shortcomings are found in structure or quality of the machinery and equipment already approved after being installed in ships.
3) When a request for withdrawal is made by the manufacturer.
4) When the approval fees are not paid.
5) When request for renewal of certificate is not made by the manufacturer.
6) When considered inappropriate for approved condition by BKI.

6.2 When necessary conduct occasional audit, where non-conformities in the approved quality system are found, or where conditions for the issuance of the certificate or for its maintenance have deteriorated, the manufacturer is to correct the non-conformities. Such corrections are to be verified by BKI. In case corrective actions are not taken within the specified period, BKI may suspend the approved certificate for a given period. In case the corrective actions are not taken for the suspended period, BKI may withdraw the approval.

6.3 A manufacturer whose approval has been withdrawn, may apply for re-approval provided that the reasons which resulted in cancellation are corrected, and BKI is to issue the approval certificate after it is confirmed that the corrective action has effectively been implemented.

6.4 Where an application for re-approval is made for product which had its design approval withdrawn, such application shall be handled according to initial design approval requirements. But, it may be considered as exceptional case in case where BKI specially accepted.

7. Handling after approval

In case the machinery and equipment obtained design approval, the manufacturers may submit a copy of design approval certificate instead of the drawings and documents required by the Rules to BKI at the application of manufacturing survey.

B. Loading Computer and Stability Programs

1. Application

Tests and inspection for the design approval of program (software) to be used for the Loading Computer System for stability calculation and longitudinal strength calculation installed in ships according to Rules for Hull (Pt.1, Vol.II) Sec. 1 and Sec. 5, are to be carried out according to Guidance for Certification of Loading Computer System (Pt.4, Vol.1).

C. Container Lashing Calculation Program

1. General

1.1 The requirements of this sub Section, under approval application, can apply to tests and inspection for in ships according to Rules for Stowage and Lashing of Containers (Pt.4, Vol.I).

1.2 For the design approval of container lashing calculation program, the review and acceptance of design is necessary for two sample ships at least according to typical test condition in Rules for Stowage and Lashing of Containers (Pt.4, Vol.I) Appendix F.

2. Documentation to submit

The manufacturers wishing to obtain design approval are to submit a copy of the application of design approval and three copies of the following documents:

- User manual
- Program description
- Test report
- Stored ship's characteristics data

It is to be contained information of the sample ships but not needs to contain information of specific ship such as name of builder, building number and identification number of the ship in these documentations.

3. Requirements

The design requirements of container lashing calculations program:

3.1 The program is to present the following of each container arrangement.

- Draught
- GM value
- Each container weight
- Position of each container stack
- Lashing arrangement
- Accelerations of each container
- The calculated load of each container
- Strength limitation (according to internal forces in containers, forces in securing equipment and forces in supports)
- A clear warning is to be given if any of the strength limitations are not complied with
- The data is to be presented as screen and hard copy output to the user in a clear and unambiguous manner

3.2 The program is to reject input errors by the user.

3.3 The program and the stored characteristic data are to be protected against erroneous use by the user.

4. Approval

4.1 The acceptable criteria of the calculation results of the program is according to the following:

[(Value calculated by program) – (Value calculated by BKI)] / (allowable) ≤ ± 5 %

4.2 The general approval procedure is in accordance with A. not specified in this sub section.

4.3 All changes to the program are to be made by the designer and BKI informed immediately, since such changes invalidate any certificate issued and the certificates shall be re-issued for the changes by BKI.

Section 5 Approval of Alternative Certification Scheme (ACS)

A. General 5–1
B. Assessment 5–3
C. Approval 5–4
D. Requirements of Quality System 5–6

A. General

1. Application

1.1 The requirements of this Section apply to the procedures for the approval of Alternative Certification Scheme (ACS) to carry out the plant audit and to evaluate the capability of the quality assurance of the manufacturer of materials and equipment in accordance with the requirements of relevant BKI Rules to assure the product(s) comply with BKI Rules and Standards.

1.2 The manufacturers wishing to obtain the approval of ACS are to comply with the requirements specified in the relevant Section in this Guidance according to the kind of equipment and materials in addition to the requirements in this Section.

1.3 The manufacturers wishing to obtain the approval of BKI for items other than those in 1.1 above are to comply with the requirements of this Section.

1.4 The manufacturers wishing to obtain the approval of BKI for their machining, construction and/or repair process, etc. are to comply with the requirements of this Section.

1.5 An ACS may be arranged with product manufacturers and/or sub-suppliers.

1.6 An ACS with a manufacturer must define the handling of subcontracted parts (those that require BKI or work certificates or in any other way are addressed in the BKI's Rules).

The sub-supplier may be included in the ACS of the manufacturer or have his own ACS or deliver parts that are inspected and certified by the BKI.

2. Type of certification scheme

2.1 Fully entrusted certification scheme

2.1.1 This type is to entrust all of the required inspection and testing without the presence of BKI Surveyor.

2.1.2 Generally, the object of fully entrusted ACS is mass produced machinery or material's company which maintains ISO 9001:2015 certification, low level nonconforming product rate and high reliability. Examples for product are high speed diesel engine, steel plates.

2.1.3 The approved manufacturer shall stamp KIQ punch on equipment and materials which are passed KI-ACS Maintain Procedure on behalf of BKI surveyor.

2.2 Partial entrusted certification scheme

2.2.1 This type is to entrust parts of the required inspection and testing without the presence of BKI Surveyor

2.2.2 Generally intermediate survey is omitted, and partial main inspection item and/or final survey shall be carried out with attending.

2.2.3 General, the object of Partial entrusted ACS are materials and equipment manufacturers (ex.: propeller, boiler, main engine for marine vessel) which are producing product with a various kind of small quantity or product on demand and which maintain ISO 9001:2015, lower ratio of inferior goods and have high reliability of product or items for which ship owners or customers tend to attend the test practically.

2.2.4 Equipment and materials shall be stamped KI punch by BKI surveyor while attending final inspection.

2.3 BKI surveyor may attend tests, inspections and issue the relative material certificates in case of founding quality defect or upon request of ship owner or customer even though it is Full or Partial ACS approved item

3. Approval application

3.1 The manufacturers wishing to the approval of ACS are to submit a copy of the application form together with following data in 3.2 to BKI.

3.2 Data to be submitted

3.2.1 Approval documents: Procedure for maintaining approval of ACS (electronically)

1) Scope: Manufacturer's factories and products to be approved by ACS, permission range of manufacturer's self-inspection from BKI
2) Responsibility and authority: Person in charge of manufacturing survey and personnel (Quality, Production etc.) relating with ACS [Department, Title, Name, Works (control of BKI Rules and punch and verification of inspection report) relating with ACS etc.]
3) Relevant Document: List of quality control documents including inspection criteria to comply with BKI Rule requirement and/or the list of suppliers or sub-contractors for components and/or materials, including certificates.
4) Procedure for preparing test and inspection report to BKI office
5) Product marking method
6) Control of BKI punch (If applicable)
7) Verification of inspection report/Identification and traceability of products according to permission of manufacturer's tests and inspection
8) Inspection and test plan

3.2.2 Reference

1) Quality manual (electronically)
2) Other data deemed necessary by BKI for the approval of ACS.

3.3 The manufacturers wishing to obtain the approval of BKI for items not specified in this Guidance or for machining, construction and/or repair process, etc. are to submit in electronic format of following data additionally to BKI.

1) Outline of the products to which the quality assurance system is applied (product name, range of application for approval, etc.)
2) Outline of the machining, construction and/or repair process, etc. to which the quality assurance system is applied, Applicable codes, etc.

B. Assessment

1. Documentation assessment

In the documentation assessment, the data submitted under the requirements in A.3.2. above are investigated to confirm that the documented quality system is in conformity with D.1. and D.2. below.

2. Plant audit

2.1 Upon satisfactory outcome of the assessment of the documentation, a visit is made to evaluate the Manufacturing survey arrangement and to verify that the manufacturer's quality assurance system is to be in conformity with D.1. and D.2. below.

2.2 When parts of products are produced by subcontractors, BKI may request the audit of their facilities to assess the manufacturing process and quality control at their location.

2.3 When an external person takes part in the manufacturing process relating to quality of products at works, BKI may request the audit of that person.

2.4 When deficiencies in the quality assurance system are found, the manufacturer is to be informed by documentation, and after the corrective action of the deficiencies is taken by the manufacturer, the Surveyor's revisit may be made to evaluate the validity of the corrective action.

2.5 Upon satisfactory outcome of the audits, the extent, duration and conditions of the ACS are documented.

3. Intermediate audit

3.1 Intermediate audit is to be carried out to the manufacturer's workshop within after two (2) years but not three (3) years passing from the initial or the renewal approval date to confirm that the approved quality system, etc. of the works are maintained satisfactorily. However, the intermediate audit may be performed with a shorter interval than that above, where deemed necessary by BKI.

3.2 Intermediate audit is to be carried out in accordance with 1. and 2. above.

3.3 When deficiencies in the quality assurance system are found, it is to be in accordance with 2.4 above.

4. Renewal audit

4.1 When the valid term of the approval certificate is expired, if the manufacturer intends renewal of the approval, renewal audit is to be carried out to the manufacturer's workshop in accordance with 1. and 2. above.

4.2 Where deemed acceptable, a part of data to be submitted and audit may be reduced.

4.3 When deficiencies in the quality assurance system are found, it is to be in accordance with 2.4 above.

5. Occasional audit

5.1 BKI may request the occasional audit if any of the following condition happens:

1) Important changes of approved quality system
2) Products to be approved are changed or added (However, where the manufacturer obtained other approval specified in the relevant Section in this Guidance in addition to the approval of quality

assurance system, occasional audit may substitute for conforming the change or addition during the next periodical audit or renewal audit)

3) Where problem in the quality of the approved product is reported.

5.2 In the occasional audit, it is to be confirmed by BKI that all the necessary requirement is in a satisfactory condition.

5.3 When deficiencies in the quality assurance system are found, it is to be in accordance with 2.4 above.

C. Approval

1. Notification and announcement of approval

1.1 After satisfactory completion of the documentation assessment and plant audit in B.1. and B.2. above, BKI is to issue the Approval Certificate for Alternative Certification Scheme and send it to the applicant.

1.2 BKI announces the manufacturers who have been granted quality assurance system certification in the "List of The Approved Manufacturer & Type Approved Products" containing the types of products and the main conditions of approval.

2. Validity of the certificate

2.1 The Approval Certificate for Alternative Certification Scheme will be valid for five (5) years from the date of issue. In case where the approval certificate is reissued in accordance with the requirements specified in the preceding B.5, the expiration date will not be changed.

2.2 This approval maintains its validity under the acceptance of periodical audit in B.3. above.

2.3 The manufacturer who intends to have a continuation of the approval is to submit an application to BKI three (3) months before the due date together with the contents of the alteration if there is any alteration to the manufacturing facilities and to the quality assurance systems.

2.4 Where for operational reasons, the renewal audit falls outside the period of approval, the manufacturer will still be considered as approved if agreement to this audit date is made within the period of three months after expiry of the validity, in this instance if successful, the extension of approval will be back dated to the original renewal date.

3. Suspension and withdrawal of certification

3.1 When non-conformities in the approved quality assurance system are found, or when conditions for the issuing of the certificate or those for its maintenance have deteriorated, the manufacturer is to correct the non-conformities. Such corrections are to be verified by BKI. In case corrective actions are not taken within the specified period, BKI may suspend the approved certificate for a given period. In case the corrective actions are not taken for the suspended period, BKI may withdraw the approval of quality assurance system.

3.2 BKI can withdraw the approval of a quality assurance system if any of the following conditions happens:

1) When important changes having significant effect on the quality system is not communicated to BKI.
2) When the periodical, occasional or renewal audit is not carried out in the relevant period.
3) When a request for withdrawal is made by the manufacturer.

4) When the approval fees are not paid.
5) In case where forged or falsified stamps or certificates are used.
6) When the manufacturer's quality is questionable in accordance with 5.5.
7) When considered inappropriate for approved condition by BKI.

3.3 When the approval is withdrawn, the manufacturer is to return BKI stamp (KIQ) to BKI.

3.4 A manufacturer whose approval has been withdrawn, may apply for re-approval provided that the reasons which resulted in cancellation are corrected, and BKI is to issue the approval certificate after it is confirmed that the corrective action has effectively been implemented.

3.5 Where an application for re-approval is made for product which had its quality assurance system approval withdrawn, such application shall be handled according to initial quality assurance system approval requirements. But, it may be considered as exceptional case in case where BKI specially accepted.

4. Change in the quality assurance system

4.1 In case of any change of the company organization, the quality manual, etc. having effect on the quality system, it is to be promptly communicated by the manufacturer to BKI. Especially, important changes having significant effect on the approved quality system is as follows:

1) Overall alteration or abolition of the quality manual, etc.
2) Alteration of major management (owner, director's committee, etc.)
3) Alteration of organization (consolidation of the quality system, etc.)
4) Alteration, abolition and transfer of the manufacturing process (machining, construction, etc.), major facilities and manufacturing survey arrangement defined in quality manual.

5. Handling after approval (permission of manufacturer's tests and inspection)

5.1 The manufacturer's tests and inspections in accordance with the approved ACS granted by BKI may be allowed partially or wholly.

5.2 The person in charge of manufacturing survey is to be qualified and to have experience to BKI's satisfaction, to manage the manufacturing survey arrangement, to survey, to make records and to control the BKI stamp provided by BKI, and not to be affected for quality control by the managements. The experience of the person in charge of the manufacturing survey arrangement is to be not less than one year as a person in charge of quality control at the works and the person is recommended to complete the quality education course of BKI or equivalent.

5.3 The person in charge of manufacturing survey is to carry out the tests and inspections according to the approved manufacturing survey arrangement, and mark the accepted products with the descriptions given and the stamp (KIQ) provided by BKI. However, for products where marking on them is difficult such as fire protection materials, welding materials, etc., they may be marked with the mark of approval by BKI at a suitable position on them or their packing materials.

5.4 The person in charge of manufacturing survey is to submit the work certificate or test reports, recorded manufacturing number, final test date, major description, etc., to BKI. When satisfactory with the submitted reports, BKI issues the individual product certificate to the manufacturer. However, for the products whose inspection is not required after approval, such as fire protection materials, welding materials, etc., the submission of their reports and certificate is exempted.

5.5 For material manufacturers (rolled steels, castings, forgings, etc.) with the approval of fully entrusted certification scheme, the Surveyor may unexpectedly request witnessing of tests even after submitting the self-test reports. For this purpose, the manufacturer is to keep enough specimens or

samples for at least one week after the application date. Chemical composition and mechanical properties are to be verified in the presence of the Surveyor and the results are not to show a significant deviation from those already submitted. If the results are suspicious or do not meet the requirements, the Surveyor may request re-tests and, if necessary, suspend or withdraw the approval.

5.6 Regardless of the survey delegation, BKI may directly issue the product certificate upon witnessing of the test in case one of the followings is concerned.

- The customer especially requests
- There is any problem with the quality of certified products.

5.7 BKI may carry out unscheduled inspections at the manufacturer and/or subcontractor at least once in a year.

D. Requirements of Quality System

1. General requirements

1.1 The manufacturers wishing to obtain the approval of ACS are to comply with the requirements of ISO 9001:2015.

1.2 Where deemed appropriate by BKI, equivalent other than the requirements in this Section may be considered satisfactory to this Section.

1.3 The manufacturers intending to apply for the requirement in 1.2 above, in advance, are to inform BKI.

2. Special requirements

2.1 Control of approved drawings by BKI

The manufacturer is to establish and maintain documented procedures to control the approved drawings by BKI, and appoint the responsible personnel.

2.2 Conformity on the Rules of BKI

In purchasing incoming materials, the manufacturer is to establish and maintain the documented procedures to confirm that they meet the requirements in the Rules.

2.3 Identification and traceability of products possessed BKI's certificate

The manufacturer is to establish and maintain the documented procedures to confirm the relation between the products with BKI's certificate and their materials for the identification and traceability of products, if necessary.

2.4 Qualified personnel

Welding or NDT operators among special processes operators which requiring pre-qualification of their process capability are be qualified by BKI or by another body recognized by BKI.

2.5 Approval of the non-conforming products by BKI

2.5.1 Where non-conforming products are intended to use after repair or rework, the manufacturer is to ensure that the tests or inspection for use are to be carried out in the presence of the Surveyor.

2.5.2 Any deficiencies found on products which are approved in accordance with this Section are promptly to be eliminated. The manufacturer is to establish and maintain the documented procedures to communicate those affecting the ultimate quality of the products to BKI.

2.6 Notification of the corrective action

The procedures for corrective action are to include communication method to BKI confirming that the corrective action is carried out and that it is effective.

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Section 6 Manufacturer Approval

A. General 6–1
B. Quality system requirements 6–1
C. Assessment 6–2
D. Approval 6–3

A. General

1. Application

1.1 The requirements in this Section apply to the procedures for manufacturer approval of product (paints and fire protection materials, etc.) having no individual product inspection, after type approval in accordance with the requirements in this Guidance.

1.2 The manufacturers wishing to obtain the approval of BKI for items other than those in 1.1 above are to comply with the requirements of this Section.

1.3 In such assessment of a manufacturer, an investigation on the quality system, production procedures, production facilities and personnel, etc. and, an approval test where necessary, are carried out, and comprehensive evaluation is made.

2. Approval application

2.1 The manufacturers wishing to obtain the Manufacturer Approval for the first time are to submit the application of manufacturer approval together with data (electronically) in Section 3, A.2.3.1 to BKI.

2.2 The manufacturers wishing to the Periodical Audit and Renewal Audit of manufacturer approval are to submit a copy of the application of manufacturer approval together with following data to BKI.

1) Reviewed manufacturing process during previous plant audit, the specification and list of the alteration to the manufacturing facilities (where practicable, to be mentioned with a comparison table form between new and old).
2) List of Type Approved Equipment issued by BKI.
3) Test records and the date list of accuracy and calibration of inspection and testing facilities. (electronically)
4) Service records to BKI.

2.3 However, the required data previously submitted to BKI, according to the Rules, may be exempted from submission.

3. Facilities and personnel of the manufacturer

For the requirements of facilities and personnel of the manufacturer refer to Section 2.A.4.

B. Quality system requirements

For the requirements of quality system refer to Section 5.D.

C. Assessment

1. Preparations for Assessment

1.1 All such preparations as required for assessment specified in 3. through 5. are to be made by the manufacturer. On such occasions, the management representative is also to be present at the assessment.

1.2 In case necessary preparations have not been made or in case no responsible person specified in 1.1 above is present at the assessment, BKI may suspend the assessment.

2. Documentation assessment

BKI examines the data submitted under the requirements in A.2. above.

3. Plant audit

3.1 Upon satisfactory outcome of the assessment of the documentation, a visit is made to evaluate the Manufacturing survey arrangement and to verify that the manufacturer's quality assurance system is to be in conformity.

3.2 When parts of products are produced by subcontractors, BKI may request the audit of their facilities to assess the manufacturing process and quality control at their location.

3.3 When an external person takes part in the manufacturing process relating to quality of products at works, BKI may request the audit of that person.

3.4 When deficiencies in the quality assurance system are found, the manufacturer is to be informed by documentation, and after the corrective action of the deficiencies is taken by the manufacturer, the Surveyor's revisit may be made to evaluate the validity of the corrective action.

4. Periodical audit

4.1 Periodical audit is to be carried out to the manufacturer's workshop annually within 3 months before and after the anniversary date to confirm that the approved quality system, etc. of the works are maintained satisfactorily. However, the periodical audit may be performed with a shorter interval than that above, where deemed necessary by BKI.

4.2 Periodical audit is to be carried out in accordance with 2. and 3. above.

4.3 When deficiencies in the quality assurance system are found, it is to be in accordance with 3.4 above.

5. Renewal audit

5.1 When the valid term of the approval certificate is expired, if the manufacturer intends renewal of the approval, renewal audit is to be carried out to the manufacturer's workshop in accordance with 2. and 3. above.

5.2 Where deemed acceptable, a part of data to be submitted and audit may be reduced.

5.3 When deficiencies in the quality assurance system are found, it is to be in accordance with 3.4 above.

5.4 Where for operational reasons, the renewal audit falls outside the period of approval, the manufacturer will still be considered as approved if agreement to this audit date is made within the period

of three (3) months after expiry of the validity, in this instance if successful, the extension of approval will be back dated to the original renewal date.

6. Occasional audit

6.1 BKI may request the occasional audit if any of the following condition happens:

1) Important changes of approved quality system.
2) Products to be approved are changed or added (However, where the manufacturer obtained other approval specified in the relevant section in this Guidance in addition to manufacturer approval, occasional audit may substitute for conforming the change or addition during the next periodical audit or renewal audit).
3) Where problem in the quality of the approved product is reported.

6.2 In the occasional audit, it is to be confirmed by BKI that all the necessary requirement is in a satisfactory condition.

6.3 When deficiencies in the quality assurance system are found, it is to be in accordance with 3.4 above.

6.4 When amendment of the certificate is necessary during occasional audit, the validity period of new certificate will be dated as previous certificate.

D. Approval

1. Issuance of assessment record

As a result of the assessment or the surveillance, an assessment record stating corrective action requests on the quality system, etc. is issued to the manufacturer.

2. Notification and announcement of approval

2.1 After satisfactory completion of the documentation assessment and plant audit, BKI is to issue the Manufacturer Approval Certificate and send it to the applicant.

2.2 BKI announces the manufacturers who have been granted Manufacturer Approval Certification in the “List of Approved Manufacturer & Type Approved Product” containing the types of products and the main conditions of approval.

3. Validity of the certificate

3.1 The valid term of an approval certificate is not exceeding 5 years from the date of the initial or the renewal approval. In case where the renewal audit is carried out within 3 months before the expiry date, the valid term of the approval certificate will be dated to the original renewal date.

3.2 The manufacturer who intends to have a continuation of the approval is to submit an application to BKI three months before the due date together with the contents of the alteration if there is any alteration to the manufacturing facilities and to the quality assurance systems.

3.3 Where for operational reasons, the renewal audit falls outside the period of approval, the manufacturer will still be considered as approved if agreement to this audit date is made within the period of three months after expiry of the validity, in this instance if successful, the extension of approval will be back dated to the original renewal date.

4. Suspension and withdrawal of certification

4.1 When nonconformities are found in the periodical audit, renewal audit or occasional audit or when conditions for the issuing of the certificate or those for its maintenance have deteriorated, the manufacturer is to correct the non-conformities. Such corrections are to be verified by BKI. In case corrective actions are not taken within the specified period, BKI may suspend the approved certificate for a given period. In case the corrective actions are not taken for the suspended period, BKI may withdraw the Manufacturer Approval.

4.2 BKI can withdraw the Manufacturer Approval and Type Approval of products if any of the following conditions happens:

1) When important changes having significant effect on the quality system is not communicated to BKI.
2) When the periodical, occasional or renewal audit is not carried out in the relevant period.
3) When a request for withdrawal is made by the manufacturer.
4) When the approval fees are not paid.
5) In case where forged or falsified stamps or certificates are used.
6) When considered inappropriate for approved condition by BKI.

5. Changes in the approved contents

5.1 In case of any change having effect on the manufacturing process and the quality system, it is to be promptly communicated by the manufacturer to BKI. BKI may request an occasional plant audit, where deemed necessary upon reviewing the contents of alteration.

5.2 When the manufacturing sites (including that of subcontractor's works) were relocated, changed or added, the manufacturer is to submit the application for alteration to BKI together with the detailed documents of the alteration (where practicable, to be mentioned with a comparison table form between new and old). BKI is to carry out the plant audit for the manufacturing process and quality system by visiting.

Annex A Procedures for Prototype Tests for Type Approval and Production Tests of Lifeboats

A. Procedures for Prototype Tests for Type Approval of Lifeboats A–1
B. Procedures for Production Tests of Lifeboats A–15

Numbering in bracket [.....] refer to paragraph on IMO Resolution MSC.81(70) for Reference

A. Procedures for Prototype Tests for Type Approval of Lifeboats

1. Material Test

1.1 Material Test for Boat Hulls and Rigid Covers

The materials of boat hulls and rigid covers made of materials other than metals are to be subjected to the following tests:

1.1.1 Fire-redundancy Test [6.2.1]

.1 The test is to be carried out in accordance with 5.24 “Fire Retarding Characteristics A Method” of JIS K 6911 “Testing Methods for Thermosetting Plastics“. The burning time and burning distance, measured after the test, are to be less than 180 seconds and not more than 25 mm respectively;

.2 Where there are any difficulties in conducting the test in accordance with 1.1.1.1 above, an equivalent test procedure may be acceptable.

1.1.2 Material Test for FRP

Where the material is FRP, tests are to be carried out in respect of the following and it is to be ascertained that they conform to the design standards of the manufacturer:

1) Glass contents;
2) Tensile strength;
3) Bending strength;
4) Barcol hardness.

1.2 Material Test for Buoyant Materials [6.2.2～6.2.7]

The dimensions of a test specimen are to be 300 mm × 300 mm × 150 mm

1.2.1 Test for Stability under Temperature Cycling (Six specimens) [2.6.1～2.6.4]

The dimensions of test specimens are to be measured at the beginning and end of the tests.

.1 Specimens are to be alternately subjected to surrounding temperatures of -30°C and +65°C. These alternating cycles need not follow immediately after each other and the following procedure, repeated for ten cycles, is acceptable:

1) First Day

The specimens are to be exposed for 8 hours at a minimum temperature of +65°C. They are then to be removed from the warm chamber, and are to be left exposed at a temperature of 20°C ± 3°C until the next day;

2) Second Day

The specimens subjected to the tests referred to in 1) above are to be exposed for 8 hours at a maximum temperature of -30°C. They are then to be removed from the cold chamber, and are to be left exposed at a temperature of 20°C ± 3°C until the next day.

As a result of the tests, the specimens are to show no sign of external change of structure or of mechanical qualities.

.2 The dimensions of the specimens (except kapok) are to be recorded at the end of the ten-cycle period. The specimens should be carefully examined and should not show any sign of external change of structure or of mechanical qualities.

1.2.2 Test for Water Absorption [2.6.5～2.6.7]

.1 The test specimens are to be the following six:

1) two specimens as supplied;
2) two specimens which have been subjected to the temperature cycling as prescribed in 1.2.1.1; and
3) two specimens which have been subjected to the temperature cycling as prescribed in 1.2.1.1 followed by the immersion for a period of 24 hours under a 100 mm head of high octane petroleum spirit at normal room temperature.

.2 The dimensions of the test specimens are to be measured at the beginning and end of these tests.

.3 The specimens are to be immersed for a period of seven (7) days under a 1,25 m head of fresh water.

.4 The mass (in N) which each specimen could support out of the water after 1 and 7 days immersion is to be measured.

.5 As a result of the tests, the reduction ratio of buoyancy of the 7 days immersion specimen to the 1 day immersion specimen is not to exceed 10% for specimens which have been exposed to the high octane petroleum sprit and not to exceed 5% for all other specimen. The specimens are to show no sign of damage such as shrinking, cracking, swelling or changes of mechanical qualities.

1.2.3 Oil resistance Test [6.2.3, 6.2.4, 6.2.6, 6.2.7]

Two specimens of the material are each to be immersed in each of the following for a period of 14 days under a 100 mm head. These tests are to be carried out at normal room temperature (approximately 18°C). The dimensions of the specimens are to be measured at the beginning and end of these tests:

1) Crude oil;
2) Fuel oil;
3) Diesel oil;
4) High octane petroleum spirit; and
5) Kerosene

The mass (in kilograms) which each specimen could support out of the water after 14 days immersion is to be measured. The reduction ratio of buoyancy after 14 days immersion is not to exceed 5%, and the specimens are to show no sign of damage such as shrinking, cracking, swelling, dissolution or change of mechanical qualities.

2. Strength and Performance Tests

2.1 General [6.1]

2.1.1 Except as specified otherwise, the mass of an average person as used herein is to be taken to be 75 kg for a lifeboat intended for a passenger ship or 82,5 kg for a lifeboat intended for a cargo ship.

2.1.2 When weights are placed to represent the persons in the lifeboat, the centre of gravity of the weight in each seat is to be placed 300 mm above the seatpan along the seat back.

2.2 Lifeboat Overload Test [6.3]

2.2.1 Davit-launched Lifeboats [6.3.1～6.3.6]

.1 The unloaded lifeboat is to be placed on blocks or suspended from the lifting hooks. The measurements required in .4 are then to be made. Where the unloaded lifeboat is placed on blocks, the position of the blocks is to correspond to the position of the lifting hooks.

.2 The lifeboat is to then be loaded with properly distributed weights to represent the fully equipped lifeboat loaded with the full complement of persons for which it is to be approved. The measurements required in .4 are again to be made.

.3 Additional weights are then to be added so that the suspended load is 25%, 50%, 75% and 100% greater than the weight of the fully equipped and loaded lifeboat. In the case of metal lifeboats, the testing is to stop at 25% overload. The weights for the various overload conditions are to be distributed in proportion to the loading of the lifeboat in its service condition, but the weights used to represent the persons need not be placed 300 mm above the seatpan. Testing by filling the lifeboat with water are not to be accepted as this method of loading does not give the proper distribution of weight. Machinery may be removed in order to avoid damage to it, in which case weights are to be added to the lifeboats to compensate for the removal of such machinery. At each incremental overload, the measurements required in .4 are to be made.

.4 The following are to be measured and recorded at each condition of load specified in .1 through .3:

1) deflection of keel amidships;
2) change in length as measured between the top of stem and stern posts;
3) change in breadth over the gunwale at the quarter length forward, amidships and the quarter length aft; and
4) change in depth measured from gunwale to keel.

.5 The keel deflection and change in breadth in .4.1) and .4.3) are not to exceed 1/400 of the lifeboats length when the lifeboat is subjected to 25% overload; the results at 100% overload, if required by 2.2.1.3, are to be approximately in proportion to those obtained at 25% overload.

.6 The weights are then to be removed and the dimensions of the lifeboat checked. The residual deflection is not to exceed 1/1000 of the lifeboat s length. Any permanent deflection as a result of these tests is to be recorded. If the lifeboat is made of GRP, such measurement is to be taken after a lapse of time sufficient to permit the GRP to recover its original form (approximately 18 hours).

2.2.2 Free-fall Lifeboats [6.3.7～6.3.9]

.1 It is to be demonstrated that the lifeboat has sufficient strength to withstand the forces acting upon it when loaded with a distributed mass equal to the mass of the number of persons for which it is to be approved and its equipment when free-fall launched from a height of 1,3 times the height for which it

is to be approved. If the lifeboat is normally ramp-launched, and a ramp is not available, this test may be conducted by dropping the lifeboat vertically with the keel at the same angle that normally occurs during water entry.

.2 After this test the lifeboat is to be unloaded, cleaned and carefully examined to detect the position and extent of damage that may have occurred as a result of this test. An operational test is then to be conducted in accordance with 2.9.1. After this test the lifeboat is again to be unloaded, cleaned, and inspected for possible damage.

.3 This test is to be considered successful if the lifeboat passes the operational test to the satisfaction of BKI; no damage has been sustained that would affect the lifeboat s efficient functioning; and any deflections of the hull or canopy as measured during the test would not cause injury to lifeboat occupants.

2.3 Davit-launched Lifeboat Impact and Drop Test

2.3.1 Impact Test [6.4.1, 6.4.2]

.1 The fully equipped lifeboat, including its engine, is to be loaded with weights equal to the mass of the number of persons for which the lifeboat is to be approved. In totally enclosed lifeboats, representative safety belts and fastenings which will experience high loads as a result of the impact are to be secured about weight equal to 100 kg to simulate holding a person during the test. The weights are to be distributed to represent the normal loading in the lifeboat. Skates or fenders, if required, are to be in position. The lifeboat, in a free hanging position, is to be pulled laterally to a position so that when released it will strike a fixed rigid vertical surface at a velocity of 3,5 m/s. It is then to be released to impact against the rigid vertical surface.

.2 In the case of totally enclosed lifeboats, the acceleration forces are to be measured and evaluated in accordance with 2.16 at different positions within the prototype lifeboat to determine the most severe occupant exposure to acceleration considering the effects of fenders, lifeboat elasticity, and seating arrangement.

2.3.2 Drop Test [6.4.3, 6.4.4]

.1 The fully equipped lifeboat, with its engine, is to be loaded with weights equal to the mass of the maximum number of persons for which the lifeboat is to be approved. Included in this loading is to be a weight of 100 kg loaded in one of each type of seat installed in the lifeboat. The remainder of the weights are to be distributed to represent the normal loading condition but need not be placed 300 mm above the seatpan. The lifeboat is then to be suspended above the water so that the distance from the lowest point of the lifeboat to the water is 3 m. The lifeboat is then to be released so that it falls freely into the water.

.2 The drop test is to be conducted with the lifeboat that was used in the impact test.

2.3.3 Operational Test after Impact and Drop Tests [6.4.5]

After the impact and drop tests, the lifeboat is to be unloaded, cleaned and carefully examined to detect the position and extent of damage that may have occurred as a result of the tests. An operational test is then to be conducted in accordance with 2.9.1.

2.3.4 Acceptability Criteria for Impact and Drop Tests [6.4.6, 6.4.7]

.1 After the tests required in 2.3.1 to 2.3.3, the lifeboat is to be unloaded, cleaned, and inspected for possible damage.

.2 The impact and drop tests are to be considered successful if :

1) no damage has been sustained that would affect the lifeboat s efficient functioning;
2) the damage caused by the impact and drop tests has not increased significantly as a result of the test specified in 2.3.3;
3) machinery and other equipment has operated to full satisfaction;
4) no significant ingress of seawater has occurred; and
5) accelerations measured during the impact and subsequent rebound, if required during the impact test, are in compliance with the criteria of either 2.16.3.1 to 2.16.3.4 or 2.16.4.1 to 2.16.4.5 when using the emergency limits specified in Table 2 or Table 3, respectively.

2.4 Free-fall Lifeboat Free-fall Test [6.6]

2.4.1 Free-fall Tests [6.5.1～6.5.3]

.1 A lifeboat designed for free-fall launching is to be subjected to test launches conducted from the height for which the lifeboat is to be approved taking into account conditions of unfavourable list (20°) and trim (10°), unfavourable locations of the centre of gravity, and extreme conditions of load.

.2 During the free-fall launches, acceleration forces are to be measured and the data evaluated in accordance with 2.16 at different locations in the lifeboat to determine the worst occupant exposure to acceleration taking into consideration the seating arrangement.

.3 The tests required in this section may be conducted with correctly scaled models that are at least 1 m in length. As a minimum, the dimensions and mass of the lifeboat, the location of its centre of gravity, and its second moment of mass, is to be scaled in a reasonable manner. Depending on the construction and behaviour of the free-fall lifeboat, other parameters may also have to be reasonably scaled to effect correct behaviour of the model.

If models are used, sufficient full-scale tests are to be conducted to verify the accuracy of the model measurements. As a minimum, the following full-scale tests are to be conducted with the ship on an even keel using the same type of launching arrangement as the production lifeboat and from the height for which the lifeboat is to be approved:

1) lifeboat fully loaded;
2) lifeboat loaded with its required equipment and minimum launching crew only;
3) lifeboat loaded with its required equipment and one half of the full complement of persons distributed in the forward half of the seating positions of the lifeboat; and
4) lifeboat loaded with its required equipment and one half of the full complement of persons seated in the after half of the seating positions of the lifeboat.

2.4.2 Acceptability Criteria for Free-fall Tests [6.5.4]

.1 The free-fall tests required in 2.4.1 are to be considered acceptable if :

1) the acceleration forces are in compliance with the Training condition specified in Table 2 and Table 3 of 2.16 during the launch, free-fall, and subsequent water entry for those tests with the ship on even keel;
2) the acceleration forces are in compliance with the Emergency condition specified in Table 2 and Table 3 of 2.16 during the launch, free-fall, and subsequent water entry for those tests with the ship under unfavourable conditions of list and trim;
3) the lifeboat makes positive headway immediately after water entry.

2.5 Lifeboat Seating Strength Test [6.6]

2.5.1 Davit-launched Lifeboats [6.6.1]

The seating is to be loaded with a mass of 100 kg in each position allocated for a person to sit in the lifeboat. The seating is to be able to support this loading without any permanent deformation or damage.

2.5.2 Free-fall Lifeboats [6.6.2]

The seats experiencing the highest acceleration forces, and those seats which are supported in a manner different from the other seats in the lifeboat, are to be loaded with a mass of 100 kg. The load is to be arranged in the seat so that both the seatback and the seatpan are affected. The seating is to be able to support this load during a free-fall launch from a height of 1,3 times the approved height, without any permanent deformation or damage. This test may be conducted as part of the test in 2.2.2.1 to 2.2.2.3.

2.6 Lifeboat Seating Space Test [6.7]

2.6.1 Boarding and Seating Test [6.7.1]

The lifeboat is to be fitted with its engine and its equipment. The number of persons for which the lifeboat is to be approved having an average mass of 75 kg for a lifeboat intended for a passenger ship or 82,5 kg for a lifeboat intended for a cargo ship, and wearing a lifejacket and any other essential equipment is to be able to board the lifeboat and be properly seated within a period of 3 min in the case of a lifeboat intended for a cargo ship and as rapidly as possible in the case of a lifeboat intended for a passenger ship. The lifeboat is then to be manoeuvred and all equipment on board tested by an individual to demonstrate that the equipment can be operated without difficulty and without interference with the occupants.

2.6.2 Non-skid Finish Inspection [6.7.2]

The surfaces on which persons might walk are to be visually examined to determine that they have a non-skid finish.

2.7 Lifeboat Freeboard and Stability Tests [6.8]

2.7.1 Flooded Stability Test [6.8.1～6.8.3]

.1 The lifeboat is to be loaded with its equipment. If provision lockers, water tanks and fuel tanks cannot be removed, they are to be flooded or filled to the final waterline resulting from the test in .3. Lifeboats fitted with watertight stowage compartments to accommodate individual drinking water containers are to have these containers aboard and placed in the stowage compartments which are to be sealed watertight during the flooding tests. Ballast of equivalent weight and density is to be substituted for the engine and any other installed equipment that can be damaged by water.

.2 Weights representing persons who would be in the water when the lifeboat is flooded (water level more than 500 mm above the seat pan) may be omitted. Weights representing persons who would not be in the water when the lifeboat is flooded (water level less than 500 mm above seat pan) are to be placed in the normal seating positions of such persons with their centre of gravity approximately 300 mm above the seat pan. Weights representing persons who would be partly submerged in the water when the lifeboat is flooded (water level between 0 and 500 mm above the seat pan) are to additionally have an approximate density of 1 kg/dm³ (for example water ballast containers) to represent a volume similar to a human body.

.3 When loaded as specified in .1 and .2, the lifeboat is to have positive stability when filled with water to represent flooding which would occur when the lifeboat is holed in any one location below the

waterline assuming no loss of buoyancy material and no other damage. Several tests may have to be conducted if holes in different areas would create different flooding conditions.

.4 The flooded stability may be substituted by calculations instead of the above test where a circumstance does not permit the test.

2.7.2 Freeboard Test [6.8.4, 6.8.5]

.1 The lifeboat with its engine is to be loaded with a mass equal to that of all the equipment. One half of the number of persons for which the lifeboat is to be approved is to be seated in a proper seating position on one side of the centreline. The freeboard is then to be measured on the low side.

.2 This test is to be considered successful if the measured freeboard on the low side is not less than 1,5% of the lifeboat's length or 100 mm, whichever is greater.

2.8 Release Mechanism Test [6.9]

2.8.1 Davit-launched Lifeboats [6.9.1～6.9.5]

.1 The lifeboat with its engine fitted is to be suspended from the release mechanism just clear of the ground or the water. The lifeboat is to be loaded so that the total mass equals 1,1 times the mass of the lifeboat, all its equipment and the number of persons for which the lifeboat is to be approved. The lifeboat is to be released simultaneously from each fall to which it is connected without binding or damage to any part of the lifeboat or the release mechanism.

.2 It is to be confirmed that the lifeboat will simultaneously release from each fall to which it is connected when fully waterborne in the fully loaded condition without a mass of the number of persons for which the lifeboat is to be approved, and in a 10% overload condition.

.3 It is to be demonstrated that the release mechanism can release the fully equipped lifeboat when loaded with weights equal to the mass of the number of persons for which the lifeboat is to be approved, when the lifeboat is being towed at speeds up to 5 knots. In lieu of a waterborne test, this test may be conducted as follows:

1) a force equal to 25% of the safe working load of the hook is to be applied to the hook in the lengthwise direction of the boat at an angle of 45° to the vertical. This test is to be conducted in the aftward as well as the forward direction;
2) a force equal to the safe working load of the release mechanism is to be applied to the hook in an athwartships direction at an angle of 20° to the vertical. This test is to be conducted on both port and starboard sides;
3) a force equal to the safe working load of the hook is to be applied to the hook in a direction half-way between the positions of tests 1) and 2) above (i.e., 45° to the longitudinal axis of the boat in plan view) at an angle of 33° to the vertical. This test is to be conducted in four positions. There is to be no damage to the hook as a result of this test, and in the case of a waterborne test, there is to be no damage to the lifeboat or its equipment.

.4 A release mechanism is to be conditioned and tested as follows:

1) the lifeboat release and retrieval system and the longest used connection cable/linkage associated with the system is to be mounted and adjusted according to instructions from the original equipment manufacturer and then loaded to 100% of its safe working load and released. Load and release is to be repeated 50 times. During the 50 releases, the lifeboat release and retrieval system are to be released simultaneously from each fall to which it is connected without any binding or damage to any part of the lifeboat release and retrieval system. The system is to be considered as failed if any

failure during the conditioning or unintended release occurs when load is applied but the system has not yet been operated;

2) the lifeboat release and retrieval system are to then be disassembled, the parts examined and wear recorded. The release and retrieval system are to then be reassembled;

3) the hook assembly, whilst disconnected from the operating mechanism, is to then be tested 10 times with cyclic loading from zero load to 1,1 times the safe working load, at a nominal 10 seconds per cycle. However, if the release mechanism has been specifically designed to operate as an off-load hook with on-load capability using the weight of the boat to close the hook, the cyclic load is to be from no more than 1% to 1,1 times the SWL. For cam-type designs, the test is to be carried out at an initial cam rotation of 0^{o} (fully reset position), and repeated at 45^{o} in either direction, or 45^{o} in one direction if restricted by design. The specimen is to remain closed during the test. The system is to be considered as failed if any failure during this test or any unintended release or opening occurs;

4) the cable and operating mechanism are to then be reconnected to the hook assembly; and the lifeboat release and retrieval system are to then be demonstrated to operate satisfactorily under its safe working load. The actuation force is to be no less than 100 N and no more than 300 N. If a cable is used, it is to be the maximum length specified by the manufacturer, and secures in the same manner it would be secured in the lifeboat. The demonstration is to verify that any interlocks, indicators and handles are still functioning and are correctly positioned in accordance with the operation and safety instruction from the original equipment manufacturer;

5) the release mechanism is deemed to have passed the testing when the tests 1) to 4) above have all been conducted successfully. The system is to be considered as failed if any failure during this test or any unintended release or opening occurs.

.5 Another testing piece of the release mechanism tested in .4 above is to be tested as follows:

1) the actuation force of the release mechanism is to be measured loaded with 100% of its safe working load. The actuation force is to be no less than 100 N and no more than 300 N. If a cable is used, it is to be of the maximum length specified by the manufacturer, and secured in the same manner it would be secured in a lifeboat. The demonstration is to verify that any interlocks, indicators and handles are still functioning and are correctly positioned in accordance with the operation and safety instruction from the original equipment manufacturer;

2) the release mechanism is to be mounted on a tensile strength testing device. The load is to be increased to at least six times the working load of the release mechanism without failure of the release mechanism.

2.8.2 Free-fall Lifeboats [6.9.6～6.9.7]

.1 It is to be demonstrated that the free-fall release mechanism can operate effectively when loaded with a force equal to at least 200% of the normal load caused by the fully equipped lifeboat when loaded with the number of persons for which it is to be approved.

.2 The release mechanism is to be mounted on a tensile strength testing device. The load is to be increased to at least six times the safe working load of the release mechanism without failure of the release mechanism.

2.9 Lifeboat Operation Test [6.10]

2.9.1 Operation of Engine and Fuel Consumption Test [6.10.1]

The lifeboat is to be loaded with weights equal to the mass of its equipment and the number of persons for which the lifeboat is to be approved. The engine is to be started and the lifeboat manoeuvred for a period of at least 4 hours to demonstrate satisfactory operation. The lifeboat is to be run at a speed of not less than 6 knots for a period which is sufficient to ascertain the fuel consumption and to establish that the

fuel tank has the required capacity. The maximum towing force of the lifeboat is to be determined. This information is to be used to determine the largest fully loaded liferaft the lifeboat can tow at 2 knots. The fitting designated for towing other craft is to be secured to a stationary object by a tow rope. The engine is to be operated ahead at full speed for a period of at least 2 minutes. There is to be no damage to the towing fitting or its supporting structure. The maximum towing force of the lifeboat is to be recorded on the type approval certificate.

2.9.2 Compass [6.10.7]

It is to be determined that the compass performance is satisfactory and that it is not unduly affected by magnetic fittings and equipment in the lifeboat.

2.9.3 Survival recovery test [6.10.8]

It is to be demonstrated by test that it is possible to bring helpless people on board the lifeboat from the sea.

2.10 Lifeboat Towing and Painter Release Test [6.11]

2.10.1 Towing Test [6.11.1]

It is to be demonstrated that the fully equipped lifeboat, loaded with a properly distributed mass equal to the mass of the number of persons for which it is to be approved, can be towed at a speed of not less than 5 knots in calm water and on an even keel. There are to be no damage to the lifeboat or its equipment as a result of this test.

2.10.2 Davit-launched Lifeboat Painter Release Test [6.11.2～6.11.3]

.1 It is to be demonstrated that the painter release mechanism can release the painter on a fully equipped and loaded lifeboat that is being towed at a speed of not less than 5 knots in calm water.

.2 The painter release mechanism is to be tested in several distinct directions of the upper hemisphere not obstructed by the canopy or other constructions in the lifeboat. The direction specified in 2.8.1.3 is to be used if possible.

2.11 Other Performance Tests

2.11.1 Bringing of Stretchers into the Lifeboats

The lifeboat is to be placed on the test bed. It is then to be demonstrated that a stretcher with a person is to be brought into the lifeboat without difficulties.

2.11.2 Emergency Steering Test

It is to be demonstrated that for a lifeboat fitted with a remote steering mechanism, a changeover is possible without difficulties from steering by the remote steering mechanism to steering by the tiller.

2.11.3 Watertightness Test of Battery Casings

Casings covering the batteries are to be filled with water and are to show no sign of water leakage.

2.11.4 Charging Test

Batteries used for engine starting and for supplying to the search light are to be tested to be rechargeable.

2.11.5 Rowing Test for Davit-launched Lifeboats

It is to be possible for the davit-launched lifeboat to be capable of being rowed without difficulties.

2.11.6 Test for Bailing Means

A test is to be carried out to ascertain effectiveness of the bailing means.

2.12 Canopy erection test [6.13.1, 6.13.2]

2.12.1 During the test the lifeboat is to be loaded with the number of persons for which it is to be approved.

2.12.2 It is to be demonstrated that the canopy can be easily erected by not more than two persons.

2.13 Additional Tests for Totally Enclosed Lifeboat [6.14]

2.13.1 Self-righting test

A suitable means are to be provided to rotate the lifeboat about a longitudinal axis to any angle of heel and then release it. The lifeboat, in the enclosed condition, is to be incrementally rotated to angles of heel up to and including 180° and is to be released. After release, the lifeboat is always to return to the upright position without the assistance of the occupants. These tests are to be conducted in the following conditions of load.

.1 When the lifeboat with its engine is loaded in the normal position with properly secured weights representing the fully equipped lifeboat with a full complement of persons on board. The weight used to represent each person, assumed to have an average mass specified in 2.1.1, is to be secured at each seat location and have its centre of gravity approximately 300 mm above the seatpan so as to have the same effect on stability as when the lifeboat is loaded with the number of persons for which it is to be approved.

.2 When the lifeboat is in the light condition.

2.13.2 Operation test

At the beginning of these tests, the engine is to be running in neutral position, and the following tests are to be carried out.

.1 Unless arranged to stop automatically when inverted, the engine is to continue to run when inverted and for 30 min after the lifeboat has returned to the upright position.

.2 If the engine is arranged to stop automatically when inverted, it is to be easily restarted and run for 30 min after the lifeboat has returned to the upright position.

2.13.3 Flooded capsizing test

.1 The lifeboat is to be placed in the water and fully flooded until the lifeboat can contain no additional water. All entrances and openings should be secured to remain open during the test.

.2 Using a suitable means, the lifeboat is to be rotated about a longitudinal axis to a heel angle of 180° and then released. After release, the lifeboat is to attain a position that provides an above-water escape for the occupants.

.3 For the purpose of this test, the mass and distribution of the occupants may be disregarded. However, the equipment, or equivalent mass, is to be secured in the lifeboat in the normal operating position.

2.14 Additional Tests for Lifeboats with a Self-contained Air Support System [6.15]

2.14.1 Application of Tests Required for Totally Enclosed Lifeboats

Tests required for the totally enclosed lifeboat as specified in 2.13 are to apply.

2.14.2 Air supply test

All entrances and openings of the lifeboat are to be closed, and the air supply to the inside of the lifeboat turned on to the design air pressure. The engine is to then be run at revolutions necessary to achieve full speed with the fully loaded boat including all persons and with the sprinkler system in use for a period of 5 min, stopped for 30 s, then restarted for a total running time of 10 min. During this time the atmospheric pressure within the enclosure is to be continuously monitored to ascertain that a small positive air pressure is maintained within the lifeboat and to confirm that noxious gases cannot enter. The internal air pressure is to be never fall below the outside atmospheric pressure nor should it exceed outside atmospheric pressure by more than 20 hPa during the test. It is to be ascertained, by starting the engine with air supply turned off, that when the air supply is depleted, automatic means are activated to prevent a dangerous under pressure of more than 20 hPa being developed within the lifeboat.

2.15 Additional Tests for Fire-protected Lifeboats [6.16]

2.15.1 Application of Tests Required for Lifeboats with a Self-contained Air Support System

Tests required for lifeboats with a self-contained air support system as specified in 2.14 is to apply.

2.15.2 Fire Test [6.16.1～6.16.7]

.1 The lifeboat is to be moored in the centre of the area which is not less than five times the maximum projected plan area of the lifeboat and which is surrounded by divisions to prevent any leakage of kerosene for the fire test. Sufficient kerosene is to be floated on the water within the area so that when ignited it will sustain a fire which completely envelops the lifeboat for the period of time specified in .3.

.2 The engine is to be run at full speed; however, the propeller need not be turning. The gas- and fire-protective systems are to be in operation throughout the fire test.

.3 The kerosene is to be ignited. It is to continue to burn and envelop the lifeboat for 8 min.

.4 During the fire test, the temperature is to be measured and recorded as a minimum at the following locations:

1) at not less than 10 positions on the inside surface of the lifeboat;
2) at not less than five positions inside the lifeboat at locations normally taken by occupants and away from the inside surface; and
3) on the external surface of the lifeboat.

   The positions of such temperature recorders are to be to the satisfaction of BKI. The method of temperature measurement is to allow the maximum temperature to be recorded.

.5 The atmosphere inside the lifeboat is to be continuously sampled and representative retained samples are to be analysed for the presence and quantity of essential, toxic, and injurious gases or substances. The analysis is to cover the range of anticipated gases or substances that may be produced and which can vary according to the materials and fabrication techniques used to manufacture the lifeboat. The analysis is to indicate that there is sufficient oxygen and no dangerous levels of toxic or injurious gases or substances.

.6 The pressure inside the lifeboat is to be continuously recorded to confirm that a positive pressure is being maintained inside the lifeboat.

.7 At the conclusion of the fire test, the condition of the lifeboat is to be such that it could continue to be used in the fully-loaded condition.

.8 The fire test may be waived for any totally enclosed lifeboat provided that the lifeboat differs in size from, but is identical in construction to and retains essentially the same form as another lifeboat which has successfully completed the fire test, that the lifeboat has the protective system as effective as that of the lifeboat tested, and that the water delivery rate and film thickness at various locations around the hull and canopy of the lifeboat are equal to or exceed the measurements made on the lifeboat tested.

2.15.3 Water Spray Test

.1 Start the engine and the spray pump. With the engine running at its designed output, the following are to be measured to obtain the rated value and speed of the pump:

1) the rpm of the engine and the pump;
2) the pressure at the suction and delivery side of the pump.

.2 With the lifeboat in an upright position, on an even keel and in the fully loaded condition with the exception of the weights equal to the number of the persons for which the lifeboat is to be approved, run the pump at the rated speed. Measure the delivery rate of water or the thickness of the sprayed water film at the external surface of the lifeboat. The delivery rate of water or the sprayed water film thickness over the lifeboat is to be to the satisfaction of BKI.

.3 Successively trim the lifeboat 5° by the head and 5° by the stern, and heel it 5° to port and 5° to starboard. In each condition the sprayed water film is to cover the whole surface of the lifeboat.

2.16 Measuring and Evaluating Acceleration Forces [6.17]

2.16.1 Selection, Placement and Mounting of Accelerometers [6.17.1～6.17.5]

.1 The accelerometers used to measure the acceleration forces in the lifeboat are:

1) to have adequate frequency response for the test in which they are to be used but the frequency response are to be at least in the range of 0 to 200 Hz;
2) to have adequate capacity for the acceleration forces that will occur during the tests;
3) to have an accuracy of ±5%.

.2 Accelerometers are to be placed in the lifeboat, parallel to the principal axes of the lifeboat, at those locations necessary to determine the worst occupant exposure to acceleration.

.3 The accelerometers are to be mounted on a rigid part of the interior of the lifeboat in a manner to minimize vibration and slipping.

.4 A sufficient number of accelerometers is to be used at each location at which acceleration forces are measured so that all likely acceleration forces at that location can be measured.

.5 The selection, placement, and mounting of the accelerometers are to be to the satisfaction of BKI.

2.16.2 Recording Method and Rate [6.17.6～6.17.8]

.1 The measured acceleration forces may be recorded on magnetic media as either an analog or a digital signal or a paper plot of the acceleration signal may be produced.

.2 If the acceleration forces are to be recorded and stored as a digital signal, the sampling rate is to be at least 500 samples per second.

.3 Whenever an analog acceleration signal is converted to a digital signal, the sampling rate is to be at least 500 samples per second.

2.16.3 Evaluation with the Dynamic Response Model [6.17.9～6.17.12]

.1 The dynamic response model is the preferred method to evaluate potential for the occupant in a lifeboat to be injured by exposure to acceleration forces. In the dynamic response model, the human body is idealized as a single-degree-of-freedom spring-mass acting in each co-ordinate direction as shown in Fig. 1. The response of the body mass relative to the seat support, which is excited by the measured accelerations, can be evaluated using a procedure acceptable to BKI. The parameters to be used in the analysis are shown in Table 1 for each co-ordinate direction.

.2 Before performing the dynamic response analysis, the measured accelerations are to be oriented to the primary axes of the seat.

.3 The desired outcome from the dynamic response analysis is the displacement time-history of the body mass relative to the seat support in each co-ordinate direction.

.4 At all times, the following expression is to be satisfied:

$$\sqrt{\left(\frac{d_x}{S_x}\right)^2+\left(\frac{d_y}{S_y}\right)^2+\left(\frac{d_z}{S_z}\right)^2} \le 1$$

where d_x , d_y , and d_z are the concurrent relative displacements of body mass with respect to the seat support, in the *x*, *y*, and *z* body axis, as computed from the dynamic response analysis and *Sx* , *S y* , and *z S* are relative displacements which are presented in Table 2 for the appropriate launch condition.

2.16.4 Evaluation Using the *SRSS* (Square Root Sum of the Squares) Method [6.17.13～6.17.17]

.1 In lieu of the procedure in 2.16.3.1 to 2.16.3.4, the potential for an occupant in a lifeboat to become injured by an acceleration can be evaluated using the procedure presented in this section.

.2 Before performing the *SRSS* analysis, the measured accelerations are to be oriented to the primary axes of the seat.

.3 Full-scale acceleration data are to be filtered with no less than the equivalent of a 20 Hz low-pass filter. Any filtering procedure acceptable to BKI may be used.

.4 Acceleration data measured on a model are to be filtered with a low-pass filter having a frequency not less than that obtained with the following expression:

$$\text{f model} = \frac{20}{\sqrt{\frac{L_{model}}{L_{prototype}}}}$$

where model *f* is the frequency of the filter to be used, model *L* is the length of the model lifeboat, and prototype *L* is the length of the prototype lifeboat.

.5 At all times, the following expression is to be satisfied:

$$\sqrt{\left(\frac{g_x}{G_x}\right)^2+\left(\frac{g_y}{G_y}\right)^2+\left(\frac{g_z}{G_z}\right)^2}\le 1$$

where g_x, g_y, and g_z are the concurrent accelerations in the *x*, *y* and *z* seat axes and G_x, G_y and G_z are allowable accelerations which are presented in Table 3 for the appropriate launch condition.

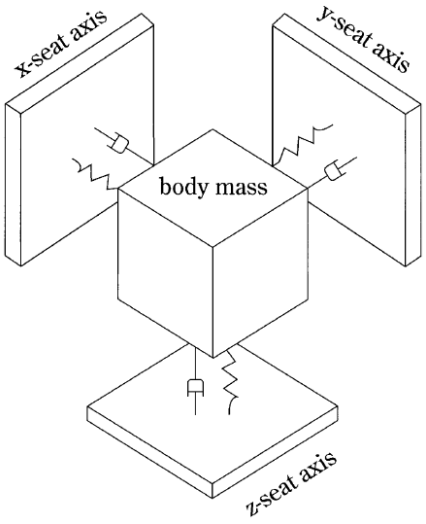

Fig. 1 Independent Single-Degree-Of-Freedom Representation of Human Body

Table 1 Parameters of the Dynamic Response Model

Co-ordinate axis	Natural frequency (rad/s)	Damping ratio
x	62,8	100
Y	58,0	0,090
z	52,9	0,224

Table 2 Suggested Displacement Limits for Lifeboats

Acceleration direction	Displacement (cm)	
	Training	Emergency
+X ..... Eyeballs in	6,96	8,71
−X ..... Eyeballs out	6,96	8,71
+Y ..... Eyeballs right	4,09	4,95
−Y ..... Eyeballs left	4,09	4,95
+Z ..... Eyeballs down	5,33	6,33
−Z ..... Eyeballs up	3,15	4,22

Table 3 SRSS Acceleration Limits for Lifeboats

Acceleration direction	Displacement (cm)	
	Training	Emergency
+X ..... Eyeballs in	15,0	18,0
−X ..... Eyeballs out	15,0	18,0
+Y ..... Eyeballs right	7,0	7,0
−Y ..... Eyeballs left	7,0	7,0
+Z ..... Eyeballs down	7,0	7,0
−Z ..... Eyeballs up	7,0	7,0

B. Procedures for Production Tests of Lifeboats

1. Strength and Performance Tests

1.1 Performance Test of Release Mechanisms of Davit Launched Lifeboats [5.3.1]

The test is to be in accordance with 2.8.1.1 and 2.8.1.2.

1.2 Operation Test [5.3.3]

The lifeboat is to be operated for at least 2 hours. During the operation test, it is to be ascertained that the whole system works.

1.3 Release gear test for lifeboats launched by falls [5.3.4]

1.3.1 The connection of each release gear which is fixed to lifeboats launched by falls is to be subjected to a load equal to the weight of the lifeboat with its full complement of persons and equipment (or two times the weight of the lifeboat with its full complement of persons and equipment in the case of single fall systems). There is to be no damage to the release gear or its connection to the lifeboat.

1.3.2 The test specified in 1.3.1 above is not required for the secondary means of launching for freefall lifeboats.

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Annex B Procedures for Prototype Tests for Type Approval and Production Tests of Rescue Boats

A. Procedures for Prototype Tests for Type Approval of Rescue Boats B–1
B. Procedures for Production Tests of Rescue Boats B–15

Numbering in bracket [.....] refer to paragraph on IMO Resolution MSC.81(70) for Reference

A. Procedures for Prototype Tests for Type Approval of Rescue Boats

1. Material Test

1.1 Material Test for Rigid Rescue Boats and Rigid Fast Rescue Boats

1.1.1 Material Test for Boat Hulls and Rigid Covers [7.1.1, 6.2.1]

The material test is to be in accordance with 1.1 of Annex A.

1.1.2 Material Test for Buoyant Materials [7.1.1, 6.2.1～6.2.7]

The material test is to be in accordance with 1.2 of Annex A.

1.2 Material Test for Inflated Rescue Boats and Inflated Fast Rescue Boats [7.2.14]

The following tests 1.2.1 to 1.2.15 are to be carried out

1.2.1 Tensile strength, Elongation at break

This test is subject to the test method specified in ISO 15372:2000 6.2.1.

1.2.2 Tear strength

This test is subject to the test method specified in ISO 15372:2000 6.2.2.

1.2.3 Heat resistance

Take three test specimens of 150 mm × 150 mm, leave them in a thermostatic chamber at a temperature of 130°C ± 2°C for one hour, then take them out of the chamber, fold them quickly with hand through 180° and check for abnormalities. No abnormalities such as adhesion are to be caused.

1.2.4 Cold resistance

This test is subject to the test method specified in ISO 15372:2000 6.2.6.

1.2.5 Heat aging

This test is subject to the test method specified in ISO 15372:2000 6.2.3.

1.2.6 Weathering

This test is subject to the test method specified in ISO 15372:2000 6.2.14.

1.2.7 Flex cracking

This test is subject to the test method specified in ISO 15372:2000 6.2.8.

1.2.8 Abrasion

This test is subject to the test method specified in ISO 15372:2000 6.2.15.

1.2.9 Coating adhesion

This test is subject to the test method specified in ISO 15372:2000 6.2.7.

1.2.10 Oil resistance

This test is subject to the test method specified in ISO 15372:2000 6.2.5.

1.2.11 Piercing strength

Pierce a pan head nail N90 to a buoyancy chamber of a rescue boat, which has been inflated completely, or to the textile of a simulated buoyancy chamber (JIS A 5508):

1) No sharp pressure drop is caused when the nail pierces through;
2) No rupture or cracking is to be caused from the pierced point immediately after pulling off the nail.

1.2.12 Ozone resistance

This test is subject to the test method specified in ISO 15372:2000 6.2.10.

1.2.13 Gas permeability

Take three circular test specimens with a diameter of 150 mm and measure hydrogen permeability using a gas permeability tester (JIS K 6328). Hydrogen gas permeability is to be 3 ℓ/m^2 per 24 hours or less.

1.2.14 Seam strength

This test is subject to the test method specified in ISO 15372:2000 6.2.4.

1.2.15 Ultraviolet light resistance

Take three test specimens of 50 mm×50 mm, apply ultraviolet rays for one hour using the ultraviolet fade meter or equivalent, and check surface hue. No significant discoloration is to be caused.

1.3 Material Test for Combined Rescue Boats

The material test is to be in accordance with 1.1 and 1.2.

2. Strength and Performance Tests

2.1 Rigid Rescue Boats [7.1]

2.1.1 Overload Test [7.1.4]

The boat is to be loaded with properly distributed load of four times the weights to represent the equipment and full complement of persons each weighing 82,5 kg for which it is to be approved and suspended for five minutes from its bridle or hooks. The weights are to be distributed in proportion to the loading of the boat in its service condition, but the weights used to represent the persons need not be

placed 300 mm above the seat pan. The boat and bridle or hook and fastening device is to be examined after the test has been conducted and is not to show any signs of damage.

Testing by filling the boat with water should not be accepted. This method of loading does not give the proper distribution of weight. Machinery may be removed in order to avoid damage, in which case weights are to be added to the boat to compensate for the removal of such machinery.

2.1.2 Impact and Drop Tests [7.1.1]

Impact and drop tests are to be carried out in accordance with 2.3, with the exception of 2.3.1.2 of Annex A.

2.1.3 Seating Strength Test [7.1.1]

A seating strength test is to be carried out in accordance with 2.5.1 of Annex A.

2.1.4 Seating Space Test [7.1.3]

The rigid rescue boat is to be fitted with its engine and all its equipment. The number of persons for which the rescue boat is to be approved, having an average mass of at least 82,5 kg and all wearing lifejackets and immersion suits and any other essential equipment required, are then to board; one person is to lie down on a stretcher of similar dimensions to those shown in Fig. B.1 and the others are to be properly seated in the rescue boat. The rigid rescue boat is to be manoeuvred and all equipment on board tested to demonstrate that it can be operated without difficulty or interference with the occupants.

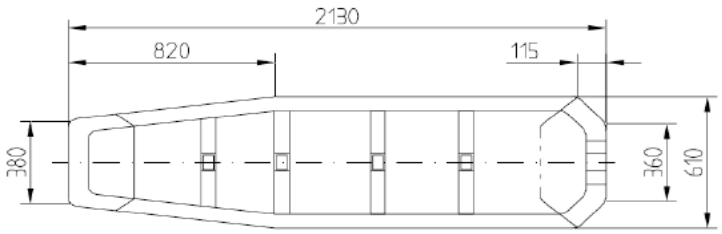

Fig.B.1 Strecher

2.1.5 Non-skid Finish Inspection [7.1.1]

A non-skid finish inspection is to be carried out in accordance with 2.6.2 of Annex A.

2.1.6 Freeboard and Stability Tests [7.1.1]

Freeboard and stability tests are to be carried out in accordance with 2.2.7.1.2) as well as 2.7 of Annex A.

2.1.7 Release Mechanism Test [7.1.1]

A release mechanism test is to be carried out in accordance with 2.8.1 of Annex A.

2.1.8 Operation Test [7.1.1, 7.1.2]

.1 The boat is to be loaded with weights equal to the mass of its equipment and the number of persons for which the boat is to be approved. The engine is to be started and the boat manoeuvred for a period of at least 4 hours to demonstrate satisfactory operation. The boat is to be run at a speed of not less than 6 knots for a period which is sufficient to ascertain the fuel consumption and to establish that the fuel tank has the required capacity.

.2 Speed and manoeuvring trials are to be carried out with engines of various powers to assess the rescue boat's performance (if a rigid rescue boat is equipped with outboard motor).

.3 Compass [6.10.7]

It is to be determined that the compass performance is satisfactory and that it is not unduly affected by magnetic fittings and equipment in the lifeboat.

.4 Survival recovery test [6.10.8]

It is to be demonstrated by test that it is possible to bring helpless people on board the lifeboat from the sea.

2.1.9 Towing and Painter Release Test [7.1.1]

A towing and painter release test is to be carried out in accordance with 2.10 of Annex A.

2.1.10 Towing test [7.1.2]

The maximum towing force of the rescue boat is to be determined. This information is to be used to determine the largest fully loaded liferaft the rescue boat can tow at two knots. The fitting designated for towing other craft is to be secured to a stationary object by a tow rope. The engine is to be operated ahead at full speed for a period of at least 2 min, and the towing force measured and recorded. There is to be no damage to the towing fitting or its supporting structure. The maximum towing force of the rescue boat is to be recorded on the type approval certificate.

2.1.11 Righting test [7.1.7]

It is to be demonstrated that both with and without engine and fuel or an equivalent mass in place of the engine and fuel tank, the rescue boat is capable of being righted by not more than two persons if it is inverted on the water. In the case of fast rescue boats which are not self-righting, the engine is to be running in neutral position and, after stopping automatically or by the helmsman's emergency release switch when inverted, it is to be easily restarted and run for 30 min after the rescue boat has returned to the upright position. For rescue boats with inboard engines, the test without engine and fuel is not applicable.

2.1.12 Manoeuvrability tests [7.1.8]

It is to be demonstrated that the rigid rescue boat can be propelled and manoeuvred by its oars or paddles in calm water conditions at a speed of at least 0,5 knots over a distance of at least 25 m, when laden with the number of persons, all wearing lifejackets and immersion suits, for which it is to be approved.

2.1.13 Other Performance Tests

.1 Retrieval Test

A retrieval test is to be carried out in accordance with 2.11.1 of Annex A.

.2 Emergency Steering Test

An emergency steering test is to be carried out in accordance with 2.11.2 of Annex A.

.3 Watertightness Test of Battery Casings

A battery casing watertightness test is to be carried out in accordance with 2.11.3 of Annex A.

.4 Charging Test

A charging test is to be carried out in accordance with 2.11.4 of Annex A.

.5 Test for Bailing Means

A test for ascertaining effectiveness of bailing means is to be carried out in accordance with 2.11.6 of Annex A.

2.1.14 Detailed inspection [7.1.9]

The rigid rescue boat, complete in all respects is to be subjected to detailed inspection to ensure that the requirements are fulfilled.

2.2 Inflated Rescue Boats [7.2]

2.2.1 Overload Test [7.2.12, 7.2.13]

.1 The inflated rescue boat is to be loaded with four times the mass of the full complement of persons and equipment for which it is to be approved and suspended from its bridle at an ambient temperature of +20°C ± 3°C with all relief valves inoperative for 5 min. The rescue boat and bridle are to be examined after the test is conducted and are to show no signs of damage.

.2 The inflated rescue boat after 6 hours conditioning at a temperature of -30°C is to be loaded with 1,1 times the mass of the full complement of persons and equipment for which it is to be approved and suspended from its bridle with all relief valves operative for 5 min. The rescue boat and bridle are to be examined after the test is conducted and are to show no signs of damage.

2.2.2 Impact Test [7.2.1]

An impact test is to be carried out in accordance with 2.3.1.1 of Annex A. On completion of the impact test, the rescue boat is to show no signs of damage which would affect its efficient functioning.

2.2.3 Drop Test [7.2.2, 7.2.3]

.1 The inflated rescue boat complete with all its equipment and with a mass equivalent to its engine and fuel in the position of its engine and fuel tank is to be dropped three times from a height of at least 3 m on to water. The drops are to be from the 45° bow-down, level-trim and 45° stern-down attitudes.

.2 On completion of these drop tests, the rescue boat and its equipment are to be carefully examined and show no signs of damage which would affect their efficient functioning.

2.2.4 Seating Strength Test [7.2.1]

A seating strength test is to be carried out in accordance with 2.5.1 of Annex A.

2.2.5 Seating Space Test [7.2.1]

A seating space test is to be carried out in accordance with 2.1.4.

2.2.6 Non-skid Finish Inspection [7.2.1]

A non-skid finish inspection test is to be carried out in accordance with 2.6.2 of Annex A.

2.2.7 Loading Test (Freeboard Measurement) [7.2.4, 7.2.5]

.1 The freeboard of the inflated rescue boat is to be taken in the various loading conditions as follows:

1) rescue boat with all its equipment;
2) rescue boat with all its equipment, engine and fuel, or an equivalent mass positioned to represent engine and fuel;
3) rescue boat with all its equipment and the number of persons for which it is to be approved having an average mass of 82,5 kg so arranged that a uniform freeboard is achieved at the side buoyancy tubes; and
4) rescue boat with the number of persons for which it is to be approved and all its equipment, engine and fuel or an equivalent mass to represent engine and fuel and the rescue boat being retrimmed as necessary.

.2 With the rescue boat in any of the conditions prescribed in .1, the minimum freeboard is to be not less than 300 mm at the buoyancy tubes and not less than 250 mm from the lowest part of the transom.

2.2.8 Stability Test [7.2.6, 7.2.7]

.1 The following tests are to be carried out with engine and fuel or an equivalent mass in place of the engine and fuel tanks:

1) the number of persons for which the inflated rescue boat is to be approved is to be crowded to one side with half this complement seated on the buoyancy tube, and then to one end. In each case the freeboard is to be recorded. Under these conditions the freeboard is to be everywhere positive; and
2) the stability of the rescue boat during boarding is to be ascertained by two persons in the rescue boat demonstrating that they can readily assist from the water a third person who is required to feign unconsciousness. The third person is to have his back towards the side of the rescue boat so that he cannot assist the rescuers. All persons are to wear approved lifejackets.

.2 These stability tests may be carried out with the rescue boat floating in still water.

2.2.9 Damage Test [7.2.8]

.1 The following tests are to be carried out with the inflated rescue boat loaded with the number of persons for which it is to be approved both with and without engine and fuel or an equivalent mass in the position of the engine and fuel tank:

1) with forward buoyancy compartment deflated;
2) with the entire buoyancy on one side of the rescue boat deflated; and
3) with the entire buoyancy on one side and the bow compartment deflated.

.2 In each of the conditions prescribed by .1, the full number of persons for which the rescue boat is to be approved is to be supported within the rescue boat.

2.2.10 Swamp Test [7.2.11]

It is to be demonstrated that the rescue boat, when fully swamped, is capable of supporting its full equipment, the number of persons each weighing 82,5 kg for which it is to be approved and a mass equivalent to its engine and fully filled fuel tank. It is also to be demonstrated that the rescue boat does not seriously deform in this condition.

2.2.11 Release Mechanism Test [7.2.1]

A release mechanism test is to be carried out in accordance with 2.8.1 of Annex A.

2.2.12 Operation Test [7.2.1]

An operation test is to be carried out in accordance with 2.1.8.

2.2.13 Manoeuvrability Tests [7.2.1]

A manoeuvrability test is to be carried out in accordance with 2.1.12.

2.2.14 Towing and Painter Release Test [7.2.1]

A towing and painter release test is to be carried out in accordance with2.10 of Annex A.

2.2.15 Righting Test [7.1.7]

Righting test is to be carried out in accordance with 2.1.11.

2.2.16 Simulated Heavy Weather Test [7.2.10]

To simulate use in heavy weather the inflated rescue boat is to be fitted with a larger powered engine than is intended to be fitted and driven hard in a wind of force 4 or 5 or equivalent rough water for at least 30 min. As a result of this test the rescue boat is not to show undue flexing or permanent strain nor have lost more than minimal pressure.

2.2.17 Mooring out Test [7.2.15]

Mooring out test is to be carried out in accordance with 2.5 of Annex C.

2.2.18 Towing test

A towing test is to be carried out in accordance with 2.1.11.

2.2.19 Other Performance Tests

.1 Bringing of Stretchers into the Rescue Boat

A test for bringing of stretchers into the rescue boat is to be carried out in accordance with 2.11.1 of Annex A.

.2 Emergency Steering Test

An emergency steering test is to be carried out in accordance with 2.11.2 of Annex A.

.3 Watertightness Test of Battery Casings

A watertightness test of battery casings is to be carried out in accordance with 2.11.3 of Annex A.

.4 Charging Test

A charging test is to be carried out in accordance with 2.11.4 of Annex A.

.5 Test for Bailing Means

A test for ascertaining effectiveness bailing means is to be carried out in accordance with 2.11.6 of Annex A.

2.2.20 Detailed Inspection [7.2.16]

The inflated rescue boat complete in all respects is to be fully inflated in the manufacturer's works and subjected to detailed inspection to ensure that all the requirements are fulfilled.

2.3 Combined Rescue Boats

2.3.1 Overload Test

Overload test is to be carried out in accordance with 2.1.1.

2.3.2 Impact Test

Impact test is to be carried out in accordance with 2.3.1.1 of Annex A.

2.3.3 Drop Test

A drop test is to be carried out in accordance with 2.2.3.

2.3.4 Seating Strength Test

A seating strength test is to be carried out in accordance with 2.5.1 of Annex A.

2.3.5 Seating Space Test

A seating space test is to be carried out in accordance with 2.1.4.

2.3.6 Non-skid Finish Inspection

A non-skid finish inspection is to be carried out in accordance with 2.6.2 of Annex A.

2.3.7 Loading Test (Freeboard Measurement)

A loading test is to be carried out in accordance with 2.2.7.

2.3.8 Stability Test

A stability test is to be carried out in accordance with 2.2.8.

2.3.9 Damage Test

A damage test is to be carried out in accordance with 2.2.9, except if the boats has its waterline below the lower side of the inflated tube.

2.3.10 Swamp Test

A swamp test is to be carried out in accordance with 2.2.10.

2.3.11 Release Mechanism Test

A release mechanism test is to be carried out in accordance with 2.8.1 of Annex A.

2.3.12 Operation Test

An operation test is to be carried out in accordance with 2.1.8.

2.3.13 Manoeuvrability Tests

A manoeuvrability test is to be carried out in accordance with 2.1.12.

2.3.14 Towing and Painter Release Test

A towing and painter release test is to be carried out in accordance with 2.10 of Annex A.

2.3.15 Righting Test

A righting test is to be carried out in accordance with 2.1.11.

2.3.16 Simulated Heavy Weather Test

A simulated heavy weather test is to be carried out in accordance with 2.2.16.

2.3.17 Mooring out Test

A mooring out test is to be carried out in accordance with 2.5 of Annex C, except if the boats have its waterline below the lower side of the inflated tube.

2.3.18 Towing Test

A Towing test is to be carried out in accordance with 2.1.10.

2.3.19 Other Performance Tests

.1 Test for Bringing of Stretchers into the Rescue Boats

A test for bringing of stretchers into the rescue boat is to be carried out in accordance with 2.11.1 of Annex A.

.2 Emergency Steering Test

An emergency steering test is to be carried out in accordance with 2.11.2 of Annex A.

.3 Watertightness Test of Battery Casings

A watertightness test of battery casings is to be carried out in accordance with 2.11.3 of Annex A.

.4 Charging Test

A charging test is to be carried out in accordance with 2.11.4 of Annex A.

.5 Test for Bailing Means

A test for ascertaining effectiveness of bailing means is to be carried out in accordance with 2.11.6 of Annex A.

2.3.20 Detailed Inspection

A detailed inspection is to be carried out in accordance with 2.2.20.

2.4 Rigid Fast Rescue Boats [7.4]

2.4.1 Overload Test

An overload test is to be carried out in accordance with 2.1.1.

2.4.2 Impact and Drop Tests

Impact and drop tests are to be carried out in accordance with 2.3, with the exception of 2.3.1.2, of Annex A.

2.4.3 Seating Strength Test

A seating strength test is to be carried out in accordance with 2.5.1 of Annex A.

2.4.4 Seating Space Test

A Seating space test is to be carried out in accordance with 2.1.4.

2.4.5 Non-skid Finish Inspection

A non-skid finish inspection is to be carried out in accordance with 2.6.2 of Annex A.

2.4.6 Freeboard and Stability Tests

Freeboard and stability tests are to be carried out in accordance with 2.2.7.1.2) as well as 2.7 of Annex A.

2.4.7 Release Mechanism Test [7.1.1]

A release mechanism test is to be carried out in accordance with 2.8.1 of Annex A.

2.4.8 Operation Test [7.1.1, 7.1.2]

.1 The boat is to be loaded with weights equal to the mass of its equipment and the number of persons for which the boat is to be approved. The engine is to be started and the boat manoeuvred for a period of at least 4 hours to demonstrate satisfactory operation. The boat should be run at a speed of not less than 6 knots for a period which is sufficient to ascertain the fuel consumption and to establish that the fuel tank has the required capacity.

.2 Speed and manoeuvring trials should be carried out with engines of various powers to assess the rescue boat's performance (if a rigid rescue boat is equipped with outboard motor).

.3 Compass test is to be carried out in accordance with 2.9.2 of Annex A.

.4 Survival recovery test is to be carried out in accordance with 2.9.3 of Annex A.

2.4.9 Towing and Painter Release Test

A towing and painter release test is to be carried out in accordance with 2.10 of Annex A.

2.4.10 Towing test

A towing test is to be carried out in accordance with 2.1.10.

2.4.11 Righting test

A self-righting test is to be carried out in accordance with 2.13 of Annex A. In the case of the boats which are not self-righting, the engine is to be running in neutral position and, after stopping automatically or by the helmsman's emergency release switch when inverted, it is to be easily restarted and run for 30 min after the rescue boat has returned to the upright position. For rescue boats with inboard engines, the test without engine and fuel is not applicable. 2.13.1.1 and 2.13.3.1 to 2.13.3.3 are not applicable. With regard to 2.13.2, a boat fitted with a helmsman s emergency release switch is to be considered to be arranged to stop automatically when inverted.

2.4.12 Manoeuvrability tests

A Manoeuvrability test is to be carried out in accordance with 2.1.12.

2.4.13 Loading Test

A loading test is to be in accordance with 2.2.7.2).

2.4.14 Other Performance Tests

.1 Retrieval Test

A retrieval test is to be carried out in accordance with 2.11.1 of Annex A.

.2 Emergency Steering Test

An emergency steering test is to be carried out in accordance with 2.11.2 of Annex A.

.3 Watertightness Test of Battery Casings

A battery casing watertightness test is to be carried out in accordance with 2.11.3 of Annex A.

.4 Charging Test

A charging test is to be carried out in accordance with 2.11.4 of Annex A.

.5 Test for Bailing Means

A test for ascertaining effectiveness of bailing means is to be carried out in accordance with 2.11.6 of Annex A.

2.4.15 Detailed inspection

Detailed inspection is to be in accordance with 2.1.14.

2.5 Inflated Fast Rescue Boats [7.5]

2.5.1 Impact Test

An impact test is to be carried out in accordance with 2.3.1.1 of Annex A.

2.5.2 Seating Strength Test

A seating strength test is to be carried out in accordance with 2.5.1 of Annex A.

2.5.3 Non-skid Finish Inspection

A non-skid finish inspection test is to be carried out in accordance with 2.6.2 of Annex A.

2.5.4 Release Mechanism Test

A release mechanism test is to be carried out in accordance with 2.8.1 of Annex A.

2.5.5 Operation Test

An operation test is to be carried out in accordance with 2.4.8.

2.5.6 Towing and Painter Release Test

A towing and painter release test is to be carried out in accordance with 2.10 of Annex A.

2.5.7 Righting Test

A righting test is to be carried out in accordance with 2.4.11.

2.5.8 Towing test

Towing test is to be carried out in accordance with 2.1.10.

2.5.9 Seating Space Test

A Seating space test is to be carried out in accordance with 2.1.4.

2.5.10 Manoeuvrability Tests

A manoeuvrability test is to be carried out in accordance with 2.1.12.

2.5.11 Drop Test

A drop test is to be carried out in accordance with 2.2.3.

2.5.12 Loading Test

A loading test is to be in accordance with 2.2.7.

2.5.13 Stability Test

A stability test is to be in accordance with 2.2.8.

2.5.14 Damage Test

A damage test is to be carried out in accordance with 2.2.9, except if the boats has its waterline below the lower side of the inflated tube.

2.5.15 Simulated Heavy Weather Test

A simulated heavy weather test is to be in accordance with 2.2.16.

2.5.16 Swamp Test

A swamp test is to be in accordance with 2.2.10.

2.5.17 Overload Test

An overload test is to be carried out in accordance with 2.2.1.

2.5.18 Mooring out Test

A mooring out test is to be carried out in accordance with 2.5 of Annex C.

2.5.19 Other Performance Tests

.1 Bringing of Stretchers into the Rescue Boat

A test for bringing of stretchers into the rescue boat is to be carried out in accordance with 2.11.1 of Annex A.

.2 Emergency Steering Test

An emergency steering test is to be carried out in accordance with 2.11.2 of Annex A.

.3 Watertightness Test of Battery Casings

A watertightness test of battery casings is to be carried out in accordance with 2.11.3 of Annex A.

.4 Charging Test

A charging test is to be carried out in accordance with 2.11.4 of Annex A.

.5 Test for Bailing Means

A test for ascertaining effectiveness bailing means is to be carried out in accordance with 2.11.6 of Annex A.

2.5.20 Detailed Inspection

A detailed inspection is to be carried out in accordance with 2.2.20.

2.6 Combined Fast Rescue Boats [7.6]

2.6.1 Overload Test

An overload test is to be carried out in accordance with 2.1.1.

2.6.2 Impact Test

An impact test is to be carried out in accordance with 2.3.1.1 Impact test of Annex A.

2.6.3 Drop Test

A drop test is to be carried out in accordance with 2.2.3.

2.6.4 Seating Strength Test

A seating strength test is to be carried out in accordance with 2.5.1 of Annex A.

2.6.5 Seating Space Test

A seating space test is to be carried out in accordance with 2.1.4.

2.6.6 Non-skid Finish Inspection

A non-skid finish inspection is to be carried out in accordance with 2.6.2 of Annex A.

2.6.7 Loading Test (Freeboard Measurement)

A loading test is to be carried out in accordance with 2.2.7.

2.6.8 Stability Test

A stability test is to be carried out in accordance with 2.2.8.

2.6.9 Damage Test

A damage test is to be carried out in accordance with 2.2.9, except if the boats has its waterline below the lower side of the inflated tube.

2.6.10 Swamp Test

A swamp test is to be carried out in accordance with 2.2.10.

2.6.11 Release Mechanism Test

A release mechanism test is to be carried out in accordance with 2.8.1 of Annex A.

2.6.12 Operation Test

An operation test is to be carried out in accordance with 2.4.8.

2.6.13 Manoeuvrability Tests

A manoeuvrability test is to be carried out in accordance with 2.1.12.

2.6.14 Towing and Painter Release Test

A towing and painter release test is to be carried out in accordance with 2.10 of Annex A.

2.6.15 Righting Test

A righting test is to be carried out in accordance with 2.4.11.

2.6.16 Simulated Heavy Weather Test

A simulated heavy weather test is to be carried out in accordance with 2.2.16.

2.6.17 Mooring out Test

A mooring out test is to be carried out in accordance with 2.5 of Annex C, except if the boats have its waterline below the lower side of the inflated tube.

2.6.18 Towing Test

A Towing test is to be carried out in accordance with 2.1.10.

2.6.19 Other Performance Tests

.1 Test for Bringing of Stretchers into the Rescue Boats

A test for bringing of stretchers into the rescue boat is to be carried out in accordance with 2.11.1 of Annex A.

.2 Emergency Steering Test

An emergency steering test is to be carried out in accordance with 2.11.2 of Annex A.

.3 Watertightness Test of Battery Casings

A watertightness test of battery casings is to be carried out in accordance with 2.11.3 of Annex A.

.4 Charging Test

A charging test is to be carried out in accordance with 2.11.4 of Annex A.

.5 Test for Bailing Means

A test for ascertaining effectiveness of bailing means is to be carried out in accordance with 2.11.6 of Annex A.

2.6.20 Detailed Inspection

A detailed inspection is to be carried out in accordance with 2.2.20.

B. Procedures for Production Tests of Rescue Boats

1. Strength and Performance Tests

1.1 Release Mechanisms Test [5.3.1]

A release mechanism test is to be carried out in accordance with 2.8.1.1 and 2.8.2.2 of Annex A.

1.2 Overload, Pressure and Tightness Tests of Inflated and Combined Rescue Boats

1.2.1 Overload Test [5.2]

Every inflated rescue boat and every combined rescue boat are to undergo a 10% overload test in accordance with the approved drawings or construction specification before the final pressure and tightness tests in the manner as specified below:

1) the rescue boat is to be inflated with air and stabilized at its working pressure;
2) the working pressure is to be determined by the reseat of the relief valves. The pressure relief valves are to be fully operational;
3) the rescue boat is to be overloaded by 10% of the mass of the rescue boat assembly together with its full equipment and complement of persons;
4) the loaded rescue boat is to remain suspended for not less than 5 min; and
5) the rescue boat is not to sustain damage to its suspension members, their attachments, or any other structural component as a result of this test. The pressure relief valves are to maintain the normal working pressure of the buoyancy tubes and their basic shape during suspension.

1.2.2 Pressure and Tightness Tests

.1 Pressure Test

The buoyancy chambers of each inflated rescue boat and combined rescue boat are to undergo a pressure test at a pressure of 1,5 times the working pressure. Keeping each relief valve inoperable, inflate the buoyancy chambers with compressed air. The pressure drop in 30 minutes or more is to be 5% or less without making corrections for temperatures and atmospheric air pressure changes, and no damage such as seam displacements, cracking or other failures are to be caused.

Measurement of pressure drops are to be started when the rubber material of the buoyancy chamber extends completely due to the inflation pressure to reach a stable condition. After these tests, the relief valve is to be tested for a blowing off pressure and shutting pressure to determine if these pressures are appropriate.

.2 Tightness Test

The gas-tightness of the buoyancy chambers of each inflated rescue boat and combined rescue boat is to be tested by inflating them with compressed air to the working pressure. Measure the pressure in 30 minutes, and make adjustments to the working pressure, if necessary. In one hour, the measured pressure drop with corrections made for temperature and atmospheric air pressure changes is not to exceed 5%. Two buoyancy chambers may be tested at one time, but one buoyancy chamber provided with a common pressure boundary is to be kept open to the atmospheric air during the test.

1.3 Operation Test [5.3.3]

An operation test is to be carried out for at least 2 hours to confirm all system operations.

1.4 Release gear test for rescue boats launched by falls [5.3.4]

The connection of each release gear which is fixed to rescue boats launched by falls is to be subjected to a load equal to the weight of the rescue boat with its full complement of persons and equipment (or two times the weight of the rescue boat with its full complement of persons and equipment in the case of single fall systems). There is to be no damage to the release gear or its connection to the rescue boat.

Annex C Procedures for Prototype Tests for Type Approval and Production Tests of Inflatable Liferafts

A. Procedures for Prototype Tests for Type Approval of Inflatable Liferafts.....C–1
B. Procedures for Production Tests for Type Approval of Inflatable Liferafts.....C–15

Numbering in bracket [.....] refer to paragraph on IMO Resolution MSC.81(70) for Reference

A. Procedures for Prototype Tests for Type Approval of Inflatable Liferafts

1. Material Test [5.17.13]

Materials for main buoyancy chambers, canopy supports, floors, floor buoyancy chambers and canopy are to be subjected to the following tests. The materials when tested are to meet the following requirements. When there are any difficulties in carrying out these tests, other testing means deemed to be equivalent may be acceptable.

1.1 The fabric is to be marked in such a manner as to allow traceability of the fabric manufacturer and production lot number.

1.2 Tests and performance criteria

1.2.1 Test samples are to be randomly selected; and test pieces cut from each sample as required by the relevant ISO standard or as otherwise prescribed for each individual test.

1.2.2 Fabric used for manufacture of buoyancy tubes, inflatable supports for canopies and floors are to meet the following requirements.

.1 Tensile strength

When tested by the method described in ISO 1421:1998 the tensile strength is to be a minimum 2255 N/50 mm width for warp and weft. Maximum elongation, for the above is to be 30% over a 200 mm gauge length, the elongation is to be expressed as a percentage of the initial test length between the jaws. Where two layers of floor fabric are provided to form an inflatable floor the main floor is to be as specified. The inner/outer layer may have a minimum tensile strength of 1470 N/50 mm widths in warp and weft direction.

.2 Tear strength

When tested with the apparatus described in ISO 1421:1998, the tear strength is to be 1030 N minimum in warp and weft directions. Where two layers of the floor fabric are provided to form an inflatable floor, the main floor is to be as specified. The inner/outer layer may have a minimum tear strength of 735 N in warp and weft directions. The preparation of the test specimens is to be as follows:

1) from the test sample cut 3 specimens each in warp and weft directions, 76 mm ± 1 mm wide and 400 mm long, with the length closely parallel to the warp and weft yarns. Space the selection across the full length and width of the sample. Make a 12,5 mm cut across the middle of each specimen at right angles to the length.
2) grip the specimen under test securely and evenly in the grips, which is to be 200 mm apart, so that the specimen length is closely in the direction of the pull. Operate the machine in accordance with ISO 1421:1998. The maximum load sustained is recorded as the wound tear strength, and the average for the 3 specimens is calculated.

.3 Surface receptiveness and adhesion of surface coating

1) when tested by the method described in ISO 2411:2000, the surface receptiveness on either face is not to be less than 75 N/50 mm width.
2) for dry surface coating adhesion a minimum of 75 N/ 50 mm is required.
3) for wet surface coating adhesion as described in 2.2.3.8 a minimum of 50 N/50 mm is required.
4) each coated face is to be tested. The specimens are to be made up as in ISO 2411:2000 bonding like coated face to like coated face.
5) the bonding used and the method of application is to be agreed between the liferaft manufacturer and the finished fabric manufacturer, and is to be the same as those used during the manufacture of the liferaft.
6) on each test specimen the bonding between the adhesive or weld and the coating is to be initially measured to determine the surface receptivity.
7) the adhesion of the coating to the base textile is then measured by cutting through one coating layer to initiate the required mode of separation.
8) after testing in 4) for adhesion of coating to the base textile the specimen is to be immersed for 24h in a 3% aqueous solution of sodium chloride at 20°C ± 2°C . At the end of the immersion period the specimen is to be removed from the solution and, while still wet tested by the method specified in ISO 2411:2000.

.4 Effects of ageing

1) Folding test

When tested as prescribed below there is to be no cracks, separation of plies or brittleness visible when the samples are inspected under a magnification of 2.

2) Tensile test

When tested as prescribed below the tensile strength after ageing is to be not less than 90% of the original tensile strength before ageing.

3) Ultra-violet resistance

This test is to be performed in accordance with the methods specified in ISO 4892-4:2004 - Open-flame carbon-arc lamps, as follows:

A) Expose the conditioned samples to an enclosed carbon arc lamp without "Corex D" filters for 100 h. The carbons are to be Copper Clad Sunshine Arc Type, No.22 for the upper pair and No.13 for the lower pair, or equivalent. Only the intended outside surface of the fabric is to be exposed to the arc in the testing apparatus. The specimens are to be exposed to water spray, with the apparatus operated so that the specimens are exposed to successive cycles of 102 min of light without spray and 18 min of light with spray. The black panel temperature is to be 80°C + 5°C . The total exposure time is to be 100 h.

B) Test the tensile strength of the material after exposure following the procedure in 1.2.2.1 above. The tensile strength is to be not less than 90% of the original tensile strength before aging.

C) The exposed material is to be bent, more heavily coated side out, around a 3,2 mm mandrel and examined visually for cracking. There is to be no cracking.

4) Alternative Ultra-violet resistance

Alternatively, this test may be performed in accordance with the methods specified in ISO 4892-2:2006 with amendment 1:2009 - Xenon Arc type testing. The specimens are to be exposed under conditions specified in Table C.1, using a controlled irradiance water cooled Xenon Arc apparatus for

a total exposure time of 150 h. Only the intended outside surface of the fabric is to be exposed to the arc. The tensile strength of the material is to be tested after exposure following the procedure in 1.2.2.1. The tensile strength is to be not less than 90% of the original strength before aging. The exposed material is to be bent, with heavily coated side out, around a 3,2 mm mandrel and each coated face examined visually for cracking. There is to be no cracking during this examination. The performance requirements specified in this subparagraph relate to the behaviour of individual specimens under particular conditions of test. As the spectrum of light from the Carbon Arc differs from that of the Xenon Arc, caution is to be exercised in interpreting the test results of both methods.

Table C.1 Condition of ultra-violet resistance test

Exposure conditions	Dark cycle (1 hour)	Light cycle (2 hours)		
Automatic irradiance (Filter Q/B)	Nil	0,55 W/m^2-nm at 340 nm		
Black panel	38°C ± 2°C	70°C ± 2°C		
Dry bulb temperature	38°C ± 2°C	47°C ± 2°C		
Relative humidity	95 ± 5%	50 ± 5%		
Conditioning water	40°C ± 4°C	45°C ± 4°C		
Water spray	60 min on front and back of specimen	40	20	60
		Nil	Front	Nil

5) Three separate specimens are to be tested as follows:
   A) dimensional stability
   B) folding
   C) tensile strength

   For A) and B) cut from the test sample 4 specimens at least 100 mm square with the sides closely parallel to the warp and weft threads. Measure the dimensions of two specimens accurately for A). For C), cut two sets of specimens as in 1.2.2.1.

6) When tested as prescribed below the difference in dimensions of the sample before and after ageing should not differ by more than 2%.

7) Ageing of specimens test procedure
   A) Freely suspend one specimen each for 5) A) and B) and one set of specimens for 5) C) in air for 7 days at 70°C ± 2°C. Suspend the other specimens above water in a loosely closed vessel for seven days at 70°C ± 2°C.
   B) Remove the two measured specimens from the ageing oven. After 15 min at room temperature, measure the dimensions and report the percentage changes in warp and weft directions.
   C) Remove the other two specimens. After 15 min at room temperature, fold the specimens consecutively in two directions parallel to the edges at right angles to each other so as to reduce the exposed area of each specimen to one quarter of its original size. Unfold and refold along the same creases but with each fold reversed in direction. After each folding, press the fold by rubbing fingers and thumb along it: inspect the specimens for cracks, separation of plies, stickiness or brittleness.
   D) For the tensile strength test remove the two sets of specimens from the ageing oven. Dry the wet aged specimens for 1 h in air at 7°C ± 2°C, and then condition both sets for 24 h. Test in accordance with 1.2.2.1.

.5 Low temperature flexing

1) When tested at a temperature no higher than -50°C by the method prescribed below, there is to be no visible cracking of the sample when inspected under a magnification of 2. The test is to be independently applied to each face of the coated fabric.
2) The apparatus, preparation of test specimens and test procedure is to be as described in ISO 4675:1990, except that:
   A) when tested at the specified low temperature no specimen is to show cracks
   B) there is to be 6 test specimens, 3 cut with the long side closely parallel to the warp and 3 cut with the long side closely parallel to the weft direction.

.6 Flex cracking

After the specimen has been conditioned by exposing the outer face to a 3% aqueous solution of sodium chloride for seven days at 20°C ± 2°C, it is to be tested as described in ISO 7854:1995. After 200 000 flexings, no cracking or delamination is to be visible when inspected under a magnification of 2.

.7 Porosity

When tested by the method prescribed below and with a pressure of 27,5 kPa applied and maintained beneath the fabric there is to be no signs of any leakage over a minimum period of 5 min.

1) Test for porosity

   A specimen of the fabric is to be prepared and tested in accordance with ISO TR 6065 paragraph A.2.10.2

.8 Oil resistance

1) When tested by the method prescribed below, after exposing the outer surface to oil ASTM No.1, for 2 h at 20°C ± 2°C, there is to be no separation of coating from textile and no residual tackiness when two exposed faces are pressed together. The coating is not to smear when rubbed with a single pass of the finger.
2) The test is to be carried out not less than 16 h after vulcanisation or curing.
3) The apparatus, preparation of specimens and test procedure is to be accordance with ISO TR 6065 paragraph A.2.5. Each coated face is to be tested.

.9 Weft distortion

The weft distortion is to be not more than the equivalent of 100 mm maximum over a fabric width of 1,5 m. A line is to be drawn across the fabric at right angles to the selvedge. The weft distortion, skew and/or bow is to be measured.

.10 Resistance to blocking

1) When tested by the method prescribed below, fabric is to exhibit no blocking.
2) The preparation of specimens and test procedure is to be in accordance with ISO 5978:1990 except that the duration of time under load is to be 7 days.

.11 Hydrolysis resistance for thermoplastic coated materials only

1) When tested by the methods prescribed below, the following performance values are to be achieved:
   A) Coating adhesion; 50 N/ 50 mm minimum
   B) Blocking resistance; 100 g maximum
   C) Folding test; No cracks, delamination or visual deterioration

2) The following test requirements are to apply to fabrics or test specimens which have been stored for 12 weeks over water in a closed container at 93°C.

3) The following test is to be performed after drying the specimens for 1 h at 80°C ± 2°C, and conditioning at 20°C ± 2°C, 65% RH for 24 h.

4) The coating adhesion of the stored material specimen is to be made up and tested in accordance with paragraph .3 above after the requirements of 2) above have been carried out.

5) The blocking resistance is to be tested in accordance with .10 above.

6) Two test samples 100 mm ± 2 mm square are to be cut from the stored material. The samples are to be folded as defined in .4.7) C) and examined for evidence of cracks, ply separation, stickiness or brittleness.

.12 Ozone resistance

1) When tested by the method prescribed below, no cracks is to be visible at a magnification of 5.

2) The preparation of samples and test procedure is to be in accordance with specification ISO 3011:1997. The following conditions are to apply.

A) Ozone concentration; 50 pphm

B) Temperature; 20°C ± 2°C

C) Exposure time; 8 h

D) Mandrel diameter; 6 x sample thickness

1.3 Fabric used for the manufacture of outer canopies is to meet the following requirements.

1) Tensile strength

When tested by the method prescribed in 1.2.2.1, the tensile strength is to be minimum 930 N/50 mm of width in warp and weft directions.

2) Tear strength

When tested by the method prescribed in 1.2.2.2, the tear strength is to be minimum 490 N in warp and weft directions.

3) Low temperature flexing

When tested at a temperature not higher than -30°C by the method prescribed in 1.2.2.5, there is to be no visible cracking of the sample when inspected under a magnification of 2. The test is to be independently applied to each face of the coated fabric.

4) Waterproofness

A) When tested by the method prescribed below, no water is to pass through the cone within 30 min. The coated fabric is not to contain any material that is known to be injurious to a survivor drinking rainwater collected from the canopy. Fabrics may be coated on one or both sides.

B) The test specimen is to be cut to a size of 300 mm x 300 mm and tested in accordance with the following procedure. Fold the specimen twice at right angles and open it out into the form of a cone. Secure the cone with a paper clip and insert it into a suitable funnel supported on a flask. Pour 500 ml of water into the cone. Record any penetration of water to the outside of the cone after 30 min.

5) Surface receptiveness and adhesion of surface coating

When tested by the method prescribed in paragraph 1.2.2.3 the surface receptiveness on either face is not to be less than 25 N/ 50 mm width surface. For coating adhesion a minimum of 25 N/ 50 mm is required.

6) Colour

The liferaft canopy is to be evaluated after the mooring out test in 2.5 or an equivalent method using artificial light to determine whether the coating is sufficiently colour fast.

7) Effects of ageing

A) Folding test. When tested by the method prescribed in 1.2.2.4, there is to be no cracks, separation of plies or brittleness visible when the samples are inspected under a magnification of 2.

B) Tensile test. When tested by the method prescribed in 1.2.2.4, at least 90% of the original tensile strength is to be retained in both warp and weft directions.

1.4 Fabric used for the manufacture of inner canopies is to meet the following requirements.

1) Tensile strength

When tested by the method prescribed in 1.2.2.1, the tensile strength is to be minimum 100 N/ 50 mm of width in warp and weft directions.

2) Porosity

As the inner canopy serves as a barrier to provide a static layer of air, it is to either be of a close weave construction or have a low porosity to air.

2. Strength and Performance Tests

2.1 Drop Test [5.1.1～5.1.4]

2.1.1 Each type of liferaft is to be subjected to a minimum of two drop tests. Where the liferaft in its operational condition is packed in a container or valise, one such test is to be carried out with the liferaft packed in each type of container or valise.

2.1.2 The liferaft, in the operationally packed condition, is to be dropped from a height of 18 m into the water. If it is to be stowed at a height greater than 18 m, it is to be dropped from the height at which it is to be stowed. The free end of the painter is to be attached to the point of suspension so that it pays out as the liferaft drops, thus simulating actual conditions.

2.1.3 The liferaft is to be left floating for 30 min:

1) in the case of a rigid liferaft it is to be lifted from the water to permit thorough inspection of the liferaft, the contents of the equipment container and, where applicable, the container or valise.
2) in the case of an inflatable liferaft, it is then to be inflated. The liferaft is to inflate upright and in the time prescribed in 2.17. The thorough inspection prescribed in 1) above is to then be carried out.

2.1.4 Damage to the container or valise, if the liferaft is normally within it when launched, is acceptable provided BKI is satisfied that it would not be a hazard to the liferaft. Damage to any item of equipment is acceptable subject to BKI being satisfied that the operational efficiency has not been impaired. Damage to fresh water receptacles may be accepted provided they do not leak. However, for drop tests from heights exceeding 18 m, leakage from up to 5% of the receptacles may be accepted provided that:

1) the equipment list for the inflatable liferaft specifies the carriage of 5% excess water or means of desalination adequate to produce an equivalent amount; or
2) the water receptacles are contained in a waterproof overwrap.

2.2 Jump Test [5.2]

2.2.1 It is to be demonstrated that a person can jump on to the liferaft, with and without the canopy erected, from a height above the floor of at least 4,5 m without damaging the liferaft. The test subject is to weigh not less than 82,5 kg and is to be wearing hard bottom shoes with smooth soles and no protruding nails. The number of jumps performed is to be equal to the total number of persons for which the liferaft is to be approved.

2.2.2 The jump test may be simulated by dropping a suitable and equivalent mass, arranged so as to impact the liferaft with shoes as described in 2.2.1 above.

2.2.3 There is to be no torn fabric, or damage to seams as a result of the test.

2.2.4 Unless the configuration of both sides of a canopied reversible liferaft are identical, this test is to be repeated for both sides of the liferaft.

2.3 Weight Test [5.3]

The fully packed liferaft container is to be weighed to determine whether its mass exceeds 185 kg. The weight test is to be performed on the heaviest variation of the liferaft, considering different containers and equipment packs which may be used. If the mass exceeds 185 kg, the different combinations of containers and equipment packs are to be weighed to determine which will and which will not exceed 185 kg.

2.4 Towing Test [5.4]

It is to be demonstrated by towing that the fully loaded and equipped liferaft is capable of being satisfactorily towed at speeds of up to 3 knots in calm water. Towing is to be by a line attached to the liferaft's towing connection. The sea anchor is to be streamed while the liferaft is towed. The liferaft is to be towed for a distance of at least 1 km. During the test the force required to tow the liferaft is to be measured at speeds of 2 knots and 3 knots and recorded on the type approval certificate.

2.5 Mooring Out Tests [5.5]

The liferaft is to be loaded with mass equal to the mass of the total number of persons for which it is to be approved and its equipment and moored in a location at sea or in a seawater harbour. The liferaft is to remain afloat in that location for 30 days. The pressure may be topped up once a day using the manual pump; however, during any 24 hours period the liferaft is to retain its shape. The liferaft is not to sustain any damage that would impair its performance. After this test, the inflatable liferaft is to be subjected to the pressure test prescribed in 2.18.

2.6 Painter System Test [5.6]

The breaking strength of the painter system, including its means of attachment to the liferaft is to be as follows:

1) not less than 7,5 kN for liferafts accommodating up to 8 persons;
2) not less than 10,0 kN for liferafts accommodating 9 to 25 persons
3) not less than 15,0 kN for liferafts accommodating more than 25 persons

2.7 Loading and Seating Test (Freeboard Measurement) [5.7]

The freeboard of the liferaft in the light condition, including its full equipment but no personnel, is to be recorded. The freeboard of the liferaft is again to be recorded when the number of persons for which the liferaft is to be approved, having an average mass of 82,5 kg, and each wearing an immersion suit and lifejacket, have boarded and are seated. It is to be established that all the seated persons have sufficient

space and headroom and it is to be demonstrated that the various items of equipment can be used within the liferaft in this condition and, in the case of an inflated liferaft, with the floor inflated. The freeboard, when loaded with the mass of the number of persons for which it is to be approved and its equipment, with the liferaft on an even keel and, in the case of an inflatable liferaft, with the floor not inflated, is not to be less than 300 mm. Unless the configuration of both sides of a canopied reversible liferaft are identical, this test is to be repeated for both sides of the liferaft.

2.8 Boarding and Closing Arrangement Test [5.8]

The boarding test is to be carried out in a swimming pool by a team of not more than four persons who are to be of mature age and of differing physiques as determined by BKI. Preferably they are not to be strong swimmers. For this test they are to be clothed in shirt and trousers or a boiler suit and are to wear approved lifejackets suitable for an adult. They must each swim about 100 m before reaching the liferaft for boarding. There must be no rest period between the swim and the boarding attempt. Boarding should be attempted by each person individually with no assistance from other swimmers or persons already in the liferaft. The water is to be of a depth sufficient to prevent any external assistance when boarding the liferaft. The arrangements will be considered satisfactory if three of the persons board the liferaft unaided and the fourth boards with the assistance of any of the others. The above mentioned test is to be carried out also with persons clothed in immersion suits and lifejackets. After the boarding test, it should be demonstrated by a person clothed in an approved immersion suit that the canopy entrance can be easily and quickly closed in 1 min and can be easily and quickly opened from inside and outside in 1 min. Unless the configuration of both sides of a canopied reversible liferaft are identical, this test is to be repeated for both sides of the liferaft.

2.9 Stability Test [5.9]

2.9.1 The number of persons for which the liferaft is to be approved is to be accommodated on one side and then at one end and in each case the freeboard is to be recorded. Under these conditions the freeboard is to be such that there is no danger of the liferaft being swamped. Each freeboard measurement is to be taken from the waterline to the top surface of the uppermost main buoyancy tube at its lowest point.

2.9.2 The stability of the liferaft during boarding may be ascertained as follows : Two persons each wearing approved lifejackets are to board the empty liferaft. It is then to be demonstrated that the two persons in the liferaft can readily assist from the water a third person who is required to feign unconsciousness. The third person must have his back towards the entrance so that he cannot assist the rescuers. It is to be demonstrated that the water pockets adequately counteract the upsetting moment on the liferaft and there is no danger of the liferaft capsizing.

2.10 Manoeuvrability Test [5.10]

It is to be demonstrated that with the paddles provided, the liferaft is capable of being propelled when fully laden in calm conditions over a distance of at least 25 m.

2.11 Swamp Test [5.11]

It is to be demonstrated that the liferaft, when fully swamped, is capable of supporting its full equipment and the number of persons for which it is to be approved. It is also to be demonstrated that the liferaft does not seriously deform in this condition.

2.12 Canopy Closure Test [5.12]

To ensure the effectiveness of the canopy closures in preventing water entering the liferaft, the efficiency of the closed entrances is to be demonstrated by means of a hose test or by any other equally effective

method. The requirement for the hose test is that about 2300 litres of water per minute be directed at and around the entrances through a 63,5 mm hose from a point 3,5 m away and 1,5 m above the level of the buoyancy tubes for a period of 5 min. The accumulation of water inside the liferaft is not to exceed 4 litres. Unless the configuration of both sides of a canopied reversible liferaft are identical, this test is to be repeated for both sides of the liferaft.

2.13 Buoyancy of Float-Free Liferafts [5.13]

It is to be demonstrated that the liferafts packed in containers which are float-free have sufficient inherent buoyancy to inflate the liferaft by means of the actuating line in the event of the ship sinking. The combination of equipment and container or valise is to be that which produces the maximum packed weight.

2.14 Weak link test

The weak link in the painter system is to be tensile tested and is to have a breaking strain of 2,2 ± 0,4 kN.

2.15 Damage Test [5.17.1]

It is to be demonstrated that, in the event of any one of the buoyancy compartments being damaged or failing to inflate, the intact compartment or compartments is (are) to support, with positive freeboard over the liferaft's periphery, the number of persons for which the liferaft is to be approved. This can be demonstrated with persons each having a mass of 82,5 kg and seated in their normal positions or by an equally distributed mass.

2.16 Righting Test [5.17.2]

This test is not required for a canopied reversible liferaft. For this test the liferaft is to be inverted so as to simulate inverted inflation.

2.16.1 The inflatable liferaft is to be loaded with its heaviest equipment pack. All of the entrances, ports, and other openings in the liferaft canopy are to be open in order to allow the infiltration of water into the canopy when capsized;

2.16.2 The canopy of the liferaft is then to be completely filled with water. Except for an automatically self-righting liferaft, this may be accomplished, if necessary by partially collapsing the canopy support, or alternatively the uninflated liferaft is to be flaked out onto the surface of the water upside down and inflation initiated. An automatically self-righting liferaft is to self-right in this condition, and is to become boardable in the upright position within 1 min after the start of the test. If the inflatable liferaft, other than an automatically self-righting liferaft, does not self-right, it is to be allowed to remain in an inverted position for at least 10 min before righting is attempted;

2.16.3 The righting test is to be carried out by the same team of persons required for the boarding test similarly clothed and wearing lifejackets and after completing the swim required in 2.8. At least one of the persons righting the inflatable liferaft is to weigh less than 82,5 kg. Each person is to attempt to right the liferaft unaided. The water is to be of sufficient depth to give no external assistance to the swimmers when mounting the inverted liferaft;

2.16.4 The righting arrangements will be considered satisfactory if each person rights the liferaft unaided. There is to be no damage to the structure of the inflatable liferaft, and the equipment pack is to remain secured in its place.

2.17 Inflation Test [5.17.3～5.17.6]

2.17.1 A liferaft, packed in each type of container, is to be inflated by pulling the painter and the time recorded:

1) for it to become boardable, i.e. when buoyancy tubes are inflated to full shape and diameter;
2) for the cover to be erect; and
3) for the liferaft to reach its full operational pressure when tested:
   A) at an ambient temperature of between 18°C and 20°C;
   B) at a temperature of -30°C; and
   C) at a temperature of +65°C.

2.17.2 When inflated in an ambient temperature of between 18°C and 20°C, it is to achieve total inflation in not more than 1 *min*. In the case of automatic self-righting liferaft, the liferaft is to achieve total inflation and be boardable in the upright position in not more than 1 min, regardless of the orientation in which the liferaft inflates. The force required to pull the painter and start inflation is not to exceed 150 N.

2.17.3 For the inflation test at -30°C the packed liferaft is to be kept at room temperature for at least 24 hours, then placed in a refrigerated chamber at a temperature of -30°C for 24 hours prior to inflation by pulling the painter. Under these conditions the liferaft is to reach working pressure in 3 min. Two liferafts are to be subjected to an inflation test at this temperature. There is to be no seam slippage, cracking, or other defect in the liferaft and it is to be ready for use after the tests.

2.17.4 For the inflation test at +65°C the packed liferaft is to be kept at room temperature for at least 24 hours, then placed in a heating chamber at a temperature of +65°C for not less than 7 hours prior to inflation by pulling the painter. Under these conditions the gas pressure relief valves must be of sufficient capacity to prevent damage to the liferaft by excess pressure and to prevent the maximum pressure during the inflation from reaching twice the reseat pressure of the release valve. There must be no seam slippage, cracking or other defect in the liferaft.

2.18 Pressure Test [5.17.7, 5.17.8]

2.18.1 Each inflatable compartment in the liferaft is to be tested to a pressure equal to three times the working pressure. Each pressure relief valve is to be made inoperative, compressed air is to be used to inflate the inflatable liferaft and the inflation source removed. The test is to continue for at least 30 min. The pressure is not to decrease by more than 5% as determined without compensating for temperature and atmospheric pressure changes, and there is to be no seam slippage, cracking or other defect in the liferaft.

2.18.2 The measurement of pressure drop due to leakage can be started when it has been assumed that compartment material has completed stretching due to the inflation pressure and achieved equilibrium.

2.19 Seam Strength Test [5.17.9]

2.19.1 It is to be demonstrated that sample seams, prepared in the same condition as in production, can withstand a test load equal to the minimum specified liferaft fabric tensile strength. Sewn seams on outer canopy fabric is to withstand a test load of at least 70% of the minimum specified fabric tensile strength when tested by the method described in ISO 1421:1998 and by using test samples as shown in Fig.1 below.

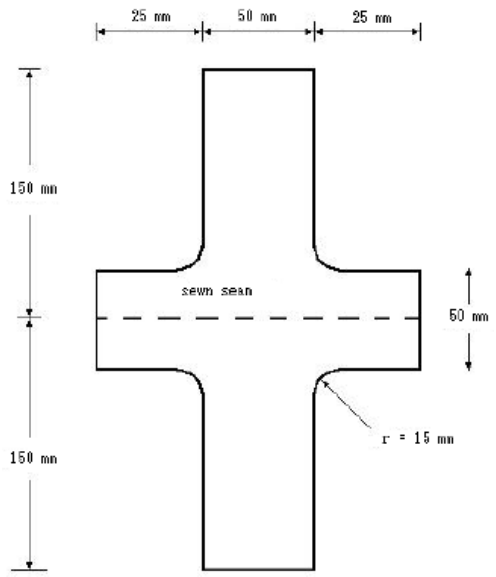

Fig. 1 Sample specification for sewn canopy seams

Samples of all types of sewing used in production are to be tested.

Seam construction in both warp and weft direction is to be tested.

The test specimens are to be cut out from pre-sewn samples of fabric and no locking of thread ends is to take place.

2.19.2 Weld strength

.1 When tested by the method prescribed below, the load required to initiate failure of the weld is to be not less than 175 N;

.2 Specimens are to be prepared and tested as given in 2.19.3.3 below.

2.19.3 Hydrolysis tests are to be conducted on sample welded seams where thermoplastic coated materials are to be used. The tests are to be conducted as follows;

.1 When tested by the method prescribed below, the weld strength of the sample seam is to achieve 125 N/ 25 mm minimum.

.2 Test method

1) Store the test specimens for 12 weeks over water in a closed container at 93 ± 2°C.
2) After the conditioning as above, dry the specimens for 1 h at 80 ± 2°C, and condition at 20 ± 2°C, 65% RH for 24 h.

.3 Welded test samples are to be prepared as follows:

Two samples of fabric 300 mm x 200 mm, cut with the short side parallel to the warp direction, are to be superimposed face to back for double coated fabrics, or coated face to coated face for single or asymmetrically coated fabrics. They are to be welded with a tool 10 mm ± 1 mm width of convenient length. 25 mm wide test specimens are to be cut transversely to the line of the weld. The test samples are to be mounted in a test machine as in ISO 1421:1998. The maximum peel load is to be recorded.

2.20 Additional Tests for Davit Launched Liferafts

2.20.1 Strength Test of Lifting Components [5.16.1]

The breaking strength of the webbing or rope and the attachments to the liferaft used for the lifting bridle is to be established by tests on three separate pieces of each different item. The combined strength of the lifting bridle components is to be at least six times the mass of the liferaft when loaded with the number of persons for which it is to be approved and its equipment.

2.20.2 Impact Test [5.16.2]

The liferaft is to be loaded with a mass equal to the mass of the number of persons for which it is to be approved and its equipment. With the liferaft in a free hanging position it is to be pulled laterally to a position so that when released it will strike a rigid vertical surface at a velocity of 3,5 m/s. The liferaft is then to be released to impact against the rigid vertical surface. After this test the liferaft is to show no signs of damage which would affect its efficient functioning.

2.20.3 Drop Test [5.16.3]

The liferaft, loaded as prescribed in 2.20.2, is to be suspended from an on-load release at a height of 3 m above the water, be released and allowed to fall freely into the water. The liferaft is then to be examined to ensure that no damage has been sustained which would affect its efficient functioning.

2.20.4 Boarding Test [5.16.4]

A davit-launched liferaft is, in addition to the boarding test prescribed in 2.8, to be subjected to the following test. The liferaft is to be suspended from a liferaft launching appliance, or from a crane with a head sheave of similar height, and bowsed in to the ship's side or simulated ship's side. The liferaft is to be boarded by the number of persons for which it is to be approved of average mass 82,5 kg. There is to be no undue distortion of the liferaft. The bowsing is then to be released and the liferaft left hanging for 5 min. It is then to be lowered to the sea or floor and unloaded. At least three tests are required in succession, with the hook of the lowering appliance so positioned that its distance from the ship’s side is:

1) half the beam of the liferaft +150 mm;
2) half the beam of the liferaft; and
3) half the beam of the liferaft -150 mm.

The boarding, which is intended to simulate actual shipboard conditions, is to be timed and the time recorded.

2.20.5 Strength Test [5.17.10～5.17.12]

.1 Overload Test at Normal Room Temperature

It is to be demonstrated by an overload test on the liferaft hanging from its centre support that the bridle system has an adequate factor of safety as follows:

1) the liferaft is to be placed in a temperature of 20 ± 3°C or a period of at least 6 hours;
2) following this period of conditioning, the liferaft is to be suspended from its lifting hook or bridle and the buoyancy chambers (not including an inflatable floor) inflated;
3) when fully inflated and when the relief valves have reseated themselves, all relief valves are to be made inoperative;

4) the liferaft is then to be lowered and loaded with a distributed mass equivalent to four times the mass of the number of persons for which it is to be approved and its equipment, the mass of each person being taken as 82,5 kg;

5) the liferaft is then to be raised and remain suspended for at least 5 min;

6) the pressure before and after the test after the weigh is removed and while it remains suspended, is to be recorded; and

7) any dimensional deflections or distortions of the liferaft are to be recorded. During the test and after its completion, the inflatable liferaft is to remain suitable for its intended use.

.2 Overload Test at Low Temperature

It is to be demonstrated, after a period of 6 hours in a chamber at a temperature of -30°C , that the liferaft will support a load of 1,1 times the number of persons for which it is to be approved and its equipment with all relief valves operative. The liferaft is to be loaded with the test weight in the refrigerated chamber. The floor is not to be inflated. The loaded inflatable liferaft is to remain suspended for at least 5 min. If the inflatable liferaft must be removed from the chamber in order to suspend it, the inflatable liferaft is to be suspended immediately upon removal from the chamber. During the test and after its completion, the inflatable liferaft is to remain suitable for its intended use.

.3 Lowering Test at Ship's Side

The inflatable liferaft is to be loaded with a weight equal to the mass of its heaviest equipment pack and the number of persons for which it is to be approved, the mass of each person being taken as 82,5 kg. Except for the floor which is not to be inflated, the inflatable liferaft is to be fully inflated with all relief valves operative. A liferaft is to be lowered for a distance of at least 4,5 min continuous contact against a structure erected to represent the side of a ship having a 20° adverse list. During the test and after its completion, the liferaft is not to sustain damage or distortion, or assume a position which would render it unsuitable for its intended purpose.

2.21 Additional tests applicable to automatically self-righting liferafts only [5.18]

2.21.1 Rigid automatic self-righting liferafts is to be tested to the righting test in 2.16.1 and 2.16.2.

2.21.2 A suitable means are to be provided to rotate the liferaft about a longitudinal axis to any angle of heel in calm water and then release it. The liferaft is to be fully equipped, with no one on board, with entrances and openings in the as-packed condition and, in the case of an inflatable liferaft, fully inflated. The liferaft is to be incrementally rotated to angles of heel up to and including 180° and is to be released. After release, the liferaft is always to return to the upright position without any assistance. Righting action is to be positive and continuous, and complete righting is to occur within the time difference between the liferaft reaching boardable shape, as determined by 2.17.1, at ambient temperature, and 1 min.

2.22 Submergence test for automatically self-righting and canopied reversible liferafts [5.19]

The liferaft and, if inflatable in its packed condition, is to be submerged to a depth of at least 4 m. A rigid liferaft is to be released at this depth, and, if an inflatable liferaft, initiate inflation at this depth. The liferaft is to float to the surface and come to its designed operational condition ready to be boarded from the sea in a sea state of at least 2 m significant wave height in association with a wind force of Beaufort force 6.

2.23 Wind velocity tests [5.20]

2.23.1 BKI is to require from a range of liferafts at least:

1) one liferaft from a range 6 to 25 persons capacity provided the material and construction arrangements are similar

2) each liferaft greater than 25 persons capacity, except in the case where it can be shown that the material and construction arrangements deem this unnecessary

2.23.2 The liferaft or liferafts in the packed condition with the entrance so arranged that it will be open on inflation, but without the container, is/are to be inflated in a wind velocity of 30 m/s and is/are to be left in this condition for 10 min.

2.23.3 During the above-mentioned conditions, whenever practicable, the liferaft or liferafts are to be swung over approximately 30^{o} to starboard, from that position to approximately 30^{o} to port and return to the starting position.

2.23.4 On completion of these first stage tests, there is to be no detachment of the arch support or canopy from the upper buoyancy tube or other damage which affects the efficient function of the liferaft.

2.23.5 Then the liferaft or liferafts are to be exposed to the above-mentioned wind velocity for 5 min in each of the following conditions.

1) with the entrance to the wind open and the other entrances closed, if there is more than one entrance
2) with the entrance to the wind closed and the other entrances open, if there is more than one entrance
3) with all entrances closed
4) The liferaft or liferafts are to show no sign of damage affecting its/their efficient function as a result of this test

2.24 Test for self-draining of floors of canopied reversible liferafts and automatically self-righting liferafts [5.21]

2.24.1 Water is to be pumped into the interior of the liferaft, while it is afloat, at a rate of 2300 litres per minute for 1 min.

2.24.2 After the water has been shut off and has drained, there is to be no appreciable accumulation of water in the liferaft.

2.24.3 If a liferaft is divided into separate areas, by thwarts or other means, each such area is to be subjected to the test.

2.25 Other Performance Tests

2.25.1 Air-charging test

The air-charging operation is to be performed using air-charging pumps or bellows fitted to the chambers. The pumps or the bellows are to be capable of raising the pressure to the necessary level whenever the pressure in the chambers falls.

2.25.2 Automatic lighting test

It is to be confirmed that the external and internal lamps light automatically when the liferaft inflates and are of sufficient intensity to enable any person in the vicinity of the internal lamp to read survival and equipment instructions while seating.

2.26 Detailed Inspection [5.16]

A liferaft, complete in all respects and in a fully inflated condition, is to be subjected to a detailed inspection in the manufacturer’s works to ensure that all the requirements are fulfilled.

B. Procedures for Production Tests of Inflatable Liferafts

1. Strength and Performance Tests

1.1 Inflation Test [5.1.1～5.1.3]

1.1.1 A completed and operationally packed liferaft is to be selected at random, and is to be subjected to an operational inflation test on a smooth dry floor or on water, e.g. a swimming pool, as a check on the packing and inflation.

1.1.2 The sampling rate of liferafts to be subjected to the operational inflation test for a period is to be determined by BKI, taking account of the number of liferafts produced for the period, the number of the liferafts to be subjected to the production test and the quality control procedures adopted and implemented. Personnel fabricating and packing inflatable liferafts are not to be made aware of which liferaft will be tested until after the liferaft has been packed in its container. The painter is to be pulled from the liferaft using a device to measure the applied force. The force required to pull the painter and start inflation is not to exceed 150 N. The inflatable liferaft is to break free from its container and attain its design shape and full erection of the canopy support tubes in not more than 1 min.

1.1.3 Each liferaft produced is to be inspected for defects and dimensional deviations.

1.2 Pressure and Tightness Tests [5.1.4～5.1.6]

1.2.1 Pressure Test

Each liferaft produced is to be inflated with air to the lesser of 2,0 times its working pressure or that sufficient to impose a tensile load on the inflatable tube fabric of at least 20% of the minimum required tensile strength. Relief valves are to be inoperative for this test. After 30 min the liferaft is not to show any signs of seam slippage or rupture, nor is the pressure to decrease by more than 5%. The measurement of the pressure drop due to leakage can be started when it has been assumed that the compartment rubber material has completed stretching due to the inflation pressure and stabilized. This test is to be conducted after equilibrium condition has been achieved. Following the test each relief valve is to be tested for proper relief and reseating pressure.

1.2.2 Tightness Test

.1 The gas-tight integrity of each inflated compartment of each liferaft produced is to be checked by inflating with air to its working pressure. After a settling time of 30 min the pressure is to be checked and adjusted to the working pressure as necessary. After 1 hour the pressure is not to have decreased by more than 5 % after compensation for temperature and barometric pressure changes. More than one compartment may be tested at one time, but adjacent compartments with common pressure barriers are to be open to the atmosphere during the test.

.2 If the insulation of the floor of the liferaft is obtained by inflation, it is to be inflated to its designed pressure. After a period of 1 hour the pressure is not to have decreased by more than 5% uncorrected pressure change.

.3 Exact NAP-test pressures can be calculated in accordance with the following equation:

$$P\ (kg/cm^2) = \frac{2\ x\ \text{tensile strength (kg per 5cm)}}{25\ x\ \text{diameter tube (cm)}}$$

1.3 10% Overload Test of Davit Launched Liferafts [5.2]

Every david-launched liferaft is to undergo a 10% overload test in accordance with the approved drawings or construction specification before the final inflation pressure test in the manner as specified below:

1) the liferaft is to be inflated with air and stabilized at its working pressure;
2) the working pressure is to be determined by the reseat of the relief valves. The pressure relief valves are to be fully operational;
3) the floor of the inflatable liferaft is not to be inflated;
4) the 10% overload is to be 10% of the mass of the liferaft together with its full equipment and complement of persons calculated at 82,5 kg per person;
5) the loaded liferaft is to remain suspended for not less than 5 min; and
6) the inflatable liferaft is not to sustain damage to its suspension members, their attachments, or any other structural component as a result of this test. The pressure relief valves are to maintain the normal working pressure of the buoyancy tubes and their basic shape during suspension.

Annex D Procedures for Prototype Tests for Type Approval and Production Tests of Launching Appliances of Lifeboats, Rescue Boats and Liferafts

A. Procedures for Prototype Tests for Type Approval of Inflatable Liferafts.....D–1
B. Procedures for Production Tests for Type Approval of Inflatable Liferafts.....D–3

Numbering in bracket [.....] refer to paragraph on IMO Resolution MSC.81(70) for Reference

A. Procedures for Prototype Tests for Type Approval of Launching Appliances

1. Strength and Performance Tests

1.1 Terminology

The terminologies used in 1. and B.1 of this Annex are as follows:

1) The maximum working load (L_{max}) of a launching appliance means the maximum load by the total mass of the following with regard to the lifeboat, rescue boat and liferaft hoisted and lowered by the launching appliance:
   A) mass of the fully equipped lifeboat, rescue boat or liferaft;
   B) mass of pulleys, ropes, etc.;
   C) mass of the number of persons (75 kg for a lifeboat intended for a passenger ship or 82,5 kg for a lifeboat intended for a cargo ship, a liferaft and a rescue boat per person) for which the lifeboat, rescue boat or liferaft is to be approved.
2) The minimum working load (L_{min}) of a launching appliance means the minimum load by the mass of 1) A) above for the lifeboat, rescue boat or liferaft hoisted and lowered by the launching appliance.
3) The maximum hoisting load (L_{lift}) of a launching appliance means the maximum load by the mass of 1) A) and B) above with the following for the lifeboat, rescue boat or liferaft hoisted and lowered by the launching appliance. For the lifeboat or liferaft, the mass of two lifeboat or liferaft crew (75 kg for a lifeboat intended for a passenger ship or 82,5 kg for a lifeboat intended for a cargo ship and for a liferaft per person) is to be added for hoisting the lifeboat or liferaft. For the rescue boat, the mass of six rescue boat crew (82,5 kg per person) is to be added for hoisting the rescue boat.
4) The maximum working load (W_{max}) of a winch means the maximum tension of the hanging rope at the winch drum when loads are being hoisted, lowered or held. For evaluation of this, friction resistance of pulleys is to be taken into account. In the case of davit launching appliances, the loads when the davits are in the maximum swing out position are also to be taken into account.

1.2 Davits and Launching Appliances

1.2.1 Overload Test [8.1.1]

For lifeboats other than free-fall lifeboats, davits and launching appliances, except the winch brakes, are to be subjected to a static proof load of 2,2 times their maximum working load (L_{max}). With the load at the full outboard position, the load is to be swung through an arc of approximately 10°to each side of vertical in the intended fore and aft plane. The test is to be done first in the upright position, followed by tests simulating a shipboard condition of list of 20° both inboard and outboard. There is to be no evidence of significant deformation or other damage as a result of this test. For free-fall lifeboats, the launching appliances for lowering a free-fall lifeboat by falls, except the winch brakes, are to be subjected to a static

proof load of 2,2 times the maximum working load (L_{max}) at the full outboard position. The launching ramp and its connection to the release mechanism is to be subjected to a static proof load of 2,2 times the maximum working load. There is to be no evidence of significant deformation or other damage as a result of this test.

1.2.2 Swing-out Test [8.1.2]

For lifeboats other than free-fall lifeboats, a mass equal to 1,1 times the maximum working load (L_{max}) is to be suspended from the lifting points with the launching appliance in the upright position. The load is to be moved from the full inboard to the full outboard position using the means of operation that is used on the ship. The test is to be repeated with the launching appliance positioned to simulate a combined 20° inboard list and 10° trim. All the tests are to be repeated with the minimum working load (L_{min}) of the appliance to ensure the satisfactory functioning of the davit under very light load conditions. The appliances are successfully to lower the load under all of the conditions, and there is to be no evidence of significant deformation or other damage as a result of the tests. For free-fall lifeboats, a mass equal to 1,1 times the maximum working load (L_{max}) is to be suspended from the lifting points. The load is to be moved from the full inboard to the full outboard position using the means of operation that is to be used on the ship. The test is to be repeated with the minimum working load (L_{min}) of the launching appliance to ensure the satisfactory functioning of the appliance under light load conditions. The appliance is successfully to lower the load under both conditions and there is to be no evidence of significant deformation or other damage as a result of the tests.

1.2.3 Recovery Operation Test [8.1.3]

A mass equal to 1,1 times the maximum working load is to be suspended from the lifting points with the launching appliance in the upright position. The load is to be moved from the full inboard to the full outboard position using the means of operation that is used on the ship. The appliance is to successfully move the maximum designed hoisting load from the outboard to the inboard position without causing permanent deformation or other damage.

1.2.4 Break Test [8.1.4]

Winch drums are to be wound to the maximum number of turns permitted and a static test load of 1,5 times the maximum working load (W_{max}) is to be applied and held by the brake. This load is then to be lowered for at least one complete revolution of the barrel shaft. A test load of 1,1 times the maximum working load (W_{max}) is then to be lowered at maximum lowering speed through a distance of at least 3 m and stopped by applying the hand brake sharply. The test load is to drop no more than 1 m when the brake is applied. This test is to be repeated a number of times. If the winch design incorporates an exposed brake, one of these tests is to be carried out with the brake wetted, but in this case the stopping distance may be exceeded. The various tests are to achieve a cumulative lowering distance of at least 150 m. Operation of the winch with a minimum working load (L_{min}) of the launching appliance is also to be demonstrated.

1.2.5 Recovery Operation Test by Rescue Boat Winches [8.1.5]

It is to be demonstrated that a winch intended for use with a rescue boat is capable of recovering the rescue boat with the number of persons for which it is to be approved and its equipment or an equivalent mass at a rate of not less than 0,3 m/s or 0,8 m/s in the case of a launching appliance for a fast rescue boat.

1.2.6 Hand Operation Test of Winches [8.1.6]

With the exception of winches intended for a free-fall lifeboat, the hand operation of the winch is to be demonstrated. If the winch is designed for quick recovery by hand with no load, this is to be demonstrated with a load of 1,5 times the mass of the empty lifting arrangements.

1.2.7 Overhaul Inspection of Winches [8.1.7]

Following completion of the tests the winch is to be stripped for inspection.

1.2.8 Pressure Test of Hydraulic Oil Systems

Components of the hydraulic system subject to a pressure of more than 1,6 MPa are to be pressure-tested under a pressure of 1,5 times the designed pressure.

1.2.9 Tests for Ramps for Free-Fall Lifeboats

The free-fall test of a full scale model free-fall lifeboat is to be carried out with a launching appliance of the same type as the one used for production free-fall lifeboats in accordance with 2.4.1.3 of Annex A. The results of the test are to meet the acceptance criteria of 2.4.2.1 3) of Annex A, and in addition, show no risk of incendiary friction or impact sparking during the launching of the lifeboat.

1.2.10 Tests for Adjustable Ramps

It is to be demonstrated that adjustable ramps for free-fall launching can be adjusted satisfactorily with the free-fall lifeboat loaded to 1,2 times its related load.

1.2.11 Launching Appliance for Fast Rescue Boats

The fast rescue boat launching appliance is to be demonstrated in a sea state associated with a force 6 wind on the Beaufort scale, in association with a significant wave height of at least 3 m. The test is to include launching and recovery of a fast rescue boat and demonstrate:

1) satisfactory operation of the device to dampen forces and oscillations due to interaction with the waves
2) satisfactory operation of the winch brake
3) satisfactory operation of the tensioning device

B. Procedures for Production Tests of Launching Appliances

1. Strength and Performance Tests

1.1 Launching Appliances Using Falls and Winches

1.1.1 Overload Test [6.1.1]

Each launching appliance, except the winch, is to be tested with a static load of 2,2 times the maximum working load with the appliance (L_{max}) in the full outboard position. For a free-fall lifeboat launching appliance, each launching ramp and its connection to the release mechanism is to be tested with a static load of 2,2 times the working load. The appliance is not to be deformed or damaged. Winches with the brakes applied are to be tested by applying a static load of 1,5 times the maximum working load (W_{max}). Any cast components of the frame and arm are to be hammer-tested to determine that they are sound and without flaw.

1.1.2 Pressure Test of Hydraulic Oil Systems

A pressure test is to be carried out in accordance with A.1.2.8.

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Annex E Procedures for Prototype Tests for Type Approval and Production Tests of Engines for Lifeboats and Rescue Boats

A. Procedures for Prototype Tests for Type Approval of Engines for Lifeboats and Rescue Boats E–1
B. Procedures for Production Tests of Engines for Lifeboats and Rescue Boats E–6

Numbering in bracket [.....] refer to paragraph on IMO Resolution MSC.81(70) for Reference

A. Procedures for Prototype Tests for Type Approval of Engines for Lifeboats and Rescue Boats

1. Internal Combustion Engines for Lifeboats and Rescue Boats (Including Reduction/Reversing Gears) (Excluding Outboard Motors)

1.1 General Performance Tests

1.1.1 Starting Test

When a battery is used for starting the engine, successive starting of six times or more is to be possible when the engine is under normal ambient temperature.

1.1.2 No Load, Low-speed Operation Test

The engine is to be subjected to the operation test with no load and with not more than half the maximum continuous rpm for 10 minutes, and it is to be ascertained that the engine runs smoothly.

1.1.3 No Load, High-speed Operation Test

This test is to be carried out for an engine not equipped with a governor. Under no load condition, the engine revolution is to be changed from less than half the maximum continuous rpm to not less than 120% of the maximum continuous rpm, and is to be maintained for 10 seconds. The test is to be repeated six times at 10 seconds intervals. Abnormal temperature rise of parts and harmful vibration are not to be present.

1.1.4 Load Test

During continuous operating tests under the load and rpm conditions shown in Table E.1, measurement of the engine performances and observation of operating conditions are to be carried out.

1.1.5 Reverse Operation/Reverse Operating Test

The reverse operations of not less than 100 times are to be carried out. Then, the reverse operation test of 0,5 hour is to be performed under the load of 0,75 of the maximum continuous output. Reverse operation is to be free from abnormalities.

1.1.6 Governor Test

This test is to be performed for an engine equipped with a governor. During maximum continuous rpm, the load is to be abruptly changed from 100% load to 0%, and the instantaneous speed variation, the time

required for stabilization and the speed variation after stabilization are to be recorded. The instantaneous speed variation when the load is changed from 100% to 0% is to be 20% or less.

1.1.7 Charging Test

The charging ability is to be confirmed.

1.1.8 Insulation resistance Test

The insulation resistance is to be measured by means of a DC 500 *V* insulation resistance tester. In case, however, apparatus and circuits are not suitable to be tested as above, the test may be dispensed with. The measured insulation resistance is to be 10 MΩ and over.

1.1.9 Endurance Test

.1 To ascertain the durability of the engine, the engine is to be subjected to the continuous operation test for 50 hours under conditions of the maximum continuous output and the maximum continuous rpm. Performances and durability are to be free from abnormalities.

.2 The endurance test may be omitted or the period for the endurance test may be shortened when BKI considers it appropriate, taking into consideration the operating experience, or, in case the engine is being newly developed, having examined the development records.

Table E.1 Loads and Operating Time

Load	Operating time (Hour)	RPM
Max. continuous output × 0,25	0,5	RPM is basically to be changed in proportion to the cubic root ratio of the load and the max. continuous output.
Max. continuous output × 0,50	0,5	
Max. continuous output × 0,75	0,5	
Max. continuous output × 1,00	4,0	
Max. continuous output × 1,10	0,5	

1.2 Cold Engine Starting Tests [6.10.2～6.10.4]

1.2.1 The engine may be removed from the lifeboat for this test, however, it is to be equipped with accessories and the transmission that will be used in the lifeboat. The engine, along with its fuel and coolant, is to be placed in a chamber at a temperature of -15°C.

1.2.2 The temperature of the fuel, lubricating oil and cooling fluid (if any) is to be measured at the beginning of this test and is not to be higher than -15°C. Samples of each fluid at this temperature are to be collected in a container for observation.

1.2.3 The engine is to be started three times. The first two times, the engine is to be allowed to operate long enough to demonstrate that it runs at operating speed. After the first two starts the engine is to be allowed to stand until all parts have again reached chamber temperature. After the third start, the engine is to be allowed to continue to run for at least 10 min and during this period the transmission is to be operated through its gear positions without difficulty.

1.3 Engine-out-of-water Test [6.10.5]

The engine is to be operated for at least 5 min at idling speed under conditions simulating normal storage. The engine is not to be damaged as a result of this test.

1.4 Submerged Engine Test [6.10.6]

The engine is to be operated for at least 5 min while submerged in water to the level of the centreline of the crankshaft with the engine in a horizontal position. The engine is not to be damaged as a result of this test.

1.5 Additional Tests for Engines for Totally Enclosed Lifeboats, Lifeboats with a Self-Contained Air Support System and Fire-protected Lifeboats

1.5.1 Engine Inversion Test [6.14.6～6.14.8]

.1 The engine and its fuel tank are to be mounted on a frame that is arranged to rotate about an axis equivalent to the longitudinal axis of the boat. A pan is to be located under the engine to collect any oil which may leak from the engine so that the quantity of such oil can be measured.

.2 The following procedure is to be followed during this test:

1) start the engine and run it at full speed for 5 min;
2) stop the engine and rotate it in a clockwise direction through 360°;
3) restart the engine and run it at full speed for 10 min;
4) stop the engine and rotate it in a counter-clockwise direction through 360°;
5) restart the engine, run it at full speed for 10 min, and then stop the engine;
6) allow the engine to cool;
7) restart the engine and run it at full speed for 5 min;
8) rotate the running engine in a clockwise direction through 180°, hold at the 180° position for 10 seconds, and then rotate it 180° further in a clockwise direction to complete one revolution;
9) if the engine is arranged to stop automatically when inverted, restart it;
10) allow the engine to continue to run at full speed for 10 min;
11) shut the engine down and allow it to cool;
12) repeat the procedure in 7) through 11), except that the engine is to be turned in a counter-clockwise direction;
13) restart the engine and run it at full speed for 5 min;
14) rotate the engine in a clockwise direction through 180° and stop the engine. Rotate it 180° further to complete a full clockwise revolution;
15) restart the engine and run it at full speed for 10 min;
16) repeat the procedure in 14), turning the engine counter-clockwise; and
17) restart the engine, run it at full speed for 10 min and then shut it down.

.3 During these tests, the engine is not to overheat, fail to operate or leak more than 250 ml of oil during any one inversion.

1.6 Overhaul Inspection [6.14.8]

After the tests 1.1 to 1.5, the engine is to be dismantled for examination. The engine is to show no evidence of overheating or excessive wear.

2. Outboard Motors for Rescue Boats

2.1 General Performance Tests

2.1.1 Starting Test

The start test is to be carried out in accordance with 1.1.1.

2.1.2 No Load, Low-speed Operating Test

The test is to be carried out in accordance with 1.1.2.

2.1.3 No Load, High-speed Test

The test is to be carried out in accordance with 1.1.3.

2.1.4 Full Load Test

The engine is to be subjected to a full load test with the rpm for the maximum continuous output for 20 minutes. Basically, along with measuring performance of the engine in the range of the rpm at which the engine is being operated stably with the throttle fully open, observations of operating performances are to be carried out. The operating conditions are to be smooth without overheating or damage, and the performance is to be in compliance with the specifications.

2.1.5 Minimum Speed Operating Test

At the minimum rpm with the clutch engaged, operation is to be maintained for 10 minutes. Operation is to be smooth.

2.1.6 Reverse Operation and Reverse Operating Test

In case the engine is equipped for reverse operation, reverse operation and reverse operating test are to be carried out in conformity with 1.1.5.

2.1.7 Governor Test (when governor is equipped)

During the maximum continuous rpm, the load is to be abruptly changed from 100% to 0%, or from 0% to 100%, and the instantaneous speed variation, the time required for stabilization and the speed variation after stabilization are to be recorded. The instantaneous speed variation when the load is changed from 100% to 0% is to be 20% or less.

2.1.8 Quick Speed Changing Test

The revolution of the engine is to be changed 100 times, by opening/closing the throttle valve, between the minimum rpm under no load condition and 10% higher than the rpm corresponding to the maximum continuous output. The standard one cycle of the rpm changing is 15 seconds. Operation during the test is to be smooth.

2.1.9 Engine-out-of-water Test

An engine-out-of-water test is to be carried out in accordance with 1.1.3.

2.1.10 Charging Test

When the engine is equipped with a charger, charging capacity is to be ascertained.

2.1.11 Insulation Resistance Test

An insulation resistance test is to be carried out in accordance with 1.1.8.

2.1.12 Endurance Test

An endurance test is to be carried out in accordance with 1.1.9.

2.2 Tests of Motors for Rescue Boats

2.2.1 Test Rigs [7.7.2]

The motor, fitted with a suitable propeller, is to be placed in a test rig such that the propeller is completely submerged in a water tank, simulating service conditions.

2.2.2 Running Test [7.7.3]

The motor is to be run at the maximum continuous rpm using the maximum power obtainable for 20 min, and is not to be overheat or be damaged.

2.2.3 Water Drench Test [7.7.4]

The motor protective cover is to be removed and the motor thoroughly drenched with water, by hose, except for the intake to the carburettor. The motor is to be started and run at speed for at least 5 min while it is still being drenched. The motor is not to falter or be damaged by this test.

2.2.4 Hot Start Test [7.7.5]

While still in the test rig referred to in 2.2.1, the motor is to be run at idling speed in order to heat up the cylinder block. At the maximum temperature achievable, the motor is to be stopped and immediately restarted. This test is to be carried out at least twice. The motor is not to fail to restart.

2.2.5 Manual start test [7.7.6, 7.7.7]

.1 The motor is to be started at ambient temperature by manual means. The means are to be either a manual automatic-rewind system or a pull cord round the top flywheel of the motor. The motor is to be started twice within 2 min of commencement of the start procedure.

.2 The motor is to be run until normal operating temperatures are reached, then it is to be stopped and started manually twice within 2 min, in accordance with .1.

2.2.6 Cold start test [7.7.8, 7.7.9]

.1 The motor, together with the fuel, fuel lines and battery, is to be placed in a chamber at a temperature of -15°C and allowed to remain until the temperature of all parts has reached the temperature of the chamber. The temperature of the fuel, battery and motor is to be measured for this test. The motor is to be started twice, within 2 min of commencement of the start procedure, and allowed to run long enough to demonstrate that it runs at operating speed. It is recommended that this period is not to exceed 15 seconds.

.2 Where, in the opinion of BKI, having regard to the particular voyages in which the ship carrying the boat is constantly engaged, a lower temperature is appropriate, that lower temperature is to be substituted for -15°C for the cold test.

2.2.7 Engine-out-of-water test

The engine is to be operated for at least 5 min at idling speed under conditions simulating normal storage. The engine is not to be damaged as a result of this test.

2.2.8 Engine inversion test (for engines destined for fast rescue boats only)

The engine and its fuel tank is to be mounted on a frame that is arranged to rotate about an axis equivalent to the longitudinal axis of the boat at the height of the boat transom. The propeller is to be in a water basin to the height of the cavitation plate. The engine is then to be subjected to the test procedure specified in paragraphs 1.5.1.2.1) through 13), and then dismantled for examination. With regard to 1.5.1.2.9), the engine is to be stopped automatically or by the helmsman's emergency release switch when inverted. During these tests, the engine is not to overheat or fail to operate or leak more than 250 ml of oil during any one inversion. When examined after being dismantled the engine is to show no evidence of overheating or excessive wear.

2.3 Overhaul Inspection

After the tests of 2.1 to 2.2, the motor is to be subjected to the overhaul examination. The motor is to show no evidence of overheating or excessive wear.

B. Procedures for Production Tests of Engines for Lifeboats and Rescue Boats

1. Performance Tests

1.1 Items for Performance Tests

The performance tests to be carried out are shown below. The procedures for these tests are to be in accordance with those specified in A. unless otherwise specified.

1.1.1 Internal Combustion Engines for Lifeboats or Rescue Boats (including Reduction/Reverse Gears) (excluding Outboard Motors)

1) Starting test
2) No load, low-speed operating test
3) No load, high-speed operating test (when no governor is equipped)
4) Load test
   The load test is to be in accordance with Table E.2.
5) Reversing operation and reversing test
   The reversing test is to be performed with a load of 75% for 20 minutes.
6) Governor test (when equipped)
7) Charging test
8) Insulation resistance test
9) Overhaul inspection

1.1.2 Outboard Motors for Rescue Boats

1) Starting test
2) No load, high-speed operating test (when no governor is equipped.)
3) Full load test

4) Minimum speed operating test
5) Reverse operation / reverse test
6) Governor test (when equipped)
7) Charging test (when a charger is equipped)
8) Insulation resistance test
9) Overhaul inspection

Table E.2 Load Test

Load	Operating time	RPM
Max. continuous output × 0,25	20 minutes	RPM is basically to be changed in proportion to the cubic root ratio of the load and the max. continuous output.
Max. continuous output × 0,50	20 minutes	
Max. continuous output × 0,75	20 minutes	
Max. continuous output × 1,00	60 minutes	
Max. continuous output × 1,10	20 minutes	

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Annex F Procedures for Prototype Tests for Type Approval and Production Tests of Release Mechanisms of Lifeboats or Rescue Boats Launched by Falls other than Free-Fall Lifeboats

A. Procedures for Prototype Tests for Type Approval of Release Mechanisms F–1
B. Procedures for Production Tests of Engines for Release Mechanisms F–2

Numbering in bracket [.....] refer to paragraph on IMO Resolution MSC.81(70) for Reference

A. Procedures for Prototype Tests for Type Approval of Release Mechanisms

1. Release Mechanism Test [6.9.1～6.9.5]

1.1 The lifeboat with its engine fitted is to be suspended from the release mechanism just clear of the ground or the water. The lifeboat is to be loaded so that the total mass equals 1,1 times the mass of the lifeboat, all its equipment and the number of persons for which the lifeboat is to be approved. The lifeboat is to be released simultaneously from each fall to which it is connected without binding or damage to any part of the lifeboat or the release mechanism.

1.2 It is to be confirmed that the lifeboat will simultaneously release from each fall to which it is connected when fully waterborne in the fully loaded condition without a mass of the number of persons for which the lifeboat is to be approved, and in a 10% overload condition.

1.3 It is to be demonstrated that the release mechanism can release the fully equipped lifeboat when loaded with weights equal to the mass of the number of persons for which the lifeboat is to be approved, when the lifeboat is being towed at speeds up to 5 knots. In lieu of a waterborne test, this test may be conducted as follows:

1) a force equal to 25% of the safe working load of the hook is to be applied to the hook in the lengthwise direction of the boat at an angle of 45° to the vertical. This test is to be conducted in the aftward as well as the forward direction;
2) a force equal to the safe working load of the release mechanism is to be applied to the hook in an athwartships direction at an angle of 20° to the vertical. This test is to be conducted on both port and starboard sides;
3) a force equal to the safe working load of the hook is to be applied to the hook in a direction half-way between the positions of tests 1) and 2) above (i.e., 45° to the longitudinal axis of the boat in plan view) at an angle of 33° to the vertical. This test is to be conducted in four positions. There is to be no damage to the hook as a result of this test, and in the case of a waterborne test, there is to be no damage to the lifeboat or its equipment.

1.4 A release mechanism is to be conditioned and tested as follows:

1) the lifeboat release and retrieval system and the longest used connection cable/linkage associated with the system is to be mounted and adjusted according to instructions from the original equipment manufacturer and then loaded to 100% of its safe working load and released. Load and release is to be repeated 50 times. During the 50 releases, the lifeboat release and retrieval system are to be released simultaneously from each fall to which it is connected without any binding or damage to any part of the lifeboat release and retrieval system. The system is to be considered as failed if any failure during the conditioning or unintended release occurs when load is applied but the system has not yet been operated;

2) the lifeboat release and retrieval system are to then be disassembled, the parts examined and wear recorded. The release and retrieval system is to then be reassembled;

3) the hook assembly, whilst disconnected from the operating mechanism, is to then be tested 10 times with cyclic loading from zero load to 1,1 times the safe working load, at a nominal 10 seconds per cycle. However, if the release mechanism has been specifically designed to operate as an off-load hook with on-load capability using the weight of the boat to close the hook, the cyclic load is to be from no more than 1% to 1,1 times the SWL. For cam-type designs, the test is to be carried out at an initial cam rotation of 0^{o} (fully reset position), and repeated at 45^{o} in either direction, or 45^{o} in one direction if restricted by design. The specimen is to remain closed during the test. The system is to be considered as failed if any failure during this test or any unintended release or opening occurs;

4) the cable and operating mechanism are to then be reconnected to the hook assembly; and the lifeboat release and retrieval system are to then be demonstrated to operate satisfactorily under its safe working load. The actuation force is to be no less than 100 N and no more than 300 N. If a cable is used, it is to be the maximum length specified by the manufacturer, and secures in the same manner it would be secured in the lifeboat. The demonstration is to verify that any interlocks, indicators and handles are still functioning and are correctly positioned in accordance with the operation and safety instruction from the original equipment manufacturer;

5) the release mechanism is deemed to have passed the testing when the tests 1) to 4) above all have been conducted successfully. The system is to be considered as failed if any failure during this test or any unintended release or opening occurs.

1.5 Another testing piece of the release mechanism tested in 1.4 above is to be tested as follows:

1) the actuation force of the release mechanism is to be measured loaded with 100% of its safe working load. The actuation force is to be no less than 100 N and no more than 300 N. If a cable is used, it is to be of the maximum length specified by the manufacturer, and secured in the same manner it would be secured in a lifeboat. The demonstration is to verify that any interlocks, indicators and handles are still functioning and are correctly positioned in accordance with the operation and safety instruction from the original equipment manufacturer;

2) the release mechanism is to be mounted on a tensile strength testing device. The load is to be increased to at least six times the working load of the release mechanism without failure of the release mechanism.

B. Procedures for Production Tests of Engines for Release Mechanisms

1. Performance Tests [5.3.1]

The test is to be in accordance with A.1.1 and A.1.2.

2. Strength Test [5.3.4]

The connection of each release gear which is fixed to lifeboats or rescue boats launched by falls is to be subjected to a load equal to the weight of the lifeboat or rescue boat with its full complement of persons and equipment (or two times the weight of the lifeboat or rescue boat with its full complement of persons and equipment in the case of single fall systems). There is to be no damage to the release gear or its connection to the lifeboat or rescue boat.