CLASS PROGRAMME

Approval of manufacturers

DNVGL-CP-0249  Edition May 2016

Iron castings
FOREWORD

DNV GL class programmes contain procedural and technical requirements including acceptance criteria for obtaining and retaining certificates for objects and organisations related to classification.

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This is a new document.
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SECTION 1 GENERAL

1 Objective

The objective of this class programme (CP) is to provide a description for which the Society bases its approval of manufacturers intending to supply iron castings in accordance with RU SHIP Pt.2 or other applicable standards provided by the Society.

2 Scope and application

This programme is applicable for the approval of material manufacturers of:

— Iron castings

as referred in the Society's rules and standards. For a description of general requirements, conditions and procedures related to the approval, please refer to DNVGL CP 0346 which shall be applied in combination with this programme.

The product(s) used for approval testing (see Sec.3) will place limitations on the range of approval. The approval will be limited to the cast iron grades and types tested. However, test data supplied for the DNV GL grades with higher elongation and impact toughness requirements may cover approval of grades with lower elongation and toughness requirements, see App.A.

In the absence of relevant DNV GL rules, approval may also be given for the manufacture of cast iron types not covered by the rules, i.e. materials specified in recognised national or international standards, e.g. austenitic cast irons.

Approval is given for a maximum casting mass, maximum casting thickness and where relevant, a heat treatment condition.

Where iron castings are repaired by welding, or two or more items are joined by welding to form a composite item, the manufacturer's welding shop shall either be approved for welding in accordance with this programme, or be approved as welding workshop. For welding workshop approval, see DNVGL CP 0352.

The manufacturer's own heat treatment facilities shall be evaluated and approved by the Society either under this approval programme, or as approved "heat-treatment workshop" through the separate approval programme DNVGL CP 0351.

3 Request for approval

When applying for AoM, the manufacturer shall indicate the cast iron grades and approval groups to be covered by the approval, including maximum casting weight, maximum section/wall thickness and heat treatment/delivery conditions as given in [3].

For this a list or table shall be given, including at least:

— type of products
— applicable cast iron types and grades
— manufacturing method as part of manufacturing summary
— range of applicable product sizes (dimensions and weight)
— applicable cast iron types and grades
— heat treatment delivery conditions
— reference to DNV GL rules for the applicable chemical composition, mechanical properties and heat treatment (if applicable), or recognised standards. Approval to and recognition of other standards is subject to agreement with the Society.
4 References

Table 1 List of references

<table>
<thead>
<tr>
<th>No.</th>
<th>Reference</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ASTM A 247</td>
<td>Test Method for Evaluating the Microstructure of Graphite in Iron Castings</td>
</tr>
<tr>
<td>2</td>
<td>EN 1563</td>
<td>Founding – Spheroidal graphite cast irons</td>
</tr>
</tbody>
</table>
SECTION 2 DOCUMENTATION REQUIREMENTS

1 Manufacturing summary
Manufacturer shall submit documentation of the specific manufacturing process and related production records for products for which approval is requested. Documentation shall also include manufacturer’s metallurgical specifications related the manufacturing process as described in this section.

2 Moulding
The following shall be documented:
— type and material of templates/pattern
— moulding process including sands for moulding
— information on equipment used for sand mixing and reclamation shall be submitted if applicable
— details of mould design for casting subjected to approval testing.

3 Melting and pouring
The following shall be documented:
— type of furnace and capacity
— maximum capacity for weight of casting if other than above
— type of raw materials
— hot metal ratio and composition, when relevant
— ladle capacity
— refining and alloying practice
— pouring temperature range
— a summary of the sampling practices and methods for chemical analysis shall be submitted.

4 Cleaning and finishing
The following shall be documented:
— shakeout temperature
— method of surface cleaning
— method of surplus metal removal (gates, risers).

5 Welding (if applicable)
The following shall be documented. The information provided shall comply with the approval of welding workshop (WWA) programme DNVGL CP 0352:
— description of welding:
  — equipment
  — welding job instruction
  — for repair welding: qualifications of welders. For production welding: qualification of welders and welding supervisors. Certificates to be submitted
  — welding procedure specifications (WPS)
  — welding procedure qualification report (WPQR)
  — extent and depths allowed for weld repair
  — heat treatment after welding
— surface preparation after welding
— non-destructive testing before and after welding
— reference to manufacturers procedure for preparation and maintenance of records of weld repairs.

6 Heat Treatment (if applicable)

The following shall be documented:
— type of furnace and dimensions
— heating source
— sketch indicating the positions of thermocouples
— working zone dimension and sketch of working zone
— accuracy and calibration status of temperature control devices
— records of furnace uniformity test
— furnace loading plan and procedure
— heat treatment procedures, specifying temperatures and holding times, and where applicable, information about heating and cooling rates, quenching medium and cooling medium after tempering
— records of heat treatment
— any re-heat treatment procedure to be given, if applicable

7 Records, test facilities and procedures

The following shall be documented:
— visual inspection: relevant templates for recording, and a few records of previously performed visual inspections of same or similar products
— details and description of relevant in-house testing facilities and calibration details, test procedures and qualification of testing personnel
— NDT procedures, equipment for NDT including calibration details, and qualification of personnel for NDT
— information about and procedures for important manufacturing and testing routines, such as cutting and macrographic inspection of products etc.

8 Test results and records

Additional requirements for reporting of test results:
— Sampling of test specimens:
  — sketches, drawings and photos showing the position of test blocks (incl. their dimensions), gates, risers and chills shall be submitted. Type of test blocks and their dimensions shall be reported, and if applicable reference shall be made to recognised standards e.g. EN 1563.
— Chemical composition:
  — a summary of the sampling practices and methods for chemical analysis is to be submitted
  — the chemical composition shall be reported in percentage by mass.
— Tensile test:
  — for grey cast iron, the tensile strength shall be reported
  — for nodular cast iron, the proof stress, tensile strength, and elongation shall be reported
  — for cast iron types not covered by the rules, the mechanical properties specified in the relevant recognised standard shall be reported.
— Charpy V-notch impact toughness test:
— the test temperature and absorbed energy (average and single values) and fracture appearance shall be reported.

— Bend test:
  — a summary of the testing parameters and brief report on test results shall be submitted
  — the applied etching methods for the metallographic examination shall be stated in the report.

— Metallographic examination:
  — high quality photomicrographs showing the microstructure at 100x magnification shall be presented with a brief description. The magnification shall be indicated on the micrographs by a line symbol, e.g. with length of 0.5 mm. Arrows or letters may be used to identify features referred to in the report
  — the applied etching methods for the metallographic examination shall be stated in the report.

— Hardness test:
  — test results shall be presented as a test report
  — the applied test method and test parameters shall be stated in the report.

— Visual examination:
  — report for visual inspection, dimensional measurements and surface condition.

— Non-destructive testing:
  — detailed records of non-destructive testing with clear conclusions written by qualified personnel shall be submitted, giving the extent of testing, methods of testing, acceptance criteria, and qualification of the NDT operator.
SECTION 3 APPROVAL TESTING

1 Test products and testing scope

1.1 General

The test products shall be selected so that the testing will cover and qualify the full range of product types, grades, dimensions etc. for which approval is requested, see Sec.1 [3].

1.2 Extent of approval testing

For each selected material grade and delivery condition, testing shall be carried out on castings from at least two heats where the first heat shall represent maximum thickness (dimension) and the second heat should represent an average thickness of the product for which approval is requested.

Where two or more material grades shall be covered by the approval testing, subject to agreement with the Society the testing may be considered for reduction to one heat per steel type per application area.

1.3 Selection and position of the test samples

The sampling shall comply with the requirements of RU SHIP Pt.2 Ch.2 Sec.9 and the following:

a) for grey cast iron:
   — test material shall be separately cast in the form of cylindrical bars with nominal diameter 30 mm and minimum length 150 mm. The overall length of the tensile test piece may be 100 mm. For castings with thickness more than 20 mm and with mass exceeding 200 kg, samples may be integrally cast upon agreement with the Society.

b) for nodular cast iron:
   — Y-blocks, U-block or double U-block to be either separately cast or gated to the casting. The test blocks shall have minimum thickness 30 mm and minimum length 150 mm. The dimensions of the sample shall be matched to the relevant wall thickness of the casting, although the thickness of the sample needs not to exceed 75 mm
   — separately cast stepped wedge with individual step lengths and widths of 50 mm, step heights corresponding to the maximum wall thickness 10, 15, 20, 30, 40 and 50 mm or 15, 30, 50, 75 and 100 mm.

Where separately cast test blocks are used, these shall receive substantially the same casting practices as the production castings represented.

Unless specified in the rules, sampling positions may be proposed by the manufacturer and then agreed on case by case basis.

2 Testing requirements

2.1 Chemical composition

The following is required:

— chemical composition shall be determined both by heat and by product analysis and shall comprise all the elements required by relevant DNV GL rules (or where agreed, applicable standards or recognized manufacturer’s specification). The analyses shall also comprise any other elements intentionally added or designated as residual elements

— the chemical composition shall be reported in percentage by mass.
2.2 Tensile testing
The following is required:
— from each test block one tensile specimens shall be tested.

2.3 Impact testing
The following is required:
— for the nodular cast iron grades VL NCI-1 and VL NCI-2, one set of Charpy V-notch impact tests shall be made from each test block and shall be tested at the prescribed temperature
— for cast iron types not covered by the rules, the impact toughness specified in the relevant recognised standard shall apply.

2.4 Bend testing
Bend testing is applicable only for nodular ferritic cast iron for delivery in a heat treated condition.
— bend test shall be carried out on at least 2 test specimens with following parameters:
  — bending angle: 180°
  — mandrel diameters (D):
    — D = 3 times specimen thickness for grades with \( R_m = 350 \text{ and } 370 \text{ N/mm}^2\)
    — D = 4 times specimen thickness for grades with \( R_m = 400 \text{ N/mm}^2\).

2.5 Metallographic examination
High quality photomicrographs showing the microstructure at 100x magnification shall be presented with a brief description. The magnification shall be indicated on the micrographs by a line symbol, e.g. with length of 0.5 mm. Arrows or letters may be used to identify features referred to in the report
— one specimen shall be taken as described below:
  — grey cast iron: from the non-deformed part of the tensile test specimen (or a similar location)
  — nodular cast iron: from hardness test coupon at the thermal centre of each step of the stepped wedge
— for nodular cast iron the graphite structure and the metallic matrix shall be assessed. For classification of graphite, ASTM A247 shall be used
— the applied etching methods for the metallographic examination shall be stated in the report.

2.6 Hardness testing
The following is required:
— grey cast iron: Brinell hardness test shall be performed according to DIN 50351, ASTM E10 or another recognized standard, on the round bars at the point where the tensile test specimens have been taken
— nodular cast iron: Hardness test shall be performed at the thermal centre of each step of the stepped wedge.

2.7 Visual Examination
Visual examination shall be conducted according to the relevant rule requirements
— the surfaces shall be adequately prepared for inspection
— the surfaces shall not be hammered, peened or treated in any way which may obscure discontinuities
— examination shall be done for all applicable sides and areas and manufacturer shall ensure that lifting devices for handling and turning of the component are available
— when relevant, visual examination shall include internal surfaces
— measurements shall be made for all applicable dimensions
— manufacturer shall present representative products used for approval purpose to the surveyor, including reports for visual inspection, dimensional measurements and surface condition.

2.8 Non-destructive testing

Each product of nodular cast iron shall be subjected to relevant non-destructive testing in accordance with the requirements of a recognised standard or a manufacturer’s procedure. NDT is not required for grey cast irons.

— inspection shall be done for all applicable sides and areas and manufacturer shall ensure that lifting devices for handling/turning of the component are available.

Magnetic particle testing (MT) or liquid penetrant testing (PT):
— MT shall be carried out for ferritic and ferritic/pearlitic cast irons. PT shall be applied for austenitic cast irons. As a minimum the following areas shall be checked:
   — at all accessible fillets and abrupt changes of section
   — at positions where surplus metal has been removed by flame cutting, scarfing or arc-air gouging
   — at positions where chaplets have been located.

Ultrasonic testing (UT) or radiographic testing (RT):
— where required, UT or RT shall be carried out.

2.9 Other tests (if applicable)

— In case other tests, e.g. pressure testing etc. are required by the referred rules and standard, the type of test and test results shall be submitted.
Table 1 Range of approval for nodular cast iron

<table>
<thead>
<tr>
<th>Approval test on grade:</th>
<th>Grades covered by approval tests</th>
<th>Special grades</th>
<th>Ordinary grades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>VL NCI-1</td>
<td>VL NCI-2</td>
</tr>
<tr>
<td>Special grades</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ferrite</td>
<td>VL NCI-1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Ferrite</td>
<td>VL NCI-2</td>
<td></td>
<td>X</td>
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<td>Ferrite</td>
<td>VL NCI370</td>
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<td></td>
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<td>Ferrite</td>
<td>VL NCI400</td>
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<td></td>
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<td>Ferrite/ Pearlite</td>
<td>VL NCI500</td>
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<td>X</td>
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<tr>
<td>Pearlite</td>
<td>VL NCI600</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Pearlite or tempered</td>
<td>VL NCI700</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>structure</td>
<td>VL NCI800</td>
<td></td>
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</table>
### APPENDIX B RANGE OF APPROVAL FOR GREY CAST IRON

**Table 1 Range of approval for grey cast iron**

<table>
<thead>
<tr>
<th>Approval test on grade:</th>
<th>Grades covered by approval tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>200</td>
</tr>
<tr>
<td>200</td>
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CHANGES – HISTORIC

There are currently no historical changes for this document.
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