CLASS PROGRAMME

Approval of manufacturers

DNVGL-CP-0347 Edition May 2016

Steel hollow sections
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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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 steel hollow sections 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:
— Steel hollow sections,
as referred in the Society's rules and standards, e.g. RU SHIP Pt.2 Ch.2 Sec.2 [2]. 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.

Note:
Manufacture of steel pipes used in the construction of piping for pressure, cargo, and process systems is not covered by this program, but shall follow the programme DNVGL CP 0252
This CP does not cover any further assembly of hollow sections by welding, which requires additional approval according to DNVGL CP 0352.

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 type of steel hollow section (i.e. circular/rectangular) and manufacturing method (welded/seamless) as indicated in App.A.
The applicable scope of approval depends on the dimensions presented and tested for the qualification tests. As a rule the dimensional limits in Table 1 apply. If deemed necessary by the Society, different dimensional limits may apply.

Table 1 Dimensional ranges of approval

<table>
<thead>
<tr>
<th>Shape of hollow section</th>
<th>Diameter category (mm)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
<td>Medium</td>
</tr>
<tr>
<td>Round</td>
<td>1.5 x d\text{presented} max. 101.6</td>
<td>1.5 x d\text{presented} max. 323.9</td>
</tr>
<tr>
<td>Square</td>
<td>1.5 x B\text{presented} max. 100</td>
<td>1.5 x B\text{presented} max. 300</td>
</tr>
<tr>
<td>Rectangular</td>
<td>1.5 x B\text{presented} x H\text{presented} max. 100 x 60</td>
<td>1.5 x B\text{presented} x H\text{presented} max. 300 x 200</td>
</tr>
</tbody>
</table>

The wall thickness of the hollow section covered by the approval is related to the scope of testing and the actual wall thickness presented in the approval test. If deemed necessary by the Society, different limits on the wall thickness may apply.
Applicable approval for wall thickness for hollow sections without impact tests (< 6 mm) is limited to max. 6 mm.
Applicable approval for wall thickness for hollow sections with impact tests (≥ 6 mm) is limited to the maximum thickness of the tested product.
The designation “steel type group” is applied for:
— carbon and carbon-manganese (C and C-Mn) steels
— the individual alloy steels
— the individual stainless steels.

For material grades and heat treatment/delivery condition, the same limitations as indicated in DNVGL CP 0243 apply.

When steel hollow sections manufacturer operates their own steel making and/or rolling facilities to produce their own pre-material (plates/billets/ingots etc.), the manufacturer shall also use class programmes DNVGL CP 0242 and DNVGL CP 0243 to approve these facilities as appropriate.

When pre-materials/starting material are not produced at the steel hollow section manufacturer, these shall be procured from steelmaker/rolling mill approved by the Society for relevant steel grades.

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" through the separate approval programme DNVGL CP 0351.

If critical manufacturing steps are performed by a sub-supplier, the Society's manufacturer approval of the sub-supplier may be required accordingly.

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, heat treatment and delivery conditions as per [3].

For this a list or table shall be given, including at least:
— type of products
— manufacturing method
— range of applicable product sizes (dimensions and weight)
— applicable steel types and steel grades, see RU SHIP Pt.2 Ch.2 Sec.2 and DNVGL CP 0243
— heat treatment and delivery conditions
— reference to the rules for the applicable chemical composition, mechanical properties and heat treatment (if applicable) or recognised standards if agreed in advance
— in case pre-material (plates/billets/ingots etc.) are delivered from other manufacturers; a list of these suppliers and a copy of their manufacturer approval certificate.

4 References

/1/ ASTM E112, Standard test method for determining average grain size
/2/ ASTM E562, Standard test method for determining volume fraction by systematic manual point count
/3/ ISO 643, Steels – Micrographic determination of the apparent grain size
/5/ EN 10210-2, Hot finished structural hollow sections of non-alloy and fine grain steels Part 2: Tolerances, dimensions and sectional properties
/6/ ASTM E436, Standard test method for drop-weight tear test of ferritic steels
/7/ ASTM E208, Standard test method for drop-weight tear test to determine nil-ductility transition temperature of ferritic steels
/8/ EN 10164, Steel products with improved deformation properties perpendicular to the surface of the product - technical delivery conditions
/9/ ASTM A770, Standard specification for through-thickness tension testing of steel plates for special applications
/10/ EN 10160, *Ultrasonic testing of steel flat products of thickness equal or greater than 6mm (reflection method)*

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 to the manufacturing process as described in this section.

2 Production facilities and equipment
The manufacturer shall submit documentation describing the following equipment and processes. For process descriptions, the manufacturer’s quality manual procedures or job-descriptions are required:
— heating furnaces
— drawing and/or pressing benches
— rolling stands
— welding plants
— heat treatment furnaces (see [4])
— cutting and machining devices
— finishing department.

3 Process description
For seamless hollow sections the following shall be submitted:
— method of manufacture
— preheating of billets (if applicable)
— hot or cold finishing.
For welded hollow sections the following shall be submitted:
— starting material
— welding process
— welding procedure specification
— cold finishing (if applicable).

4 Heat treatment (if applicable)
Heat treatment documentation shall include:
— type of furnace and dimensions
— heating source
— working zone dimension and sketch of working zone
— sketch indicating the positions of thermocouples
— 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, 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
5 Welding (if applicable)
The following shall be submitted:
— equipment
— welding procedure specifications (WPS)
— reports on welding procedure qualification tests (WPQR)
— in case welding is carried out in accordance with procedures or standards not covered by the DNV GL rules and standards, e.g. for high-frequency welding (HFW), the manufacturer shall submit specification including the allowable ranges of the essential variables, including appropriate qualification and verification
— qualifications of welders and welding supervisors
— unless otherwise agreed with the Society, the information provided shall comply with the approval of welding workshop (WWA) programme DNVGL CP 0352.

6 Records, test facilities and procedures
The following shall be submitted:
— visual inspection: relevant templates for recording, and a 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.
— demonstration of efficiency of non-destructive testing equipment (e.g. ultrasonic test) on hollow sections of same grades and dimensions, and demonstration of the calibration on hollow sections of similar grades and dimensions (with artificial defects).

7 Automatic non-destructive testing (if applicable)
For the use of automatic non-destructive testing on-line equipment for testing the whole length of the hollow sections is required. The following information shall be submitted:
— general description of test method including reference to standards or specifications
— type of equipment and capacity, i.e. hollow dimension range (wall thickness and outside dimensions)
— calibration of equipment to establish a minimum sensitivity level for rejection, including information on dimension and position of artificial defects in standard test hollow sections
— sensitivity toward internal and external discontinuities
— frequency of calibration
— orientation of discontinuities capable of detection
— description or procedure for disposition of material with indications exceeding the acceptance criteria
— description or procedure for disposition of untested length at hollow sections ends.

8 Test results and records
Additional requirements for reporting of test results:
— Sampling of test specimens:
  — sketches, drawings and photographs showing the position of test samples shall be submitted.
— 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
— alloying and impurity elements shall be reported in the following sequence silicon, iron, copper,
manganese, magnesium, chromium, nickel, zinc, titanium, other elements, sum of impurity elements,
aluminium
— the report shall give the specified limits and the measured content of all the required elements.

— Tensile test:
— yield (or proof) stress, tensile strength, elongation and reduction of area shall be reported. For non-
proportional specimens, the actual dimensions 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.

— Strain age testing:
— in addition to reporting of all the test results, the artificial straining method, records of deformation
(stress-strain curves) and temperature records of artificial ageing shall be reported.

— Drop weight testing, weldability test, metallographic examination, through thickness test, visual
examination:
— see DNVGL CP 0243.

— Supplementary tests for welded hollow sections:
— testing parameters and test results shall be documented, see Sec.3 [2.10].

— 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 product 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].
In addition to the testing required this program, the testing shall in general follow the corresponding requirements of DNVGL CP 0243.

1.2 Extent of approval testing

1.2.1 The manufacturer shall prepare a test plan proposal for review and acceptance by the Society, indicating all details of the testing including the products for testing, number of test samples, tests to be carried out, etc. The test plan shall cover the products stated in the request for approval with respect to steel grades, dimensions and conditions of supply. At least two hollow sections originating from two different heats shall be presented for approval tests for each relevant:
— dimensional category
— wall thickness (at least one of maximum wall thickness)
— steel grade
— delivery condition.

Dimensional categories are given in Table 1

Table 1 Dimensional categories for sampling

<table>
<thead>
<tr>
<th>Shape of hollow section</th>
<th>Diameter category (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
</tr>
<tr>
<td>Round</td>
<td>21.3 &lt; d ≤ 101.6</td>
</tr>
<tr>
<td>Square</td>
<td>20 &lt; B ≤ 100</td>
</tr>
<tr>
<td>Rectangular</td>
<td>(50 x 25) &lt; (B x H) ≤ (100 x 60)</td>
</tr>
</tbody>
</table>

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

1.3 Selection and position of the test samples
The following is required:
— the products shall be representative of the dimensions for which approval is requested. Test samples shall be taken out in final delivery condition and shall not be subjected to any separate heat treatment. The test samples shall be taken from both ends of each test section selected for the approval test
— the position of test samples shall as far as possible be similar to that required for plates, or it may comply with a recognized relevant international standard such as EN 10210-2
— unless specified in the rules sampling positions may be proposed by the manufacturer and then agreed on a case by case basis.
2 Testing requirements

2.1 Chemical composition

See DNVGL CP 0243.

For the case where an element is found to have content outside the expected range for the alloy type/grade in question, that is, for elements not particularly specified with maximum and minimum limits in the rules, this will be subjected to special consideration.

2.2 Tensile testing

Tensile testing shall be in compliance with RU SHIP Pt.2 Ch.1 Sec.3 and DNVGL CP 0243. In addition, the following applies:

— test specimen for circular hollow sections shall comply with form E or F according to the RU SHIP Pt.2 Ch.1 Sec.3. Alternatively, long sections of the entire hollow section may be tested
— test specimen for square/rectangular hollow sections shall comply with form B or D according to the RU SHIP Pt.2 Ch.1 Sec.3
— for square/rectangular hollow sections, additional longitudinal tensile specimens sampled from the corner region shall be tested. Test specimen shall be of form F according to the RU SHIP Pt.2 Ch.1 Sec.3
— one tensile test specimen shall be tested for each product and position
— yield (or proof) stress, tensile strength, elongation and reduction of area shall be determined. For non-proportional specimens, the actual dimensions shall be reported.

The mechanical properties shall comply with relevant rules, or if agreed in advance, with a standards or the manufacturer’s specification.

2.3 Impact testing

2.3.1 In general, for requirements to impact testing, DNVGL CP 0243 shall be applied. For material grades not covered by DNVGL CP 0243, the following is required:

— Charpy V-notch specimens shall be tested for wall thickness ≥ 6 mm, both for transverse and for longitudinal directions.
— Applicable test temperatures are given in Table 4, where “definition temperature” indicates the applicable test temperature given by the relevant rules or standards for the grade tested.

Table 2 Test temperatures for notch bar impact tests

<table>
<thead>
<tr>
<th>Definition temperature</th>
<th>Applicable test temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+20 °C</td>
</tr>
<tr>
<td>+20 °C 0 °C</td>
<td>X</td>
</tr>
<tr>
<td>-20 °C</td>
<td>X</td>
</tr>
<tr>
<td>-40 °C</td>
<td>X</td>
</tr>
<tr>
<td>-60 °C</td>
<td></td>
</tr>
</tbody>
</table>

2.3.2 For square/rectangular hollow sections, additional longitudinal Charpy V-notch specimens shall be prepared from the corner region, with the notch perpendicular to the outer surface of the corner.
2.3.3 The impact toughness test results shall fulfil the corresponding rule requirements, i.e. for the temperature specified by the rules and at higher temperatures.

2.4 Strain age testing

2.4.1 Tensile and impact testing shall be performed for both artificially strained and for artificially strained and aged condition (5%, 1 h, 250°C), see RU SHIP Pt.2 Ch.1 Sec.3 [3.8].
Provided that the calculated maximum cold deformation ratio for the product is more than 5%, the straining before testing shall be carried out to the maximum calculated deformation. For calculation formulas, see RU SHIP Pt.2 Ch.3 Sec.6.

2.4.2 Longitudinal tensile tests are required for both the strained and for the strained and aged condition. The test results shall satisfy the corresponding rule requirements.

2.4.3 Longitudinal Charpy V-notch impact tests are required for both the strained and for the strained and aged condition. Applicable test temperatures in relation to the definition temperature of material grade is shown in Table 3.

Table 3 Test temperatures for notch bar impact tests in artificial aged condition

<table>
<thead>
<tr>
<th>Definition temperature</th>
<th>+20 °C</th>
<th>0 °C</th>
<th>-20 °C</th>
<th>-40 °C</th>
<th>-60 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>+20 °C</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20 °C</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>-40 °C</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>-60 °C</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

2.4.4 The impact toughness test results shall fulfil the corresponding rule requirements at and above the specified test temperature.
For section thickness less than 6 mm, the test scope and requirements are subject to special consideration by the Society. Strain and strain age test will normally be required for product thickness > 2.5 mm.

2.5 Drop weight testing

2.5.1 Drop weight testing shall be performed in accordance with DNVGL CP 0243.

2.5.2 Subject to agreement with the Society, drop weight testing may be replaced by other tests if acceptable test samples (as per ASTM E436) cannot be made due to geometrical constraints (i.e. too small outer diameter).

2.6 Bend tests
Longitudinal or transverse bend tests shall be performed. Bending angle: 180°, bending radius: 2 x test specimen thickness for normal strength and 3 x test specimen thickness for higher strength steels. Test specimen according to RU SHIP Pt.2 Ch.1 Sec.3.
2.7 Weldability testing
Weldability testing shall be performed in accordance with DNVGL CP 0243.

2.8 Through thickness testing (optional)
Through thickness testing shall be performed in accordance with DNVGL CP 0243.

2.9 Metallographic examination
Metallographic testing shall be performed in accordance with DNVGL CP 0243.
For square/rectangular hollow sections additional micrographs taken from the corner region with a
magnification of 100:1 shall be submitted. Locations are near outer surface and mid-thickness of the
product’s corner.

2.10 Supplementary tests for welded hollow sections

2.10.1 Transverse tensile tests across the weld or longitudinal including the weld (for small sections) shall be
performed.

2.10.2 For hollow sections where outer diameter is exceeding 200 mm, weld bend tests shall be performed
with the outer and inner side of the weld in tension.

2.10.3 If wall thickness ≥ 6 mm, impact tests on Charpy V-notch specimens shall be performed for
transverse direction. Notch position: centre of weld, fusion line and heat affected zone (fusion line + 2 mm).
Applicable test temperatures in relation to the definition temperature of material grade as shown in Table 4.

Table 4 Test temperatures for notch bar impact tests on welding seam of welded hollow sections

<table>
<thead>
<tr>
<th>Definition temperature</th>
<th>+20 °C</th>
<th>0 °C</th>
<th>-20 °C</th>
<th>-40 °C</th>
<th>-60 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>+20 °C</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 °C</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20 °C</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-40 °C</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>-60 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

In case sub-size specimens are used, the width of the specimen (7.5 mm or 5 mm) shall be stated in the test
report. The measured impact energy shall be reported.

2.10.4 Microstructure photographs of weld centre, fusion line and heat affected zone shall be prepared.

2.10.5 Chemical composition of weld metal (fusion welded sections only) shall be determined.

2.10.6 Macrosection with three hardness testing lines across the weld area (photographs with a
magnification of 2:1) shall be prepared.

2.10.7 Non-destructive tests of the weld by ultrasonic and/or radiographic method shall be performed.
2.11 Visual examination
Visual examination shall be performed in accordance with DNVGL CP 0243. Additionally, visual examination shall include the inspection of internal surfaces for a length of at least 1 m.

2.12 Non-destructive testing

2.12.1 Each product shall be subjected to relevant non-destructive testing in accordance with the requirements given in the rules, or in accordance with an agreed standard.

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

2.12.3 The applicable non-destructive testings and requirements are given in RU SHIP Pt.2 Ch.2 Sec.2 [2].
## APPENDIX A APPROVAL COVERAGE

### 1 Approval coverage of material grades and steel types

<table>
<thead>
<tr>
<th>Rule reference:</th>
<th>Steel types/material grades</th>
<th>Approval coverage:</th>
</tr>
</thead>
<tbody>
<tr>
<td>RU SHIP Pt.2 Ch.2 Sec.2 [2]</td>
<td>See DNVGL CP 0243</td>
<td>— seamless hollow sections, circular</td>
</tr>
<tr>
<td></td>
<td></td>
<td>— seamless hollow sections, rectangular/square</td>
</tr>
<tr>
<td></td>
<td></td>
<td>— welded hollow sections, circular</td>
</tr>
<tr>
<td></td>
<td></td>
<td>— welded hollow sections, rectangular/square</td>
</tr>
<tr>
<td></td>
<td></td>
<td>— in case of welded hollow sections the approval coverage concerning the welding procedure see DNVGL CP 0243</td>
</tr>
</tbody>
</table>
CHANGES – HISTORIC

There are currently no historical changes for this document.
Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16 000 professionals are dedicated to helping our customers make the world safer, smarter and greener.