



Rules on Materials and Welding for the Classification of Marine Units

July 2021

**Rule Note
NR216 DT R12 E**

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1. INDEPENDENCE OF THE SOCIETY AND APPLICABLE TERMS

- 1.1** The Society shall remain at all times an independent contractor and neither the Society nor any of its officers, employees, servants, agents or subcontractors shall be or act as an employee, servant or agent of any other party hereto in the performance of the Services.
- 1.2** The operations of the Society in providing its Services are exclusively conducted by way of random inspections and do not, in any circumstances, involve monitoring or exhaustive verification.
- 1.3** The Society acts as a services provider. This cannot be construed as an obligation bearing on the Society to obtain a result or as a warranty. The Society is not and may not be considered as an underwriter, broker in Unit's sale or chartering, expert in Unit's valuation, consulting engineer, controller, naval architect, designer, manufacturer, shipbuilder, repair or conversion yard, charterer or shipowner; none of the above listed being relieved from any of their expressed or implied obligations as a result of the interventions of the Society.
- 1.4** Only the Society is qualified to apply and interpret its Rules.
- 1.5** The Client acknowledges the latest versions of the Conditions and of the applicable Rules applying to the Services' performance.
- 1.6** Unless an express written agreement is made between the Parties on the applicable Rules, the applicable Rules shall be the Rules applicable at the time of entering into the relevant contract for the performance of the Services.
- 1.7** The Services' performance is solely based on the Conditions. No other terms shall apply whether express or implied.

2. DEFINITIONS

- 2.1** "Certificate(s)" means classification or statutory certificates, attestations and reports following the Society's intervention.
- 2.2** "Certification" means the activity of certification in application of national and international regulations or standards ("Applicable Referential"), in particular by delegation from different governments that can result in the issuance of a Certificate.
- 2.3** "Classification" means the classification of a Unit that can result or not in the issuance of a classification Certificate with reference to the Rules. Classification (or Certification as defined in clause 2.2) is an appraisalment given by the Society to the Client, at a certain date, following surveys by its surveyors on the level of compliance of the Unit to the Society's Rules and/or to Applicable Referential for the Services provided. They cannot be construed as an implied or express warranty of safety, fitness for the purpose, seaworthiness of the Unit or of its value for sale, insurance or chartering.
- 2.4** "Client" means the Party and/or its representative requesting the Services.
- 2.5** "Conditions" means the terms and conditions set out in the present document.
- 2.6** "Industry Practice" means international maritime and/or offshore industry practices.
- 2.7** "Intellectual Property" means all patents, rights to inventions, utility models, copyright and related rights, trade marks, logos, service marks, trade dress, business and domain names, rights in trade dress or get-up, rights in goodwill or to sue for passing off, unfair competition rights, rights in designs, rights in computer software, database rights, topography rights, moral rights, rights in confidential information (including know-how and trade secrets), methods and protocols for Services, and any other intellectual property rights, in each case whether capable of registration, registered or unregistered and including all applications for and renewals, reversions or extensions of such rights, and all similar or equivalent rights or forms of protection in any part of the world.
- 2.8** "Parties" means the Society and Client together.
- 2.9** "Party" means the Society or the Client.
- 2.10** "Register" means the public electronic register of ships updated regularly by the Society.
- 2.11** "Rules" means the Society's classification rules (available online on veristar.com), guidance notes and other documents. The Society's Rules take into account at the date of their preparation the state of currently available and proven technical minimum requirements but are not a standard or a code of construction neither a guide for maintenance, a safety handbook or a guide of professional practices, all of which are assumed to be known in detail and carefully followed at all times by the Client.
- 2.12** "Services" means the services set out in clauses 2.2 and 2.3 but also other services related to Classification and Certification such as, but not limited to: ship and company safety management certification, ship and port security certification, maritime labour certification, training activities, all activities and duties incidental thereto such as documentation on any supporting means, software, instrumentation, measurements, tests and trials on board. The Services are carried out by the Society according to the Rules and/or the Applicable Referential and to the Bureau Veritas' Code of Ethics. The Society shall perform the Services according to the applicable national and international standards and Industry Practice and always on the assumption that the Client is aware of such standards and Industry Practice.
- 2.13** "Society" means the classification society 'Bureau Veritas Marine & Offshore SAS', a company organized and existing under the laws of France, registered in Nanterre under number 821 131 844, or any other legal entity of Bureau Veritas Group as may be specified in the relevant contract, and whose main activities are Classification and Certification of ships or offshore units.
- 2.14** "Unit" means any ship or vessel or offshore unit or structure of any type or part of it or system whether linked to shore, river bed or sea bed or not, whether operated or located at sea or in inland waters or partly on land, including submarines, hovercrafts, drilling rigs, offshore installations of any type and of any purpose, their related and ancillary equipment, subsea or not, such as well head and pipelines, mooring legs and mooring points or otherwise as decided by the Society.

3. SCOPE AND PERFORMANCE

- 3.1** Subject to the Services requested and always by reference to the Rules, and/or to the Applicable Referential, the Society shall:
- review the construction arrangements of the Unit as shown on the documents provided by the Client;
 - conduct the Unit surveys at the place of the Unit construction;
 - class the Unit and enter the Unit's class in the Society's Register;
 - survey the Unit periodically in service to note whether the requirements for the maintenance of class are met.
- The Client shall inform the Society without delay of any circumstances which may cause any changes on the conducted surveys or Services.
- 3.2** The Society will not:
- declare the acceptance or commissioning of a Unit, nor its construction in conformity with its design, such activities remaining under the exclusive responsibility of the Unit's owner or builder;
 - engage in any work relating to the design, construction, production or repair checks, neither in the operation of the Unit or the Unit's trade, neither in any advisory services, and cannot be held liable on those accounts.

4. RESERVATION CLAUSE

- 4.1** The Client shall always: (i) maintain the Unit in good safety condition after surveys; (ii) present the Unit for surveys; and (iii) inform the Society in due time of any circumstances that may affect the given appraisalment of the Unit or cause to modify the scope of the Services.
- 4.2** Certificates are only valid if issued by the Society.
- 4.3** The Society has entire control over the Certificates issued and may at any time withdraw a Certificate at its entire discretion including, but not limited to, in the following situations: where the Client fails to comply in due time with instructions of the Society or where the Client fails to pay in accordance with clause 6.2 hereunder.
- 4.4** The Society may at times and at its sole discretion give an opinion on a design or any technical element that would 'in principle' be acceptable to the Society. This opinion shall not presume on the final issuance of any Certificate nor on its content in the event of the actual issuance of a Certificate. This opinion shall only be an appraisalment made by the Society which shall not be held liable for it.

5. ACCESS AND SAFETY

- 5.1** The Client shall give to the Society all access and information necessary for the efficient performance of the requested Services. The Client shall be the sole responsible for the conditions of presentation of the Unit for tests, trials and surveys and the conditions under which tests and trials are carried out. Any information, drawing, etc. required for the performance of the Services must be made available in due time.
- 5.2** The Client shall notify the Society of any relevant safety issue and shall take all necessary safety-related measures to ensure a safe work environment for the Society or any of its officers, employees, servants, agents or subcontractors and shall comply with all applicable safety regulations.

6. PAYMENT OF INVOICES

- 6.1** The provision of the Services by the Society, whether complete or not, involves, for the part carried out, the payment of fees thirty (30) days upon issuance of the invoice.
- 6.2** Without prejudice to any other rights hereunder, in case of Client's payment default, the Society shall be entitled to charge, in addition to the amount not properly paid, interest equal to twelve (12) months LIBOR plus two (2)

per-cent as of due date calculated on the number of days such payment is delinquent. The Society shall also have the right to withhold Certificates and other documents and/or to suspend or revoke the validity of Certificates.

- 6.3** In case of dispute on the invoice amount, the undisputed portion of the invoice shall be paid and an explanation on the dispute shall accompany payment so that action can be taken to resolve the dispute.

7. LIABILITY

- 7.1** The Society bears no liability for consequential loss. For the purpose of this clause consequential loss shall include, without limitation:
- Indirect or consequential loss;
 - Any loss and/or deferral of production, loss of product, loss of use, loss of bargain, loss of revenue, loss of profit or anticipated profit, loss of business and business interruption, in each case whether direct or indirect.
- The Client shall defend, release, save, indemnify, defend and hold harmless the Society from the Client's own consequential loss regardless of cause.
- 7.2** Except in case of wilful misconduct of the Society, death or bodily injury caused by the Society's negligence and any other liability that could not be, by law, limited, the Society's maximum liability towards the Client is limited to one hundred and fifty per-cent (150%) of the price paid by the Client to the Society for the Services having caused the damage. This limit applies to any liability of whatsoever nature and howsoever arising, including fault by the Society, breach of contract, breach of warranty, tort, strict liability, breach of statute.
- 7.3** All claims shall be presented to the Society in writing within three (3) months of the completion of Services' performance or (if later) the date when the events which are relied on were first discovered by the Client. Any claim not so presented as defined above shall be deemed waived and absolutely time barred.

8. INDEMNITY CLAUSE

- 8.1** The Client shall defend, release, save, indemnify and hold harmless the Society from and against any and all claims, demands, lawsuits or actions for damages, including legal fees, for harm or loss to persons and/or property tangible, intangible or otherwise which may be brought against the Society, incidental to, arising out of or in connection with the performance of the Services (including for damages arising out of or in connection with opinions delivered according to clause 4.4 above) except for those claims caused solely and completely by the gross negligence of the Society, its officers, employees, servants, agents or subcontractors.

9. TERMINATION

- 9.1** The Parties shall have the right to terminate the Services (and the relevant contract) for convenience after giving the other Party thirty (30) days' written notice, and without prejudice to clause 6 above.
- 9.2** The Services shall be automatically and immediately terminated in the event the Client can no longer establish any form of interest in the Unit (e.g. sale, scrapping).
- 9.3** The Classification granted to the concerned Unit and the previously issued Certificates shall remain valid until the date of effect of the termination notice issued, or immediately in the event of termination under clause 9.2, subject to compliance with clause 4.1 and 6 above.
- 9.4** In the event where, in the reasonable opinion of the Society, the Client is in breach, or is suspected to be in breach of clause 16 of the Conditions, the Society shall have the right to terminate the Services (and the relevant contracts associated) with immediate effect.

10. FORCE MAJEURE

- 10.1** Neither Party shall be responsible or liable for any failure to fulfil any term or provision of the Conditions if and to the extent that fulfilment has been delayed or temporarily prevented by a force majeure occurrence without the fault or negligence of the Party affected and which, by the exercise of reasonable diligence, the said Party is unable to provide against.
- 10.2** For the purpose of this clause, force majeure shall mean any circumstance not being within a Party's reasonable control including, but not limited to: acts of God, natural disasters, epidemics or pandemics, wars, terrorist attacks, riots, sabotages, impositions of sanctions, embargoes, nuclear, chemical or biological contaminations, laws or action taken by a government or public authority, quotas or prohibition, expropriations, destructions of the worksite, explosions, fires, accidents, any labour or trade disputes, strikes or lockouts.

11. CONFIDENTIALITY

- 11.1** The documents and data provided to or prepared by the Society in performing the Services, and the information made available to the Society, will be treated as confidential except where the information:
- is properly and lawfully in the possession of the Society;
 - is already in possession of the public or has entered the public domain, other than through a breach of this obligation;
 - is acquired or received independently from a third party that has the right to disseminate such information;
 - is required to be disclosed under applicable law or by a governmental order, decree, regulation or rule or by a stock exchange authority (provided that the receiving Party shall make all reasonable efforts to give prompt written notice to the disclosing Party prior to such disclosure).
- 11.2** The Parties shall use the confidential information exclusively within the framework of their activity underlying these Conditions.
- 11.3** Confidential information shall only be provided to third parties with the prior written consent of the other Party. However, such prior consent shall not be required when the Society provides the confidential information to a subsidiary.
- 11.4** Without prejudice to sub-clause 11.1, the Society shall have the right to disclose the confidential information if required to do so under regulations of the International Association of Classifications Societies (IACS) or any statutory obligations.

12. INTELLECTUAL PROPERTY

- 12.1** Each Party exclusively owns all rights to its Intellectual Property created before or after the commencement date of the Conditions and whether or not associated with any contract between the Parties.
- 12.2** The Intellectual Property developed by the Society for the performance of the Services including, but not limited to drawings, calculations, and reports shall remain the exclusive property of the Society.

13. ASSIGNMENT

- 13.1** The contract resulting from these Conditions cannot be assigned or transferred by any means by a Party to any third party without the prior written consent of the other Party.
- 13.2** The Society shall however have the right to assign or transfer by any means the said contract to a subsidiary of the Bureau Veritas Group.

14. SEVERABILITY

- 14.1** Invalidity of one or more provisions does not affect the remaining provisions.
- 14.2** Definitions herein take precedence over other definitions which may appear in other documents issued by the Society.
- 14.3** In case of doubt as to the interpretation of the Conditions, the English text shall prevail.

15. GOVERNING LAW AND DISPUTE RESOLUTION

- 15.1** These Conditions shall be construed in accordance with and governed by the laws of England and Wales.
- 15.2** Any dispute shall be finally settled under the Rules of Arbitration of the Maritime Arbitration Chamber of Paris ("CAMP"), which rules are deemed to be incorporated by reference into this clause. The number of arbitrators shall be three (3). The place of arbitration shall be Paris (France). The Parties agree to keep the arbitration proceedings confidential.
- 15.3** Notwithstanding clause 15.2, disputes relating to the payment of the Society's invoices may be submitted by the Society to the *Tribunal de Commerce de Nanterre*, France, or to any other competent local Court, at the Society's entire discretion.

16. PROFESSIONAL ETHICS

- 16.1** Each Party shall conduct all activities in compliance with all laws, statutes, rules, economic and trade sanctions (including but not limited to US sanctions and EU sanctions) and regulations applicable to such Party including but not limited to: child labour, forced labour, collective bargaining, discrimination, abuse, working hours and minimum wages, anti-bribery, anti-corruption, copyright and trademark protection, personal data protection (<https://personaldataprotection.bureauveritas.com/privacypolicy>).
- Each of the Parties warrants that neither it, nor its affiliates, has made or will make, with respect to the matters provided for hereunder, any offer, payment, gift or authorization of the payment of any money directly or indirectly, to or for the use or benefit of any official or employee of the government, political party, official, or candidate.
- 16.2** In addition, the Client shall act consistently with the Bureau Veritas' Code of Ethics and, when applicable, Business Partner Code of Conduct both available at <https://group.bureauveritas.com/group/corporate-social-responsibility/operational-excellence>.





RULES ON MATERIALS AND WELDING FOR THE CLASSIFICATION OF MARINE UNITS

NR 216

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July 2021

The English wording of these rules take precedence over editions in other languages.

Unless otherwise specified, these rules apply to Marine Units for which contracts are signed after July 1st, 2021. The Society may refer to the contents hereof before July 1st, 2021, as and when deemed necessary or appropriate.

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GENERAL REQUIREMENTS

- SECTION 1 MANUFACTURE, INSPECTION, CERTIFICATION**
- SECTION 2 TESTING PROCEDURES FOR MATERIALS**

SECTION 1

MANUFACTURE, INSPECTION, CERTIFICATION

1 General

1.1 Scope

1.1.1 Chapter 2 to Chapter 4 of these Rules specify the requirements for the manufacture, inspection and certification of steel and iron products, non-ferrous metals, various finished products and equipment such as propellers, pressure bottles, anchors, chain cables, ropes and sidescuttles, entering in the construction or repair of Units which are surveyed for classification purposes.

The general requirements relevant to the manufacture, inspection and certification of the above-mentioned materials and products, hereafter generally referred to as “products”, are given in this Chapter and are to be complied with as applicable.

The requirements Chapter 1 are also applicable, as appropriate, to products covered by other relevant Society’s Rules.

Chapter 5 specifies the requirements for approval of welding consumables and qualification of welding procedures.

1.1.2 In addition to these Rules, the requirements given for certain materials, procedures and products in the other relevant Society’s Rules or specified by the Society on the reviewed drawings, are also applicable, where appropriate.

1.1.3 Products subject to the requirements of these Rules and the relevant testing operations are those laid down in the relevant Rules of the Society dealing with the design, survey at works and testing of products, unless otherwise specified.

1.1.4 Products with properties departing appreciably from those covered by these Rules and other relevant Society’s Rules may be used with the approval of the Society.

1.2 Other specifications

1.2.1 Products complying with international, national or proprietary specifications may be accepted by the Society, provided such specifications give reasonable equivalence to the requirements of these Rules and other relevant Society’s Rules or are approved for a specific application.

Such products, when accepted, are designated by their standard identification or as agreed at the time of the approval.

Unless otherwise agreed, survey and certification of products complying with other specifications are to be carried out in accordance with the requirements of these Rules and other relevant Society’s Rules.

1.3 Information to be supplied by the purchaser

1.3.1 The purchaser is to provide the Manufacturer with the information necessary to ensure that products are tested in accordance with these Rules and other relevant Society’s Rules; optional or additional conditions are also to be clearly indicated.

2 Manufacture and quality

2.1 General

2.1.1 Manufacture

Manufacturers and their individual works are to be recognised by the Society for the type of products fabricated on a case-by-case basis or through recognition scheme given in Society’s Rule Note NR320.

To this end plants, production and treatment procedures, testing machines, laboratories for analyses, internal control systems and personnel qualification are to be suitable in the opinion of the Society.

Manufacturing procedures and techniques are to be such as to reasonably ensure constant compliance of the product with the requirements.

Where tests and analyses are performed by external laboratories or third parties, these are to be recognised by the Society on a case-by-case basis or through recognition scheme given in Society’s Rule Note NR320.

2.1.2 Approval

Depending on the type and importance of the products being supplied, the relevant manufacturing process may be required to be approved and approval tests performed for the purpose.

When approval of the manufacturing process is required, such condition is specified in the rule requirements relevant to the various products.

The provisions for the approval of Manufacturers are given in the document NR480 “Approval of the manufacturing process of metallic materials”.

2.1.3 Responsibility

Irrespective of the interventions of Surveyors, the Manufacturer is entirely and solely responsible for compliance of the supplied products with the stipulated requirements.

The Society assumes no liability by its interventions in respect of the compliance of a tested product with the stipulated regulations and requirements.

Where, in the course of manufacture or after supply, a product is found not to be in compliance with the requirements or to present unacceptable defects, it will be rejected, irrespective of any previous satisfactory test results.

2.2 Chemical composition

2.2.1 The chemical composition is to be determined and certified, as a rule, by the Manufacturer using ladle sampling analysis. The laboratory is to be adequately equipped and the analyses are to be performed by qualified personnel.

2.2.2 The analyses of the Manufacturer are generally accepted subject to occasional checks, if required by the Surveyor. When checks on the product are required, they are to be performed and the results evaluated in accordance with recognised standards.

2.3 Condition of supply

2.3.1 Unless otherwise agreed, the products are to be supplied in the finished condition as per rules, including heat treatment if required.

Heat treatment is to be carried out in suitable and efficient furnaces, fitted with appropriate means for temperature control and recording. Sufficient thermocouples are to be connected to the furnace charge to measure and record that its temperature is adequately uniform unless the temperature uniformity of the furnace is verified at regular intervals. The manufacturer is to maintain records of heat treatment identifying the furnace used, furnace charge, date, temperature and time at temperature. The records are to be presented to the surveyor on request.

The furnaces employed are to have a size sufficient to allow a uniform increase in temperature up to the required value of the entire part to be heat treated. In the case of very large parts, alternative systems proposed are to be agreed by the Society.

2.4 Identification of products

2.4.1 In the course of manufacturing, inspection and testing, the identification of the various products in respect of their origin is to be ensured as required.

To this end the Surveyor is to be given all facilities for tracing the products when required.

3 Inspection and testing

3.1 General conditions

3.1.1 As far as practicable the inspections and tests are to be carried out at the Manufacturer's works before delivery.

If the necessary facilities are not available at the Manufacturer's works, the testing is to be carried out at a testing laboratory agreed with the Society.

3.1.2 Where the testing is allowed to be carried out or completed at works other than the Manufacturer's it is in any case to be possible to trace back with certainty to the documentation of the origin.

3.1.3 Interested parties are to apply for Society's intervention in adequate time.

Prior to the survey, the Manufacturer is to provide the Surveyor with details of the orders, technical specifications and any special condition additional to the rule requirements.

3.1.4 The Surveyors are to have free access to all departments involved in production, collection of test samples, internal control and, in general, all operations concerning the manufacturing, examination and testing.

They are to be supplied with the information necessary to assess whether production and tests are performed according to the rule requirements.

3.1.5 The tests and checks required by the Rules are to be carried out in the presence of the Surveyors or, when expressly agreed with the Society, in the presence of the person responsible for internal control, specially delegated for this purpose.

The survey activities may be delegated to the Manufacturer under the conditions given in [3.2].

3.1.6 The tests required are to be performed by qualified personnel in accordance with the Society's Rules or, with recognised national or international standards, as appropriate.

The testing and measuring equipment is to be adequate, maintained in proper condition and regularly calibrated, as required; the record of such checks is to be kept up-to-date and made available to the Surveyor.

3.2 Alternative survey scheme

3.2.1 Alternative procedures to the systematic intervention of the Surveyor for testing may be adopted by Manufacturers specially recognised by the Society for the purpose.

Such alternative survey schemes, which are determined by taking into account the type of product, its mass production and the effectiveness of the certified Quality System implemented in the workshop, allow the testing operations indicated in these Rules and other relevant Society's Rules to be totally or partially carried out by the Manufacturer without the presence of the Surveyor.

Indications on the field of application of such schemes, along with conditions and procedures for their recognition, are given by the Society in a separate document.

3.3 Sampling for mechanical tests

3.3.1 The test samples are to be selected by the Surveyor or by a responsible person from the Manufacturer's staff, specially delegated, and are to be suitably marked for identification purposes.

3.3.2 The test samples are to be representative of the unit or lot of material which they are relevant to and are therefore also to have been subjected to the same heat treatment as the products except when a different procedure is agreed with the Society.

3.3.3 For the purpose of test sampling the following definitions apply:

- a) unit: single forging, casting, plate, tube or other single product
- b) rolled unit: product rolled from the same slab or billet or, when rolling proceeds directly from ingots, from the same ingot
- c) batch: number of similar units or rolled units presented as a group for acceptance testing, on the basis of the tests to be carried out on the test sample
- d) sample: a sufficient quantity of material taken from the unit, rolled unit or batch, for the purpose of producing one or more test specimens
- e) test specimens: part of sample with specified dimensions and conditions for submission to a given test.

3.4 Mechanical tests

3.4.1 The mechanical tests are to be carried out in the presence of the Surveyor unless otherwise agreed; see [3.2].

3.4.2 For the check of the mechanical properties of the material, test methods and specimens in compliance with the requirements of Sec 2 are to be used.

3.4.3 The type of tests, the number and direction of the test specimens and the results of the tests are to comply with the requirements relevant to the type of product, as indicated in the various Articles.

3.5 Re-test procedures

3.5.1 General

Where the unsuccessful outcome of any test is attributable to defective machining of the test specimen and/or to improper test procedure, the negative result is disregarded and the test repeated, in correct conditions, on a substitute test specimen.

3.5.2 Rejection or reconsideration

Where unsatisfactory results are obtained from re-tests representative of one lot of material, the unit from which the test specimens are taken is rejected.

The remainder of the lot may, at the discretion of the Surveyor, be reconsidered by performing the required tests on at least two different units; for acceptance, both the results of the new tests are to satisfy the requirements.

Otherwise, upon agreement with the Surveyor, the individual units composing the lot may be tested individually and those found satisfactory may be accepted.

The Manufacturer may resubmit for testing previously rejected material, after a suitable heat treatment or reheat treatment, or resubmit it under a different grade.

The Surveyor is to be notified of such circumstances.

Unless otherwise agreed by the Surveyor, only one new heat treatment is permitted for material which has already been heat treated.

3.6 Visual, dimensional and non-destructive examinations

3.6.1 General

The products are to be subjected to:

- a) visual examination
- b) dimensional check
- c) non-destructive examination, when applicable.

The above operations are to be carried out on products in appropriate conditions under the responsibility of the Manufacturer and are to be witnessed or repeated in the presence of the Surveyor when required.

When, following examinations and tests, there are grounds to presume that a product may be defective, the Manufacturer is obliged, for the purpose of acceptance, to demonstrate its suitability using procedures deemed necessary.

3.6.2 Visual examination

Visual examination is to be carried out by the manufacturer. A general examination is to be carried out by the surveyor at his discretion on each product tested individually, and, at random on products tested by batch.

3.6.3 Dimensional check

The dimensional checks and verification of compliance with approved drawings are the responsibility of the manufacturer. Some checks are to be made in presence of the Surveyor, as deemed necessary, solely for those parts subject to approval, or where expressly required in these Rules or other parts of the relevant Society's Rules.

3.6.4 Non-destructive examination

The non-destructive examination (also called non-destructive testing) is to be performed by the shipbuilder, manufacturer or its subcontractors in accordance with these requirements.

Non-destructive examination is to be performed by skilled and qualified personnel, using calibrated equipment of suitable type and according to approved procedures, recognized standards and the requirements of the Society.

In case of non-destructive testing carried out by an independent company from the manufacturer or shipyard, such company has to comply with the requirements set out in NR 669 "Recognition of non-destructive testing suppliers".

It is the shipbuilder's or manufacturer's responsibility to ensure that testing specifications and procedures are adhered to during the construction and the report is to be made available to the Society on the findings made by the non-destructive testing.

The Manufacturer's laboratory or other organisation responsible for the non-destructive examination is required to issue, on its own responsibility, a certificate illustrating the results and, where requested, an opinion concerning the acceptability of the product; in the latter case, the certificate is to be countersigned by the Manufacturer.

As a general rule, the Society's surveyor may require to witness the testing.

3.6.5 Qualification of personnel involved in non-destructive examination

The Shipbuilder, manufacturer or its subcontractor is responsible for the qualification and preferably 3rd party certification of its supervisors and operators to a recognised certification scheme based on ISO 9712:2012.

Personnel qualification to an employer based qualification scheme as e.g. SNT-TC-1A, 2016 or ANSI/ASNT CP-189, 2016 may be accepted if the Shipbuilder, manufacturer or its subcontractor written practice is reviewed and found acceptable by the Society. The Shipbuilder, manufacturer or its subcontractor written practice shall as a minimum, except for the impartiality requirements of a certification body and/or authorised body, comply with ISO 9712:2012.

The supervisors' and operators' certificates and competence shall comprise all industrial sectors and techniques being applied by the Shipbuilder, manufacturer or its subcontractor. Level 3 personnel shall be certified by an accredited certification body.

The operator carrying out the NDT and interpreting indications, shall as a minimum, be qualified and certified to Level 2 in the NDT method(s) concerned.

However, operators only undertaking the gathering of data using any NDT method and not performing data interpretation or data analysis may be qualified and certified as appropriate, at level 1.

The operator shall have adequate knowledge of materials, weld, structures or components, NDT equipment and limitations that are sufficient to apply the relevant NDT method for each application appropriately.

3.6.6 Advanced non-destructive examination

Advanced non-destructive examination (testing) such as Phased Array Ultrasonics, Time of Flight Diffraction and Digital Radiography are covered by Chapter 6.

3.7 Repairs of defects

3.7.1 Small surface defects may be suitably removed by grinding or other appropriate means, provided that the dimensional tolerances, prescribed for the various products in the relevant Articles, are complied with.

The repaired zone is to be found free from defects and to be acceptable in the opinion of the Surveyor.

3.7.2 Repairs by welding may be accepted only where this is not in contrast with the requirements applicable to the product, and provided that they are deemed suitable in connection with the material, extent of defects and welding procedure.

The repair procedure is to be previously agreed upon with the Surveyor.

4 Identification and certification

4.1 Identification and marking

4.1.1 General

A detailed record of the products to be tested is to be submitted to the Surveyor with indication of the necessary data, as applicable:

- name of purchaser and order number
- hull number or destination
- number, size and mass of parts or batches
- cast number and chemical composition
- part reference number, detail of manufacturing process and heat treatment
- condition of supply.

4.1.2 Manufacturer's marking

Products, which have satisfactorily undergone the required examination and tests are to be appropriately marked by the Manufacturer in at least one easily accessible location.

The marking is to contain all necessary indications, as specified in the Articles relevant to the various products, and is to correspond to the content of the survey documentation.

The marks are to be stamped, as a rule, by means of brands, except when products could be impaired by such a system. When paints or other reliable alternatives are adopted, adequate duration of marking is to be ensured.

For small pieces contained in effective containers, as well as bars and sections of modest weight, adequately bound in bundles, the marks are transferred to the container, label or top item of each bundle to the Surveyor's satisfaction.

4.1.3 Marking with the Society's brand

The products found satisfactory in accordance with the Rules and other relevant Society's Rules are to be marked with the Society's brand **SV** in the presence of the Surveyor unless otherwise agreed between Manufacturer and Surveyor.

All other additional marks required are specified in the applicable Articles depending on the products (e.g. name or initials of Manufacturer, material, grade and cast number, code for calendar year, running file number and code of the local office survey, Surveyor's personal brand, test pressure as statement of hydrostatic test).

4.1.4 Society marking for incomplete survey

Whenever a product is dispatched for delivery or is to be marked without undergoing all the examinations and tests required (whether by the provisions of these Rules or those of other relevant Society's Rules), the Society's brand **SV** will be replaced by the Society's mark **SV** for incomplete survey.

The testing documents are to contain clear indications of all outstanding examinations and tests and specify the reason why they have not been performed.

Upon satisfactory completion of all required examinations and tests, the product is to be stamped with the Society's brand **SV**.

4.1.5 Invalidation of Society's brand

When a product already marked with one of the Society's stamps is found not to be in compliance with the requirements and is therefore rejected, the Society's brand is to be invalidated by punching them.

The Surveyors may request to check the invalidation effected.

Any repairs after the product is tested are subject to the prior consent of the Society; failing this, the validity of the original testing will automatically expire and the original testing marks are to be invalidated by the interested parties.

4.1.6 Society's brand for alternative survey scheme

In the case of admission to an alternative survey scheme, the marking with the Society's brand may be delegated to the Manufacturer, who will be supplied with the special brand  to be used for this purpose.

4.2 Documentation and certification

4.2.1 Society's certificate

For products tested with satisfactory results, the Society issues a certificate signed by the Surveyor stating that the products have been tested in accordance with the Society's Rules.

This certificate is identified by the letter C for ease of reference in the various relevant Society's Rules.

A certificate issued by the Manufacturer is to be attached to the Society's certificate and is to include, as applicable, the following particulars:

- Manufacturer's name
- purchaser's name, order number and hull number
- description of the product, dimensions and weight
- results of all specified inspections and tests
- identification and testing marks stamped on the products.

In the case of testing of materials, the following particulars are also to be included:

- identification of specification or grade of material
- identification of the heat and relevant chemical analysis
- supply condition and details of heat treatment, including temperatures and holding times

- working and manufacturing procedure (for rolled products intended for hull, boilers and pressure vessels only)
- declaration that the material has been made by an approved process, as applicable, and that it has been subjected to the tests required by the Rules with satisfactory results.

For products manufactured in large quantities and tested by heats or by lot, the Manufacturer is to further state, for the individual supplies, that the products have been produced according to the Society's Rules.

4.2.2 Society's certificate for alternative survey scheme

For products covered by the alternative survey scheme, unless otherwise stated in the admission to the alternative survey scheme, the Manufacturer is to issue a Certificate of Conformity on the appropriate Society form.

This certificate is identified by the letter CA (certificate for alternative survey) for ease of reference in the various Society's Rules.

The certificate issued by the Manufacturer and including all the information required in [4.2.1] is to be attached to the (CA) certificate.

The certificate is to be submitted to the Society for endorsement according to the procedures stated in the agreement for the alternative survey scheme.

4.2.3 Works' certificates

For products which in accordance with the relevant rules may be accepted only on the basis of a certificate of conformity issued by the Manufacturer, stating the results of the tests performed, such certificate is to contain the information required under [4.2.1], as applicable.

This certificate of conformity is identified by the letter W (works' certificate) for ease of reference in the various parts of the Rules.

For particular products it may be accepted that the tests or examinations are carried out by the Manufacturer not on the product supplied, but on the current production.

This particular certificate of conformity is identified by the letter R (report) for ease of reference in the various Society's Rules.

SECTION 2 TESTING PROCEDURES FOR MATERIALS

1 General

1.1 Scope

1.1.1 This Section gives the requirements for testing procedures, testing machines and test specimens for mechanical and technological tests of materials.

Alternative testing procedures and test specimens such as those complying with recognised standards may be accepted by agreement with the Society.

The tests to be performed and the results to be obtained are given in the articles of the Rules dealing with each product.

The general conditions given in Sec 1 also apply.

1.2 Testing machines

1.2.1 Testing machines are to be maintained in satisfactory condition and recalibrated at approximately annual intervals for adequate reliability, accuracy and sensitivity. This calibration is to be traced to a nationally recognised authority and is to be to the satisfaction of the Society. The records of the calibration are to be made available to the Surveyor, kept in the test laboratory and copies provided on request.

1.2.2 Tension/compression testing machines are to be calibrated in accordance with ISO 7500-1 or other recognised standard.

The accuracy of tensile test machines is to be within plus or minus one percent.

1.2.3 Charpy impact testing machines are to have a striking energy of not less than 150J and are to be calibrated in accordance with ISO 148-2 or other recognised standard.

1.3 Preparation of test specimens

1.3.1 The samples for test specimens are to be in the same condition as the product from which they have been taken and therefore in the same heat treatment condition, if any.

1.3.2 If the test samples are cut from products by flame cutting or shearing, a reasonable margin is required to enable sufficient material to be removed from cut or sheared edges during final machining.

Test specimens are to be prepared in such a way that they are not subjected to any significant straining or heating which might alter the properties of the material.

2 Tensile test

2.1 Tensile test specimens

2.1.1 General

Test specimens of proportional type should preferably be used as the values of minimum percentage elongation after fracture specified in the Rules refer to the gauge length L_0 of these test specimens calculated by the following formula:

$$L_0 = 5,65 \sqrt{S_0}$$

This gauge length L_0 should preferably be greater than 20 mm. The gauge length may be rounded off to the nearest 5 mm provided that the difference between this length and L_0 is less than 10% of L_0 .

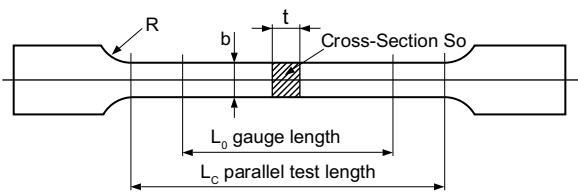
2.1.2 Proportional flat test specimen

For plates, strips and sections, proportional flat test specimens are usually used, with dimensions as shown in Fig 1.

For such products the tensile test specimens are to retain the original raw surfaces of the product.

When the capacity of the testing machine is insufficient to allow the use of test specimens of full thickness, this may be reduced by machining one of the raw surfaces.

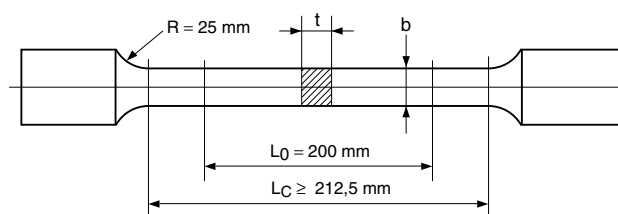
Figure 1 : Proportional flat specimen



- t : Thickness of the plate, strip or section, in mm
 b, R : Both equal to 25 mm
 L_0 : Original gauge length, in mm, equal to:
$$L_0 = 5,65 \sqrt{S_0}$$
 S_0 : Original specimen cross-section, in mm^2
 L_c : Parallel test length, in mm, equal to:
$$L_c = L_0 + 2 \sqrt{S_0}$$

2.1.3 Non-proportional flat test specimen

Alternatively to the proportional flat test specimen, non-proportional flat test specimen having original gauge length of 200 mm and other dimensions as shown in Fig 2, may be used for plates, strips and sections.

Figure 2 : Non proportional flat specimen

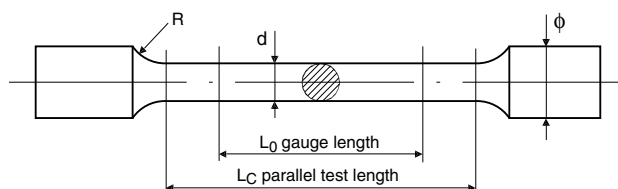
- t : Thickness of the plate, strip or section, in mm
 b, R : Both equal to 25 mm
 L_0 : Original gauge length, in mm
 L_C : Parallel test length, in mm.

2.1.4 Round proportional test specimen

Alternatively to the flat test specimen for plates, strips or sections equal to or greater than 40 mm thick, proportional round test specimen, machined to the dimensions shown in Fig 3, may be used.

Round proportional test specimen is used for rolled products in aluminium alloy with thickness higher than 12,5mm.

For rolled bars, forgings and castings, grey cast iron excluded, round proportional test specimen are usually to be used.

Figure 3 : Round proportional specimen

- d : From 10 to 20 mm, preferably taken equal to 14 mm
 L_0 : Original gauge length, in mm, equal to $5 \cdot d$
 L_C : Parallel test length, in mm, such as $L_C \geq L_0 + d / 2$
 R : 10 mm (for nodular cast iron and materials with a specified elongation less than 10%, $R \geq 1.5d$)

2.1.5 Round test specimen position

For plates, strips and sections with thickness equal to or greater than 40 mm, the longitudinal axis of the round test specimen is to be located at a distance from one of the surfaces equal to one quarter of the thickness.

For rolled products in aluminium alloy with thickness up to and including 40mm, the longitudinal axis of the round test specimen is to be located at mid-thickness. For thicknesses over 40mm, the longitudinal axis of the test specimen is to be located at a distance from one of the surfaces equal to one quarter of the thickness.

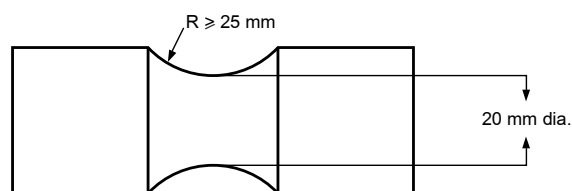
For bars and similar products, the longitudinal axis of the round test specimen is to be located at one third of the radius from the outside.

2.1.6 Through thickness tensile test specimen

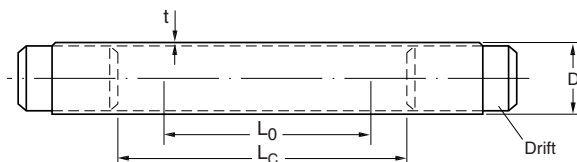
Round test specimen including built-up type by welding are to be prepared in accordance with a recognised standard.

2.1.7 Test specimen for grey cast iron

For grey cast iron, the test specimen as shown in Fig 4 is to be used.

Figure 4 : Specimen for grey cast iron**2.1.8 Test specimens for pipes and tubes**

For pipes and tubes, the test specimen may be a full cross-section of suitable length to be secured in the testing machine with plugged ends, as shown in Fig 5.

Figure 5 : Full cross section specimen

The original gauge length L_0 is to be equal to:

$$L_0 = 5,65 \sqrt{S_0}$$

and the distance between the grips L_C is to be not less than the gauge length plus D , where D is the external diameter of the tube or pipe.

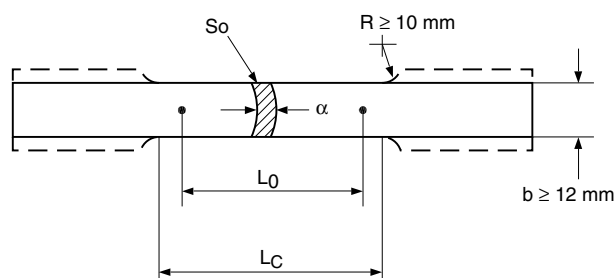
The length of the plugs projecting over the grips, in the direction of the gauge marks, is not to exceed the external diameter D , and the shape of the plugs is not to impede the elongation of the gauge length.

Alternatively, test specimens as shown in Fig 6 and taken from the tube or pipe wall may be used, where:

$$L_0 = 5,65 \sqrt{S_0}$$

$$L_C = L_0 + 2 b$$

α : Wall thickness, in mm.

Figure 6 : Specimen taken from the tube or pipe wall

The parallel test length is not to be flattened, but the enlarged ends may be flattened for gripping in the testing machine.

The round proportional test specimen shown in Fig 3 may be used provided that the wall thickness is sufficient to allow the machining of such test specimen with its axis located at the mid-wall thickness.

2.1.9 Test specimen for wires

For testing of wires, a full cross-section test specimen of suitable length is to be used.

The original gauge length is to be 200 mm and the parallel test length (distance between the grips) is to be 250 mm.

2.1.10 Test specimen for deposited metal tensile test

Round test specimen with the following dimensions is to be used:

- d = 10 mm
- L₀ = 50 mm
- L_C ≥ 55 mm
- R ≥ 10 mm

For specially small or large dimensions, other test specimens may be used after agreement with the Society, provided they conform with the geometrical relationship given in Fig 3.

2.1.11 Test specimen for butt weld transverse tensile test

Flat test specimen as shown in Fig 7 and with the following dimensions is to be used:

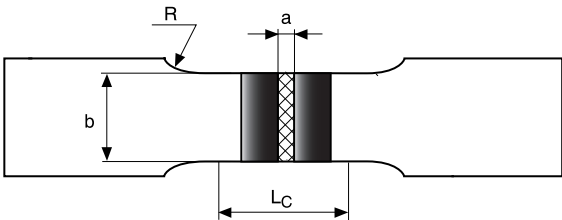
- t : Thickness of the welded plate, in mm
- a = t
- b : Equal to 12 mm for t ≤ 2 mm
25 mm for t > 2 mm
- L_C : Width of the weld + 60 mm
- R > 25 mm.

The weld is to be machined (or ground) flush with the surface of the plate.

2.1.12 Tolerances

The tolerances on test specimen dimensions are to be in accordance with ISO 6892-98 or other recognised standards as appropriate.

Figure 7 : Specimen for transverse tensile test on butt weld



2.2 Tensile test procedure

2.2.1 General

The following characteristics, as required by the Rules for each product, are to be determined by the test:

- R_{eH} : Upper yield stress (yield point), in N/mm²
- R_{p0,2} - R_{p0,5} - R_{p1,0}: Proof stress (yield strength), in N/mm²
- R_m : Tensile strength, in N/mm²
- A : Percentage elongation after fracture
- Z : Percentage reduction of area.

2.2.2 Yield and proof stress determination

For materials with well defined yield phenomenon, the upper yield stress R_{eH} is the value of stress at the moment when the first decrease in force is measured by the testing machine in the tensile tests at ambient temperature.

This applies, unless otherwise agreed, to products in carbon steels, carbon-manganese steels and alloy steels, except austenitic and duplex stainless steels.

When no well defined yield phenomenon exists, the type of proof stress required by the applicable specification is to be determined.

In general for steels, the conventional proof stress to be assumed is the 0,2 per cent proof stress or the 0,5 per cent proof stress, designated by the symbols R_{p0,2} and R_{p0,5}, respectively, where 0,2 and 0,5 are the percentage of permanent elongation.

For austenitic and duplex stainless steel products and relevant welding consumables, the 1,0 per cent proof stress, designated by the symbol R_{p1,0}, may be determined in addition to R_{p0,2}.

2.2.3 Test rate

Within the elastic range, the test is to be carried out with a stress rate within the following limits shown in Tab 1.

After reaching the yield or proof load, for ductile material the machine speed during the tensile test is not to exceed that corresponding to a strain rate of 0,008 s⁻¹.

For brittle materials such as cast iron, the elastic stress rate is not to exceed 10 N/mm² per second.

Table 1 : Stress rate within elastic range

Modulus of elasticity E of the material (N/mm ²)	Rate of stressing (N/mm ² .s ⁻¹)	
	Min.	Max.
< 150000	2	20
≥ 150000	6	60

2.2.4 Percentage elongation after fracture

The percentage elongation after fracture is usually determined on a proportional gauge length L₀. In that case, the percentage elongation after fracture is noted A or A₅.

L₀ is calculated from the following formula:

L₀ = 5,65 √S₀

where:

S₀ : Original cross-sectional area of the test specimen.

When using round proportional test specimens, L_0 is equal to 5 diameters.

When a gauge length other than proportional gauge length L_0 is used, the equivalent per cent elongation A_x required is obtained from the following formula:

$$A_x = 2A_5 \left(\frac{\sqrt{S}}{L} \right)^{0.4}$$

where:

- A_5 : Minimum elongation, in per cent, required by the Rules for the proportional test specimens illustrated in Fig 1, Fig 3 and Fig 6
- S : Area, in mm², of the original cross-section of the actual test specimen
- L : Length, in mm, of the corresponding gauge length actually used.

The above conversion formula may be used only for ferritic steel of low or medium strength and not cold worked.

The extension of the formula to other applications, such as cold worked steels, austenitic steels or non-ferrous materials is to be agreed with the Society.

In the case of disagreement, the value of elongation computed on the proportional test specimen is to be taken.

The gauge length used to determine the percentage elongation after fracture is to be indicated in the test reports.

For non-proportional test specimens with gauge length of 50 mm and 200 mm, the equivalent elongation values indicated in ISO 2566 apply.

The elongation value is, in principle, valid only if the distance between the fracture and the nearest gauge mark is not less than one third of the original gauge length. However the result is valid irrespective of the location of the fracture if the percentage elongation after fracture is equal to or greater than the expected value.

The fracture surfaces of test specimens after the tensile test is to be examined. The fracture surfaces are to be sound and free from defects and irregularities.

2.2.5 Testing at high temperature

Tensile tests at high temperature are to be performed at the specified temperature in accordance with an appropriate national or international standard in agreement with the Society.

2.3 Tensile re-test procedure

2.3.1 When the tensile test fails to meet the requirements, two further tests may be made from the same piece. If both of these additional tests are satisfactory the item and/or batch (as applicable) is acceptable. If one or both of these tests fail the item and/or batch is to be rejected.

The additional tests detailed above are to be taken, preferably from material taken adjacent to the original tests, but alternatively from another test position or sample representative of the item/batch.

3 Bend test

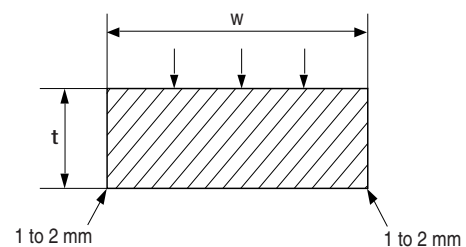
3.1 Flat bend test specimen

3.1.1 A flat bend test specimen as shown in Fig 8 is to be used.

The edges on the tension side are to be rounded to a radius of 1 to 2 mm.

The length of the test specimen is to be at least 11 times the thickness or 9 times the thickness plus the mandrel diameter, whichever is the greater.

Figure 8 : Flat bend specimen



3.1.2 For castings, forgings, and semi-finished products, the other dimensions are to be as stated below:

- thickness: $t = 20$ mm
- width: $w = 25$ mm.

3.1.3 For plates, sheets, strips and sections the other dimensions are to be as stated below:

- thickness: $t =$ thickness of the product
- width: $w = 30$ mm.

If the as rolled thickness t is greater than 25 mm, it may be reduced to 25 mm by machining on the compression side of the bend specimen.

3.1.4 For transverse face and root bend test on butt welds, the other dimensions are to be as follows:

- thickness: $t =$ thickness of welded plates
- width: $w = 30$ mm.

If the thickness t is greater than 25 mm, it may be reduced to 25 mm by machining on the compression side of the bend specimen.

The surfaces of the weld are to be machined (ground) flush with the surface of the plate.

3.1.5 For transverse side bend test on butt welds, the other dimensions are to be as follows:

- thickness: $t = 10$ mm
- width: $w =$ thickness of welded plates.

If the thickness of welded plates is equal or greater than 40mm, the side bend test specimen may be subdivided, each part being at least 20mm wide.

3.1.6 The test specimens for longitudinal face and root bend test on butt welds are to be in accordance with an appropriate recognised standard.

3.2 Bend test procedure

3.2.1 The bend test is to be performed, as a rule, by applying a continuous mechanical compressive action on one of the surfaces of the test specimen.

The required mandrel diameter and the minimum bend angle are specified in the Articles dealing with the various products.

4 Charpy V-notch impact test

4.1 Sampling

4.1.1 The Charpy V-notch impact test is, in general, performed on a set of 3 test specimens.

The longitudinal axis of the test specimens can be:

- a) parallel to the rolling direction of the plate, section or piece (longitudinal direction L), noted KVL in the Rules
- b) perpendicular to the rolling direction of the plate, section or piece (transverse direction T), noted KVT in the Rules
- c) parallel to other directions.

4.1.2 The axis of the V-notch is to be perpendicular to the faces of the plate, section or piece.

The position of the V-notch is not to be nearer than 25mm to a flame cut or sheared edge.

4.1.3 For rolled products with thickness less than or equal to 40 mm, the test specimens are to be taken retaining the original raw surface of the product or within 2 mm from it.

For rolled products with thickness higher than 40 mm, the test specimens are to be taken with their longitudinal axis located at 1/4 of the product thickness from one of the rolled surface, or as close as possible to such position.

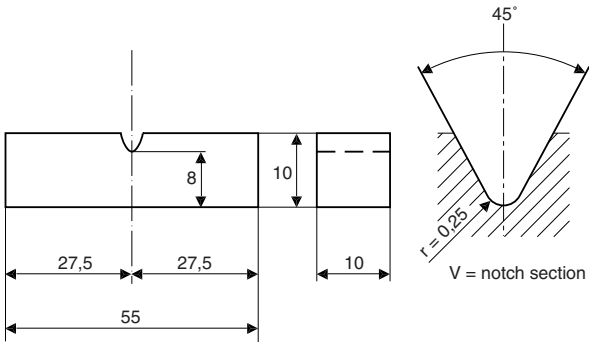
4.2 Charpy V-notch test specimens

4.2.1 The test specimens are to be fully machined at the dimensions and tolerances shown in Fig 9 and Tab 2.

Table 2 : Charpy V-notch test specimen

Dimensions	Nominal	Tolerance
Length	55 mm	± 0,60 mm
Width		
• standard test specimen	10 mm	± 0,11 mm
• subsize test specimen	7,5 mm	± 0,11 mm
• subsize test specimen	5,0 mm	± 0,06 mm
Thickness	10 mm	± 0,06 mm
Depth below notch	8 mm	± 0,06 mm
Angle of notch	45°	± 2°
Root radius	0,25 mm	± 0,025 mm
Distance of notch from end of test specimen	27,5 mm	± 0,42 mm
Angle between plane of symmetry of notch and longitudinal axis of test specimen	90°	± 2°

Figure 9 : Charpy V-notch test specimen



4.2.2 Test specimens with the largest possible size, reduced sectional area 10 x 7,5 or 10 x 5,0 are to be used if the thickness of the product does not allow to take test specimens of the standard size with sectional area 10 x 10.

The energy value required when using reduced size test specimen compared to standard size test specimen is given in Tab 3.

Table 3 : Average energy value for reduced test specimens

Sectional area of V-notch test specimens (mm²)	Minimum average energy (1)
10 x 10	KV
10 x 7,5	5/6 KV
10 x 5,0	2/3 KV
(1) KV is the required value on standard size test specimens, as per the Rules.	

4.3 Charpy V-notch test procedure

4.3.1 Ambient temperature means any temperature within the range 18 to 28°C.

Where the test temperature is lower than ambient, the temperature of the test specimen at the moment of breaking is to be the specified test temperature, within ± 2°C.

The test temperature is to be clearly stated in the testing documents.

4.3.2 The unit used to report the energy values is to be clearly stated in the testing documents and should be preferably the Joule (J).

The average of the three results from the test of the set is to comply with the value required for the product. Only one individual value may be less than the required average value, provided it is not less than 70% of that value.

4.4 Charpy V-notch re-test procedure

4.4.1 When the average value of the three initial Charpy V-notch impact test specimens fails to meet the stated requirement, or the value for more than one test specimen is below the required average value, or when the value of any one test specimen is below 70% of the specified average value, three additional specimens from the same material may be tested and the results added to those previously obtained to

form a new average. If this new average complies with the requirements and if not more than two individual results are lower than the required average and of these, not more than one result is below 70% of the specified average value the piece or batch (as applicable) may be accepted.

5 Drop weight test

5.1 Definition and test specimens dimensions

5.1.1 The drop weight test according to ASTM Standard E 208 is used for determination of the NDT (nil ductility transition) temperature.

The NDT is the maximum temperature where the drop weight test specimen breaks when tested according to the provisions of the standard.

Drop weight test specimens have one of the following dimensions (thickness by width by length, in mm³):

- type P1: 25 x 90 x 360
- type P2: 19 x 50 x 130
- type P3: 16 x 50 x 130.

5.1.2 The following apply, if not otherwise agreed:

- a) the test specimen sides are to be saw-cut or machined (minimum 25 mm distance to flame-cut surface)
- b) the machining of the sample to obtain the required thickness of the test specimen is to be carried out only on one surface; the opposite raw surface is to be maintained
- c) the specimens may be of any orientation, but the orientation is to be the same for all specimens.

6 Crack Tip Opening Displacement (CTOD) test

6.1 General

6.1.1 Unless otherwise agreed, the test is to be performed on test specimens of full thickness according to appropriate national or international standards like BS 7448 Part 1:1991 and ASTM E1820.

7 Ductility tests for pipes and tubes

7.1 Flattening test

7.1.1 The test specimen consists of a ring cut with smoothed ends perpendicular to the tube axis.

The length of the specimen is to be from 10 mm to 100 mm.

7.1.2 The test consists of compressing the test specimen between two rigid and parallel flat plates in a direction perpendicular to its longitudinal axis; the plates are to cover the whole test specimen after flattening.

It is to be continued until the distance Z between the two plates, measured under load, reaches the value specified.

In the case of welded pipes or tubes, the test is to be carried out with the weld seam positioned at 90° and at 0° to the flattening force.

After flattening, the test specimen is not to present any cracks or other flaws; however, small cracks at the ends may be disregarded.

7.2 Drift expanding test

7.2.1 The test specimen consists of a tube section having the ends perpendicular to the tube axis; the edges of the end to be tested may be rounded by filing.

7.2.2 For metallic tubes, the length of the specimen is equal to 2 D, where D is the external diameter of the tube, if the angle of the drift is 30°, or equal to 1,5 D if the angle of the drift is 45° or 60°. The test piece may be shorter provided that after testing the remaining cylindrical portion is not less than 0,5D.

7.2.3 The rate of penetration of the mandrel shall not exceed 50 mm/min.

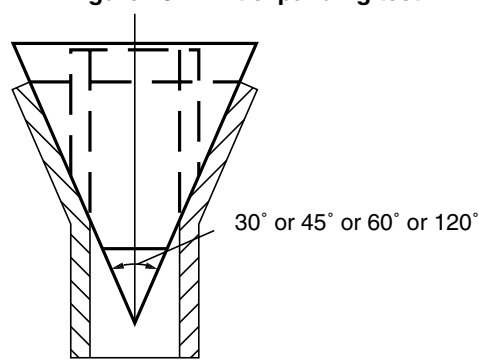
7.2.4 The test consists of flaring the end of the test specimen at ambient temperature and symmetrically, by means of a truncated-cone shaped mandrel of hardened steel having the included angle specified in [7.2.2] (see Fig 10).

The mandrel is to be lubricated but is not to be rotated in the pipe during the test.

The mandrel penetration is to continue until the increase in external diameter of the end of the expanded zone reaches the value specified in the requirements relevant to the various products.

The expanded zone of the test specimen is not to present any cracks or other flaws.

Figure 10 : Drift expanding test



7.3 Flanging test

7.3.1 The test specimen consists of a tube section cut with the ends perpendicular to the tube axis; the edges of the end to be tested may be rounded by filing.

7.3.2 The length of the test specimen is equal to approximately 1,5 times the external diameter of the tube. The test specimen may be shorter provided that after testing the remaining cylindrical portion is not less than half the external diameter.

7.3.3 The test is carried out in two stages and consists of symmetrically forming a flange at one end of the test specimen by means of a special mandrel of hardened steel; the mandrel is to be lubricated but is not to be rotated in the tube during the test.

The rate of penetration of the forming tool shall not exceed 50 mm/min.

During the first stage of flanging, the end of the test specimen is expanded by means of a truncated-cone shaped mandrel having an included angle of 90°; the test is then continued during the second stage using a special forming mandrel to complete the flange.

The test is to be continued until the expanded zone forms a flange perpendicular to the longitudinal axis of the test specimen, with an increase in the external diameter of the end of the test specimen not less than the value specified (see Fig 11).

The cylindrical and flanged portion of the test specimen is not to present any cracks or other flaws.

After testing, the remaining cylindrical portion is to be not less than half the external diameter of the tube.

7.4 Ring expanding test

7.4.1 The test specimen consists of a tube section cut with the ends perpendicular to the tube axis and the length between 10 and 16 mm.

7.4.2 The rate of penetration of the mandrel shall not exceed 30 mm/s.

7.4.3 The test specimen is to be expanded to the prescribed diameter or until fracture occurs (see Fig 12).

The expanded test specimen is not to reveal defects such as cracks, grooves or laminations and is to reach the prescribed expansion.

Figure 11 : Flanging test

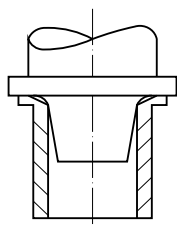
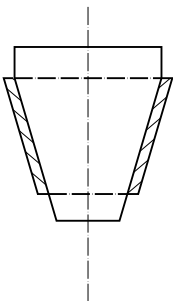


Figure 12 : Ring expanding test



7.5 Ring tensile test

7.5.1 The test specimen consists of a tube section with plain and smoothed ends cut perpendicular to the tube axis and with a length of about 15 mm.

7.5.2 The test specimen is to be drawn to fracture in a tensile testing machine by means of two mandrels having diameter equal to at least three times the wall thickness of the pipe.

The rate shall not exceed 5 mm/s.

In the case of welded pipes the weld seam is to be at 90° to the direction of the tensile load.

The test specimen after fracture is not to reveal defects such as cracks, grooves or laminations and is to show visible deformation at the point of fracture.

7.6 Bend test on pipes and tubes

7.6.1 Where feasible, the test specimen consists of full thickness strips not less than 40 mm in width (which may be machined down to 20 mm width for large thickness pipes) cut perpendicular to the pipe axis.

The edges of the test specimen may be rounded to 1,5 mm radius.

The result is considered satisfactory if, after being bent through the required angle in the direction of the original curvature, the test specimen is free from cracks and laminations; however, small cracks on the edges may be disregarded.

7.6.2 For small diameter tubes, in general not exceeding 50 mm, the test specimen consists of a tube section of sufficient length.

The test specimen is to be bent on a cylindrical mandrel with appropriate procedures as stated below, depending on the specification of the product:

- a) on a mandrel having a diameter 12 times the nominal diameter of the tube until an angle of 90° is reached
- b) on a mandrel having a diameter 8 times the nominal diameter of the tube, until an angle of 180° is reached.

The test specimen after bending is not to present any cracks or other flaws.

8 Other tests and checks

8.1 Strain age embrittlement test

8.1.1 The test is performed according to the following requirements:

- a) the material is to be deformed, generally by compression (in special cases, deformation under tension may be permitted) until the required shortening (or elongation) (usually 3%, 5% or 10%) is attained
- b) the material is then to be heat treated in a furnace at 250°C for 1/2 h unless otherwise agreed
- c) Charpy impact test specimens are to be obtained from the strained and treated material and broken at the specified temperature.

When the deformation is reached by lateral compression, the procedure of artificial aging described above may be applied directly to the individual test specimens.

8.2 Macrographic and micrographic examinations

8.2.1 The following examinations may be required to be performed as a random check for specific steel products:

- a) macrographic examination for detection of sulphur segregations (sulphur print or "Baumann test") according to ISO 4968
- b) evaluation of the primary austenitic grain size "McQuaid Ehn test" according to ASTM E 112 58 T Standards. For fine grained steels, the "fine grain" condition is considered satisfied when the grain size is 5 or finer.

Test methods according to other recognised standards may be accepted by agreement with the Society.

8.2.2 The laboratory which carries out the examination is to issue a certificate of the results and photographic documentation of typical zones is to be enclosed.

STEEL AND IRON PRODUCTS

- SECTION 1 ROLLED STEEL PLATES, SECTIONS AND BARS**
- SECTION 2 STEEL PIPES, TUBES AND FITTINGS**
- SECTION 3 STEEL FORGINGS**
- SECTION 4 STEEL CASTINGS**
- SECTION 5 IRON CASTINGS**

SECTION 1

ROLLED STEEL PLATES, SECTIONS AND BARS

1 General

1.1 Scope

1.1.1 The requirements of this Section apply to hot rolled plates, strips, sections and bars intended for hull, structural applications, boilers, pressure vessels and parts of machinery.

Article [1] specifies the requirements common to all the above-mentioned steel products, while the appropriate specific requirements are indicated in Articles [2] to [11].

1.2 Manufacture

1.2.1 Steel is to be manufactured by the electric furnace, basic oxygen or open hearth processes.

The use of other processes may be specially approved by the Society.

1.2.2 The steel is to be cast in ingot moulds or by a continuous casting process.

Provision is to be made for sufficient discard such as to ensure:

- at both ends of the ingots, the soundness of the material
- at the transitory zones of continuous casting material, a homogeneous chemical composition along the longitudinal axis.

1.3 Approval

1.3.1 The manufacturing process is to be approved by the Society for individual steelmakers, grade of steel and products, as specified in the applicable Articles.

Provisions for the approval are given in the document NR480 "Approval of the manufacturing process of metallic materials".

1.3.2 Rolling mills without their own steelmaking have to ensure that the slabs, blooms or ingots are supplied by works approved by the Society.

1.3.3 It is the manufacturer's responsibility to assure that effective process and production controls in operation are adhered to within the manufacturing specifications. Where control imperfection inducing possible inferior quality of product occurs, the manufacturer is to identify the cause and establish a countermeasure to prevent its recurrence. Also, the complete investigation report is to be submitted to the surveyor. For further use, each affected piece is to be tested to the Surveyor's satisfaction. The frequency of testing for subsequent products offered may be increased at the discretion of the Society.

1.4 Quality of materials

1.4.1 All products are to have a workmanlike finish and to be free from surface or internal defects which may impair their proper workability and use.

1.4.2 The responsibility for storage and maintenance of the delivered product(s) with acceptable level of surface conditions rests with the manufacturer or shipyard before the product(s) are used in fabrication.

1.5 Visual, dimensional and non-destructive examinations

1.5.1 General

Visual, dimensional and, as appropriate, non-destructive examinations are to be performed by the manufacturer on the materials supplied prior to delivery, as required.

Reference is made to the general provisions given in Ch 1, Sec 1, [3.6].

Non-destructive examinations may be required by the Surveyor when deemed necessary.

1.5.2 Thickness tolerances of steel plates and wide flats

The tolerances on thickness of a given product are defined as:

- minus tolerance is the lower limit of the acceptable range below the nominal thickness
- plus tolerance is the upper limit of the acceptable range above the nominal thickness.

The requirements for minus tolerances on nominal thickness are indicated in the Articles relevant to the various products.

The plus tolerance on nominal thickness are to be in accordance with a recognized national or international standard unless otherwise required by the Classification Society or purchaser.

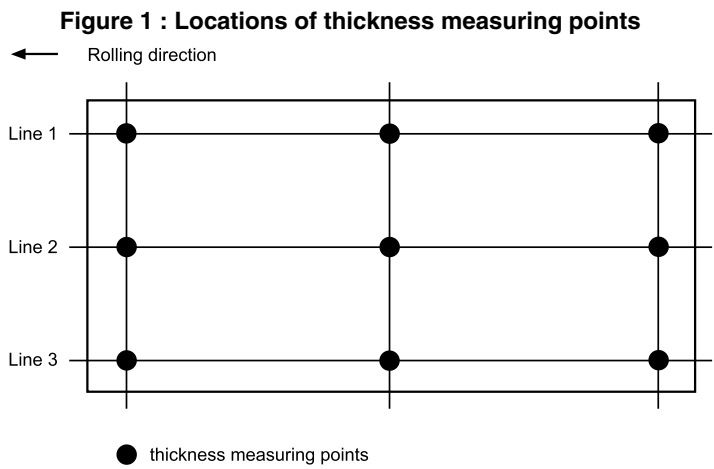
The tolerances on nominal thickness are not applicable to areas repaired by grinding.

The responsibility for verification and maintenance of the production within the required tolerances rests with the manufacturer. The Surveyor may require to witness some measurements.

1.5.3 Thickness measurements

Automated method or manual method is applied to the thickness measurements.

At least two lines among Line 1, Line 2 or Line 3 as shown in Fig 1, are to be selected for the thickness measurements and at least three points on each selected line as shown in Fig 1 are to be selected for thickness measurement. If more than three points are taken on each line the number of points shall be equal on each line.



For automated methods, the measuring points at sides are to be located not less than 10 mm but not greater than 300 mm from the transverse or longitudinal edges of the product.

For manual methods, the measuring points at sides are to be located not less than 10 mm but not greater than 100 mm from the transverse or longitudinal edges of the product.

1.6 Surface quality

1.6.1 General

The finished material is to have a surface quality in accordance with a recognized standard such as EN 10163 parts 1, 2 and 3, or an equivalent standard accepted by the Society, unless otherwise specified in this Section.

The responsibility for meeting the surface finish requirements rests with the manufacturer of the material, who is to take the necessary manufacturing precautions and is to inspect the products prior to delivery. At that stage, however, rolling or heat treatment scale may conceal surface discontinuities and defects. If, during the subsequent descaling or working operations, the material is found to be defective, the Society may require materials to be repaired or rejected.

The surface quality inspection method shall be in accordance with recognized national or international standards agreed between purchaser and manufacturer, accepted by the Society.

1.6.2 Rectification of surface defects by grinding

Defects which need to be repaired may be removed by grinding.

The general provisions of Ch 1, Sec 1 and specific requirements for the various products as specified in the relevant Articles of this Section apply.

The repaired areas are to be ground smooth to the adjacent surface of the product.

The Surveyor may request that the complete removal of defects is verified by suitable non-destructive examination.

1.6.3 Rectification of surface defects by welding

Surface defects of products which cannot be removed as stated in [1.6.2] may be repaired by chipping or grinding

followed by welding subject to the Surveyor’s consent and under his supervision.

The general provisions of Ch 1, Sec 1 and specific requirements for the various products as specified in the relevant Articles of this Section apply.

1.7 Condition of supply

1.7.1 The conditions of supply are specified in the Articles relevant to the various products.

Where alternative supply conditions are agreed, the choice of the supply condition, unless otherwise required, is left to the manufacturer; the condition of supply is always to be mentioned in the testing documentation.

1.7.2 When acceptable as an alternative to normalising, the procedures relevant to controlled or thermo-mechanical rolling process are to be specially approved for individual steelworks.

1.7.3 The rolling practice applied is to comply with the appropriate condition of supply. The applicable procedures are defined as follows:

- a) As Rolled, AR
This procedure involves steel being cooled as it is rolled with no further heat treatment. The rolling and finishing temperatures are typically in the austenite recrystallization region and above the normalising temperature. The strength and toughness properties of steel produced by this process are generally less than those of steel either heat treated after rolling or produced by advanced process.
- b) Normalising, N
Normalising involves heating rolled steel above the critical temperature, A_{c3} , and in the lower end of the austenite recrystallization region for a specific period of time, followed by air cooling. The process improves the mechanical properties of as rolled steel by refining the grain size and homogenising the microstructure.
- c) Controlled Rolling, CR (Normalising Rolling, NR)
This is a rolling procedure in which the final deformation is carried out in the normalising temperature range, allowed to cool in air, resulting in a material condition generally equivalent to that obtained by normalising.

d) Quenching and Tempering, QT

Quenching is a procedure which involves a heat treatment process in which steel is heated to an appropriate temperature above the Ac_3 , held for a specific period of time, and then cooled with an appropriate coolant for the purpose of hardening the microstructure. Tempering subsequent to quenching is a process in which the steel is reheated to an appropriate temperature not higher than the Ac_1 , maintained at that temperature for a specific period of time to restore toughness properties by improving the microstructure and reduce the residual stress caused by the quenching process.

Direct quenching after hot rolling, followed by tempering (DQ+T) is considered equivalent to conventional quenching and tempering.

e) Thermo-Mechanical rolling, TM (Thermo-Mechanical Controlled Processing, TMCP)

This is a procedure which involves the strict control of both the steel temperature and the rolling reduction. Generally a high proportion of the rolling reduction is carried out close to the Ar_3 temperature and may involve the rolling in the dual phase temperature region. Unlike controlled rolling (normalising rolling), the properties conferred by TM (TMCP) cannot be reproduced by subsequent normalising or other heat treatment.

The use of accelerated cooling on completion of TM-rolling may also be accepted, subject to the special approval of the Society. The same applies for the use of tempering after completion of the TM-rolling.

The generic designation Thermo-Mechanical rolling TM includes Direct Quenching followed by tempering (TM + DQ) after TM-rolling.

f) Accelerated Cooling, AcC

Accelerated cooling is a process which aims to improve the mechanical properties by controlled cooling with rates higher than air cooling immediately after the final TM-rolling operation. Direct quenching is excluded from accelerated cooling.

The material properties conferred by TM and AcC cannot be reproduced by subsequent normalising or other heat treatment.

1.8 Sampling and tests

1.8.1 General

All products are to be presented for testing in the final supply condition in batches or rolled units as specified in the Articles relevant to the various products.

1.8.2 Sampling

The samples required for the preparation of test specimens are, in general, to be cut from:

- the end of the plate or section corresponding to the top position of the ingot, in the case of casting in ingot moulds
- any end of the plate or section, where such products are rolled from blooms or billets manufactured by continuous casting, on the understanding that sufficient discard is taken from the transitory zones of the cast beginning and end

- both the ends of the coil for plates fabricated in coils.

Samples are to be taken from the following positions:

- plates and flats having width ≥ 600 mm: at approximately one quarter of the width from an edge (see Fig 2)
- flats having width < 600 mm, bulb flats and sections: at approximately $1/3$ of the width from an edge (see Fig 3, Fig 4 and Fig 5); alternatively, for channels, beams or bulb angles: on the web, at approximately $1/4$ of the width from the centreline (see Fig 5)
- hollow sections: if rectangular, at approximately in the centreline of one side; if circular, at any position along the circumference
- bars: at approximately $1/3$ of the radius or half-diagonal from the outer surface; the axis of the sample should be at least 12 mm from the outer surface, except for bars having diameter 25 mm or less, in which case the sample is to be concentric with the bar (see Fig 6).

1.8.3 Preparation of test specimens

The test specimens are to be cut from the samples with their principal axis parallel (longitudinal test) or perpendicular (transverse test) to the direction of rolling, as required in the Articles relevant to the various products.

For the preparation of test specimens and for the testing procedures, reference is to be made to the applicable requirements of Ch 1, Sec 2.

Figure 2 : Plates and flats

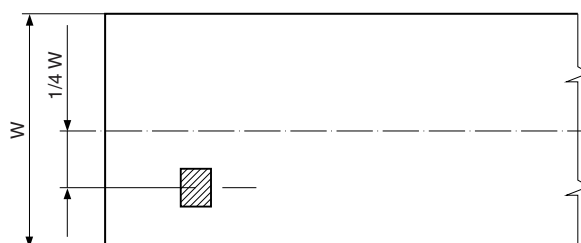


Figure 3 : Bulb flats

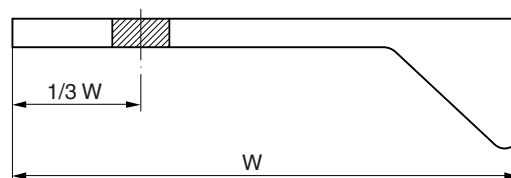


Figure 4 : Angles

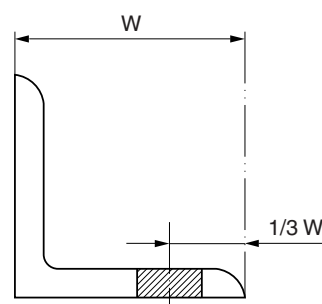


Figure 5 : Sections

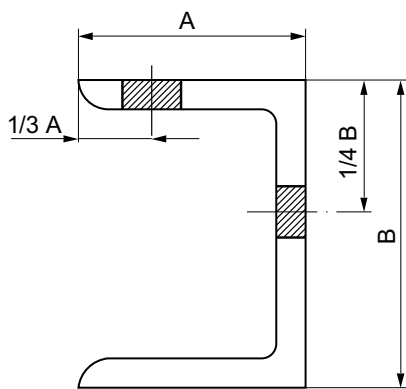
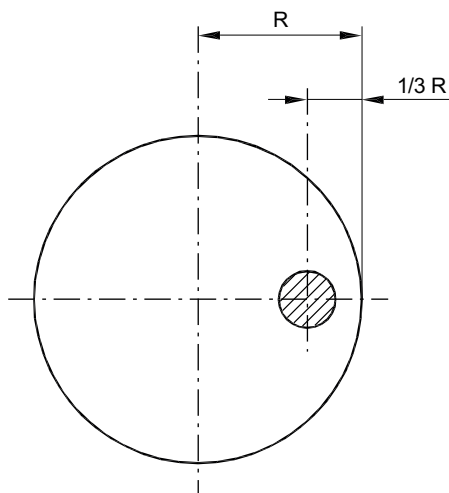


Figure 6 : Bars



1.8.4 Tensile test

The results of the test are to comply with the values specified in the Tables relevant to the various products.

If during the tensile test there is no marked yield stress R_{eH} , the 0,2% proof stress $R_{p0,2}$ may be taken as an alternative.

1.8.5 Impact test

The average value is to comply with the minimum average value specified in the Tables relevant to the various products and only one individual value may be less than the average required, provided that it is not less than 70% of it.

The minimum average values are relevant to the standard specimen 10 x 10 mm².

For subsize specimen dimensions and requirements, reference is to be made to Ch 1, Sec 2, [4.2.2].

1.8.6 Re-test procedures

Reference is made to Ch 1, Sec 1, [3.5].

For tensile re-test procedure, reference is made to Ch 1, Sec 2, [2.3].

For Charpy V-notch re-test procedure, reference is made to Ch 1, Sec 2, [4.4].

1.9 Identification and marking

1.9.1 The manufacturer is to adopt a suitable system of identification which enables the product to be traced to its original cast.

1.9.2 All products which have been tested with satisfactory results are to be identified and marked, in addition to the Society's brand required in Ch 1, Sec 1, [4.1.3], with the following indications:

- a) manufacturer's name or trade mark
- b) identification mark for the grade of steel
- c) cast number or other marking, which will enable the history of the fabrication of the product to be traced.

Different marking systems are to be agreed with the Society.

1.10 Documentation and certification

1.10.1 Information required

The testing documentation indicated in Ch 1, Sec 1, [4.2.1] is required and is to contain all the appropriate information.

The ladle analysis is to include the content of refining and alloying elements as applicable.

1.10.2 Inspection certificate

Before signing the Society's inspection certificate or endorsing the inspection certificate issued by the manufacturer (mill sheets), the Surveyor is to be provided by the manufacturer with a written declaration, stating that the material has been manufactured by a process accepted by the Society, complies with the applicable requirements and has been satisfactorily tested in accordance with the Rules.

The following wording may be acceptable, either printed or stamped on the delivery documents, with the name of the steel manufacturer and signed by one of his authorised representatives: "We hereby certify that the material has been made by an approved process and has been satisfactorily tested in accordance with the Society's Rules".

1.10.3 Casting and rolling in different works

When the steel is not produced at the works at which it is rolled, a certificate is to be supplied to the Surveyor at the rolling mill stating the process by which it was manufactured, the name of the manufacturer who supplied it, the number of the cast from which it was made and the ladle analysis. The Surveyor is to have access to the works at which the steel was produced.

2 Normal and higher strength steels for hull and other structural applications

2.1 Scope

2.1.1 The requirements of this Article apply to weldable normal and higher strength steel hot rolled plates, wide flats, sections and bars intended for use in hull construction and other structural applications.

2.1.2 Provision is made for:

- plates and wide flats of all grades not exceeding 100 mm in thickness
- sections and bars of all grades not exceeding 50 mm in thickness.

2.1.3 For thickness greater than the above, the requirements may be modified, as appropriate, in the individual cases.

2.2 Steel grades

2.2.1 The steels are classed, on the basis of a minimum yield strength level R_{eH} (N/mm²), into normal strength ($R_{eH}=235$) and higher strength (32: $R_{eH}=315$ - 36: $R_{eH}=355$ - 40: $R_{eH}=390$).

Normal strength steels are divided into four grades A, B, D and E. For normal strength steels, the letters A, B, D and E mean impact properties at +20°C, 0°C, -20°C and -40°C, respectively.

Higher strength steels are divided into four grades identified by the letters AH, DH, EH and FH followed by a number related to the yield strength level. For higher strength steels, the letters AH, DH, EH and FH mean impact properties at 0°C, -20°C, -40°C and -60°C, respectively.

2.2.2 Steels differing in chemical composition, deoxidation practice, conditions of supply and mechanical properties may be accepted, subject to the special approval of the Society. Such steels are to be given a special designation.

2.3 Manufacture**2.3.1 Approval**

The manufacturers are to be approved by the Society and the relevant requirements of [1.2] and [1.3] apply.

Provisions for the approval are given in NR480 "Approval of the manufacturing process of metallic materials".

2.3.2 Deoxidation process

The method of deoxidation is specified in Tab 1 and Tab 2.

2.3.3 Rolling practice

Where CR (NR) and TM with or without AcC are applied, the programmed rolling schedules are to be submitted to the Society at the time of the approval and are to be made available when required by the attending Surveyor. On the manufacturer's responsibility, the programmed rolling schedules are to be adhered to during the rolling operation (as per [1.3.3]). To this effect, the actual rolling records are to be reviewed by the manufacturer and, occasionally, by the Surveyor.

When deviation from the programmed rolling schedules occurs, the manufacturer is to take further measures, to the Surveyor's satisfaction, in accordance with [1.3.3].

Table 1 : Normal strength steels - Chemical composition and deoxidation practice

Steel grade	A	B	D	E
Deoxidation practice for thickness t (mm)	t ≤ 50 mm: any method except rimmed (1) t > 50 mm: killed	t ≤ 50 mm: any method except rimmed t > 50 mm: killed	t ≤ 25 mm: killed t > 25 mm: killed and fine grain treated	killed and fine grain treated
Chemical composition (%) (2) (3) (4)				
C max (5)	0,21 (6)	0,21	0,21	0,18
Mn min (5)	2,5 x C	0,80 (7)	0,60	0,70
Si max	0,50	0,35	0,35	0,35
P max	0,035	0,035	0,035	0,035
S max	0,035	0,035	0,035	0,035
Al (acid soluble) min			0,015 (8) (9)	0,015 (9)
(1) For sections up to a thickness of 12,5 mm, rimmed steel may be accepted subject to the special approval of the Society. (2) When any grade of steel is supplied in the thermo-mechanically rolled condition, variations in the specified chemical composition may be allowed or required by the Society and are to be stated at the approval. (3) The Society may limit the amount of residual elements which may have an adverse effect on the working and use of the steel, e.g. copper and tin. (4) Where additions of any other element have been made as part of the steelmaking practice, the content is to be indicated in the ladle analysis certificate. (5) C + 1/6 Mn is not to exceed 0,40%. (6) Max. 0,23% for sections. (7) When Grade B steel is impact tested, the minimum manganese content may be reduced to 0,60%. (8) Al is required for thickness greater than 25 mm. (9) The total aluminum content may be determined instead of acid soluble content. In such cases the total aluminum content is to be not less than 0,020%. Other suitable grain refining elements may be used subject to the special approval of the Society.				

Table 2 : Higher strength steels - Chemical composition and deoxidation practice

Steel grade	AH32, DH32, EH32 AH36, DH36, EH36 AH40, DH40, EH40	FH32, FH36, FH40
Deoxidation practice	killed and fine grain treated	killed and fine grain treated
Chemical composition (%) (1) (5)		
C max.	0,18	0,16
Mn	0,90 - 1,60 (2)	0,90 - 1,60
Si max.	0,50	0,50
P max.	0,035	0,025
S max.	0,035	0,025
Al (acid soluble) min (3) (4)	0,015	0,015
Nb (4)	0,02 - 0,05	0,02 - 0,05
V (4)	0,05 - 0,10	0,05 - 0,10
Ti max. (4)	0,02	0,02
Cu max.	0,35	0,35
Cr max.	0,20	0,20
Ni max.	0,40	0,80
Mo max.	0,08	0,08
N max.		0,009 (0,012 if Al is present)
(1) Alloying elements other than those listed above or exceeding the specified limits may be accepted by the Society when proposed by the steelmaker at the time of approval and their content is to be indicated in the ladle analysis. (2) Up to a thickness of 12,5 mm, the minimum manganese content may be reduced to 0,70. (3) The total aluminium content may be determined instead of the acid soluble content. In such cases the total aluminium content is to be not less than 0, 020%. (4) The steel is to contain aluminium, niobium, vanadium or other suitable grain refining elements, either singly or in any combination. When used singly, the steel is to contain the specified minimum content of the grain refining element. When used in combination, the specified minimum content of at least one grain refining element is applicable; the sum of Nb + V + Ti is not to exceed 0,12%. (5) When any grade of higher strength steel is supplied in the thermo-mechanically rolled condition, variations in the specified chemical composition may be allowed or required by the Society and are to be stated at the approval.		

2.3.4 Thickness and tolerances (t ≥ 5mm)

The average thickness of plates and wide flats is defined as the arithmetic mean of the measurements made in accordance with [1.5.2]. The average thickness of plates and wide flats is not to be less than the nominal thickness.

For plates and wide flats with thicknesses of 5 mm and over, a minus tolerance on nominal thickness of 0,3 mm is permitted.

Alternatively, Class C of ISO 7452-2013 or equivalent according to national or international standards may be applied, in which case the requirements of this Article about average thickness and associated measurements need not be applied.

Additionally, if Class C of ISO 7452-2013 is applied, it is required that the steel mill demonstrates to the satisfaction of the Society that the number of measurements and measurement distribution are appropriate to establish that the mother plates produced are at or above the specified nominal thickness.

For sections and bars with thicknesses of 5mm and over, the minus tolerance on nominal thickness is to be in accordance with the requirements of a recognized international or national standard.

The plus tolerance on nominal thickness are to be in accordance with a recognized national or international standard unless otherwise required by the Classification Society.

The tolerances on nominal thickness are not applicable to areas repaired by grinding as indicated in [2.4.3] which are to be in accordance with a recognized standard.

2.3.5 Thickness and tolerances (t < 5mm)

The thickness tolerances for products with thicknesses below 5mm are to be in accordance with a national or international standard, e.g. Class B of ISO 7452-2013. However the minus tolerance shall not exceed 0.3mm.

2.4 Surface quality

2.4.1 General

The general requirements for surface quality of [1.6] apply.

2.4.2 Acceptance criteria

a) Imperfections

Imperfections of a harmless nature, for example pitting, rolled-in scale, indentations, roll marks, scratches and grooves, regarded as being inherent of the manufacturing process, are permissible irrespective of their number, provided the maximum permissible limits of Class A of EN 10163-2 or limits specified in a recognized equivalent standard accepted by the Society, are not exceeded

and the remaining plate or wide flat thickness remains within the average allowable minus thickness tolerance specified in [2.3.4] or [2.3.5]. Total affected area with imperfection not exceeding the specified limits are not to exceed 15% of the total surface area in question.

b) Defects

Affected areas with imperfections with a depth exceeding the limits of Class A of EN 10163-2 or the maximum permissible limits specified in a recognized equivalent standard accepted by the Society, shall be repaired irrespective of their number.

Cracks, injurious surface flaws, shells (overlapping material with non-metallic inclusion), sand patches, laminations and sharp edged seams (elongated defects) visually evident on surface and/or edge of plate are considered defects, which would impair the end use of the product and which require rejection or repair, irrespective of their size and number.

2.4.3 Rectification of surface defects by grinding

Surface defects may be removed by grinding as indicated in [1.6.2] provided that:

- a) the nominal thickness will not be reduced by more than 7% or 3 mm, whichever is the less
- b) each single ground area does not exceed 0,25 m²
- c) the total ground area does not exceed 2% of the total surface of the plate
- d) adjacent repairs located at a distance less than their mean width are considered as forming a single ground area
- e) in the case of ground areas lying opposite each other on both surfaces of the plate, the resulting thickness is to satisfy in any place the values indicated in item a).

Defects or unacceptable imperfections are to be completely removed by grinding and the remaining plate or wide flat thickness shall remain within the average allowable minus thickness tolerance specified in [2.3.4] or [2.3.5].

The ground areas shall be a smooth transition to the surrounding surface of the product. Complete elimination of the defect is to be verified by magnetic particle or by liquid penetrant testing.

2.4.4 Rectification of surface defects by welding

Weld repair procedures and the method are to be reported and be approved by the Society. Repair of defects such as unacceptable imperfections, cracks, shells or seams shall be followed by magnetic particle or liquid penetrant testing.

Surface defects of products which cannot be removed as stated in [2.4.3] may be repaired by chipping or grinding followed by welding subject to the agreement of the Society and provided that:

- a) after removal of defects and weld preparation, the thickness of the piece is in no place reduced by more than 20% with respect to the nominal thickness. For occasional defects with depths exceeding 20% of nominal thickness, special consideration at the Surveyor's discretion will be necessary.

- b) repair is carried out by an approved procedure and by qualified welders. The electrodes shall be of low hydrogen type and shall be dried in accordance with the manufacturer's requirements and protected against rehumidification before and during welding.
- c) no single welded area exceeds 0,125 m² and the sum of all welded areas does not exceed 2% of the total surface area.
- d) The distance between two welded areas shall not be less than their average width.
- e) If weld repair depth exceeds 3mm, UT may be requested by the Society. If required, UT shall be carried out in accordance with an approved procedure.

2.4.5 The surface quality and condition requirements herein are not applied to products in forms of bars and tubulars, which will be subject to manufacturer's conformance standards.

2.5 Internal soundness

2.5.1 If plates and wide flats are ordered with ultrasonic inspection, this is to be made in accordance with an accepted standard at the discretion of the Classification Society.

2.5.2 Ultrasonic testing of plates intended for offshore structural applications of first and special category as defined in the Society's Offshore Rules is required and is to be performed in accordance with a recognized standard (e.g. EN 10160 or ASTM A 578) and an examination level accepted by the Society.

2.5.3 Verification of internal soundness is the responsibility of the manufacturer. The acceptance of internal soundness by the Society's surveyor shall not absolve the manufacturer from this responsibility.

2.6 Condition of supply

2.6.1 The products are to be supplied in the condition indicated in Tab 5 and Tab 6 for normal strength steels and Tab 9 and Tab 10 for higher strength steels.

The definition of the supply conditions is given in [1.7.3].

2.7 Chemical composition

2.7.1 General

The chemical composition is determined by the manufacturer on ladle samples (see Ch 1, Sec 1, [2.2.1]).

2.7.2 Normal strength steels

The chemical composition is to comply with the requirements specified in Tab 1.

2.7.3 Higher strength steels

The chemical composition is to comply with the requirements specified in Tab 2.

At the time of the approval of higher strength steels, an upper limit for carbon equivalent C_{EQ} on the ladle analysis may be specified.

Unless otherwise agreed, the value of C_{EQ} is calculated by the following formula:

$$C_{EQ} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \quad \%$$

For steel produced by thermo-mechanical rolling, C_{EQ} is to comply with the requirements of Tab 3.

Table 3 : Carbon equivalent for higher strength steels up to 100 mm in thickness produced by TM process

Steel grade	Carbon equivalent C_{EQ} max. (%) (1)	
	$t \leq 50$	$50 < t \leq 100$
AH32, DH32, EH32, FH32	0,36	0,38
AH36, DH36, EH36, FH36	0,38	0,40
AH40, DH40, EH40, FH40	0,40	0,42
t = thickness (mm)		
(1) More stringent carbon equivalent limits may be agreed between the manufacturer and the shipbuilder in individual cases.		

As an alternative to C_{EQ} , at the discretion of the Society, the cold cracking susceptibility P_{cm} may be used for evaluating the weldability.

P_{cm} is given by the following formula and an upper limit may be agreed at the time of the approval of the steel:

$$P_{cm} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B \quad \%$$

When a limit of C_{EQ} and P_{cm} is required, the relevant values are to be stated by the manufacturer and included in the testing documentation for each cast.

2.8 Mechanical properties

2.8.1 Normal strength steels

The mechanical properties are indicated in Tab 4.

The number of impact tests to be performed is indicated in Tab 5 for plates and wide flats and Tab 6 for sections and bars.

Table 4 : Normal strength steels - Mechanical properties

Steel grade	Yield stress R _{eH} (N/mm ²) min.	Tensile strength R _m (N/mm ²)	El. A ₅ (%)min (1)	Average impact energy (J) min KVL longitudinal - KVT transverse - t = thickness (mm)						
				Test temp (°C)	t ≤ 50		50 < t ≤ 70		70 < t ≤ 100	
					KVL	KVT	KVL	KVT	KVL	KVT
A	235	400/520 (2)	22	+20			34	24	41	27
B	235	400/520	22	0	27	20	34	24	41	27
D	235	400/520	22	−20	27	20	34	24	41	27
E	235	400/520	22	−40	27	20	34	24	41	27

- (1) El.: elongation. For full thickness flat tensile test specimens with a width of 25 mm and a gauge length of 200mm, the elongation is to comply with the minimum values given for strength level 32 in Tab 8.
- (2) For sections in grade A of all thicknesses, the upper limit for the specified tensile stress range may be exceeded up to a maximum of 540 N/mm².

Table 5 : Normal strength plates and wide flats - Condition of supply and number of impact tests

Steel grade	Condition of supply (1) Batch for impact tests in tons () for thickness t (mm) (2)			
	$t \leq 25$	$25 < t < 35$	$35 \leq t \leq 50$	$50 < t \leq 100$
A	A(-)			(N,TM)(-), NR(50), AR*(50) (3)
B	A (-) (4)	A(50)		(N,TM)(50), NR(25), AR*(25)
D	A(50)		(N,NR,TM)(50)	(N,TM)(50), NR(25)
E	N or TM (each piece)			

- (1) Abbreviations:
A : Any
N : Normalised Condition (heat treatment)
NR : Normalising Rolled Condition as an alternative to Normalising
TM : Thermo-Mechanical Rolling
AR* : As Rolled Condition subject to the special approval of the Society.
- (2) One set of impact tests is to be taken from each batch of the weight in tons specified in brackets (), from each fraction thereof or from each piece as indicated. When impact tests are not required the indication is (-).
- (3) Charpy V-notch tests are generally not required for fine grained grade A products over 50 mm thick N or TM; when required, the rate is at the Society's discretion.
- (4) Charpy V-notch tests are generally not required for Grade B steel with thickness of 25 mm or less; when required, the rate is at the Society's discretion.