CLASS PROGRAMME

Approval of manufacturers

DNVGL-CP-0244 Edition May 2016

Rolled austenitic and ferritic-austenitic stainless steel products
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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Any comments may be sent by e-mail to rules@dnvgl.com

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CHANGES – CURRENT

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 rolled austenitic and ferritic-austenitic steel products 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:
— Rolled austenitic and ferritic-austenitic steel products,

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.

This AoM programme is applicable for the approval of manufacturers of products indicated in Table 1 as given in RU SHIP Pt.2 Ch.2 and relevant parts of other applicable DNV GL rules and standards.

Table 1 Range of approval:

<table>
<thead>
<tr>
<th>Application areas as per RU SHIP Pt.2 Ch.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sec.3 [4]</td>
</tr>
<tr>
<td>Sec.6 [1]</td>
</tr>
</tbody>
</table>

The product(s) used for approval testing (see Sec.3) will place limitations on the range of approval. The approval will be limited to:
— each steel grade listed below
— each product category, see Table 1
— each kind of product form (plates, strips/coil, sections, bars etc.)
— particular processing route and manufacturing variables
— maximum tested thickness or diameter.

Approval of one product form will not cover other product forms (example: round/flat bars will not cover sections). However, approval for one grade of steel may also cover approval other grades, i.e. without additional approval testing. This is based on certain approval principles as given in App.A.

Approval is given to the following typical product categories, steel types and processing routes:
— rolled stainless steels for structural and low temperature service
— stainless steel strips/coil
— rolled round bars
— austenitic stainless
— duplex stainless
— steelmaking process and secondary refining
— casting method (CC, IC etc.)
— dimensions of starting material
— reduction ratio
— condition of supply (solution heat treated condition).

When applicable, approval will be given for the following additional conditions:
— austenitic and duplex stainless steel grades for low temperature applications
— rolled round bars not intended for structural application, e.g. intended for machinery components (as a substitute for forged bars). For these products the requirements for reduction ratio, sampling, acceptance criteria for mechanical properties and visual inspection and NDT shall comply with RU SHIP Pt.2 Ch.2 Sec.6 Steel forgings, as relevant. Approval test scope is given in this approval programme
— where approval is applied for steel grades specified according to other relevant international standards, approval and test scope shall be agreed with the Society on case-by-case basis

Starting material /semi-finished steel products shall be produced at works approved by the Society:
— when steel rolling mill operates their own steel making and produce their semi-finished steel products (slabs/ingots/etc.), the manufacturer shall also use the separate approval programme DNVGL CP 0242 Manufacture of semi-finished steel products – Steelmaker to approve these facilities
— when raw materials for steel rolling mill (slabs/ingots/etc.) are not produced at the rolling mill, semi-finished steel products shall be procured from DNVGL approved steelmakers.

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

Where heat treatment is performed by a sub supplier, the sub supplier shall be approved by the Society as "heat-treatment workshop" in accordance with DNVGL CP 0351.

Manufacturers and works carrying out decoiling of strip and coiled products are not covered by this programme, but need separate approval according to DNVGL CP 0349 Decoiling workshop.

3 Request for approval

When applying for AoM, the manufacturer shall indicate the material grades to be covered by the approval, including manufacturing method, dimensions and heat treatment/delivery conditions, all as per Sec.1 [3].

For this a list or table shall be given, including at least:
— type of products (sections, plates, strip/coil, round bars)
— grades selected for testing
— other grades to be included in the certificate (covered by tested grade, see App.A)
— range of applicable product sizes (width, length, thickness, diameter etc.)
— specification for chemical composition containing the range (minimum and maximum limits) and the aim analyses for all the specified elements
  — reference to DNV GL rules for the applicable chemical composition, mechanical properties and heat treatment (if applicable) or recognised standards (recognition of other standard shall be agreed in advance)
— manufacturing variables related to processing route
  — steelmaking process
  — secondary refining
  — casting method
  — condition of supply
— manufacturing/sourcing details and dimensions of semi-finished products used:
  — where any part of the manufacturing process is assigned to other companies or other manufacturing plants, additional information is to be included
  — in case raw materials for rolled products (slabs/ingots/etc.) are delivered from other manufacturers: a list of raw material suppliers and a copy of their approved certificate.

4 References
Table 2 List of references

<table>
<thead>
<tr>
<th>No.</th>
<th>Reference</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ASTM E562</td>
<td>Standard test method for determining volume fraction by systematic manual point count</td>
</tr>
<tr>
<td>2</td>
<td>ASTM G 48</td>
<td>Test methods for pitting and crevice corrosion resistance of stainless steels and related alloys by use of ferric chloride solution</td>
</tr>
<tr>
<td>3</td>
<td>ASTM A262</td>
<td>Standard practices for detecting susceptibility to intergranular attack in austenitic stainless steels</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 include manufacturer’s metallurgical specifications related to the rolling processes as described below.

2 Reheating
The following documentation shall be submitted:
- type of furnace and dimensions
- heating source
- sketch indicating the positions of thermocouples
- accuracy and calibration status of temperature control devices
- reheating temperature and soaking/holding time in furnace
- description of reheating temperatures and hold times.

3 Rolling
The following documentation shall be submitted:
- capacity of the rolling stands with respect to plate thickness, length and width, and/or section size
- details of starting material and grade, including dimensions
- hot rolling or cold rolling
- rolling schedule
- temperature and thickness at the beginning and at the end of each pass
- reduction ratio for each pass and total reduction ratio and calculation method
- descaling treatment during rolling
- finish rolling temperature
- cooling conditions/stacking method after final rolling
- type and speed of accelerated cooling, if any
- for coils:
  - minimum inner diameter
  - maximum outer diameter.

4 Heat treatment (if applicable)
The following documentation shall be submitted:
- 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
- furnace uniformity test report
- furnace loading plan and procedure
- heat treatment procedures, specifying temperatures and holding times, and where applicable, information about heating and cooling rates, and quenching medium
- any re-heat treatment procedure to be given, if applicable
5 Welding (if applicable)
The following documentation shall be submitted:
— description of welding in case production welding is involved:
   — equipment
   — qualifications of welders and welding supervisors
   — welding procedure specifications (WPS)
   — reports on welding procedure qualification tests (WPQR)
— unless otherwise agreed with the Society, the scope of welding procedure tests shall comply with RU SHIP Pt.2 Ch.4 Sec.5 and documented as described in approval of welding workshop (WWA) programme DNVGL CP 0352.

6 Records, test facilities and procedures
The following documentation shall be submitted:
— 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.
SECTION 3 APPROVAL TESTING

1 Test product and testing scope

1.1 General

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

The sampling and the testing procedures shall comply with the applicable requirements of the DNV GL rules. E.g. the reduction ratio and testing sample positions for rolled bars for machinery application, with diameter over 50 mm shall be in accordance with RU SHIP Pt.2 Ch.2 Sec.6 Steel forgings.

1.2 Extent of approval testing

Testing shall be carried out on two test products from two different heats for:
— each steel grade
— each product category, see Sec.1 Table 1
— each kind of product form (plates, strips/coil, sections, bars etc.)
— each specific manufacturing processing route (e.g. steel making etc., see Sec.1 [2]).

The first heat shall represent maximum product thickness (dimension) and the second heat should represent an average thickness (dimension). The second heat may be replaced by a typical dimension/weight of the manufacturer’s product portfolio.

It should be noted that some tests are only on products of maximum thickness as described in the scope of testing in the following sections.

The products selected for testing shall represent:
— for ingot cast material: one test sample from the top end corresponding to the top of the first ingot from the ladle, and one from the bottom end of the product (plate, section, bar etc.)
— for continuous casting: one test from the top end of the product corresponding to the tail end of the string, and the second test sample from the bottom end of the product (plate, section, bar etc.)
— "end" means the locations on the final product corresponding to the former ends of the ingot/slab/bloom/billet applied for testing, after cutting of discard.

Test samples shall be taken out in final delivery condition and shall not be subjected to any separate heat treatment except for bars for anchor chain cables, where testing shall be carried out on samples subjected to heat treatment as for finished anchor chain cables.

2 Testing requirements

2.1 Chemical composition

The following is required:
— both ladle/heat analyses and product analyses
— for all steel grades, the chemical composition as determined both by heat and by product analysis shall comprise all the elements specified in the corresponding section of RU SHIP Pt.2, and the elements specified in a relevant recognised standard (if applicable) as well as elements designated as residual elements and any other intentionally added elements
— if steel is sourced from a different maker, manufacturer shall request the complete heat analysis of all the required elements while ordering the semi-finished products
— a summary of the sampling practices and methods for chemical analysis shall be included in the report
2.2 Tensile testing

The following is required:

— tensile testing is required for all steel grades, on samples taken from top and bottom of the products, representing two heats
— for plate produced from coil, tensile tests shall be made from top and bottom ends as well as at the approximate centre lap of each coil
— alternative test for flat products (plates, wide flats, sheets, etc.) having thickness higher than 40 mm: when the capacity of the available testing machine is insufficient to allow the use of test specimens of full thickness, multiple flat specimens representing collectively the full thickness may be used. Alternatively, two round specimens with the axis located at one quarter and at mid thickness may be taken
— the tensile test results shall meet the corresponding DNV GL rule requirements
—at yield (or proof) stress, tensile strength, elongation and, in case of round specimens – reduction of area
—at austenitic steels both the 0.2% and the 1.0% yield strength
— stress–strain curves shall be included in the report.

2.3 Impact testing

Impact testing is required for all steel grades on samples taken from the products representing two heats as described below:

— for flat products (plates, wide flats, sheets, etc.) longitudinal and transverse Charpy V-notch impact tests shall be made from both ends of each sample product
— for flat products (plates, wide flats, sheets, etc.) one additional set of impact specimens shall be taken with the axis located at plate mid thickness
— for long products (sections, narrow flats, bulb flats, bars etc.) longitudinal Charpy V-notch impact tests shall be taken from both ends of each sample product
— for strip/plate produced from coil longitudinal and transverse Charpy V-notch impact tests shall also be made from the approximate centre lap of each coil
— one set of three Charpy V-notch impact specimens is required for each test location

Test temperatures:

— for austenitic steels, the products shall be tested at +20°C and at −196°C
— for duplex (ferritic-austenitic) stainless steel products, transition curves shall be established both for longitudinal and transverse samples. The testing shall be carried out at least at -60°C, -46°C and -20°C

Acceptance criteria and reporting:

— the impact energy values shall comply with applicable requirements in the rules, i.e. when tested at or above the temperature specified by the rules
— the heat number, test piece location and orientation, test temperature and absorbed energy (average and single values), fracture appearance, lateral expansion and percentage crystallinity shall be given. For duplex steels, the results shall be plotted in the form of transition curves.
2.4 Metallographic examination

The following is required:

— metallographic examination is required for all steel grades on samples taken in longitudinal and transverse directions from the top end of the products, representing two heats
— the micrographs shall be representative of the full thickness. At least three thickness locations shall be represented: near the surface, at one quarter and at mid-thickness of the product
— high quality photomicrographs showing the microstructure at 100x and 400x/500x 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 or 100 µm. Arrows or letters may be used to identify features referred to in the report
— for all grades of stainless steels the microstructure shall be free from detrimental inter-metallic phases and grain boundary precipitates
— for duplex steels, the ferrite content shall be determined in accordance with ASTM E562 or an equivalent standard and shall be within 30 to 70%
— the applied etching methods for the metallographic examination shall be stated in the report.

2.5 Weldability testing

Weldability testing is not required for austenitic stainless steel. The weldability test requirements for duplex stainless steels are described below.

2.5.1 Scope of testing (duplex stainless steel)

The following is required:

— butt weld assemblies representing the maximum thickness of duplex stainless steel plates required for approval shall be prepared and qualified according to the requirements of RU SHIP Pt.2 Ch.4 Sec.5, or where agreed, to a recognised standard. Unless stricter requirements are given in the applied standard, the testing shall also comprise:
  — Charpy V-notch impact tests at -20°C notched at the fusion line and in the heat affected zone at positions fusion line plus 2 mm and plus 5 mm
  — HAZ pitting corrosion test: Type 25Cr duplex shall be corrosion tested according to ASTM G48 method A. The test specimen shall be in the as welded state after normal weld cleaning operation. The test specimens shall be exposed to the solution at a constant temperature of 40°C for 24 hours. The test specimens shall have a dimension of full wall thickness by 25 mm along the weld and 50 mm across the weld. The test shall expose the external and internal surface and a cross section surface including the weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G48. The whole specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min. at 60°C in a solution of 20% HNO3 + 5% HF
  — macro-examination and micro-examination at a magnification of 500x in the region of the heat affected zone.

2.5.2 Acceptance criteria and reporting (duplex stainless steel)

The following is required:

— welding procedure qualification test records (WPQR) shall be provided for review
— all test results shall comply with the applicable requirements of RU SHIP Pt.2 Ch.4 Sec.5
— for macro and micro-examination, the heat affected zone (HAZ) shall be free from detrimental inter-metallic phases and grain boundary precipitates.
2.6 Corrosion testing

The following is required:

— test for resistance to corrosion shall be performed for all applicable stainless steel grades. Surface finish of the test specimens shall be representative of the surface finish of the applicable materials and products. The test sample position shall comprise the mid thickness of the plate

— austenitic stainless steels:

  — test samples from both heats shall be subjected to intercrystalline corrosion test, in order to demonstrate that the material is not susceptible to intergranular corrosion resulting from grain boundary precipitation of chromium-rich carbides
  
  — the testing shall be carried out according to ASTM A262, Practice E – Copper-copper sulfate-sulfuric acid test for detecting susceptibility to inter-granular attack in austenitic stainless steels, or another recognised standard
  
  — the bent specimens shall be free from cracks indicating the presence of intergranular attacks

— duplex stainless steels:

  — test samples from both heats and both ends of the product shall be subjected to corrosion test in accordance with ASTM G48 method A or an equivalent standard
  
  — the test temperature shall be +20°C for type 22Cr duplex and +50°C for type 25Cr duplex, respectively. The exposure time shall be 24 hours
  
  — no pitting on specimen (plate) surfaces is allowed when viewed at 20x magnification. The specimen mass loss shall be less than 4.0 g/m²

— reporting shall be in the format given by the referred test standard.

2.7 Visual examination

Visual examination shall be conducted and recorded according to the relevant rules on the products submitted for approval purposes.

— 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, i.e. manufacturer shall ensure that lifting devices for handling and turning of the component are available

— measurements shall be made on all applicable dimensions

— records of inspections including NDT shall be provided

— manufacturer shall present representative products used for approval purpose and preferably several other products from the current production to the surveyor, including reports for visual inspection of the products and surface condition.

2.8 Other tests (if applicable)

Other applicable tests which are carried out by the manufacturer, e.g. to customer purchase specification requirements shall be reported.
### APPENDIX A APPROVAL RANGE BASED ON TESTED GRADE

**Table 1 Principles for approval coverage of other grades based on any tested grade**

<table>
<thead>
<tr>
<th>Product category</th>
<th>Steel types</th>
<th>Grades</th>
<th>Range of approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel products, see RU SHIP Pt.2 Ch.2 Sec.3</td>
<td>Austenitic stainless</td>
<td>NV 304L, NV 316L, NV 317L</td>
<td>a) Approval of a higher grade (in the hierarchy given here) may, subject to agreement, cover approval of lower grades under the same approval conditions. Example: Approval of NV 316L may cover approval of NV 304L.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NV 316LN, NV 317LN</td>
<td>a) Approval of a higher grade (in the hierarchy given here) may, subject to agreement, cover approval of lower grades under the same approval conditions. Example: Approval of NV 316LN may cover approval of NV 304L.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NV 321, NV 347</td>
<td>b) Approval of one grade will not cover other grades.</td>
</tr>
<tr>
<td>Stainless steel rolled bars intended e.g. for machinery components, see RU SHIP Pt.2 Ch.2 Sec.6</td>
<td>Duplex stainless</td>
<td>UNS S31803, UNS S32750 &amp; UNS S32760</td>
<td>c) Approval of one grade will not cover other grades.</td>
</tr>
<tr>
<td></td>
<td>Austenitic 22Cr duplex 25Cr duplex</td>
<td></td>
<td>c) Approval of one grade will not cover other grades.</td>
</tr>
</tbody>
</table>
CHANGES – HISTORIC

There are currently no historical changes for this document.
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