
W8 Hull and machinery steel castings

(1978)
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July
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(Rev.2
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W8.1 Scope

W8.1.1 These requirements are applicable to steel castings intended for hull and machinery applications such as stern frames, rudder frames, crankshafts, turbine casings, bedplates, etc.

W8.1.2 These requirements are applicable only to steel castings where the design and acceptance tests are related to mechanical properties at ambient temperature. For other applications, additional requirements may be necessary, especially when the castings are intended for service at low or elevated temperatures.

W8.1.3 Alternatively, castings which comply with national or proprietary specifications may be accepted provided such specifications give reasonable equivalence to these requirements or are otherwise specially approved or required by the Classification Society.

W8.1.4 Specific requirements are not given for alloy steel castings and where the use of such materials is proposed full details of the chemical composition, heat treatment, mechanical properties, testing, inspections and rectification are to be submitted for approval of the Classification Society.

W8.1.5 (void)

W8.2 Manufacture

W8.2.1 Castings are to be made at a manufacturer approved by the Classification Society.

W8.2.2 The steel is to be manufactured by a process approved by the Classification Society.

W8.2.3 All flame cutting, scarfing or arc-air gouging to remove surplus metal is to be undertaken in accordance with recognized good practice and is to be carried out before the final heat treatment. Preheating is to be employed when necessitated by the chemical composition and/or thickness of the castings. If necessary, the affected areas are to be either machined or ground smooth.

W8.2.4 For certain components including steel castings subjected to surface hardening process, the proposed method of manufacture may require special approval by the Classification Society.

W8.2.5 (void)

W8.2.6 When two or more castings are joined by welding to form a composite component, the proposed welding procedure is to be submitted for approval. Welding procedure qualification tests may be required.

W8.3 Quality of castings

W8.3.1 All castings are to be free from surface or internal defects, which would be prejudicial to their proper application in service. The surface finish is to be in accordance with good practice and any specific requirements of the approved plan.

W8.4 Chemical composition

W8.4.1 All castings are to be made from killed steel and the chemical composition is to be appropriate for the type of steel and the mechanical properties specified for the castings.

W8.4.1 *bis* The chemical composition of each heat is to be determined by the manufacturer on a sample

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taken preferably during the pouring of the heat. When multiple heats are tapped into a common ladle, the ladle analysis shall apply.

W8.4.2 For carbon and carbon-manganese steel castings the chemical composition is to comply with the overall limits given in Table 1 or, where applicable, the requirements of the approved specification.

Table 1 Chemical composition limits for hull and machinery steel castings (%)

| Steel type | Applications | C (max.) | Si (max.) | Mn | S (max.) | P (max.) | Residual elements (max.) | | | | Total residuals (max.) |
|------------|--------------------------------------|-------------|--------------|----------------|-------------|-------------|-----------------------------|------|------|------|------------------------------|
| | | | | | | | Cu | Cr | Ni | Mo | |
| C, C-Mn | Castings for non-welded construction | 0.40 | 0.60 | 0.50 - 1.60 | 0.040 | 0.040 | 0.30 | 0.30 | 0.40 | 0.15 | 0.80 |
| | Castings for welded construction | 0.23 | 0.60 | 1.60 max. | 0.040 | 0.040 | 0.30 | 0.30 | 0.40 | 0.15 | 0.80 |

W8.4.3 (void)

W8.4.4 Unless otherwise required suitable grain refining elements such as aluminium may be used at the discretion of the manufacturer. The content of such elements is to be reported.

W8.4.5 (void)

W8.5 Heat treatment (including straightening)

W8.5.1 Castings are to be supplied in one of the following conditions:

- Fully annealed
- Normalized
- Normalized and tempered
- Quenched and tempered.

The tempering temperature is to be not less than 550°C.

W8.5.2 Castings for components such as crankshafts and engine bedplates, where dimensional stability and freedom from internal stresses are important, are to be given a stress relief heat treatment. This is to be carried out at a temperature of not less than 550°C followed by furnace cooling to 300°C or lower.

W8.5.3 Heat treatment is to be carried out in properly constructed furnaces which are efficiently maintained and have adequate means for control and recording of temperature. The furnace dimensions are to be such as to allow the whole casting to be uniformly heated to the necessary temperature. In the case of very large castings alternative methods for heat treatment will be specially considered by the Classification Society. 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.

W8.5.4 If a casting is locally reheated or any straightening operation is performed after the final heat treatment, a subsequent stress relieving heat treatment may be required in order to avoid the possibility of harmful residual stresses.

W8.5.5 The foundry 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.

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cont'd**W8.6 Mechanical tests**

W8.6.1 Test material, sufficient for the required tests and for possible retest purposes is to be provided for each casting or batch of castings.

W8.6.2 At least one test sample is to be provided for each casting. Unless otherwise agreed these test samples are to be either integrally cast or gated to the castings and are to have a thickness of not less than 30mm.

W8.6.3 Where the casting is of complex design or where the finished mass exceeds 10 tonnes, two test samples are to be provided. Where large castings are made from two or more casts, which are not mixed in a ladle prior to pouring, two or more test samples are to be provided corresponding to the number of casts involved. These are to be integrally cast at locations as widely separated as possible.

W8.6.4 For castings where the method of manufacture has been specially approved by the Classification Society in accordance with W8.2.4, the number and position of test samples is to be agreed with the Classification Society having regard to the method of manufacture employed.

W8.6.5 As an alternative to W8.6.2, where a number of small castings of about the same size, each of which is under 1000kg in mass, are made from one cast and heat treated in the same furnace charge, a batch testing procedure may be adopted using separately cast test samples of suitable dimensions. At least one test sample is to be provided for each batch of castings.

W8.6.6 (void)

W8.6.7 The test samples are not to be detached from the casting until the specified heat treatment has been completed and they have been properly identified.

W8.6.8 One tensile test specimen is to be taken from each test sample.

W8.6.9 (void)

W8.6.10 The preparation of test specimens and the procedures used for mechanical testing are to comply with the relevant requirements of W2. Unless otherwise agreed all tests are to be carried out in the presence of the Surveyors.

W8.7 Mechanical properties

W8.7.1 Table 2 gives the minimum requirements for yield stress, elongation and reduction of area corresponding to different strength levels. Where it is proposed to use a steel with a specified minimum tensile strength intermediate to those given, corresponding minimum values for the other properties may be obtained by interpolation.

W8.7.2 Castings may be supplied to any specified minimum tensile strength selected within the general limits detailed in Table 2 but subject to any additional requirements of the relevant construction Rules.

W8.7.3 The mechanical properties are to comply with the requirements of Table 2 appropriate to the specified minimum tensile strength or, where applicable, the requirements of the approved specification.

W8.7.4 (void)

W8.7.5 Re-test requirements for tensile tests are to be in accordance with UR W2.

W8.7.6 (void)

W8.7.7 The additional tests detailed in W8.7.5 are to be taken, preferably from the same, but alternatively from another, test sample representative of the casting or batch of castings.

W8.7.8 At the option of the manufacturer, when a casting or batch of castings has failed to meet the test requirements, it may be reheat treated and re-submitted for acceptance tests.

Table 2. Mechanical properties for hull and machinery steel castings

| Specified minimum tensile strength ⁽¹⁾ (N/mm^2) | Yield stress (N/mm^2) min. | Elongation on $5,65 \sqrt{S_o}$ (%) min. | Reduction of area (%) min. |
|-----------------------------------------------------------------------------|--------------------------------------|------------------------------------------------|-------------------------------|
| 400 | 200 | 25 | 40 |
| 440 | 220 | 22 | 30 |
| 480 | 240 | 20 | 27 |
| 520 | 260 | 18 | 25 |
| 560 | 300 | 15 | 20 |
| 600 | 320 | 13 | 20 |
| NOTE | | | |
| (1) A tensile strength range of $150 N/mm^2$ may additionally be specified. | | | |

W8.8 Inspection

W8.8.1 All castings are to be cleaned and adequately prepared for examination; suitable methods include pickling, caustic cleaning, wire brushing, local grinding, shot or sand blasting. The surfaces are not to be hammered, peened or treated in any way which may obscure defects.

W8.8.2 Before acceptance all castings are to be presented to the Surveyors for visual examination. Where applicable, this is to include the examination of internal surfaces. Unless otherwise agreed, the verification of dimensions is the responsibility of the manufacturer.

W8.8.3 When required by the relevant construction Rules, or by the approved procedure for welded composite components (see W8.2.6.), appropriate non-destructive testing is also to be carried out before acceptance and the results are to be reported by the manufacturer. The extent of testing and acceptance criteria are to be agreed with the Classification Society. IACS Recommendation No. 69 is regarded as an example of an acceptable standard.

W8.8.4 (void)

W8.8.5 (void)

W8.8.6 (void)

W8.8.7 When required by the relevant construction Rules castings are to be pressure tested before final acceptance. These tests are to be carried out in the presence of the Surveyor and are to be to their satisfaction.

W8.8.8 In the event of any casting proving to be defective during subsequent machining or testing it is to be rejected notwithstanding any previous certification.

W8.9 Rectification of defective castings**W8.9.1 General**

- (i) The approval of the Classification Society is to be obtained where steel castings from which defects were removed are to be used with or without weld repair.
- (ii) Procedure of removal of defect and weld repair is to be in accordance with IACS Recommendation No. 69.
- (iii) Where the defective area is to be repaired by welding, the excavations are to be suitably shaped to allow good access for welding. The resulting grooves are to be subsequently ground smooth and complete elimination of the defective material is to be verified by MT or PT.
- (iv) Shallow grooves or depressions resulting from the removal of defects may be accepted provided that they will cause no appreciable reduction in the strength of the casting. The resulting grooves or depressions are to be subsequently ground smooth and complete elimination of the defective material is to be verified by MT or PT. Small surface irregularities sealed by welding are to be treated as weld repairs.
- (v) The manufacturer is to maintain full records detailing the extent and location of repairs made to each casting and details of weld procedures and heat treatments applied for repairs. These records are to be available to the Surveyor and copies provided on request.

8.9.2 Weld Repairs

When it has been agreed that a casting can be repaired by welding, the following requirements apply:

- (i) Before welding is started, full details of the extent and location of the repair, the proposed welding procedure, heat treatment and subsequent inspection procedures are to be submitted for approval.
- (ii) All castings in alloy steels and all castings for crankshafts are to be suitably pre-heated prior to welding. Castings in carbon or carbon-manganese steel may also require to be pre-heated depending on their chemical composition and the dimensions and position of the weld repairs.
- (iii) Welding is to be done under cover in positions free from draughts and adverse weather conditions by qualified welders with adequate supervision. As far as possible, all welding is to be carried out in the downhand (flat) position.
- (iv) The welding consumables used are to be of an appropriate composition, giving a weld deposit with mechanical properties similar and in no way inferior to those of the parent castings. Welding procedure tests are to be carried out by the manufacturer to demonstrate that satisfactory mechanical properties can be obtained after heat treatment as detailed in W8.5.1.
- (v) After welding has been completed the castings are to be given either a suitable heat treatment in accordance with the requirements of W8.5.1 or a stress relieving heat treatment at a temperature of not less than 550°C. The type of heat treatment employed will be dependent on the chemical composition of the casting and the dimensions, positions and nature of the repairs .
- (vi) Subject to the prior agreement of Classification Society, special consideration may be given to the omission of postweld heat treatment or to the acceptance of local stress-relieving heat treatment where the repaired area is small and machining of the casting has reached an advanced stage.
- (vii) On completion of heat treatment the weld repairs and adjacent material are to be ground smooth and examined by magnetic particle or liquid penetrant testing. Supplementary examination by ultrasonics or radiography may also be required depending on the dimensions and nature of the original defect. Satisfactory results are to be obtained from all forms of non-destructive testing used.

W8.10 Identification of castings

W8.10.1 The manufacturer is to adopt a system of identification which will enable all finished castings to be traced to the original cast and the Surveyors are to be given full facilities for so tracing the castings when required.

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W8.10.2 Before acceptance, all castings which have been tested and inspected with satisfactory results are to be clearly marked by the manufacturer. At the discretion of individual Classification Societies any of the following particulars may be required:

- (i) Steel quality.
- (ii) Identification number, cast number or other marking which will enable the full history of the casting to be traced.
- (iii) Manufacturer's name or trade mark.
- (iv) The Classification Society's name, initials or symbol.
- (v) Abbreviated name of the Classification Society's local office.
- (vi) Personal stamp of Surveyors responsible for inspection.
- (vii) Where applicable, test pressure.

W8.10.3 Where small castings are manufactured in large numbers, modified arrangements for identification may be specially agreed with the Classification Society.

W8.11 Certification

W8.11.1 The manufacturer is to provide the required type of inspection certificate giving the following particulars for each casting or batch of castings which has been accepted:

- (i) Purchaser's name and order number.
- (ii) Description of castings and steel quality.
- (iii) Identification number.
- (iv) Steel making process, cast number and chemical analysis of ladle samples.
- (v) Results of mechanical tests.
- (vi) Results of non-destructive tests, where applicable.
- (vii) Details of heat treatment, including temperatures and holding times.
- (viii) Where applicable, test pressure.

