FOREWORD

DNV is a global provider of knowledge for managing risk. Today, safe and responsible business conduct is both a license to operate and a competitive advantage. Our core competence is to identify, assess, and advise on risk management. From our leading position in certification, classification, verification, and training, we develop and apply standards and best practices. This helps our customers safely and responsibly improve their business performance. DNV is an independent organisation with dedicated risk professionals in more than 100 countries, with the purpose of safeguarding life, property and the environment.

The Rules lay down technical and procedural requirements related to obtaining and retaining a Class Certificate. It is used as a contractual document and includes both requirements and acceptance criteria.

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Any comments may be sent by e-mail to rules@dnv.com

If any person suffers loss or damage which is proved to have been caused by any negligent act or omission of Det Norske Veritas, then Det Norske Veritas shall pay compensation to such person for his proved direct loss or damage. However, the compensation shall not exceed an amount equal to ten times the fee charged for the service in question, provided that the maximum compensation shall never exceed USD 2 million.

In this provision “Det Norske Veritas” shall mean the Foundation Det Norske Veritas as well as all its subsidiaries, directors, officers, employees, agents and any other acting on behalf of Det Norske Veritas.
CHANGES – CURRENT

General
This document supersedes the January 2014 edition.

Text affected by the main changes in this edition is highlighted in red colour. However, if the changes involve a whole chapter, section or sub-section, normally only the title will be in red colour.

Det Norske Veritas AS, company registration number 945 748 931, has on 27th November 2013 changed its name to DNV GL AS. For further information, see www.dnvgl.com. Any reference in this document to “Det Norske Veritas AS” or “DNV” shall therefore also be a reference to “DNV GL AS”.

Main changes July 2014, entering into force 1 January 2015

- Sec.9 Goal-based ship construction standards for bulk carriers and oil tankers
  — This is a new section based on IACS UR Z23 Appendix 2, which contains requirements to a ship construction file (SCF).

Editorial corrections
In addition to the above stated main changes, editorial corrections may have been made.
# CONTENTS

CHANGES – CURRENT .......................................................................................................................... 3

Sec. 1 General requirements .............................................................................................................. 7

A. General ............................................................................................................................................ 7
A 100 Introduction ............................................................................................................................ 7
A 200 References ........................................................................................................................... 7

B. Documentation requirements ........................................................................................................ 9
B 100 Plans and particulars ............................................................................................................. 9
B 200 Certification requirements ................................................................................................... 9
B 300 Survey and testing requirements ......................................................................................... 10

Sec. 2 Requirements for builders of ships .......................................................................................... 11

A. General ........................................................................................................................................... 11
A 100 Application ............................................................................................................................ 11
A 200 Basic requirements .............................................................................................................. 11

B. Survey arrangement .................................................................................................................... 11
B 100 Quality management system ............................................................................................... 11

C. Workmanship and supervision ................................................................................................... 11
C 100 General .................................................................................................................................... 11

Sec. 3 Qualification of welders .......................................................................................................... 12

A. General ........................................................................................................................................... 12
A 100 Application ............................................................................................................................ 12
A 200 Requirements for welding operators ................................................................................. 12

B. Qualification testing and certification of welders ...................................................................... 12
B 100 General .................................................................................................................................... 12
B 200 Certification .......................................................................................................................... 12

Sec. 4 Welding consumables ............................................................................................................. 13

A. General ........................................................................................................................................... 13
A 100 Application ............................................................................................................................ 13
A 200 Basic groups and grades ....................................................................................................... 13

Sec. 5 Welding procedures ................................................................................................................. 17

A. General ........................................................................................................................................... 17
A 100 Application ............................................................................................................................ 17
A 200 Wide gap welding ............................................................................................................... 17
A 300 Welding processes .............................................................................................................. 17

B. Welding procedure specification ............................................................................................... 17
B 100 General .................................................................................................................................... 17
B 200 Approved welding procedure specification .................................................................. 18

C. Welding procedure qualification test assembly and sampling of test pieces ......................... 19
C 100 Butt welds in plates ............................................................................................................. 19
C 200 Butt welds in pipes ............................................................................................................. 21
C 300 Full penetration T-, Y-, and K- joints .................................................................................. 22
C 400 Branch connection .............................................................................................................. 23
C 500 Fillet welds ......................................................................................................................... 24

D. Non Destructive testing of test assemblies ............................................................................. 25
D 100 Butt welds in plates and pipes and full penetration T-, Y-, and K-joints ......................... 25
D 200 Fillet welds and partial penetration welds ....................................................................... 25

E. Destructive testing acceptance criteria ...................................................................................... 25
E 100 Transverse tensile test ........................................................................................................ 25
E 200 Bend test ............................................................................................................................. 25
E 300 Macrosection and hardness testing .................................................................................... 25
E 400 Impact testing ...................................................................................................................... 26
E 500 Welds between different material grades ......................................................................... 26
E 600 Fracture mechanics (FM) test .............................................................................................. 27
SECTION 1 GENERAL REQUIREMENTS

A. General

A 100 Introduction

101 Objective
The objective of this chapter is to provide requirements to fabrication and testing of welded structures and components.

102 Scope
This chapter contains requirements to:

— builders of ship structures and components
— qualification of welders
— welding consumables
— welding procedures
— fabrication and tolerances
— non-destructive testing of welds
— structural and tightness testing.

103 Application
The requirements herein apply to builders and sub-contractors of vessels and components constructed and equipped for assignment of main class for ships.

104 Welding of important structures like:

— hull, superstructure taking part in the overall strength
— hull equipment, stern frames, rudders, rudder stocks and rudder horn,

shall be carried out by certified welders and qualified welding operators, with approved welding procedures and welding consumables, and at builders and subcontractors, all complying with Sec.2 to 8 of this Chapter. The alternative goal based construction requirements are included in sec.9.

105 Relation to other DNV documents
Specific or additional requirements may also be provided in other parts of the rules, Pt. 3 to Pt. 8. In case of conflicting requirements, the specific or additional requirements in Pt. 3 to Pt. 8 are prevailing.

A 200 References

201 Terminology and definitions

<table>
<thead>
<tr>
<th>Builder</th>
<th>Signifies the party contracted to build a vessel in compliance with the Society’s rules, e.g. yard involved in fabrication planning, building, assembly and testing of structures and components for classification.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully automatic processes</td>
<td>Welding where all operations are mechanized.</td>
</tr>
<tr>
<td>Fully mechanised welding</td>
<td>Welding where all main operations (excluding the handling of the work piece) are mechanized.</td>
</tr>
<tr>
<td>Inspection</td>
<td>An activity carried out by the builder or subcontractor to verify compliance with the applicable rules and specifications</td>
</tr>
<tr>
<td>Manual welding</td>
<td>Welding where the electrode holder, welding hand gun, torch or blowpipe is manipulated by hand.</td>
</tr>
<tr>
<td>New Building Survey Arrangement (NSA)</td>
<td>Agreement between the builder and the Society defining responsibility and authority of personnel and items to be controlled with acceptance criteria, quality control functions. The activities through this agreement are complementary to the Society’s own survey scheme.</td>
</tr>
<tr>
<td>Partly mechanised welding</td>
<td>Manual welding where the wire feed is mechanized.</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>A.C.</td>
<td>Alternating Current</td>
</tr>
<tr>
<td>ACCP</td>
<td>ASNT Central Certification Program</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>AR</td>
<td>As Rolled</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>ASNT</td>
<td>The American Society For Non-destructive Testing</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing of Materials</td>
</tr>
<tr>
<td>AWS</td>
<td>American Welding Society</td>
</tr>
<tr>
<td>BM</td>
<td>Base material</td>
</tr>
<tr>
<td>CE</td>
<td>Carbon equivalent</td>
</tr>
<tr>
<td>C-Mn</td>
<td>Carbon manganese</td>
</tr>
<tr>
<td>CTOD</td>
<td>Crack tip opening displacement</td>
</tr>
<tr>
<td>DAC</td>
<td>Distance amplitude curve</td>
</tr>
<tr>
<td>D.C.</td>
<td>Direct Current</td>
</tr>
<tr>
<td>DNV</td>
<td>Det Norske Veritas</td>
</tr>
<tr>
<td>EN</td>
<td>European Norm</td>
</tr>
<tr>
<td>ET</td>
<td>Eddy current Testing</td>
</tr>
<tr>
<td>FCAW</td>
<td>Flux Cored Arc Welding</td>
</tr>
<tr>
<td>FL</td>
<td>Fusion Line</td>
</tr>
<tr>
<td>FM</td>
<td>Fracture mechanics</td>
</tr>
<tr>
<td>GMAW</td>
<td>Gas Metal Arc Welding</td>
</tr>
<tr>
<td>GTAW</td>
<td>Gas Tungsten Arc Welding</td>
</tr>
<tr>
<td>HAZ</td>
<td>Heat affected zone</td>
</tr>
<tr>
<td>HV</td>
<td>Vickers Hardness</td>
</tr>
<tr>
<td>IACS</td>
<td>International Association of Classification Societies</td>
</tr>
<tr>
<td>IIW</td>
<td>International Institute of Welding</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organisation for Standardisation</td>
</tr>
<tr>
<td>KV</td>
<td>Charpy V-notch test</td>
</tr>
<tr>
<td>MAG</td>
<td>Metal active gas (welding)</td>
</tr>
<tr>
<td>MIG</td>
<td>Metal inert gas (welding)</td>
</tr>
<tr>
<td>MT</td>
<td>Magnetic particle testing</td>
</tr>
<tr>
<td>N</td>
<td>Normalized</td>
</tr>
<tr>
<td>NACE</td>
<td>National Association of Corrosion Engineers</td>
</tr>
<tr>
<td>NDT</td>
<td>Non-destructive testing</td>
</tr>
<tr>
<td>NSA</td>
<td>New Building Survey Arrangement</td>
</tr>
<tr>
<td>NR</td>
<td>Normalizing Rolling</td>
</tr>
<tr>
<td>PSC</td>
<td>Performance standard for protective coatings for dedicated seawater ballast tanks in all types of ships and double-side skin spaces of bulk carriers, adopted by IMO Res. MSC 215(82), as amended and Performance standard for protective coatings for cargo oil tanks of crude oil tankers, adopted by IMO Res. MSC 288(87), as amended</td>
</tr>
<tr>
<td>PT</td>
<td>Penetrant testing</td>
</tr>
<tr>
<td>PWHT</td>
<td>Post weld heat treatment</td>
</tr>
<tr>
<td>pWPS</td>
<td>Preliminary welding procedure specification</td>
</tr>
<tr>
<td>QSP</td>
<td>Quality survey plan</td>
</tr>
<tr>
<td>QT</td>
<td>Quenched and Tempered</td>
</tr>
</tbody>
</table>
### B. Documentation requirements

**B 100 Plans and particulars**

101 Documentation shall be submitted as required by Table B1.

<table>
<thead>
<tr>
<th>Table B1 Documentation requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Object</strong></td>
</tr>
<tr>
<td>Ship hull</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

102 For general requirements to documentation, including definition of the Info codes, see Pt.0 Ch.3 Sec.1.

103 For a full definition of the documentation types, see Pt.0 Ch.3 Sec.2.

**B 200 Certification requirements**

201 Certification requirements are given in Table B2.

<table>
<thead>
<tr>
<th>Table B2 Certification requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Object</strong></td>
</tr>
<tr>
<td>Welder</td>
</tr>
<tr>
<td>Tack welder</td>
</tr>
<tr>
<td>Welding operator</td>
</tr>
<tr>
<td>Welding consumables</td>
</tr>
<tr>
<td>Shop primer</td>
</tr>
<tr>
<td>NDT operators</td>
</tr>
</tbody>
</table>
For a definition of the certificate types, see Pt.1 Ch.1 Sec.4 B (Ships) and Pt.1 Ch.1 Sec.3 A908 (HSLC).

**B 300 Survey and testing requirements**

**301** General requirements to builders involved in building activities of structures intended for classification by the Society are given in Sec.2 to 7.
SECTION 2 REQUIREMENTS FOR BUILDERS OF SHIPS

A. General

A 100 Application

101 This section specifies general requirements to builders, involved in building activities of structures and components intended for classification by the Society. This section shall also apply to subcontractors of builders, when performing fabrication work defined under the Society’s classification scope for the project.

A 200 Basic requirements

201 Prior to commencement, builders unknown to the Society shall demonstrate their capability to carry out fabrication in line with the overall requirements of this section.

All builders and subcontractors shall comply with the criteria given in IACS UR Z23 Hull survey for New Construction and provide the documentation there stated.

B. Survey arrangement

B 100 Quality management system

101 Builders of hull structures shall possess a documented and implemented quality management system or if otherwise, the Society will consider extended survey scheme. The extent of the quality management system shall be dependent on the size and type of the organisation, complexity and interaction of the processes and competence of personnel.

C. Workmanship and supervision

C 100 General

101 Builders and subcontractors shall ensure that works are executed in accordance with fabrication procedures and work instructions, inspection and test plans.

102 Builders shall ensure that all works are effectively and systematically controlled at all stages.

— Builders and subcontractors will have to prove and document their abilities for the welding operations in question.
— Builders and subcontractors shall make use of the necessary equipment for carrying out inspection of the welding operations in a satisfactory manner.
— Builders shall present the results of own and subcontractors’ inspections before surveys by the Society
— Important welding operations shall be carried out under daily supervision of an inspector, who has the experience and qualifications which enable him to judge this type of work. The work of each welder shall be regularly examined.

Guidance note:

Quality requirements for welding may be based on EN ISO 3834-series.

103 Builders shall be in control of work performed at the location of subcontractors and/or of subcontractors performing work at the builder.
SECTION 3 QUALIFICATION OF WELDERS

A. General

A 100 Application

101 These requirements shall apply to the Society’s acceptance of welders and welding operators for fusion welding of steel and non-ferrous metals.

A 200 Requirements for welding operators

201 Welding operators using fully mechanized or fully automatic processes shall be required to have records of proficiency, which provide evidence that the operators are receiving adequate regularly training in setting, programming and operating of the equipment (in accordance with an applicable WPS). The training of welding operators shall also include training in evaluation of groove dimensions according to WPS, groove cleanliness requirements, weather and wind requirements, and handling of welding consumables. Appropriate records of training shall be maintained. Alternatively to training records, welding operators certificates according to a recognized standard may be accepted, e.g. EN 1418, ISO 14732, ASME Section IX or ANSI/AWS D1.1.

B. Qualification testing and certification of welders

B 100 General

101 Welders shall be qualified and certified to a standard recognised by the Society, e.g. EN 287, ISO 9606, ASME Section IX, ANSI/AWS D1.1.

102 Builders and subcontractors shall keep a card index or register of all certified welders. The register shall give information on training of the welders and date and results of qualification tests. Information about the base metal, type of welding consumable, joint design and welding positions shall be stated in the event of re-qualification tests. Appropriate validation of welders certificates (in line with the referred standards) every 6 months, and records thereof are required. The surveyor shall be allowed to examine the register at any time.

103 Recognition of other standards is subject to acceptance by the Society.

B 200 Certification

201 Welding and testing of weld assemblies for welder qualification shall be performed in the presence of the Society’s representative. Upon successful completion, and on client’s request, the Society will certify that the welder has passed the approval testing.

202 Where certification is performed by another recognized classification society or independent organisations e.g. accredited or nationally approved certification bodies, recognition of such certification will be evaluated on a case by case basis. The Society reserves the right, however, to require verification of welders’ qualifications when deemed necessary. Such verification may include testing prior to production, extra NDT and/or welding production tests (WPT).
SECTION 4 WELDING CONSUMABLES

A. General

A 100  Application

101 This section specifies basic groups and grades for type approved welding consumables, application of the various grades and grouping of the shielding gases.

A 200  Basic groups and grades

201 Welding consumables are divided into groups, depending on the strength of the filler metal and further divided into grades depending on the impact test temperature and the chemical composition of the filler metal.

The grades of welding consumables are specified in Table A1.

<table>
<thead>
<tr>
<th>Grade of welding consumables</th>
<th>Normal strength steels</th>
<th>High strength steels</th>
<th>Extra high strength steels</th>
<th>Austenitic stainless steels</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1</td>
<td>2 Y</td>
<td>3/4/5 Y42</td>
<td>308 /308Mo/ 308L</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3 Y</td>
<td>III/IV/V Y42</td>
<td>309 /309L/ 309Nb/</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4 Y</td>
<td>3/4/5 Y46</td>
<td>309 Mo/309Mo L</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5 Y</td>
<td>III/IV/V Y46</td>
<td>310/310 Nb/310Mo</td>
</tr>
<tr>
<td>I</td>
<td>2/3/4/5 Y40</td>
<td></td>
<td></td>
<td>312</td>
</tr>
<tr>
<td>II</td>
<td>I Y</td>
<td></td>
<td></td>
<td>316/316 L</td>
</tr>
<tr>
<td>III</td>
<td>II Y</td>
<td></td>
<td></td>
<td>317/317 L</td>
</tr>
<tr>
<td>V</td>
<td>III Y</td>
<td></td>
<td></td>
<td>347</td>
</tr>
<tr>
<td></td>
<td>IV Y</td>
<td></td>
<td></td>
<td>349</td>
</tr>
<tr>
<td></td>
<td>V Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>II/III/IV/V Y40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>II/III/IV/V Y62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>III/IV/V Y62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>III/IV/V Y69</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:

— Grades 1, 2, 3, 4 and 5 mean covered electrodes; grades I, II, III, IV and V mean other consumables.
— Increasing number means increasing impact toughness test requirements (test temperature grade 1/I: 20ºC, grade V: -60ºC).
— Y means high strength steels.
— Y followed by a number means extra high strength steels of corresponding strength (×10).

202 Type approved welding consumables for ferritic-austenitic (duplex) steels shall be selected according to the manufacturers recommendation for the applicable grade of steel.

203 Welding consumables which have satisfied the requirements for a higher toughness grade are also considered as complying with the requirements for a lower toughness grade of the same group.

204 The following tables (Table A2 to Table A7) show which welding consumables that can be applied for various steel grades.

When two different steel grades shall be joined, the welding consumable shall have yield strength not below that of the lower strength steel.

When welding high strength steels of grade E, it is recommended that the applied welding consumables have been tested at -40ºC (grade 4 or IV).

205 Where applicable, the composition of the shielding gas shall be reported. The approval of a wire /gas combination with any particular gas can be applied to or transferred to any combination of the same wire and any gas in the same numbered group as defined in Table A8.
### Table A2 Correlation of welding consumables to hull structural steels

<table>
<thead>
<tr>
<th>Hull structural steel grade</th>
<th>Grade of welding consumables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (DP) 2 2 Y 1) 2 Y40 1) 3 3 Y 1) 3 Y40 1) 4 Y 1) 4 Y40 1)</td>
<td></td>
</tr>
<tr>
<td>NV A</td>
<td>X</td>
</tr>
<tr>
<td>NV B</td>
<td>X</td>
</tr>
<tr>
<td>NV D</td>
<td>X</td>
</tr>
<tr>
<td>NV E</td>
<td>X</td>
</tr>
<tr>
<td>NV A27S</td>
<td>X</td>
</tr>
<tr>
<td>NV D27S</td>
<td>X</td>
</tr>
<tr>
<td>NV E27S</td>
<td>X</td>
</tr>
<tr>
<td>NV A32/36</td>
<td>X</td>
</tr>
<tr>
<td>NV D32/36</td>
<td>X</td>
</tr>
<tr>
<td>NV E32/36</td>
<td>X</td>
</tr>
<tr>
<td>NV F32/36</td>
<td>X</td>
</tr>
<tr>
<td>NV A40</td>
<td>X</td>
</tr>
<tr>
<td>NV D40</td>
<td>X</td>
</tr>
<tr>
<td>NV E40</td>
<td>X</td>
</tr>
<tr>
<td>NV F40</td>
<td>X</td>
</tr>
</tbody>
</table>

1) To have Hydrogen mark H15, H10 or H5

### Table A3 Correlation of welding consumables to hull structural steels

<table>
<thead>
<tr>
<th>Hull structural steel grade</th>
<th>Grade of welding consumables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Y Y II II Y II Y40 III III Y III Y40 IV Y, V Y IV Y40, V Y40</td>
<td></td>
</tr>
<tr>
<td>NV A</td>
<td>X</td>
</tr>
<tr>
<td>NV B</td>
<td>X</td>
</tr>
<tr>
<td>NV D</td>
<td>X</td>
</tr>
<tr>
<td>NV E</td>
<td>X</td>
</tr>
<tr>
<td>NV A27S</td>
<td>X</td>
</tr>
<tr>
<td>NV D27S</td>
<td>X</td>
</tr>
<tr>
<td>NV E27S</td>
<td>X</td>
</tr>
<tr>
<td>NV A32/36</td>
<td>X</td>
</tr>
<tr>
<td>NV D32/36</td>
<td>X</td>
</tr>
<tr>
<td>NV E32/36</td>
<td>X</td>
</tr>
<tr>
<td>NV F32/36</td>
<td>X</td>
</tr>
<tr>
<td>NV A40</td>
<td>X</td>
</tr>
<tr>
<td>NV D40</td>
<td>X</td>
</tr>
<tr>
<td>NV E40</td>
<td>X</td>
</tr>
<tr>
<td>NV F40</td>
<td>X</td>
</tr>
</tbody>
</table>

### Table A4 Correlation of welding consumables to boilers and pressure vessel steels and steels for low temp. service

<table>
<thead>
<tr>
<th>For welding of steel grade</th>
<th>Grade of welding consumables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(DP) 2 2Y 1) 2Y40 1) 3 3Y 1) 3Y40 1) 4Y 1) 4Y40 1) 5 5Y 1) 5Y40 1)</td>
<td></td>
</tr>
<tr>
<td>NV 360-ON</td>
<td>X</td>
</tr>
<tr>
<td>NV 360-1FN</td>
<td>X</td>
</tr>
<tr>
<td>NV 360-2FN</td>
<td>X</td>
</tr>
<tr>
<td>NV 410-ON</td>
<td>X</td>
</tr>
<tr>
<td>NV 410-1FN</td>
<td>X</td>
</tr>
<tr>
<td>NV 460-ON</td>
<td>X</td>
</tr>
<tr>
<td>NV 460-1FN</td>
<td>X</td>
</tr>
<tr>
<td>NV 490-ON</td>
<td>X</td>
</tr>
<tr>
<td>NV 490-1FN</td>
<td>X</td>
</tr>
<tr>
<td>NV 510-1FN</td>
<td>X</td>
</tr>
<tr>
<td>NV 2-2</td>
<td>X</td>
</tr>
<tr>
<td>NV 2-3</td>
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<tr>
<td>NV 2-4 (L)</td>
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<td>NV 4-2</td>
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<td>NV 4-4 (L)</td>
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1) To have Hydrogen mark H15, H10 or H5
Table A5 Correlation of welding consumables to boilers and pressure vessel steels and steels for low temp. service

<table>
<thead>
<tr>
<th>Grade of welding consumables</th>
<th>1</th>
<th>I Y</th>
<th>II</th>
<th>II Y</th>
<th>II Y40</th>
<th>III</th>
<th>III Y</th>
<th>III Y40</th>
<th>IV Y</th>
<th>IV Y40</th>
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<td>NV 360.ON</td>
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<td>X</td>
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<td>X</td>
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<td>NV 360-2FN</td>
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Table A6 Correlation of welding consumables to hull structural steels

<table>
<thead>
<tr>
<th>Grade of welding consumable</th>
<th>1) Y42H10</th>
<th>1) Y46H10</th>
<th>1) Y50H10</th>
<th>Y55H5</th>
<th>Y62H5</th>
<th>Y69H5</th>
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1) May have hydrogen mark H5
2) Shall have hydrogen mark H5
### Table A7 Selection of suitable consumables for combinations of aluminium alloys

<table>
<thead>
<tr>
<th></th>
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<tr>
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<td>5356, 5556, 5183</td>
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<td>5356, 5556, 5183</td>
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<td></td>
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</tr>
</tbody>
</table>

**Note:** All consumables are covered by the AWS specification. The prefix “ER” is omitted.

1) Other consumables may be used if allowable stresses are reduced, see Sec.5, Table J1.

### Table A8 Grouping of shielding gases, ¹)

<table>
<thead>
<tr>
<th>Group</th>
<th>Gas composition (Vol.%)</th>
<th>CO₂</th>
<th>O₂</th>
<th>H₂</th>
<th>He</th>
<th>Ar</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>100</td>
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<td>&gt; 0 to 95</td>
<td>Rest</td>
</tr>
<tr>
<td>M 11</td>
<td>&gt; 0 to 5</td>
<td></td>
<td></td>
<td></td>
<td>&gt; 0 to 5</td>
<td>Rest ²)</td>
</tr>
<tr>
<td>M 12</td>
<td>&gt; 0 to 5</td>
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<td></td>
<td></td>
<td>Rest ²)</td>
<td>Rest ²)</td>
</tr>
<tr>
<td>M 13</td>
<td>&gt; 0 to 5</td>
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<td></td>
<td></td>
<td>Rest ²)</td>
<td>Rest ²)</td>
</tr>
<tr>
<td>M 14</td>
<td>&gt; 0 to 5</td>
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<td></td>
<td></td>
<td>Rest ²)</td>
<td>Rest ²)</td>
</tr>
<tr>
<td>M 21</td>
<td>&gt; 5 to 25</td>
<td>&gt; 3 to 10</td>
<td></td>
<td></td>
<td>Rest ²)</td>
<td>Rest ²)</td>
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<tr>
<td>M 22</td>
<td>&gt; 5 to 25</td>
<td>&gt; 0 to 8</td>
<td></td>
<td></td>
<td>Rest ²)</td>
<td>Rest ²)</td>
</tr>
<tr>
<td>M 23</td>
<td>&gt; 5 to 25</td>
<td>&gt; 0 to 3</td>
<td></td>
<td></td>
<td>Rest ²)</td>
<td>Rest ²)</td>
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<tr>
<td>M 31</td>
<td>&gt; 25 to 50</td>
<td>&gt; 10 to 15</td>
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<td>Rest ²)</td>
<td>Rest ²)</td>
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<tr>
<td>M 32</td>
<td>&gt; 5 to 50</td>
<td>&gt; 8 to 15</td>
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<td></td>
<td>Rest ²)</td>
<td>Rest ²)</td>
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<tr>
<td>C 1</td>
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<td></td>
<td>Rest</td>
<td>&gt; 0 to 30</td>
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<tr>
<td>C 2</td>
<td>Rest</td>
<td></td>
<td></td>
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<td>2)</td>
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</table>

¹) The compositions of shielding gasses in group I are in accordance with EN 439, while group M and C gasses are in accordance with IACS W17:1993.

²) Argon may be partly substituted by Helium up to 95% of the Argon content.
SECTION 5 WELDING PROCEDURES

A. General

A 100 Application

101 This section specifies requirements for welding procedure specifications (WPS) and welding procedure qualification tests (WPQT) for carbon-manganese steels (C-Mn) and low alloy steels, aluminium, austenitic stainless steel, ferritic-austenitic (duplex) stainless steels and copper alloys. Additional requirements for liquefied gas systems are also given. (C-Mn and low alloy steels are in this context referred to as “steels”).

102 WPS for overlay- / clad welding shall be qualified according to ISO 15614-7, AWS D1.1 or ASME IX or another recognized standard.

103 WPS for materials not covered by this section shall be qualified in accordance with a recognized standard and/or a recognized practice accepted by the Society.

A 200 Wide gap welding

201 Wide gap welding for butt joint shall when the gap is more than 16 mm and up to maximum 25 mm, be qualified by a separate WPQT. The largest gap in production shall be used.

Buttering of the weld groove shall be qualified by a separate WPQT, when the buttering process essential variables are different from the essential variables of the process used for subsequent completion of the joint, or the thickness of the buttering exceed 8 mm on either side of the bevel. For the WPQT to be qualified, the buttered area shall be 100% tested with MT (ferromagnetic materials) or PT (non-magnetic materials) before the filling of the groove starts. No surface linear indications are accepted.

For typical butt- and fillet weld plate edge preparation repairs, guidance is given to IACS REC. No.47 Shipbuilding and Repair Quality Standard, Part A.

A 300 Welding processes

301 Welding may be performed with the following processes unless otherwise specified (methods numbering system in accordance with ISO 4063):

— 111 manual metal arc welding (metal arc welding with covered electrode, SMAW)
— 114 self-shielded tubular-cored arc welding (FCAW-S)
— 121 submerged arc welding (SAW) with solid wire electrode
— 122 submerged arc welding (SAW) with strip electrode
— 131 metal inert gas welding, (MIG, GMAW) welding with solid wire electrode
— 132 tubular-cored metal inert gas welding ((MIG, FCAW-G)
— 135 metal active gas welding, (MAG, GMAW) welding with solid wire electrode
— 136 tubular-cored metal arc welding with active gas shield (MAG, FCAW-G)
— 141 gas Tungsten arc welding (TIG, GTAW)
— 15 plasma arc welding.

302 Other processes and/or high heat input welding (> 5 kJ/mm) shall be specially approved.

B. Welding procedure specification

B 100 General

101 A WPS shall as a minimum contain the following information as relevant for the welding operation:

— identification of builder or subcontractor
— identification of the WPS and reference to the WPQR
— material: standard, grade and modification, and delivery conditions (AR, N, NR, TM, QT)
— nominal thickness or diameter range (dimensions) welding process(es), including the order of processes if more than one process is used
— joint or groove design with tolerances of angles, root face and root gap. Throat thickness range for fillet welds. Backing and backing material
— welding position(s) and direction of progression
— welding consumables: trade name, electrode or wire diameter, shielding gas type, purity and flow rate, flux and recognised classification
— welding sequence: number and order of passes or layers
— electrical parameters: voltage range, current range, polarity, pulse welding details (machine settings and/or programme selection)
— travel speed ranges
— heat input ranges at least for root, fill and cap passes
— stringer or weave
— preheat and interpass temperatures
— post weld heat treatment parameters (temperature, time, etc.)
— details on cleaning processes employed and restrictions if any
— minimum length of tack welds, when relevant.

102 The builder or subcontractor shall submit to the Society a preliminary welding procedure specification (pWPS) for review prior to the WPQT. The pWPS shall give all relevant parameters as required in 101. The pWPS may be modified and amended during the procedure welding as deemed necessary. In case that the test pieces welded according to the pWPS show unacceptable results, the pWPS shall be adjusted by the builder or subcontractor. The new pWPS shall be prepared and the test pieces welded in accordance with the new pWPS.

103 All relevant instruments for checking of welding parameters (e.g. temperature, ampere, volt, gas flow) applied for the WPQT shall have valid calibration certificates and the adequacy of any control software shall be documented.

104 Qualification welding shall be performed under general conditions representative of the actual working environment for the work shop site where the production welding will be performed.

105 The test results shall meet the specified minimum requirements given in this standard in order to be valid for qualification of a WPS.

106 During qualification test welding, all welding parameters (see 101) shall be recorded for each welding pass. The report summarizing the records from the welding and the test results, i.e. a welding procedure qualification record (WPQR), shall be prepared. The WPQR shall also give the material certificate of the base and filler materials applied in the WPQT.

107 The WPS shall be used as a basis for the production welds, and upon satisfactory completion of the tests based upon the pWPS, the Society may approve it as a WPS. In case that a WPS is approved by the Society the approval range shall be in compliance with F.

B 200 Approved welding procedure specification

201 WPSes shall be approved by the Society prior to welding.

202 A WPS may be approved based on one of the following alternatives:

a) Review of a WPQR corresponding to the WPS in question. The WPQT on which the WPQR is based shall be witnessed by the Society or by a party recognised by the Society.

b) Review and verification of documentation showing successful application of the WPS over a prolonged period of time.

c) The WPS is compiled on basis of other approved WPSes.

203 For the following type of services the approval of WPS shall be based on alternative 202 a):

— butt welds used in cargo tanks, process pressure vessels and/or piping systems for liquefied gases
— all welds in aluminium
— butt welds and essential fillet welds used in cargo tanks, hull structure and process pressure vessels.
— piping systems in ferritic-austenitic stainless steels
— butt welds in plate thickness above 50 mm
— butt welds of material grade E and F single-side butt welds with and without backing in the vertical down positions, welded connections between castings/forgings and rolled material, such as e.g. stern frames, rudder, rudder horns and struts. Welding of highly stressed butt welds and cruciform joints located at large hatch openings
— all welds on grade NV 47 steels for container vessels.

204 One or more WPS(es) may be prepared based on the data of one or more accepted WPQR(s) provided the essential variables are kept within the acceptable limits. All limits and ranges for the applicable essential variables for the welding to be performed shall be stated in the WPS.

205 For multi-process procedures the WPS approval may be carried out with separate WPQTs for each welding process. It is also possible to make the WPQT as a multi-process procedure test. The approval of such a test is only valid for the process sequence carried out during the multi-process procedure test.
C. Welding procedure qualification test assembly 
and sampling of test pieces

C 100 Butt welds in plates

101 The test assembly consists of two plates welded together. For rolled plates impact tested in the longitudinal direction (KV_L-tested, see Fig. 1), the butt weld of the test assembly is perpendicular to the rolling direction of the two plates. For extra high strength steel grades impact tested in the transverse direction (KV_T-tested, see Fig. 1), the butt weld of the assembly is parallel to the rolling direction of the two plates. As far as possible the plates shall have a size which can simulate the heat transfer during the production welding. For manual or semiautomatic welding, a test assembly according to Fig.1 shall be carried out with:

- \( l_{\text{min}} = 300 \text{ mm} \)
- \( L_{\text{min}} = 350 \text{ mm} \)

For automatic welding, the dimensions shall be:

- \( l_{\text{min}} = 400 \text{ mm} \)
- \( L_{\text{min}} = 1000 \text{ mm} \)

Edge preparation and fit-up shall be as detailed in the pWPS. The plates shall be joined and held by tack welds to provide the correct gap for the edge preparation used. 50 mm of each end of the test piece shall be discarded.

---

Fig. 1
Test assembly for butt welds in plates

102 The following mechanical tests are required from each assembly (see Fig.2):

- 2 tensile tests (flat specimen transverse to the weld)
- 2 root and 2 face bend specimens shall be tested. For thickness 12 mm and over, 4 side bend specimens may alternatively be tested
- when the welding consumable is not approved, 1 extra tensile test (round specimen from the weld metal)
Guidance note:

Non-approved consumables may be accepted for qualification of a WPS. Consumables for production welding shall be approved by the Society as required in Sec.1 B200.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

— 12 Charpy V-notch tests with the notch location as given in 107
— 1 macrosection test (metallographic examination + hardness measurements).

Specimens for transverse tensile testing shall be in accordance with L200, type B. Location of fracture (WM or BM), and tensile strength shall be reported.

![Sampling of test specimens in plates](image)

**Fig. 2**

**Sampling of test specimens in plates**

103 When round tensile test specimen is required, the specimen shall be machined to the dimensions shown in L200, type A, care being taken that the longitudinal axis coincides with the intersection between the midplane of the weld, and the midplane of the plates. If the section area of the weld metal is too small to allow sampling of the round specimen, an all-weld-metal tensile test shall be carried out.

104 Transverse side bend, root bend and face bend specimens shall be machined to the dimensions shown in L300. For a mixed or heterogeneous butt joint, longitudinal bend test specimens may replace transverse bend test specimens. The test specimens shall be bent on a mandrel with diameter $4 \times t$, where $t$ is the thickness of the specimen, except for extra high strength steels grades 550, 620, and 690 where the diameter shall be $5 \times t$. The bending angle shall be at least 180°.
105 The macrosection shall include about 10 mm of unaffected base material and shall be prepared and etched on one side to clearly reveal the fusion line and the HAZ.

106 The hardness testing shall be in accordance with ISO 6507-1 or equivalent, and is only required for grades with specified minimum yield stress 265 MPa and higher. Unless otherwise agreed, the Vickers method (HV10) is used. Indentations shall be made along traverses in the weld, HAZ and the parent metal maximum 2 mm below the surface. For each traverse a minimum of 3 indentations shall be made in the weld, HAZ (both sides) and parent metal (both sides). For HAZ the first indentation shall be placed as close to the fusion line as possible. For double sided welds, for fillet and T-butt welds, one additional row of indentations shall be made through the root area.

For material grade NV 47, one additional row of indentations shall be made from the mid-thickness of the plate.

107 The Charpy V-notch specimens shall be machined in accordance with the requirements given in Ch.1 Sec.2 (ISO148). Four sets of three specimens each shall be sampled 2 mm below the surface of the parent material and transverse to the weld. The V-notch shall be perpendicular to the plate surface.

12 Charpy V-notch specimens shall be localized in the welded joint as follows:

- 3 specimens with the notch along the weld metal centreline (WM)
- 3 specimens with the notch in the fusion line (FL)
- 3 specimens with the notch in the HAZ, 2 mm from the fusion line (FL+2)
- 3 specimens with the notch in the HAZ, 5 mm from the fusion line (FL+5).

For plate thicknesses > 50 mm, two additional sets of specimens shall be taken from the root area: one with the notch in the centre of the weld and one with the notch in the fusion line.

108 HAZ impact test specimens are normally not required for austenitic stainless steels with service temperature above -105°C. For material thicknesses below 6 mm impact testing is not required unless specifically required by the Society.

Where multiple welding processes are qualified in a single test piece, impact test specimens shall be taken from the weld metal and HAZ that include each process. This does not apply to the process and consumables used to make the first weld run or root deposit of a multi-pass weld.

For dissimilar metal joints and/or joints between cast or forged and rolled materials, impact tests shall be carried out on test specimens with notch in fusion line, 2 mm from fusion line and 5 mm from fusion line in each parent material.

109 Where fracture mechanics testing (e.g. CTOD test) is required by the relevant construction rules, it shall be carried out in accordance with the method described in Ch.1 Sec.2. Acceptance criteria are given in E600.

Testing of the HAZ or the weld deposit can be omitted if tests with satisfactory results according to the requirements in this standard have been carried out previously by either the steel manufacturer or the welding consumable manufacturer.

C 200 Butt welds in pipes

201 The test assembly shall be in accordance with Fig.3.

![Diagram of test assembly for butt welds in pipes]

Edge preparation and fit-up as detailed in the pWPS

\[ a = \text{minimum value } 150 \text{ mm} \]

\[ D = \text{outside diameter} \]

Fig. 3
Test assembly for butt welds in pipes
The following mechanical tests are required from each assembly (see Fig. 4):

- 2 tensile test (flat specimen transverse to the weld)
- 1 root and 1 face bend tests when \( t \leq 20 \) mm and 2 side bend tests when \( t > 20 \) mm
- 12 Charpy V-notch tests with the notch location as given in 107
- 1 macrosection test (metallographic examination + hardness measurements).

**Fig. 4**
Sampling of test specimens in pipes

**C 300  Full penetration T-, Y-, and K- joints**

**301**  WPQT's for full penetration groove welds between plates at right angles or inclined, i.e. T- or Y- and K-configurations, shall cover a weld length of minimum 350 mm (see Fig. 5).

**Fig. 5**
Test assembly for full penetration T-joints

\[ a = 3 \ t; \text{ minimum value } 150 \ \text{mm} \]
\[ b = 6 \ t; \text{ minimum value } 350 \ \text{mm} \]
The following mechanical tests are required from each assembly (see Fig.6):

- 12 Charpy V-notch tests with the notch location as given in 107
- 1 macrosection test (metallographic examination + hardness measurements).

Tests as detailed do not provide information on the tensile strength of the joint. Where the tensile strength properties are relevant for the application an additional butt weld qualification shall be performed using the same welding parameters.

**Fig. 6**
Sampling of test specimens in full penetration T-joints

---

**C 400 Branch connection**

**401** The following mechanical tests are required from each assembly (see Fig.7):

- 12 Charpy V-notch tests sampled at 9 o'clock in the branch pipe and with the notch location as given in 107
- two (2) macrosection tests (metallographic examination + hardness measurements), one at 12 and one at 6 o'clock.

**402** For joint configuration involving acute angles (less than 15°), restrictions and testing should be specified and accepted by the Society prior to qualification.

Edge preparation and fit-up as detailed in the pWPS

---

\[ a = \text{minimum value 150 mm} \]
\[ D1 = \text{outside diameter of the main pipe} \]
\[ t1 = \text{wall thickness of the main pipe} \]
\[ D2 = \text{outside diameter of the branch pipe} \]
\[ t2 = \text{wall thickness of the branch pipe} \]

**Fig. 7**
Test assembly for branch connections
C 500 Fillet welds

501 For plate fillet welds, the two plates are assembled and positioned edgewise so as to constitute a tee-assembly with no clearance. As far as possible the plates shall be of a sufficient size to ensure a reasonable heat distribution. For plate fillet welds the test assembly shall be as defined in Fig.8.

Fig. 8
Test assembly for plate fillet welds

For manual and semi-automatic welding the length of the test piece shall be:

\[ L_{\text{min}} = 350 \text{ mm}. \]

For automatic welding the length shall be:

\[ L_{\text{min}} = 1000 \text{ mm}. \]

Weld and fit-up shall be as detailed in the pWPS. The test assembly shall be welded on one side only. However, for automatic two side fillet welding (tandem technique), welding from two sides is acceptable. For manual and
semi-automatic welding, the stop/restart position is normally to be included in the test length and shall be clearly marked for subsequent examination. The ends of the specimen are exempted from examination over a length of 50 mm.

502 The following destructive tests shall be performed:

— two macrosection tests (metallographic examination, hardness measurements). One of the macrosections shall be taken at the marked position of the stop/restart (for more details see 106). For hardness testing, see E302.
— one fracture test. Shall be performed by folding the upright plate onto the through plate. Evaluation is to concentrate on cracks, porosity and pores, inclusions, lack of fusion and incomplete penetration. Imperfections that are detected shall be assessed in accordance with EN ISO 5817 quality level B
— tests as detailed do not provide information on the mechanical properties of the joint. Where these properties are relevant for the application an additional butt weld qualification shall be performed using the same welding parameters.

When the shop primer is not approved refer to Sec.6 C, extra testing according to Type Approval Programme 1-602.2 is required.

503 WPQTs of pipe fillet welds and corresponding WPS shall be in accordance with an international recognised standard. Test assembly is shown in Fig. 9.

D. Non Destructive testing of test assemblies

D 100 Butt welds in plates and pipes and full penetration T-, Y-, and K-joints

101 The extent of the testing shall be as follows:

— 100% visual testing (VT)
— 100% radiographic testing (RT) or ultrasonic testing (UT)
— 100% surface crack detection (Magnetic particle testing (MT) for ferromagnetic materials or Penetrant testing (PT) for non-ferromagnetic materials).

Acceptance criteria: The soundness of the weld shall comply, unless otherwise specified, with EN ISO 5817 quality level B. Regarding use of EN ISO 5817 and EN ISO 10042 for RT, UT, MT and PT, EN ISO 17635 shall be followed.

For ultrasonic testing, Level 2 of ISO 11666 is considered equal to Level B of ISO 5817.

D 200 Fillet welds and partial penetration welds

201 The extent of the testing shall be as follows:

— 100% VT
— 100% surface crack detection (MT for ferromagnetic materials or PT for non-ferromagnetic materials).

Acceptance criteria: The soundness of the weld shall comply, unless otherwise specified, with EN ISO 5817 quality level B. If the stop/restart spot is included in the test length, special attention shall be paid to this position with respect to profile, proper fusion and absence of crater defects.

E. Destructive testing acceptance criteria

E 100 Transverse tensile test

101 The tensile strength shall not be below the specified minimum tensile strength for the material grade in question. Location of fracture (WM or BM), and tensile strength shall be reported.

E 200 Bend test

201 After bending, the test specimens shall not reveal any open defects in any direction greater than 3 mm. Defects appearing at the corners of a test specimen during testing shall be investigated case by case.

E 300 Macrosection and hardness testing

301 Macrosection: Cracks and lack of fusion are not accepted. Other defects shall follow Level B of ISO 5817. The welded joints shall have a regular profile with smooth transitions to the base materials and without significant or excessive reinforcement. Acceptance criteria for weld profile according to IACS Rec. No. 47.
302 Hardness test:
— For material grades up to and including NV 420 a maximum hardness limit of 350 HV10 shall be met.
— For NV 47 grades the maximum hardness limit shall be 380 HV10.
— For NV 460, NV 500, NV 550, NV 620 and NV 690 grades the maximum hardness limit shall be 420 HV10.
— For single run fillet welds a maximum hardness limit of 380 HV10 shall be met.

E 400 Impact testing

401 Hull construction
The test temperature and absorbed energy shall be in accordance with the following requirements:

<table>
<thead>
<tr>
<th>Impact test temperatures</th>
<th>For grades:</th>
</tr>
</thead>
<tbody>
<tr>
<td>+20°C</td>
<td>A, A27S, A32, A36 and A40</td>
</tr>
<tr>
<td>0°C</td>
<td>B, D, D27S, D32, D36 and D40</td>
</tr>
<tr>
<td>-20°C</td>
<td>E, E27S, E32, E36 and E40</td>
</tr>
<tr>
<td>-40°C</td>
<td>F32, F36 and F40</td>
</tr>
</tbody>
</table>

The average value for absorbed energy in WM, FL and HAZ shall not be less than:
— for grades NVA and NVB, all welding methods and positions: 27 J.

For all other grades given above:
— for manual and semi-automatic welding in all welding positions except vertical: 47 J
— for automatic welding and fully mechanised welding: 34 J (NV 40 grades 39 J)

For extra high strength structural steels, boiler and pressure vessel steels, and weldable C- and C-Mn hull steel castings and forgings, the Charpy V-notch test temperature and the average value for absorbed energy in weld metal, fusion line and HAZ shall be the same as required for the base material. For steels for low temperature services, including nickel alloy steels, see G200. For stainless steels, see H100 and I200.

402 The average impact requirements shall be satisfied for each notch location, but one single value of three values from specimens from the same notch location may be below the average requirements, but not below 70% of minimum average.

403 In the case of reduced Charpy V-notch test specimens (10 × 7.5 mm and 10 × 5 mm); the impact energy values to be obtained shall satisfy Table E1:

<table>
<thead>
<tr>
<th>Dimensions of Charpy V-notch test specimen</th>
<th>Impact energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 × 10 mm</td>
<td>KV</td>
</tr>
<tr>
<td>10 × 7.5 mm</td>
<td>5/6 KV</td>
</tr>
<tr>
<td>10 × 5 mm</td>
<td>2/3 KV</td>
</tr>
</tbody>
</table>

404 Where the results from a set of three impact test specimens do not comply with the requirements, an additional set of three impact test specimens may be taken. The results obtained shall be combined with the original results to form a new average which, for acceptance, shall be not less than the required value. Additionally, for these combined results not more than two individual values shall be less than the required average value, and of these, not more than one shall be less than 70% of the required average value.

E 500 Welds between different material grades

501 When a butt weld is made between two plates of different grades, the test temperature and achieved impact energy shall comply with the minimum specified requirements for the lower grade (see E401 and E402). In the same way, the tensile strength to be obtained on the welded assembly shall be in agreement with the requirements relating to the plate steel having the lower strength. As an example the test temperature, impact energy and tensile strength for the butt welded joints given in Fig.10 are those required for the plate of grade D in the left assembly and for the plate of grade E in the right assembly.
E 600 Fracture mechanics (FM) test

601 The critical CTOD for all of the specimens shall be equal to or larger than 0.15 mm.

602 If (for HAZ or weld deposit) one or more of the three specimens has a critical CTOD lower than 0.15 mm additional tests may be carried out. In such a case the characteristic value, as defined in Table C5, shall be equal to or larger than 0.15 mm.

Table C5 Characteristic value of CTOD

<table>
<thead>
<tr>
<th>Number of valid tests</th>
<th>Characteristic value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 to 5</td>
<td>Lowest result</td>
</tr>
<tr>
<td>6 to 10</td>
<td>Second lowest result</td>
</tr>
<tr>
<td>11 to 15</td>
<td>Third lowest result</td>
</tr>
</tbody>
</table>

1) All valid tests that have been carried out shall be included in the evaluation. It is not permissible to discard any valid test result.

603 If the characteristic value as specified in Table C5 is lower than 0.15 mm an ECA (Engineering Critical Assessment) may be carried out with the purpose of demonstrating that extra capacity may be available in the structure. Acceptance based on ECA shall be approved.

E 700 Retesting

701 If the WPQT fails to comply with any of the requirements for NDT one extra WPQT may be welded and subjected to the same testing. If this additional test does not meet the relevant requirements, the actual pWPS shall be considered as not qualified and a re-specification of the pWPS shall be made prior to a new qualification test.

If the result of any destructive test fails to meet the requirements, two further tests may be made from the same welded joint if there is sufficient material available. If not, a new assembly may be welded using the same WPS. If either of these additional test specimens does not comply with the relevant requirements, the WPS shall be regarded as not capable of complying with the requirements without modification.

F. Validity of approved welding procedures

F 100 General

101 The validity of an approved WPS is restricted to the builder/subcontractor receiving the approval, including yards/subcontractors under the same technical management and working in accordance with the same QA system and procedures. Builders WPS may be transferred to and used by a subcontractor provided the principles of ISO 3834-2 and ISO 14731 are implemented, documented and accepted by the Society. For this case WPT or extended NDT may be required, if found necessary by the Society.
Qualification of a WPS remains valid provided the parameters are kept within the qualified ranges during production welding. The qualified ranges are given in F 200. When one or more variations outside the qualification ranges occur, the WPQT shall be considered invalid, and the WPS is therefore to be re-specified and re-qualified.

**F 200 Range of qualification**

**201** A qualified WPS shall be used within the ranges of the parameters of essential variables listed below.

**202 Base material**

The following changes shall lead to a new qualification:

a) In general, significant change of material properties which will obviously affect the weldability and mechanical properties.

   **Guidance note:**
   For steels with $C \geq 0.22$ and/or $C_{eq} \geq 0.45$ the WPQT on which the WPS is based, should be qualified on a base material having a CE not less than 0.03 of the material to be welded.

   ---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

   — A change from wrought (rolled, forged) steel to cast steel or vice versa (applicable also for stainless steels)
   — A change from delivery condition quenched and tempered (QT) to any other delivery condition or vice versa; applicable for forgings, castings, and steel plates of grade D40, E40, F32, F40 and extra high strength steels
   — A change from delivery condition thermo-mechanical rolling (TM) to any other delivery conditions, but not vice versa. Change from delivery condition TM to other delivery conditions may, however, be accepted provided the carbon equivalent of the qualified TM-steel is same or higher than the steel to be covered

b) Additional considerations for strength levels and toughness grades for rolled steel plates:

   i) For normal and high strength steels (see Pt.2 Ch.2 Sec.1), WPQTs are considered applicable to the same and two lower strength levels as that tested (the DNV special grade 27S is not counted, e.g. qualification of A36 may qualify welding of grades A, A27S and A32)
   ii) For extra high strength steels, WPQTs are considered applicable to the same and one lower strength level as that tested (e.g. qualification of A500 will also qualify grade A460
   iii) For high heat input welding processes (> 5 kJ/mm), the WPQT is applicable to the same and one lower strength level as that tested
   iv) The qualification of steel grades of higher toughness requirements will qualify the grades of lower toughness but not vice versa (e.g. qualification of grade E will also qualify grades A, B and D)

c) Additional considerations for strength levels and toughness grades for castings and forgings:

   A change to a grade of higher specified strength A change to higher specified toughness requirements (that is; lower impact toughness temperature requirements or higher impact toughness value requirements)

**203 Thickness**

Thickness, $t$, is defined as follows:

a) For a butt weld:
   The base metal thickness, which for welds between dissimilar thicknesses is that of the thinner material.

b) For a T-butt joint in plate:
   The thickness of the prepared plate (abutting member)

c) For a fillet weld:
   The range of approval is to be applied to both base materials

d) For a set-on branch connection:
   The thickness of the branch pipe.

e) For a set-in or set-through branch connection:
   The thickness of the main pipe.

The requirements to qualified thickness range for butt welds shall be as given in Table F1. This table is also applicable to full penetration T, Y, K-joints.
In addition to the requirements of Table F1, the range of approval of throat thickness “a” for fillet welds shall be as follows:

1) The maximum thickness qualified for vertical downward welding is $1.0 \times t$.
2) For high heat input processes over 5 kJ/mm, the upper limit of range of approval is $1.0 \times t$.
3) For multiprocess procedures, the recorded thickness contribution of each process is to be used as a basis for the range of approval for the individual welding process.
4) The approval of maximum thickness of base metal for any technique is to be restricted to the thickness of test assembly if three of the hardness values in the heat affected zone are found to be within 25 HV of the maximum permitted, as stated in E302.
5) Where a fillet weld is qualified by a butt weld qualification, the throat thickness range qualified shall be the same as the qualified plate thickness range.
6) For welds between materials of dissimilar thickness, the qualified range shall be applied to both parent materials independently. Example: Multi-run fillet weld. Thickness of abutting member is 15 mm, thickness of base plate is 25 mm. Qualified range for abutting member is $7.5 \times t$ to $30 \times t$, qualified range for base plate is $12.5 \times t$ to $50 \times t$. Qualified throat thickness “a” range is $7.5 \times t$ to $30 \times t$.
7) WPQT on plates of thickness 25 mm to 50 mm will qualify WPS for max. 50 mm, unless Charpy V-notch impact test is carried out for the root in line with C106. Alternatively, the WPS may be qualified up to $2 \times t$ by WPT with Charpy V-notch tests from the root on a plate of thickness > 50 mm.

In addition to the requirements of Table F1, the range of approval of throat thickness “a” for fillet welds shall be as follows:

— Single run: “0.75 × a” to “1.5 × a”
— Multi-run: Same qualification range as for thickness (t) of multi-run butt welds (i.e. a = t, see Table F1).

### Diameter of pipes and branch connections

The qualification of a WPQT on diameter D shall include qualification for diameters in the following ranges as given in Table F2.

<table>
<thead>
<tr>
<th>Diameter of the test piece $D$ (mm)</th>
<th>Qualification range</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D \leq 25$</td>
<td>$0.5 \times D$ to $2 \times D$</td>
</tr>
<tr>
<td>$D &gt; 25$</td>
<td>$\geq 0.5 \times D$ and plates</td>
</tr>
</tbody>
</table>

1) $D$ is the outside diameter of the pipe or outside diameter of the branch pipe.
2) Qualification given for plates also covers pipes when the outside diameter is greater than 500 mm.

### Angle of branch connections

A WPQT carried out on a branch connection with angle $\alpha$ shall qualify all branch connection angles in the range of $\alpha$ to 90°.

### Welding consumables

The following changes shall lead to a new qualification:

— any change in consumable classification (e.g. AWS Classification ER 70S-X, ISO classification ISO 14341-A-G 3Si1).
— change of consumable brand when impact testing for WPQT is required at temperatures below -20°C
— any significant change of mixture/composition (see Sec.4 Table A8), flow rate, filling time and filling volume for shielding and purging gases.

### Welding positions

The following changes shall lead to a new qualification.

Change from one principal welding position (see Figs. 11, 12, 13) to another, unless complying with Table F3.
The following changes shall lead to a new qualification:

— change from fillet weld to butt weld
— change from two sided welding to one side, but not vice versa
— deletion of back gouging
— deletion of backing (except where backing is replaced by back-gauging and two sided welding)
— change from T-, Y- or K-joint to butt weld but not vice versa
— change from butt joint in plates to butt joints in pipes with outside diameter less than 500 mm.
— any change of groove dimensions outside the following limits, unless otherwise approved:
  — butt welds, groove angle ≥ 40°; -5° and +10°
  — butt welds, groove angle 35° to 40°; minimum 35° and +10°
  — butt welds, groove angle < 35°; 0° and +10°
  — butt welds, root gap, manual or semiautomatic welding without backing; ± 2 mm, standard 3 mm, maximum 5 mm
  — butt welds, root gap, automatic welding without backing; -0.8 mm and +1.2 mm, standard 0.8 mm, maximum 2 mm
  — butt welds, root gap, with backing; -2 mm, +6 mm, standard 3-9 mm, maximum 16 mm (see also A200)
— fillet welds and remedial welding, see IACS Recommendation No. 47.

209 Welding condition

The following changes shall lead to a new qualification:
— any change of welding process
— change in heat input beyond ± 25%. For high heat input welding (> 5 kJ/mm) and/or for material with specified minimum yield stress (SMYS) equal to or above 420 MPa the change shall not be more than ± 10%. The heat input range shall be established at least for (1) root pass and (2) filling and cap passes

Guidance note:
Average heat input for the relevant welding passes (root, fill, cap) is calculated based on the recorded values from the WPQT. The qualified range (± 25% or ± 10% as relevant) is based on the calculated average value.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

— any decrease in preheat temperature
— higher interpass temperature than that used in the qualification test
— change of post weld heat treatment parameters used in the qualification test. Holding time may be adjusted as a function of thickness
— change from weaving to stringer bead technique or vice versa (weaving of less than three times electrode diameter is considered stringer)
— change from multi-pass welding to one-pass welding
— change in welding current from A.C. to D.C. or vice versa, or change in polarity. If recommended by the consumable manufacturer particular exemption may be given for SMAW in change from A.C. to D.C.
— change in metal powder or wire addition beyond ± 10%.

Fig. 13
Positions of test plate for fillet welds
Additional requirements WPQT for liquefied gas systems

**G 100  Welds in plates and pipes**

101 Test assembly shall be as described in C101 or C201.

102 From each test assembly for plates the following additional test specimens shall be taken:

— one set of Charpy V test specimens (each set consists of 3 specimens) with the notch 1 mm from the fusion line.

For austenitic stainless steels, only one set of Charpy V test specimens with the notch in the centre of the welds are required for design temperature below -105°C.

**G 200  Test requirements**

201 The butt weld tensile test shall comply with the following requirements:

Generally, the tensile strength shall not be less than the specified minimum tensile strength for the parent material. In cases where the Society has approved the use of welding consumables which give lower tensile strength in the weld metal than that required for the parent material, the approved value for the welding consumable in question applies. The position of fracture shall be reported.

202 Charpy V testing shall be conducted at the temperature prescribed for the base material (see Pt.5 Ch.5 Sec.2 of the Rules for Classification of Ships). When specimens of $10 \times 10$ mm cross-section are used, the average value from 3 tests shall not be less than 27 J for weld metal. One single test may give a value below the required average but not lower than 19 J.

For fusion line and heat affected zone the requirement for minimum average value is the same as for the base material.

**G 300  Weld production test requirements**

301 In general the tests requirements shall comply with G100.

302 Impact testing is for carbon-manganese steels, austenitic chromium-nickel steels and nickel steels to be conducted at the temperature prescribed for the base material. For austenitic chromium-nickel steels, testing are only required for design temperature below -105°C. For welding of plates the following apply when pieces of $10 \times 10$ mm cross section are used:

— If the impact test pieces from plate materials are taken with their longitudinal axes transverse to the main direction of rolling, the average value from 3 tests shall not be less than 27 J for weld metal, fusion line, heat affected zone and parent material. One single test may give a value below the required average, but not lower than 19 J.

— If the impact test pieces from plate materials are taken with their longitudinal axes parallel with the main
direction of rolling the average value from 3 tests is for the fusion line and the heat affected zone not to be less than 41 J, and for the weld metal not to less than 27 J. One single test may give a value below the required average but not lower than 29 J and 19 J respectively. For testing of thin materials where it is impossible to use a standard test piece 10 × 10 mm, the larger of the following pieces shall be used:
— 10 × 7.5 mm, 10 × 5 mm.

The impact values are then reduced to respectively 5/6 and 2/3 of the required values of the standard test pieces.

303 If the impact test (3 specimens) fails to meet the requirements, 3 additional impact test specimens may be prepared and tested provided that only one of the below mentioned three cases occurred in the first test:

1) The average value was below the requirement, one value being below the average requirement but not below the minimum requirement for a single value.
2) The average value met the requirement. Two values were below the average requirement but not below the requirement for a single value.
3) The average met the requirement. Two values were above or equal to the average requirement and one value was below the requirement for a single value. The initial 3 impact values and the additional 3 values shall form a new average of six values. If this new average complies with the requirement and no more than two individual results of all six specimens are lower than the required average and no more than one result is lower than the required value for a single specimen, the test may be accepted.

304 If the impact values do not comply with the requirements in 302 and 303, the results may be submitted for consideration. The production weld test may be accepted subject to acceptable results from additional test prescribed by the Society.

H. Additional requirements WPQT for Ferritic-Austenitic Stainless Steel (Duplex)

H 100 Test requirements

101 Impact testing shall be as described in C107 using an impact test temperature of -20°C. The average value for absorbed energy shall not be less than 27 J.

102 When a butt weld is made between dissimilar material grades, both sides of the weld (HAZ) shall be impact tested.

103 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.

The following test requirements shall be fulfilled:
— there shall be no pitting at 20X magnification
— general weight loss shall be less than 4.0 g/m².

Guidance note:
Welds between Ferritic-Austenitic steels and other grades of stainless, C/Mn steels or for welds in “non corrosive” area may not need to be corrosion tested.

104 Duplex stainless steel types shall be micro-structurally examined and the test samples shall comprise the weld metal, heat affected zone and base metal. The microstructure shall be suitably etched and examined at 400X magnification and shall be free from grain boundary carbides and precipitates. The ferrite content in the weld metal root and un-reheated weld cap shall be determined in accordance with ASTM E 562 and be in the range of 30-70%.

H 200 Validity of a qualified welding procedure

201 Reference is made to F200 and any change in the following additional essential variables which shall lead to a new qualification:
— variation in the heat input greater than ±15%.
I. Additional requirements WPQT for Austenitic Stainless Steel

I 100 Welds in plates and pipes
101 Test assembly shall be as described in C101 or C201.
102 Impact testing is not required for design temperatures above -105°C.

I 200 Test requirements
201 If impact testing is required, the testing shall be conducted at -196°C meeting an average impact energy level of 27 J.

I 300 Range of approval
301 The requirements of F200 applies. In addition; a change to a grade of higher specified strength or higher impact toughness requirements shall lead to a new qualification.

J. Welding procedures qualification for aluminium

J 100 General
101 Basic requirements are given in A General and B Welding procedures.
102 Welding consumables shall be one of those recommended in Sec. 4, Table A7.

J 200 Butt welds in plates
201 Test assembly shall be as described in C101.
202 The following mechanical tests are required from each assembly:
   — 1 tensile test specimen
   — 1 root and 1 face or 2 side bend specimens
   — 1 macro test specimen.

Fig. 14
Location of test specimens for a butt weld on plate

203 One tensile specimen shall be taken from each of the welded assemblies. The test specimen, 25 mm wide and with full plate thickness and orientated transverse to the weld, is shown in Fig.15.
204 Side-bend tests shall be carried out for thickness equal to and above 10 mm. Two bend specimens shall be taken from each of the welded assemblies. The bend test specimens shall be machined to the dimensions given in L300.

205 For thickness below 10 mm one face bend and one root bend test specimens shall be taken. The diameter of the bending mandrel shall be as given in 702.

J 300 Butt welds in pipes

301 Test assembly shall be as described in C201.

302 The following mechanical tests are required from each assembly:
   — 1 tensile test specimen
   — 1 root and 1 face or 2 side bend specimens
   — 1 macro test specimen.

303 One tensile specimen shall be taken from each of the welded assemblies. The test specimen, 25 mm wide and with full plate thickness and orientated transverse to the weld, is shown in Fig.15.

304 Side-bend tests shall be carried out for thickness equal to and above 10 mm. Two bend specimens shall be taken from each of the welded assemblies. The bend test specimens shall be machined to the dimensions given in L300.

305 For thickness below 10 mm one face bend and one root bend test specimens shall be taken. The diameter of the bending mandrel shall be as given in 702.

306 One macrosection shall be prepared from the test assembly to reveal the weldment macro structure. The macrosection shall be visually inspected using a magnification of 5 to 10X.
J 400 Branch connections
401 The following mechanical tests are required from each assembly (see Fig.7):
— two macrosection tests at 12 and 6 o'clock.

J 500 Fillet welds
501 Test assembly shall be as described in C501.
502 The following tests shall be performed:
— two macrosection tests. One of the macrosections shall be taken at the marked position of the stop/restart. The macrosection shall include about 10 mm of unaffected base material and shall be prepared and etched on one side to clearly reveal the fusion line and the HAZ.

J 600 Non-destructive testing of test assemblies
601 Non-destructive testing shall be according to D100 for butt welds and D200 for fillet welds and partial penetration welds.

J 700 Destructive testing
701 The tensile strength of the test specimens shall not be less than specified for the parent alloy in Table J1.

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Temper</th>
<th>Filler</th>
<th>Tensile strength $R_{\text{tw}}$ (minimum $N/mm^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV-5052</td>
<td>0, H111, H32, H34</td>
<td>5356</td>
<td>170</td>
</tr>
<tr>
<td>NV-5754</td>
<td>0, H111, H24</td>
<td>5356, 5183</td>
<td>190</td>
</tr>
<tr>
<td>NV-5154A</td>
<td>0, H111, H32, H34</td>
<td>5356, 5183</td>
<td>215</td>
</tr>
<tr>
<td>NV-5454</td>
<td>0, H111, H32, H34</td>
<td>5356, 5183</td>
<td>215</td>
</tr>
<tr>
<td>NV-5086</td>
<td>0, H111, H112, H116, H321, H34</td>
<td>5356, 5183</td>
<td>240</td>
</tr>
<tr>
<td>NV-5083</td>
<td>0, H111, H112; $t \leq 6$ mm</td>
<td>5183</td>
<td>270</td>
</tr>
<tr>
<td>NV-5383</td>
<td>0, H111, H116, H321</td>
<td>5183</td>
<td>270</td>
</tr>
<tr>
<td>NV-5059</td>
<td>0, H111, H116, H321</td>
<td>5183</td>
<td>270</td>
</tr>
<tr>
<td>NV-6060</td>
<td>T4, T5, T6</td>
<td>5356, 5183</td>
<td>95</td>
</tr>
<tr>
<td>NV-6061</td>
<td>T4, T5, T6</td>
<td>5356, 5183</td>
<td>165</td>
</tr>
<tr>
<td>NV-6063</td>
<td>T4, T5, T6</td>
<td>5356, 5183</td>
<td>100</td>
</tr>
<tr>
<td>NV-6005A</td>
<td>T4, T5, T6</td>
<td>5356, 5183</td>
<td>165</td>
</tr>
<tr>
<td>NV-6082</td>
<td>T4, T5, T6</td>
<td>5356, 5183</td>
<td>170</td>
</tr>
</tbody>
</table>

702 The bend test specimens shall be bent on a mandrel with maximum diameter as given in the formula below. The bending angle shall be at least 180°. After bending, the test specimens shall not reveal any open defects in any direction greater than 3 mm. Smaller cracks developing from the edges of the specimens shall not normally be considered as significant, unless there is definite evidence that they result from inclusions or other defects. «Wrap around» bending as shown in L300 is the preferred bending method.

$$d = \frac{100t_s}{A} - t_s$$

where
- $d$ = maximum former diameter
- $t_s$ = thickness of the bend test specimen (this includes side bends)
- $A$ = minimum tensile elongation required by the material specification (for combination between different alloys, the lowest individual value shall be used).

703 The macrosections shall show a regular weld profile with smooth transitions to the base materials and without significant or excessive reinforcement. Cracks and lack of fusion are not acceptable.

704 When a butt weld is made between two plates of different alloys the tensile strength to be obtained on the welded assembly shall be in agreement with the requirements relating to the alloy having the lower strength.

705 If the WPQT fails to comply with any of the requirements for NDT one extra WPQT shall be welded and subjected to the same testing. If this additional test does not meet the relevant requirements, the actual WPS shall be considered as not qualified and a re-specification of the WPS shall be made prior to a new WPQT.
**J 800  Range of qualification**

**801** The validity of approved WPS shall be as given in F100.

**802** A qualified WPS shall be used within the ranges of the parameters below.

**Base material**

The following changes shall lead to a new qualification:

a) In general, significant change of material properties which will obviously affect the weldability and mechanical properties.

b) More specifically, aluminium alloys are grouped in the following categories:

   i) NV-5052, NV-5754A, NV-5154, NV-5454
   
   ii) NV-5086, NV-5083, NV-5383, NV-5059
   

The qualification on aluminium alloys in category iii) will qualify for the alloys in category ii) and category i) but not vice versa. The qualification on aluminium alloys in category ii) will qualify for the alloys in category i) but not vice versa.

Any other combination and dissimilar metal joints, shall lead to a specific test with no range of qualification for other base materials.

**Thickness**

Thickness, $t$, is defined as follows:

a) For a butt weld: The base metal thickness, which for welds between dissimilar thicknesses is that of the thinner material.

b) For a fillet weld: The base metal thickness, which for welds between dissimilar thicknesses is that of the thicker material. However, for each thickness range qualified, as in Table B2 there is an associated range of qualified throat thickness as given below.

c) For a set-on branch connection: The thickness of the branch pipe.

d) For a set-in or set-through branch connection: The thickness of the main pipe.

e) For a T-butt joint in plate: The thickness of the prepared plate.

The requirements to qualified thickness range for butt welds shall be as given in Table J2.

### Table J2 Qualified thickness range

<table>
<thead>
<tr>
<th>Thickness $t$ (mm) of test piece</th>
<th>Qualification range</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t &lt; 3$</td>
<td>$0.5 \times t$ to $2 \times t$</td>
</tr>
<tr>
<td>$3 \leq t \leq 20$</td>
<td>$3$ to $2 \times t$</td>
</tr>
<tr>
<td>$t &gt; 20$</td>
<td>$\geq 0.8 \times t$</td>
</tr>
</tbody>
</table>

In addition to the requirements of Table J2, the range of qualification of the throat thickness “$a$” of fillet welds is given in Table J3.

### Table J3 Range of qualification for the throat thickness for plates and pipes

<table>
<thead>
<tr>
<th>Throat thickness of the test piece $a$</th>
<th>Range of qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a &lt; 10$</td>
<td>$0.75 \times a$ to $1.5 \times a$</td>
</tr>
<tr>
<td>$a \geq 10$</td>
<td>$\geq 7.5$</td>
</tr>
</tbody>
</table>

Where a fillet weld is qualified by means of a butt weld test, the throat thickness range qualified shall be based on the thickness of the deposited weld metal.

**Diameter of pipes and branch connections**

The qualification of a welding procedure test on diameter D shall include qualification for diameters in the following ranges as given in Table J4.

### Table J4 Qualified range for pipe and branch connection diameters

<table>
<thead>
<tr>
<th>Diameter of the test piece $D$ (mm)</th>
<th>Qualification range</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D \leq 25$</td>
<td>$0.5 \times D$ to $2 \times D$</td>
</tr>
<tr>
<td>$D &gt; 25$</td>
<td>$\geq 0.5 \times D$ and plates</td>
</tr>
</tbody>
</table>

1) $D$ is the outside diameter of the pipe or outside diameter of the branch pipe.
Angle of branch connections
A WPQT carried out on a branch connection with angle $\alpha$ shall qualify all branch connection angles in the range of $\alpha$ to 90°.

Welding consumables
The following changes shall lead to a new qualification:
— any change in consumable classification
— any significant change of shielding gas mixture.

Welding positions
The following changes shall lead to a new qualification:
— change from one principal welding position (see figures in F200) to another, unless complying with Table J6.

Type of joint
The following changes shall lead to a new qualification:
— change from fillet weld to butt weld
— change from two sided welding to one side, but not vice versa
— deletion of back gouging
— deletion of backing
— change from butt joint in plates to butt joints in pipes with outside diameter less than 500 mm.
— any change of groove dimensions specified in the WPS.

Welding condition
The following changes shall lead to a new qualification:
— any change of welding process
— change from spray arc to short arc or pulsed arc or vice versa
— change in heat input beyond ±25%
— any decrease in preheat temperature
— higher interpass temperature than that used in the WPQT
— change of heat treatment used in the WPQT. Holding time may be adjusted as a function of thickness
— change from weaving to stringer bead technique or vice versa
— change from multi-pass welding to one-pass welding
— change in welding current from A.C. to D.C. or vice versa, or change in polarity. If recommended by the consumable manufacturer particular exemption may be given for SMAW in change from A.C. to D.C.

Table J6 Qualified principal positions for butt welds and fillet welds, aluminium

| Test weld Joint configuration | Principal positions | Qualified positions 1) | Butt welds | Fillet welds
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Plates</td>
<td>Pipes</td>
<td>Plates</td>
</tr>
<tr>
<td>Butt welds in plates</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1F</td>
</tr>
<tr>
<td></td>
<td>2G</td>
<td>1G, 2G, 3G</td>
<td>1G, 2G, 3G</td>
<td>1F, 2F, 3F</td>
</tr>
<tr>
<td></td>
<td>3G</td>
<td>1G</td>
<td>All</td>
<td>1F</td>
</tr>
<tr>
<td></td>
<td>4G</td>
<td>1G, 2G, 3G</td>
<td>All</td>
<td>1F</td>
</tr>
<tr>
<td>Butt welds in pipes</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1F</td>
</tr>
<tr>
<td></td>
<td>2G</td>
<td>1G, 2G, 3G</td>
<td>1G, 2G, 3G</td>
<td>1F, 2F, 4F</td>
</tr>
<tr>
<td></td>
<td>5G</td>
<td>All</td>
<td>1G, 5G</td>
<td>All</td>
</tr>
<tr>
<td>Fillet welds</td>
<td>1F</td>
<td>1F</td>
<td>1F</td>
<td>1F</td>
</tr>
<tr>
<td></td>
<td>2F</td>
<td>1F, 2F, 3F</td>
<td>1F, 2F, 3F</td>
<td>1F, 2F, 3F</td>
</tr>
<tr>
<td></td>
<td>3F</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>4F</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>5F</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
</table>

1) Pipes with D > 500 mm are considered equivalent to plates (apply only to the main pipe in branch connections).
2) Branch connections shall be qualified separately.
3) The vertical downwards position shall be qualified separately.

J 900 Retesting
901 If the WPQT fails to comply with any of the requirements for NDT one extra WPQT shall be welded and subjected to the same testing. If this additional test does not meet the relevant requirements, the actual WPS shall be considered as not qualified and a re-specification of the WPS shall be made prior to a new WPQT.
If the result of any destructive test fails to meet the requirements, two further tests may be made from the same welded joint if there is sufficient material available. If not, a new assembly shall be welded using the same WPS. If either of these additional test specimens does not comply with the relevant requirements, the WPS shall be regarded as not capable of complying with the requirements without modification.

**K. Welding procedure qualification, copper alloys**

**K 100 Pipes, plates, castings and other product forms, not including propeller castings**

101 WPS for pipes and plates shall be qualified in accordance with ISO 15614-6 unless otherwise agreed.

**K 200 Copper Alloy Castings for Propellers**

201 General recommendations for filler metal and pre- and post-weld heat treatment of copper alloy propeller castings are given in Table F1.

202 For qualification of WPS, a test assembly of minimum 30 mm thickness shall be welded. See Fig.17.

203 Prior to sectioning, the test assembly shall be visually inspected and liquid penetrant tested in accordance with a recognized standard, e.g. ISO 3452, ASTM E165. Imperfections shall be assessed in accordance with Table F2.

204 Three macro-sections shall be prepared and etched on one side to clearly reveal the weld metal, the fusion line, and the heat affected zone. The sections shall be visually inspected for any imperfections present in the weld metal and HAZ. Inclusions or pores greater than 3 mm and cracks or lack of fusion are not permitted.

205 Two tensile test pieces shall be prepared as shown in Fig.18. The tensile strength for copper alloy propeller castings shall meet the specified minimum values given in Table F3. The tensile strength for other copper alloy castings shall meet the requirements of the base material. The location of fracture shall be reported, i.e. weld metal, HAZ or base material.

206 Provided qualified according to this chapter, all thicknesses are qualified. Range of approval for other parameters shall follow ISO 15614-6 unless otherwise agreed.
Table F1 Recommendations for welding of copper alloy propeller castings

<table>
<thead>
<tr>
<th>Alloy type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mn-bronze, Cu1</td>
<td>Use Al-bronze(^1) or Mn-bronze filler metal. Preheat to 150°C and interpass temperature not to exceed 300°C. Stress relief at 350°C to 500°C.</td>
</tr>
<tr>
<td>Mn-Ni-bronze, Cu2</td>
<td>Use Al-bronze or Mn-Ni-bronze filler metal. Preheat to 150°C and interpass temperature not to exceed 300°C. Stress relief at 350°C to 550°C.</td>
</tr>
<tr>
<td>Ni-Al-bronze, Cu3</td>
<td>Use Al-bronze, Ni-Al-bronze(^2) or Mn-Al-bronze filler metal. Preheat to 100°C and interpass temperature not to exceed 250°C. Stress relief at 450°C to 500°C.</td>
</tr>
<tr>
<td>Mn-Al-Bronze, Cu4</td>
<td>Use Mn-Al-bronze filler metal. Preheat to 100°C and interpass temperature not to exceed 300°C. Stress relief at 450°C to 600°C.</td>
</tr>
</tbody>
</table>

1) Ni-Al-Bronze and Mn-Al-Bronze acceptable
2) If Ni-Al-Bronze is used, stress relief is not required

Table F2 Allowable number and size of indications depending on severity zones

<table>
<thead>
<tr>
<th>Severity zone</th>
<th>Maximum total number of indications</th>
<th>Indication type</th>
<th>Maximum number for each type (^1,2)</th>
<th>Maximum dimension of indication (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>Non-linear</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linear or aligned</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>14</td>
<td>Non-linear</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linear or aligned</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>20</td>
<td>Non-linear</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linear or aligned</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

1) Single non-linear indications less than 2 mm in zone A and less than 3 mm in other zones may be disregarded.
2) The total number of non-linear indications may be increased to the maximum total number, or part thereof, represented by the absence of linear or aligned indications.

Table F3 Tensile strength requirements for WPQT

<table>
<thead>
<tr>
<th>Alloy type</th>
<th>Tensile strength (N/mm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mn-Bronze, Cu1 (brass)</td>
<td>370</td>
</tr>
<tr>
<td>Mn-Ni-Bronze, Cu2 (brass)</td>
<td>410</td>
</tr>
<tr>
<td>Ni-Al-Bronze, Cu3 (bronze)</td>
<td>500</td>
</tr>
<tr>
<td>Mn-Al-Bronze, Cu4 (bronze)</td>
<td>550</td>
</tr>
</tbody>
</table>
L. Testing

L 100 General

101 Testing of welds shall be carried out as specified in 200 to 300. Reference is also made to relevant paragraphs in Ch.2 Sec.1.

L 200 Tensile testing at ambient temperature

201 For tensile testing of all-weld-metal and butt welds two different types of test specimens may be used, round test specimens or flat test specimens, see Fig.19, and description below.

— Deposited metal tensile test

Normally, round test specimens with the following dimensions shall be used:

\[
\begin{align*}
    d &= 10 \text{ mm} \\
    L_o &= 50 \text{ mm} \\
    L_c &= 60 \text{ mm} \\
    R &\geq 5 \text{ mm}
\end{align*}
\]

— Butt weld tensile test

Flat test specimens with the weld machined flush with the surface of the plate shall be used. The dimensions shall be as follows:

\[
\begin{align*}
    a &= \text{thickness of plate, } t \\
    b &= 25 \text{ mm} \\
    L_o &= L_c = 3t \text{ or } 2t + \text{width of weld, whichever is the greatest} \\
    R &= 25 \text{ mm}
\end{align*}
\]

Fig. 19
Tensile test specimen
I. 300  Bend testing

301  Flat bend test specimens, as given in Fig.20 shall be used. Edges on tension side to be rounded to a radius of 1 to 2 mm.

![Fig. 20](image)

**Fig. 20**
Bend test specimen

302  When the wrap around bend test, exemplified in Fig.21 is used, e.g. for the side bend test of a weld, the length of the test specimen has to be greater than the length $11a$ shown in Fig.20.

303  For butt weld bend test specimens, the weld shall be machined flush with the surface of the plate.

304  For transverse face-bend and root-bend test specimens for butt weld test the dimensions shall be as follows:
- $a =$ as rolled thickness $t$ of the plate
- $b =$ 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 test specimen.

305  For transverse side-bend test specimens for butt weld test the dimensions shall be as follows:
- $a =$ 10 mm
- $b =$ as rolled thickness $t$ of the plate.

If $t \geq 40$ mm, the side-bend test specimen may be subdivided, each part being at least 20 mm wide.

306  When a longitudinal face-bend or root-bend weld test is required, a test specimen according to an appropriate standard will be accepted.
SECTION 6 FABRICATION AND TOLERANCES

A. General

A 100 Application
101 This section specifies general requirements for steel fabrication processes, including essential variables, which shall be maintained and controlled by the builders.

B. Material identification

B 100 General
101 A material identification system which ensures correct installation and documentation of the material grades shall be established.

C. Approval of shop primers

C 100 General
101 Shop primer applied over areas, which will subsequently be welded, shall be of approved type as having no detrimental effect on the finished weld.

Guidance note:
Type approved shop primers are listed under “Non-Metallic Materials (K)” in the DNV register of approved products and manufacturers, available on the DNV Internet site.

102 Approved shop primers or thin coatings of linseed oil may be applied to welds subject to tightness test in agreement with the manufacturer’s recommendation. In general the applied film thickness on welds shall not exceed 50 microns.

D. Welding environment

D 100 General
101 Welding work shall not be carried out in environmental conditions that may have a detrimental effect such as wind, damp and cold.

Guidance note:
Recommendations for preheating for welding at low temperatures are given in IACS REC. No. 47, Table 6.12.

102 Welding processes sensitive to draughts shall be adequately protected.
103 The grooves shall by dry at all time of welding.
104 Preheating temperature, whenever required, shall in any case be within the limit of essential variables, see E306.
105 The welding interpass temperature shall not drop below the minimum required preheating temperature
106 Prefabrication and welding of stainless steels should be performed in a workshop, or a part thereof, which is reserved exclusively for these types of materials.

E. Cutting, forming, assembly and welding

E 100 Cutting
101 Cut edges shall be accurate and uniform in order to provide a shape compatible with the weld joint design.
102 Deviation of cut edges shall generally be within the standard specified by IACS REC No.47 Shipbuilding and Repair Quality Standard Part A.
103 Attention shall be paid to avoid excessive local hardening and carbon contaminations by thermal cutting.
104 The effect of work hardening and risk of cracked edges shall be considered if shearing is used for cutting of material.
105 Correction by welding as compensation for improper cutting shall be in accordance with procedures for repairs.

E 200 Forming
201 Forming and straightening of materials shall be performed according to procedures which outline the succession of the controlled steps.
202 The degree of cold forming for steels in structural members shall be carried out within the deformation range recommended by the manufacturer. Should however such documentation not be available, the deformation rate for carbon manganese steels shall be less than 10%, respectively 20% for austenitic and ferritic-austenitic steels. If the deformation exceeds 10%, respectively 20% either heat treatment or strain ageing test shall be carried out in accordance with an agreed procedure as stipulated in Pt.3 Ch.3 Sec.3 C1100 (Rules for Classification of Ships).

Guidance note:
The plastic deformation $e$ may be calculated by the following simplified formulae:

*Single-curvature deformation*
Cold rolling or pressing of plates to cylindrical forms:
$$ e = \frac{t}{2R_c} \times 100\% $$

Cold bending of straight pipes to bends:
$$ e = \frac{D}{2R_c} \times 100\% $$

*Double curvature deformation*
Forming of plates to spheres:
$$ e = \frac{t(1 + \nu)}{2R_c} \times 100\% $$

203 Forming of steels at high temperatures shall be effectuated with due regard to adverse effects of the material’s properties. Forming of steels above 650ºC shall be subject to agreement with the Society.

E 300 Assembly and Welding
301 Members to be welded shall be brought into correct alignment and held in position by clamps, tack welds, or other suitable devices, until welding has been completed or progressed to a stage where in control of the process. Such arrangement shall be suitably arranged to minimise distortion and built-in stresses.
302 Fit-up shall be checked for dimensional accuracy before welding. Special attention shall be drawn to assure correct fit-up of areas, of which direct visual inspection is impossible.
303 Surfaces to be welded shall be free from mill scale, slag, rust, paint or other contaminating substances.
304 Grooves produced by gouging shall be followed by grinding removing carbonized material. Grooves shall be within the groove profile particulars given by the WPS. Grooves shall be slag free.
305 All welding, including tack welding, seal welding, welding of lifting lugs and attachment welds as well as repair welding, shall be performed within the limits of essential variables of the qualified WPS.
306 Preheating, when required, shall be applied in accordance with agreed procedures. Special attention shall be paid to temperature control during the welding process such that the preheat temperature is kept uniformly in affected part of the welded object.

Guidance note:
Normal strength steels may require preheating depending on the combined plate thicknesses and the degree of joint restraint.
Preheating is normally required for welding of high and extra high strength steels depending on chemical composition, rolling process, joint restraint and combined plate thickness. Post heating may additionally be required for extra high strength steels.

---end-of-Guidance-note---

307 The welding sequence shall be such that the amount of shrinkage, distortions and residual stresses are minimised.

308 Welds shall be terminated in a manner such that all welds are sound and without end craters. Run-off plates shall be used, where practicable, and be removed upon completion and cooling of the weld. Cut welds shall be made smooth and flush with the edges of the abutting parts.

309 Tack welding shall be carried out in accordance with approved WPS, specifying the applied minimum welding length.

310 Tack welds used for assembly shall be removed before welding leaving the affected area free from defects.

311 Tack welds, if retained as part of the welding process, shall be free from defects and provide adequate conditions for pass welding.

312 Storage and handling of welding consumables shall be in accordance with the manufacturer’s recommendations, and in accordance with procedures giving details regarding conditions in storage rooms, temperature in storage ovens and quivers, length of exposure and conditions, as applicable.

313 Consumables which have been contaminated by moisture, rust, oil, grease, dirt or other deleterious matters, shall be discarded unless properly reconditioned.

314 Recycling of fluxes for -SAW- shall be performed in a manner that ensures a mixture of new and used flux with continually homogenous properties.

315 Addition requirements applicable for NV 47 steels:

— Wherever possible, multi-pass welding shall be applied.
— Tack welds shall have a length not less than 50 mm. For steel with Pcm ≤ 0.19, tack welds with length not less than 25 mm may be accepted subject to qualification and approval.
— Preheating is to be 50°C or over when air temperature is 5°C or below. For steel with Pcm less than or equal to 0.19, air temperature below 5°C may be adopted subject to qualification and approval. The pre-heating temperature shall be measured at a distance of minimum 75 mm from the edges of the groove at the opposite side of the heating source when practically possible. When preheating is required, the temperature shall be strictly controlled.

Guidance note: For the required preheating, electric heating elements are considered adequate in order to give sufficient temperature control. When preheating is not strictly required by the rules, and/or air temperature below 5°C is accepted without preheating, drying out using a properly designed gas torch should be considered. Cutting torch is considered not suitable for drying out. For repair welding, preheating temperature should be increased 50°C above minimum specified preheating temperature given by the WPS.

— Special care shall be paid to the final welding so that harmful defects do not remain. Jig mountings shall be completely removed with no defects in general, otherwise the treatment of the mounting shall be accepted by the Society.
— Welding procedures (WPS) shall be qualified through welding procedure qualification test (WPQT) as described in Sec.5, with the additional requirements for Fracture Mechanics testing (FM) as follows: CTOD testing is required for base material, heat affected zone and weld metal. Testing to be carried out at -10°C or design temperature, whichever is lower. Test method and acceptance criteria are given in Pt.2 Ch.3 Sec.5. Provided that the relevant CTOD requirements are qualified during the approval of manufacturer test for relevant welding parameters, the applicable CTOD testing need not be repeated. (Note that CTOD testing of the weld metal is not commonly covered by the approval of manufacturer test).
— Verification of the WPS during welding shall be carried out and recorded.
— Gouging shall be followed by grinding to remove any carburised layer. In doubtful cases proof of satisfactory performance of gouging may be required.
— Arc strikes shall be repaired by mechanical removal of affected base material followed by Magnetic particle testing, MT, to verify absence of cracks.

316 When deemed necessary, welding production tests (WPT) shall be made during fabrication of welds to verify that the produced welds are of acceptable quality.
F. Repairs

F 100 General

101 Guidance to general welding repair work is given in IACS REC No.47 Shipbuilding and Repair Quality Standard Part A.

102 Defects in welds may be repaired by grinding, machining and/or welding. In order to verify complete removal of defects, affected areas shall be examined with suitable NDT methods.

F 200 Repair welding

201 Repairs by welding shall be carried out in accordance with approved WPS. Mechanical properties shall satisfy the minimum specified properties of the material in question.

202 Defects shall be completely removed before necessary repairs are carried out. Repairs with arc-air gouging shall be followed by grinding.

203 Repair welding in the same area may be carried out twice. Further repairs shall be subject to agreement with the Society.

204 All weld repairs shall at least be re-inspected with the same NDT methods as originally applied.

F 300 Flame straightening

301 Members distorted by welding may be straightened by mechanical means or by a limited amount of localised heat.

Flame straightening shall be done in accordance with an agreed procedure.

302 Corrective measures relating to flame straightening shall be carried out with due regard to possible degradation of the material properties.

Reference is made to IACS REC No.47 Shipbuilding and Repair Quality Standard Part A Table 6.5, regarding max. temperature on the surface.

G. Inspection, survey and tolerances

G 100 General

101 Inspection shall be carried out in accordance with inspection and test plans to confirm that work is carried out in accordance with established project procedures and plans such that all project requirements are complied with to the satisfaction of the Society. Reference is given to IACS UR Z23 regarding survey of hull structure.

102 Due consideration shall be given to the access and the time required for adequate inspection and survey during fabrication.

103 High non-conformance rates in execution of the work or in the product itself shall call for special considerations in agreement with the Society. Such special considerations may include, but not be limited to, increased inspection by the builder and increased surveys by the Society, re-qualification of personnel or other agreed remedial actions.

G 200 Alignment and straightness

201 Allowable acceptable alignment shall be established depending on the criticality of the design. Special requirements relating to special type and service are given in Pt.5.

202 In general fabrication tolerances shall be in compliance with IACS REC No.47 Shipbuilding and Repair Quality Standard, Part A.

G 300 Weld production test (WPT) requirements

301 The Society may require WPTs to be carried out. The extent and type of testing shall be agreed with the Society.

302 When WPTs are required the test assembly and test requirements shall comply with the relevant requirements of Sec.5.

303 If the achieved test results do not comply with the requirements of Sec.5, the results may be submitted for consideration. The WPT may be accepted subject to acceptable results from additional test prescribed by the Society.
SECTION 7 NON DESTRUCTIVE TESTING OF WELDS

A. General

A 100 Application

101 This section provides requirements for quality control of ship hull welds during newbuilding. The section contains requirements for the application of non-destructive testing (NDT) - methods, extent of testing and required quality level for satisfactory workmanship.

102 Additional requirements to extent of testing and acceptance criteria are given in Pt.5 for the relevant ship types.

A 200 Basic requirements

201 The rules are based on the following conditions mentioned below.

Weld joint types

The following main weld joints are covered (see figures in Sec.5):

— butt joints
— T-joints (with and without full penetration)
— fillet welds.

Types of imperfections

The main types of imperfections in fusion welding are given in EN ISO 6520-1 *Welding and Allied Processes – Classification of Geometric Imperfections in Metallic materials, Part 1: Fusion Welding*.

Testing methods

— For detection of surface imperfections the following methods applies: Visual testing (VT), Magnetic particle testing (MT) and Penetrant testing (PT).
— For detection of sub-surface imperfections the following methods applies: Ultrasonic testing (UT) and Radiographic testing (RT).

The choice of test methods to be applied in each case depends on the component- or weld shape, the material and the defects to be detected.

202 For NV 420 grades and higher, final inspection and NDT shall not be carried out before 48 hours after completion unless heat treatment has been carried out.

B. NDT procedures

B 100 General

NDT shall be performed in accordance with agreed written procedures. The procedures shall be in accordance with DNV Classification Notes No.7. Other recognised standards may be accepted based on case by case approval. The approved procedures shall as a minimum give detailed information on the following aspects:

— applicable code or standard
— materials, dimensions and temperature of tested material
— periodically verification of equipment requirements
— joint configuration and dimensions
— technique (sketches/ figures to be referenced in the NDT report)
— equipment and consumables
— sensitivity, and light/viewing conditions for MT and PT
— calibration techniques and calibration references
— testing parameters and variables
— assessment of imperfections and the surfaces from which the testing has been performed
— reporting and documentation of results. The reporting system shall ensure that there is no doubt what is tested, where it is tested and give a clear and exact description of reportable defect location.
— reference to applicable WPS(es)
— personnel qualification
— acceptance criteria.

101 Unless otherwise agreed, the surface to be tested shall be presented clean and smooth, i.e. free from dirt, scale, rust, welding spatter, etc. which may influence the results of the testing.
B 200 Visual testing (VT)

201 If necessary mechanical aids (gauges and rulers) should be used to assess and size the discontinuities. Unless otherwise agreed, VT shall be completed before other NDT methods are applied.

B 300 Magnetic particle testing (MT)

301 Where possible, both sides of the welds shall be tested. MT shall be applied for welds in ferro-magnetic materials if not otherwise agreed.

B 400 Radiographic testing (RT)

401 For radiographic testing, X-ray source shall be used whenever possible. Gamma-ray sources may be used as outlined in Classification Note No.7. RT may be replaced by ultrasonic testing and vice versa, when methodologically justifiable and in agreement with the Society.

402 Processing and storage shall be such that the radiographs maintain their quality throughout the agreed storage time. The radiographs shall be free from imperfections due to processing.

403 Suspect planar indications discovered by RT that is left un-repaired shall be type determined, located and sized by UT.

B 500 Ultrasonic testing (UT)

501 UT procedures shall contain sketches for each type of joint and dimensional range of joints which clearly show scanning pattern and probes to be used.

UT shall not be carried out on welds with thickness < 10 mm if not qualified and accepted down to 8 mm.

UT of welds shall include testing of the area adjacent to the weld for laminations and scanning for transverse defects in the weld and base material.

B 600 Penetrant testing (PT)

601 Where possible, both sides of the welds shall be tested. PT shall only be applied for welds in non-ferro magnetic materials if not otherwise agreed.

C. Personnel qualifications

C 100 General

101 All testing shall be carried out by qualified and certified personnel. The NDT operators shall be certified according to a recognized certification scheme accepted by the Society, e.g. with a grade equivalent to level II qualification of, EN ISO 9712, or ASNT Central Certification Program (ACCP). SNT-TC-1A may be accepted if the NDT company’s written practice is reviewed and accepted by the Society. The certificate shall clearly state the qualifications as to which testing method, level and within which industrial sector the operator is certified.

D. Extent of NDT

D 100 General

101 The extent of testing will depend on the type of ship and the location of the joints.

102 The basic requirements for all ship types are that all welds are subject to 100% visual testing carried out by the builder’s qualified personnel. In addition, welds shall be subjected to testing with other test methods as given in the table below.

The extent may be extended further depending on quality of welds and repair rate (see E201).

103 The locations and areas to be examined shall be incorporated into the NDT plan. The NDT plan shall clearly identify the critical areas as defined below.
The different areas in Table D1 are defined as follow:

**Critical areas**
Areas in way of critical load transfer points and large stress concentrations where a failure will endanger the safety of the ship, such as:

— stress concentrations in rudders or intersection between rudder structure and hull
— for twin hull vessels stress concentrations in way of connections between hull and wet deck
— deck beams in open hatch container ships
— strength deck plating at outboard corners of cargo hatch openings in container carriers and other ships with similar hatch opening configuration
— other areas where the likelihood of occurrence of detrimental defects is considered to be extra high.

**Guidance note:**
Areas to be considered for classification under this item are:

— welds produced by welding methods which the yard has little or no user experience
— welds produced by high heat input (>5 kJ/mm) welding methods
— welds in large thickness (> 50 mm).

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

**Deck and bottom plating within 0.4L amidship**

— Sheer strake at strength deck.
— Stringer plate in strength deck.
— Deck strake at longitudinal bulkhead.
— Strength deck plating at corners of cargo hatch openings in bulk carriers, ore carriers, combination carriers and other ships with similar hatch opening configuration.
— Bilge strake.
— Longitudinal hatch coamings of length greater than 0.15 L.
— End brackets and deck house transition of longitudinal cargo hatch coamings.
— All watertight bulkheads independent of location.

**Guidance note:**
For ships with no clearly defined strength deck e.g. cruise ships, the above extents shall be applied to the decks contributing most to the hull strength

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

**General**
Areas not mentioned above.

NDT shall cover start and stop points of automatically welded seams, except for internal stiffeners where the extent of testing should be agreed with the Society. (Extent is as given in Table D1).
E. Acceptance criteria for NDT

E 100 General

101 All welds shall show evidence of good workmanship. For visual inspection IACS REC No.47 “Shipbuilding and Repair Quality Standard Part A” may be applied. Acceptance criteria for NDT shall normally comply with EN ISO 5817 quality level C, intermediate/primary/secondary. For critical/special areas more stringent requirements such as EN ISO 5817 quality level B, may be applied. Regarding use of EN ISO 5817 and quality level for RT, UT, MT and PT, correlation is given in EN ISO 17635 as follows:

Relevant standard for MT/PT is ENISO 23278 and EN ISO 23277, respectively (see correlation in ISO 17635). Level B and C according to EN ISO 5817 correspond to level 2X in EN ISO 23277 and EN ISO 23278.

Relevant standard for UT is EN ISO11666: Level B and level C of EN ISO 5817 are equal to, respectively, acceptance level 2 and 3 of ISO 11666 (see correlation given in ISO 17635). Regarding UT EN ISO 11666 level 2 or level 3 applies with the following amendment: All imperfections from which the reflected echo amplitude exceeds the evaluation level shall be characterised, and all that are characterised as planar e.g. cracks, lack of fusion, incomplete penetration shall be rejected.

Relevant standard for RT is EN ISO 10675 Level 1 and 2 (see correlation in ISO 17635).

Welds tested and accepted by the builder/manufacturer may be verified if deemed necessary by the Society.

E 200 Non-conforming weldments

201 If a non-conforming discontinuity is detected the lengths welded immediately before and after the section containing the discontinuity shall be examined by the same method. If systematically repeated discontinuities are revealed, the extent of testing shall be increased for welds manufactured under same conditions and where similar defects may be expected.

202 If non-conforming discontinuities are found to occur regularly, the WPS shall be reassessed before continuation of the welding, and necessary actions shall be taken to bring the production to the required quality level.

203 Detected non-conforming discontinuities shall be repaired unless they are found acceptable by the Society. Removal of weld discontinuities and repair shall be performed in accordance with a procedure approved by the Society.

204 After repair welding has been performed, the complete weld, (i.e. the repaired area plus at least 100 mm on each side) shall be subjected to at least to the same NDT method(s) as specified for the original weld.
SECTION 8 STRUCTURAL AND TIGHTNESS TESTING

A. General

A 100 Application

101 This section specifies general requirements to structural and tightness testing of tanks and holds of:

— new ships prior to delivery
— structures involved in, or affected by, conversions or repairs.

102 For Liquefied Gas Carriers additional requirements are given in Pt.5 Ch.5 (Rules for Classification of Ships).

103 HSCL and naval surface crafts are not subject to testing requirements in this section.

B. Testing

B 100 Definitions

101 The following terms are used in B:

— Structural testing is a hydrostatic test, carried out in order to demonstrate the tightness of the tanks and the structural adequacy of the design. Where hydrostatic testing is not practically feasible, hydropneumatic testing may be carried out instead under provision that the test is simulating, as far as practicable, the actual loading of the tank.
— Leak testing is an air or other medium test, carried out in order to demonstrate the tightness of the structure.
— Shop primer is a thin coating applied after surface preparation and prior to fabrication as a protection against corrosion during fabrication.
— Protective coating is a coating protecting the structure from corrosion.
— Watertight means capable of preventing the passage of water through the structure under a head of water for which the surrounding structure is designed.
— Weathertight means that in any sea conditions water will not penetrate into the ship.
— FRP - Fibre reinforced plastic.

102 Definition of each type of test is as follows:

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrostatic Test</td>
<td>A test by filling the space with a liquid to a specified head.</td>
</tr>
<tr>
<td>(Leak and Structural)</td>
<td></td>
</tr>
<tr>
<td>Hydropneumatic Test</td>
<td>A test wherein the space is partially filled with liquid and air pressure applied on top of the liquid surface.</td>
</tr>
<tr>
<td>(Leak and Structural)</td>
<td></td>
</tr>
<tr>
<td>Hose Test</td>
<td>A test to verify the tightness of the joint by a jet of water. The hose pressure shall be at least 200 kN/m² and applied at a maximum distance of 1.5 m. The nozzle inside diameter shall be at least 12.0 mm</td>
</tr>
<tr>
<td>(Leak)</td>
<td></td>
</tr>
<tr>
<td>Air Tests</td>
<td>A test to verify the tightness by means of air pressure differential and leak detection solution. It includes tank air tests and joint air tests, such as a compressed air test and vacuum box test. An efficient indicating liquid shall be applied, when air is used as the test medium. The air pressure shall be kept at a maximum pressure of 20 kN/m² for 1 hr. and shall be reduced to 15 kN/m² before inspection. In addition to an effective means of reading the air pressure, a safety valve, or a reliable equivalent alternative, shall be connected to the compartment being tested.</td>
</tr>
<tr>
<td>(Leak)</td>
<td></td>
</tr>
<tr>
<td>Compressed Air Fillet Weld Test</td>
<td>An air test of a fillet welded tee joint with a leak indicating solution applied on the fillet welds. Pressure gauges are to be arranged so that an air pressure of at least 15 kN/m² can be verified at each end of all passages within the portion being tested.</td>
</tr>
<tr>
<td>(Leak)</td>
<td></td>
</tr>
<tr>
<td>Vacuum Box Test</td>
<td>A box over a joint with leak indicating solution applied on the fillet or butt welds. A vacuum (20 to 26 kN/m²) is created inside the box to detect any leaks.</td>
</tr>
<tr>
<td>(Leak)</td>
<td></td>
</tr>
<tr>
<td>Ultrasonic Test</td>
<td>A test to verify the tightness of a sealing by means of ultrasound.</td>
</tr>
<tr>
<td>(Leak)</td>
<td></td>
</tr>
<tr>
<td>Penetration Test</td>
<td>A test to verify that no continuous leakages exist in the boundaries of a compartment by the application of low surface tension liquids.</td>
</tr>
<tr>
<td>(Leak)</td>
<td></td>
</tr>
</tbody>
</table>
B 200 General requirements

201 Structural testing may be carried out after a protective coating has been applied, provided a leak test is carried out before application of the protective coating. All pipe connections to tanks shall be fitted before structural testing.

When structural testing at the building berth is undesirable or impossible, structural testing afloat may be accepted. The structural testing shall be carried out by filling each tank separately to the test head. Examination of bottom and lower side structures shall be made in empty tanks at the maximum practical attainable draught.

202 Leak testing shall be carried out prior to the protective coating being applied to the welds. Shop primer may be applied to welds prior to leak test.

Test pressure shall be verified by means of one master pressure gauge. The Society may accept alternative means which are considered to be equivalently reliable.

Guidance note:
Silicate based shop primer may be applied to welds before leak testing. The layer of the primer should be maximum 50 microns. Other primers of uncertain chemical composition shall be maximum 30 microns.

B 300 Specific requirements for extent and type of testing

301 The requirements in 300 give conditions for testing for:
— gravity tanks
— watertight or weathertight structures.

Guidance note:
Gravity tank means a tank that is subject to vapour pressure not greater than 70 kPa.

302 Leak testing shall be carried out on all weld connections of tank boundaries, pipe penetrations and erection joints on tank boundaries, except for automatic full penetration T-joints and butt welds of erection joints, see Table B2.

Selected locations of automatic erection welds and pre-erection manual or automatic welds may be required to be similarly tested taking account of the quality control procedures operating in the shipyard.

303 A structural test is to be carried out for at least one tank of the same construction (i.e. tanks of the same structural design and configuration and same general workmanship as determined by the attending Surveyor) on each vessel provided all subsequent tanks are tested for leaks by an air test. The relaxation to accept leak testing using an air test instead of a structural test does not apply to cargo space boundaries in tankers and combination carriers and tanks for segregated cargoes or pollutants. However, where structural adequacy of a tank was verified by structural testing required in Table B1, the subsequent vessels in the series (i.e. sister ships built in the same shipyard) may be exempted from such testing for other tanks which have the structural similarity to the tested tank, provided that the water-tightness in all boundaries of exempted tanks are verified by leak tests and thorough inspection. For sister ships built several years after the last ship of the series, such exemption may be reconsidered. In any case, structural testing is to be carried out for at least one tank for each vessel in order to verify structural fabrication adequacy. The relaxation to accept leak testing and thorough inspections instead of a structural test on subsequent vessels in the series does not apply to cargo space boundaries in tankers and combination carriers and tanks for segregated cargoes or pollutants.

304 For watertight boundaries of spaces other than tanks (excluding chain lockers), structural testing may be exempted, provided that the water tightness in all boundaries of exempted spaces are verified by leak tests and thorough inspection.

305 Subsequent tanks may require structural testing if found necessary after the structural testing of the first tank.

306 Tanks for structural test are to be selected so that all representative structural members are tested for the expected tension and compression.

307 Test requirements for tanks and boundaries are given in Table B1.
### Table B1 Test requirements for tanks and boundaries

<table>
<thead>
<tr>
<th>Item to be tested</th>
<th>Type of testing</th>
<th>Structural test pressure</th>
<th>Extent of structural testing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All ship types</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Double bottom tanks | Structural and leak testing | The greater of the following:  
  - head of water up to top of overflow  
  - 2.4 m head of water above highest point of tank. For FRP tanks: 1.0 m above highest point of tank.  
  - top of bulkhead deck | Tank boundary tested from at least one side 1), 2)  
  Including tanks arranged in accordance with the provisions of SOLAS regulation II-1/9.4 |
| Double side tanks | Structural and leak testing | The greater of the following:  
  - head of water up to top of overflow  
  - 2.4 m head of water above highest point of tank. For FRP tanks: 1.0 m above highest point of tank.  
  - top of bulkhead deck | Tank boundary tested from at least one side 1), 2) |
| Cargo oil tanks | Structural and leak testing | The greater of the following:  
  - head of water up to top of overflow  
  - 2.4 m head of water above highest point of tank.  
  - top of bulkhead deck  
  - pressure relief valve opening pressure | Tank boundary tested from at least one side 1), 2) |
| Peak tanks | Structural and leak testing | The greater of the following:  
  - head of water up to top of overflow  
  - 2.4 m head of water above highest point of tank. For FRP tanks: 1.0 m above highest point of tank.  
  - top of bulkhead deck | Tank boundary tested from at least one side 1), 2)  
  Test of aft peak tank to be carried out after the stern tube has been fitted |
| Fore peak voids | Leak testing | | Test of aft peak tank to be carried out after the stern tube has been fitted |
| After peak voids | Leak testing | | Including duct keels and dry compartments arranged in accordance with the provisions of SOLAS regulation II-1/9.4 |
| Double side and bottom voids | Leak testing | | |
| Deep tanks other than those listed elsewhere in this table | Structural and leak testing | The greater of the following:  
  - head of water up to top of overflow  
  or,  
  - 2.4 m head of water above highest point of tank | 1), 2) |
| Chain locker | Structural and leak testing | Head of water up to top of chain pipe | |
| Double plate rudders | Leak testing | | |
| Watertight doors below freeboard or bulkhead deck and watertight hatch covers | Leak testing | | Each door and hatch cover 3), 6) |
| Weathertight doors, shell doors, hatch covers, and closing appliances | Leak testing | | 3) |
| Watertight bulkheads and decks | Leak testing | | 3), 4), 5) |
| Superstructure end bulkhead | Leak testing | | External fillet weld (superstructure / deck boundary) on exposed weather decks 3) |
| Ballast ducts | Structural and leak testing | — ballast pump maximum pressure, or  
  — setting of any pressure relief valve | 1), 2) |
| Trunks, tunnels and ventilators | Leak testing | | 5) |
| Cofferdams | Leak testing | | |
Table B1 Test requirements for tanks and boundaries (Continued)

<table>
<thead>
<tr>
<th>Item to be tested</th>
<th>Type of testing</th>
<th>Structural test pressure</th>
<th>Extent of structural testing</th>
</tr>
</thead>
</table>
| Independent tanks | Structural and leak testing | The greater of the following:  
  — head of water up to top of overflow  
  — 0.9 m head of water above highest point of tank  
  — pressure relief valve opening pressure | 1), 2) |
| Dual purpose tank/dry cargo hatch cover | Leak testing | | |
| Dry bulk cargo carrier | | | |
| Ballast holds | Structural and leak testing | The greater of the following:  
  — head of water up to top of overflow  
  or  
  — top of cargo hatch coaming | 1), 2) |
| Combination carriers (OBOs) | | | |
| Watertight hatch covers of cargo tanks | Structural and leak testing | The greater of the following:  
  — head of water up to top of overflow  
  — 2.4 m head of water above hatch coaming  
  — pressure valve opening pressure | At least every second hatch cover, provided that leak testing is carried out for all hatch covers |
| Chemical carriers | | | |
| Integral and independent cargo tanks | Structural and leak testing | 1) Integral and independent tanks with a design pressure of less than 70 kN/m², the greater of the following:  
  — 2.4 m head of water above the highest point of the tank  
  — top of tank plus setting of any pressure relief valve.  
  2) Independent tanks with a design pressure exceeding 70 kN/m² shall be tested to 1.5 times the pressure valve opening pressure | Tank boundary tested from at least one side 1), 2) |
| Edible independent liquid tanks | Structural and leak testing | The greater of  
  — top of the overflow, or;  
  — to 0.9 m above top of tank | 1), 2) |

1) Structural test is to be carried out for at least one tank of the same construction (i.e., same design and same workmanship) on each vessel provided all subsequent tanks are leak tested. These relaxations do not apply to cargo space boundaries in tankers and combination carriers and tanks for segregated cargoes or pollutants.  
2) Where structural adequacy of a tank was verified by structural testing, the subsequent vessels in the series (i.e., sister ships built in the same shipyard) may be exempted from such testing for other tanks which have the structural similarity to the tested tank, provided that the water-tightness in all boundaries of exempted tanks are verified by leak tests and thorough inspection is carried out. In any case, structural testing is to be carried out for at least one tank for each vessel in order to verify structural fabrication adequacy. These relaxations do not apply to cargo space boundaries in tankers and combination carriers and tanks for segregated cargoes or pollutants.  
3) When a hose test cannot be performed without possible damage to outfitting (machinery, cables, switchboards, insulation, etc.) already installed, it may be replaced, at the Society’s discretion, by a careful visual inspection of all the crossings and welded joints; where necessary, dye penetrant test, leak test or an ultrasonic leak test may be required (SOLAS regulation II-1/11.1).  
4) Testing main compartments (not tanks for liquids) by filling them with water is not compulsory. When such testing is not carried out, a hose test is compulsory. This test shall be carried out in the most advanced stage of the fitting out of the ship. In any case, a thorough inspection of the watertight bulkheads shall be carried out (SOLAS regulation II-1/11.1).  
5) After completion, a hose or flooding test shall be applied to watertight decks and a hose test to watertight trunks, tunnels and ventilators. (SOLAS Ch. II-1/16-1.4)  
6) Where water tightness of watertight door has not confirmed by prototype test, testing by filling watertight spaces with water is to be carried out. See SOLAS regulation II-1/16.2 and MSC/Circ.1176.
### Table B2 Application of leak test, coating and provision of safe access for type of welded joints

<table>
<thead>
<tr>
<th>Type of Welded Joints</th>
<th>Leak Test</th>
<th>Coating 1)</th>
<th>Safe Access 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before Leak Test</td>
<td>After Leak Test &amp; before Structural Test</td>
</tr>
<tr>
<td>Butt and T-joints, full penetration 3)</td>
<td>Automatic</td>
<td>Not required</td>
<td>Allowed</td>
</tr>
<tr>
<td></td>
<td>Manual or Semi-automatic</td>
<td>Required</td>
<td>Not allowed</td>
</tr>
<tr>
<td>Fillet and T-joints partly penetration 3)</td>
<td>Automatic, Semi-automatic or Manual</td>
<td>Required</td>
<td>Not allowed</td>
</tr>
</tbody>
</table>

1) Coating refers to internal (tank/hold coating), where applied, and external (shell/deck) painting. It does not refer to shop primer.

2) Temporary means of access for verification of the leak test.

3) Boundaries including penetrations.
SECTION 9 GOAL-BASED SHIP CONSTRUCTION STANDARDS FOR BULK CARRIERS AND OIL TANKERS

A. General

A 100 Application

101 This section provides requirements for tankers and bulk carriers subject to SOLAS Chapter II-1 Part A-1 Regulation 3-10, Goal-based ship construction standards for bulk carriers and oil tankers.

102 Reference is made to IACS UR Z23, Hull Survey for New Construction, Appendix 2.

B. Examination and test plan for newbuilding activities

B 100 Requirements

101 The shipbuilder shall provide plans of the items which are intended to be examined and tested in accordance with the DNV's Rules in the quality survey plan (QSP), taking into account the ship type and design. This QSP shall be reviewed at the time of the kick off meeting, and must include:

— Types of surveys (visual, non-destructive examination, etc.) depending on location, materials, welding, casting, coatings, etc.
— Establishment of a construction survey schedule for all assembly stages from the kick-off meeting, through all major construction phases, up to delivery.
— Quality survey plan, including provisions for critical areas identified during design approval.
— Criteria for acceptance.
— Interaction with shipyard, including notification and documentation of survey results.
— Correction procedures to remedy construction defects.
— List of items that would require scheduling or formal surveys.
— Determination and documentation of areas that need special attention throughout ship's life, including criteria used in making the determination.

102 A set of requirements, including specifying the extent and scope of the construction survey(s) and identifying areas that need special attention during the survey(s), to ensure compliance of construction with mandatory ship construction standards including:

103 A description of the requirements for all types of testing during survey, including test criteria.

C. Design transparency

C 100 General

101 For ships subject to compliance with IMO Res. MSC.287(87), IMO Res. MSC.290(87), IMO Res. MSC.296(87) and IMO MSC.1/Circ.1343, readily available documentation is to include the main goal-based parameters and all relevant design parameters that may limit the operation of the ship.

D. Ship construction file

D 100 Content of ship construction file

101 A ship construction file (SCF) with specific information on how the functional requirements of the goal-based ship construction standards for bulk carriers and oil tankers have been applied in the ship design and construction is to be provided upon delivery of a new ship, and kept on board the ship and/or ashore and updated as appropriate throughout the ship's service. The contents of the SCF are to conform to the requirements below.

102 The following design specific information is to be included in SCF:

— Areas requiring special attention throughout the ship's life. (including critical structural areas).
— All design parameters limiting the operation of a ship.
— Any alternatives to the rules, including structural details and equivalency calculations.
— “As built” drawings and information which are verified to incorporate all alterations approved by the recognized organization or flag State during the construction process including scantling details, material details, location of butts and seams, cross section details and locations of all partial and full penetration.
welds.
— Net (renewal) scantlings for all the structural constituent parts, as built scantlings and voluntary addition thicknesses.
— Minimum hull girder section modulus along the length of the ship which has to be maintained throughout the ship's life, including cross section details such as the value of the area of the deck zone and bottom zone, the renewal value for the neutral axis zone.
— A listing of materials used for the construction of the hull structure, and provisions for documenting changes to any of the above during the ship's service life.
— Copies of certificates of forgings and castings welded into the hull (Ref. IACS UR W7 and UR W8).
— Details of equipment forming part of the watertight and weather tight integrity of the ship.
— Tank testing plan including details of the test requirements (Ref. IACS UR S14).
— Details for the bottom survey afloat, when applicable, information for divers, clearances measurements instructions etc., tank and compartment boundaries.
— Docking plan and details of all penetrations normally examined at dry docking.
— Coating Technical File, for ships subject to compliance with the IMO Performance Standard for Protective Coatings (PSPC).

103 Refer to Table D1 for details of information to be further included. This information has to be kept on board the ship and/or ashore and updated as appropriate throughout the ship's life in order to facilitate safe operation, maintenance, survey, repair and emergency measures.

104 It is to be noted that parts of the content of the SCF may be subject to various degrees of restricted access and that such documentation may be appropriately kept ashore.

105 The SCF has to include the list of documents constituting the SCF and all information listed in Table D1, which is required for a ship's safe operation, maintenance, survey, repair and in emergency situations. Details of specific information that is not considered to be critical to safety might be included directly or by reference to other documents.

106 When developing an SCF, all of the columns in Table D1 have to be reviewed to ensure that all necessary information has been provided.

107 It may be possible to provide information listed in Table D1 under more than one Tier II functional requirement as a single item within the SCF, for example, the Coating Technical File required by the PSPC is relevant for both “Coating life” and “Survey during construction”.

108 The SCF has to remain with the ship and, in addition, be available to its classification society and flag State throughout the ship's life. Where information not considered necessary to be on board is stored ashore, procedures to access this information should be specified in the onboard SCF. The intellectual property provisions within the SCF should be duly complied with.

109 The SCF should be updated throughout the ship's life at any major event, including, but not limited to, substantial repair and conversion, or any modification to the ship structure.
<table>
<thead>
<tr>
<th>Tier II items</th>
<th>Information to be included</th>
<th>Further explanation of the content</th>
<th>Example documents</th>
<th>Normal storage location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DESIGN</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Design life</td>
<td>— assumed design life in years</td>
<td>— statement or note on midship section</td>
<td>— SCF-specific</td>
<td>on board ship</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>— midship section plan</td>
<td>on board ship</td>
</tr>
<tr>
<td>2 Environmental conditions</td>
<td>— assumed environmental conditions</td>
<td>— statement referencing data source or Rule (specific rule and data) or; in accordance with Rule (date and revision)</td>
<td>— SCF-specific</td>
<td>on board ship</td>
</tr>
<tr>
<td><strong>3 Structural strength</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 General design</td>
<td>— applied Rule (date and revision)</td>
<td>— applied design method alternative to Rule and Subject structure(s)</td>
<td>— SCF-specific</td>
<td>on board ship</td>
</tr>
<tr>
<td></td>
<td>— applied alternative to Rule</td>
<td></td>
<td>— capacity plan</td>
<td>on board ship</td>
</tr>
<tr>
<td>3.2 Deformation and failure modes</td>
<td>— calculating conditions and results;</td>
<td>— allowable loading pattern</td>
<td>— loading manual</td>
<td>on board ship</td>
</tr>
<tr>
<td></td>
<td>— assumed loading conditions</td>
<td>— maximum allowable hull girder bending moment and shear force</td>
<td>— trim and stability booklet</td>
<td>on board ship</td>
</tr>
<tr>
<td>3.3 Ultimate strength</td>
<td>— operational restrictions due to structural strength</td>
<td>— maximum allowable cargo density or storage factor</td>
<td>— loading instrument instruction manual</td>
<td>on board ship on board ship on shore archive</td>
</tr>
<tr>
<td>3.4 Safety margins</td>
<td>— strength calculation results</td>
<td>— bulky output of strength calculation</td>
<td>— areas prone to yielding and/or buckling</td>
<td>on board ship</td>
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<tr>
<td></td>
<td>— plan showing highly stressed areas (e.g. critical structural areas) prone to yielding and/or buckling</td>
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<td></td>
<td>— gross hull girder section modulus</td>
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</tbody>
</table>
### Table D1- List of information to be included in the ship construction file (Continued)

<table>
<thead>
<tr>
<th>Tier II items</th>
<th>Information to be included</th>
<th>Further explanation of the content</th>
<th>Example documents</th>
<th>Normal storage location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>— minimum hull girder</td>
<td></td>
<td>— general arrangement plan</td>
<td>on board ship</td>
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<tr>
<td></td>
<td>section modulus along the</td>
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<td>length of the ship to</td>
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<td>be maintained throughout</td>
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<td>the ship’s life, including</td>
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<td>cross section details such</td>
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<td>as the value of the area</td>
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<td>of the deck zone and bottom</td>
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<td>zone, the renewal value</td>
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<td>for the neutral axis zone</td>
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<td>— gross scantlings of</td>
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<td>— key construction plans</td>
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<td></td>
<td>structural constituent</td>
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<td>parts</td>
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<td>— net scantlings of</td>
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<td>— rudder and</td>
<td>on board ship</td>
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<td>structural constituent</td>
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<td>rudder and stern</td>
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<td>parts, as built scantlings</td>
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<td>frame</td>
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<td>and voluntary addition</td>
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<td>thicknesses</td>
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<td>typical members</td>
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<td>drawings</td>
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<td>— rudder and</td>
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<td>rudder stock plans</td>
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<td>— structural details of</td>
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<td>typical members</td>
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<td>details</td>
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<td>— dangerous area plan</td>
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<td>— dangerous area</td>
<td>on board ship</td>
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<td>plan</td>
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<td>key construction</td>
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<td>plans</td>
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<td>— lines plan</td>
<td>on shore archive</td>
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<td></td>
<td>— hull form data stored</td>
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<td>— hull form data</td>
<td>on board ship</td>
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<td>within an onboard</td>
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<td>stored within an</td>
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<td>computer necessary for</td>
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<td>trim and stability and</td>
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<td>necessary for</td>
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<td>longitudinal strength</td>
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<td>trim and stability</td>
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<td>calculations</td>
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<td>and longitudinal</td>
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<td>strength</td>
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<td>calculations</td>
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<td></td>
<td>— applied Rule (date and</td>
<td></td>
<td>— SCF-specific</td>
<td>on board ship</td>
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<td>4 Fatigue life</td>
<td>revision)</td>
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<td>— applied alternative to</td>
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<td>Rule</td>
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<td>— calculating conditions</td>
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<td>and results;</td>
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<td></td>
<td>— assumed loading conditions</td>
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<td></td>
<td>and rates</td>
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<td></td>
<td>— structural details</td>
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</tbody>
</table>

**Example documents**

- Normal storage location:
  - on board ship
  - on shore archive
  - equivalent
  - or
<table>
<thead>
<tr>
<th>Tier II items</th>
<th>Information to be included</th>
<th>Further explanation of the content</th>
<th>Example documents</th>
<th>Normal storage location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>assumed loading conditions</td>
<td></td>
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<tr>
<td></td>
<td>fatigue life calculation results</td>
<td>bulky output of fatigue life calculation</td>
<td>fatigue life calculation</td>
<td>on shore archive</td>
</tr>
<tr>
<td></td>
<td>plan showing areas (e.g. critical structural areas) prone to fatigue</td>
<td>areas prone to fatigue</td>
<td></td>
<td>on board ship</td>
</tr>
<tr>
<td>5 Residual strength</td>
<td>applied Rule (date and revision)</td>
<td>SCF-specific</td>
<td></td>
<td>on board ship</td>
</tr>
<tr>
<td>6 Protection against corrosion</td>
<td></td>
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</tr>
<tr>
<td>6.1 Coating life</td>
<td>coated areas and target coating life and other measures for corrosion protection in holds, cargo and ballast tanks, other structure-integrated deep tanks and void spaces</td>
<td>plans showing areas (e.g. critical structural areas) prone to excessive corrosion</td>
<td>SCF-specific</td>
<td>on board ship</td>
</tr>
<tr>
<td></td>
<td>specification for coating and other measures for corrosion protection in holds, cargo and ballast tanks, other structure-integrated deep tanks and void spaces</td>
<td>areas prone to excessive corrosion</td>
<td></td>
<td>on board ship</td>
</tr>
<tr>
<td></td>
<td>gross scantlings of structural constituent parts</td>
<td>key construction plans</td>
<td></td>
<td>on board ship</td>
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<tr>
<td>6.2 Corrosion addition</td>
<td></td>
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<td>on board ship</td>
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<tr>
<td></td>
<td>net scantlings of structural constituent parts, as built scantlings and voluntary addition thicknesses</td>
<td></td>
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<td>on board ship</td>
</tr>
<tr>
<td>7 Structural redundancy</td>
<td>applied Rule (date and revision)</td>
<td>SCF-specific</td>
<td></td>
<td>on board ship</td>
</tr>
</tbody>
</table>
**Table D1- List of information to be included in the ship construction file (Continued)**

<table>
<thead>
<tr>
<th>Tier II items</th>
<th>Information to be included</th>
<th>Further explanation of the content</th>
<th>Example documents</th>
<th>Normal storage location</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Watertight and weathertight integrity</td>
<td>— applied Rule (date and revision)</td>
<td>— key factors for watertight and weathertight integrity</td>
<td>— SCF-specific</td>
<td>on board ship</td>
</tr>
<tr>
<td></td>
<td>— details of equipment forming part of the watertight and weathertight integrity</td>
<td></td>
<td>— structural details of hatch covers, doors and other closings integral with the shell and bulkheads</td>
<td>on board ship</td>
</tr>
<tr>
<td>9 Human element considerations</td>
<td>— list of ergonomic design principles applied to ship structure design to enhance safety during operations, inspections and maintenance of ship</td>
<td></td>
<td>— SCF-specific</td>
<td>on board ship</td>
</tr>
<tr>
<td>10 Design transparency</td>
<td>— applied Rule (date and revision)</td>
<td>— applicable industry standards for design transparency and IP protection</td>
<td>— intellectual property provisions</td>
<td>on board ship</td>
</tr>
<tr>
<td></td>
<td>— reference to part of SCF information kept ashore</td>
<td></td>
<td>— summary, location and access procedure for part of SCF information on shore</td>
<td>on board ship</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Construction quality procedures</td>
<td>— applied construction quality standard</td>
<td>— recognized national or international construction quality standard</td>
<td>— SCF-specific</td>
<td>on board ship</td>
</tr>
<tr>
<td>12 Survey during construction</td>
<td>— survey regime applied during construction (to include all owner and class scheduled inspections during construction)</td>
<td>— applied Rules (date and revision) — copies of certificates of forgings and castings welded into the hull</td>
<td>— SCF-specific — tank testing plan</td>
<td>on board ship on board ship</td>
</tr>
<tr>
<td></td>
<td>— information on non-destructive examination</td>
<td></td>
<td>— non-destructive testing plan</td>
<td>on board ship</td>
</tr>
<tr>
<td>IN-SERVICE CONSIDERATIONS</td>
<td></td>
<td></td>
<td>— Coating Technical File required by PSPC</td>
<td>on board ship</td>
</tr>
<tr>
<td>13 Survey and maintenance</td>
<td>— maintenance plans specific to the structure of the ship where higher attention is called for</td>
<td>— plan showing highly stressed areas (e.g. critical structural areas) prone to yielding, buckling, fatigue and/or excessive corrosion</td>
<td>— SCF-specific — operation and maintenance manuals (e.g. hatch covers and doors)</td>
<td>on board ship on board ship</td>
</tr>
<tr>
<td>Tier II items</td>
<td>Information to be included</td>
<td>Further explanation of the content</td>
<td>Example documents</td>
<td>Normal storage location</td>
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</tr>
<tr>
<td>— preparations for survey</td>
<td>— arrangement and details of all penetrations normally examined at dry-docking</td>
<td>— docking plan</td>
<td>on board ship</td>
<td></td>
</tr>
<tr>
<td>— gross hull girder section modulus</td>
<td>— details for dry-docking</td>
<td>— dangerous area plan</td>
<td>on board ship</td>
<td></td>
</tr>
<tr>
<td>— minimum hull girder section modulus along the length of the ship to be maintained throughout the ship’s life, including cross section details such as the value of the area of the deck zone and bottom zone, the renewal value for the neutral axis zone</td>
<td>— details for in-water survey</td>
<td>— Ship Structure Access Manual</td>
<td>on board ship</td>
<td></td>
</tr>
<tr>
<td>— gross scantlings of structural constituent parts</td>
<td>— key construction plans</td>
<td></td>
<td>on board ship</td>
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<tr>
<td>— net scantlings of structural constituent parts, as built scantlings and voluntary addition thicknesses</td>
<td>— rudder and rudder stock</td>
<td></td>
<td>on board ship</td>
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<tr>
<td>— hull form information indicated in key construction plans</td>
<td>— structural details</td>
<td></td>
<td>on board ship</td>
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<tr>
<td>— lines plan</td>
<td>— yard plans</td>
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<td>on shore archive</td>
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<td>— hull form</td>
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<td>on shore archive</td>
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<td>— equivalent</td>
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<td></td>
<td>on board ship</td>
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</tbody>
</table>
Notes:

1) “SCF-specific” means documents to be developed especially to meet the requirements of these GBS guidelines (MSC.1/Circ.1343).

2) “Key construction plans” means plans such as midship section, main O.T. and W.T. transverse bulkheads, construction profiles/plans, shell expansions, forward and aft sections in cargo tank (or hold) region, engine-room construction, forward construction and stern construction drawings.

3) “Yard plans” means a full set of structural drawings, which include scantling information of all structural members.

4) “Hull form” means a graphical or numerical representation of the geometry of the hull. Examples would include the graphical description provided by a lines plan and the numerical description provided by the hull form data stored within an onboard computer.

5) “Lines plan” means a special drawing which is dedicated to show the entire hull form of a ship.

6) “Equivalent (to Lines plan)” means a set of information of hull form to be indicated in key construction plans for SCF purposes. Sufficient information should be included in the drawings to provide the geometric definition to facilitate the repair of any part of the hull structure.

7) “Normal storage location” means a standard location where each SCF information item should be stored. However, those items listed as being on board in the table above should be on board as a minimum to ensure that they are transferred with the ship on a change of owner.

8) “Shore archive” is to be operated in accordance with applicable international standards.

**E. Determination of number of surveyor(s)**

**E 100 General**

101 DNV will assign adequate number of suitable qualified surveyor(s) for new building projects according to the construction progress of each ship to meet appropriate coverage of the examination and testing activities as agreed in the Quality Survey Plan.
CHANGES – HISTORIC

Note that historic changes older than the editions shown below have not been included. Older historic changes (if any) may be retrieved through http://www.dnv.com. Note that historic changes older than the editions shown below have not been included. Older historic changes may be obtained through http://www.dnv.com.

January 2014 edition

Main changes January 2014, entering into force 1 July 2014

• General
The update has been done to:
— incorporate requirements to steel plates with thickness over 50 mm, of steel grades NV 36, NV 40 and NV 47
— give additional requirements to steel plates with thickness over 50 mm, of steel grade NV 47.
In addition a general update of the document has been done.

• Sec.4 Welding consumables
— New item A202 has been added containing requirements related to welding consumables for duplex steels.
— Table A6 has been amended. Added consumables selection for NV 47 steels.

• Sec.5 Welding procedures
— A301: Added abbreviations for MIG, MAG and TIG.
— B101: Added “throat thickness range for fillet weld”, “gas purity”, and “temperature, time” for PWHT.
— B203: New list item added: “All welds on grade NV 47 steels for container vessel”.
— C106: Added requirements for hardness test of NV 47 steels.
— C107: Text has been amended to give clearer description of specimen position. Requirements moved from previous 108.
— New item C109 regarding fracture mechanics testing to be alignment with CN30.10 and IACS UR W31 / EFN12-331 has been added
— New item C303 regarding additional butt weld qualification to be aligned with ISO 15614-1 has been added.
— C502: A new list item aligned with ISO 15614-1 has been added.
— E302: A new list item has been added with requirements for NV 47. Alignment with CN30.10 and IACS UR W31
— New sub-section E600: Added acceptance criteria for CTOD test. Alignment with CN30.10 and IACS UR W31.
— Table F1 has been amended. Note 6 and 7 have been added.

• Sec.6 Fabrication and tolerances
— New item E315 with additional requirements for NV 47 steels has been added.

July 2013 edition

Amendments September 2013

• Coming into force date
— The coming into force date for the July 2013 changes has been corrected to 1 January 2014.

Main changes coming into force 1 January 2014

• General
— General updates in order to align rules with IACS requirements. Furthermore, the welding part is no longer limited to structural steel, but includes e.g. pipes and copper alloy components. The rules have also been more aligned with DNV OS-C401. Title has been changed to reflect the change of scope for the document.

• Sec.3 Qualification of Welders
— Give recognition for welding operators’ certification.

• Sec.5 Welding Procedures
— Aligned with IACS, particularly with respect to WPS coverage. Aligned with DNV OS-C401 in general.
WPQT requirements for copper alloys have been added.

- **Sec.7 Non Destructive Testing of Welds**
  - The applicable standards have been updated.

- **Sec.8 Structural and Tightness Testing**
  - B303 and Table B1: The text has been updated in accordance with revised IACS UR S14.

**January 2013 edition**

Main changes coming into force 1 July 2013

- **Sec.8 Structural and Tightness Testing**
  - Completely revised in order to comply with IACS UR S14 Rev 4, Aug. 2012.