



STANDARDS FOR CERTIFICATION

No. 2.9

Approval of manufacturers No. 301

STEELMAKING AND ROLLED FERRITIC STEEL PLATES, SECTIONS AND BARS

JULY 1999

DET NORSKE VERITAS

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FOREWORD

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DET NORSKE VERITAS AS is a fully owned subsidiary Society of the Foundation. It undertakes classification and certification of ships, mobile offshore units, fixed offshore structures, facilities and systems for shipping and other industries. The Society also carries out research and development associated with these functions.

DET NORSKE VERITAS operates a worldwide network of survey stations and is authorised by more than 120 national administrations to carry out surveys and, in most cases, issue certificates on their behalf.

Standards for Certification

Standards for Certification (previously Certification Notes) are publications that contain principles, acceptance criteria and practical information related to the Society's consideration of objects, personnel, organisations, services and operations. Standards for Certification also apply as the basis for the issue of certificates and/or declarations that may not necessarily be related to classification.

A list of Standards for Certification is found in the latest edition of the Introduction booklets to the "Rules for Classification of Ships", the "Rules for Classification of Mobile Offshore Units" and the "Rules for Classification of High Speed and Light Craft". In "Rules for Classification of Fixed Offshore Installations", only those Standards for Certification that are relevant for this type of structure, have been listed.

The list of Standards for Certification is also included in the current "Classification Services – Publications" issued by the Society, which is available on request. All publications may be ordered from the Society's Web site <http://exchange.dnv.com>.

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1. General

1.1 Scope

This programme gives the procedure to be followed to obtain the Society's approval for steelmaking and the manufacture of rolled ferritic steel plates, sections, and bars in accordance with the requirements of DNV Rules for Classification of Ships, High Speed and Light Craft or Mobile Offshore Units.

1.2 Range of approval

Approval is required for each steel grade. However, test data supplied for a higher grade may cover lower grades for which approval is also requested provided the steelmaking process, deoxidation and fine grain practice, casting method, and condition of supply are the same.

1.3 Validity

The approval will be valid for four years. To maintain the approved status, the manufacturer must be re-inspected every four years. Application for renewal should be made not later than three months before the expiry date of the certificate.

Any alteration to the approved condition during the period of validity, e.g. steelmaking process, fine grain practice, casting method, maximum thickness or condition of supply is to be reported to the Society. A re-inspection and/or re-testing may be required when deemed necessary by the Society.

2. Approval Procedure

2.1 Submission of documents

Application for approval should be sent to the local DNV office together with the following information:

- name and address of the manufacturer
- a list of products for which approval is requested, including product form, grade, thickness and condition of supply
- an outline of the organisation structure including quality control responsibilities
- an outline of manufacturing facilities and equipment
- manufacturing flow chart(s) indicating all process steps and the associated testing and inspection points
- reference to written procedures for testing and inspection. Procedures need not be submitted, but must be available for review at the manufacturer's works upon request
- a list of equipment used for chemical analysis, mechanical testing, metallographic examination, non-destructive testing and thickness measurements
- qualifications of personnel engaged in testing and inspection
- description of the system used for product identification and traceability.

2.2 Works inspection

After receipt and review of the information requested in 2.1 the DNV surveyor will carry out a works inspection to verify that the necessary manufacturing, testing, and inspection facilities are available and supervised by qualified personnel.

2.3 Submission of approval test report

On completion of approval testing, the manufacturer is to submit a report containing the information and test data requested in sections 3 and 4. The report is to be signed and dated by the manufacturer's representative and endorsed by the surveyor witnessing the tests.

2.4 Approval of manufacturer certificate

Manufacturers whose works has been inspected and whose approval documentation has been reviewed with satisfactory result will be granted an "Approval of manufacturer certificate" and an entry made in DNV's publication "Register of approved manufacturers".

3. Information on Manufacturing Route

This section lists the information to be provided relevant to the manufacturing route for those products tested per section 4. For the approval of steelmaking and delivery of semi-finished products only, sub-sections 3.1 to 3.4 apply.

3.1 Steelmaking

- steelmaking process and capacity of furnace
- hot metal ratio and composition. Type of scrap used
- deoxidation and fine grain practice
- refining and alloying practice, when relevant
- ladle treatment; e.g. vacuum degassing, desulphurisation, Ar or N₂ rinsing.

3.2 Casting

- type of casting machine (when continuously cast) and teeming practice. Any method used for prevention of re-oxidation and reduction of oxide inclusions and segregation (stream shrouding, submerged teeming, argon flushing in the mould via the stopper rod, electromagnetic stirring etc.) should be stated
- slab/bloom/billet size (when continuously cast)
- type of mould (when ingot cast). Top pouring or bottom pouring to be stated
- ingot size and weight.

3.3 Slabbing/blooming of ingots

- soaking temperature and time for ingots
- rolling temperatures
- slab/bloom/billet size.

3.4 Conditioning of semi-finished steel

- slab/bloom/billet scarfing or grinding
- hydrogen diffusion treatment, if applied.

3.5 Reheating and finish rolling

- reheating temperature and time in furnace
- rolling and finishing temperatures
- for controlled rolling or thermo-mechanical controlled processing a detailed description of the rolling schedule is to be presented including reheating, rolling and finishing temperatures, reduction ratio for the final few passes, cooling conditions etc.
- descaling treatment during rolling
- plate thickness and width, section size.

3.6 Heat treatment

- type of furnace and dimensions, heating source, positions of temperature control instruments
- heat treatment records for temperatures and holding times, and where applicable information on heating and cooling rates, quenching medium and cooling medium after tempering
- roller quenching to be stated, if used
- any re-heat treatment to be stated.

3.7 Plates produced from coil

For plates produced from coil, the following additional information is to be submitted:

- minimum and maximum coil weight
- minimum and maximum strip thickness and width.
- minimum inner coil diameter
- rolling finishing temperatures and cooling conditions after rolling. Aim temperature range for rolling finishing to be stated
- coiling temperatures. Aim temperature range to be stated
- description of the system for temperature control during rolling and coiling
- routines for control of strip dimensions.

4. Approval Testing

4.1 General requirements

- Unless otherwise specified herein, the testing procedures, test piece shape, test piece location and orientation, and test results are to comply with the appropriate requirements of the Rules part 2.
- Approval tests, except for determination of chemical composition and metallographic examination, are to be witnessed by DNV's surveyor, unless carried out at a recognised independent laboratory.
- For the approval of steelmaking and delivery of semi-finished products only, sub-sections 4.2 a) and 4.3 apply.

4.2 Test material

- Except as specified in 4.5 d), 4.6 and 4.9, the testing is to be carried out on two different heats.
- One product from each heat is to be sampled. The products should represent the maximum thickness and the average thickness, respectively, for which approval is requested.

- The sample products are to originate from the top of the ingot or, in case of continuous casting, preferably from the tail end of the string (after cutting of discards).

4.3 Chemical composition

- The chemical composition, as determined by heat analysis, is to comprise the elements C, Si, Mn, P, S, Cu, Cr, Ni, Mo, V, Nb, Ti, Al, and N, as well as any other element intentionally added.
- Steels manufactured from electric or open-hearth furnace are in addition to be analysed for the elements Sn, Sb, As and B.
- A summary of the sampling practices and methods for chemical analysis is to be submitted.
- For steels supplied in controlled rolled or thermo-mechanical treated condition composition limits are to be specified for the relevant fine grain elements and any combinations thereof, e.g. Al, Al+Nb, Al+V, Al+Nb+Ti, Al+Nb+V.

4.4 Tensile testing

- Tensile tests are to be made from both ends of each sample product. Yield (or proof) stress, tensile strength, elongation and reduction of area is to be reported.
- For each controlled rolled or thermo-mechanical treated plate, one additional tensile test is to be made from material in stress relieved condition. The stress relieving temperature should not be less than 580°C with holding time 1 hour per 25 mm thickness, unless justified.
- For plate produced from coil, tensile tests are to be made from both ends and the approximate center lap of each coil.

4.5 Impact testing

- Longitudinal and transverse Charpy V-notch impact tests are to be made from both ends of each sample product. The test piece orientation, test temperature and absorbed energy (average and single values) is to be reported.
- Steel grade NV A with thickness up to maximum 50 mm is to be tested at +20°C and comply with average energy 27 J longitudinal and 20 J transverse, respectively.
- For plate produced from coil, longitudinal and transverse Charpy V-notch impact tests are to be made from both ends and the approximate center lap of each coil.
- The Charpy V-notch impact transition behavior is to be established for the thickest sample product of one heat. Longitudinal tests from one end of the product are to be made. The test temperature range is to be wide enough to establish the upper and lower shelf energies, with at least two tests at intermediate temperatures. The heat number, test temperatures and absorbed energies (average and single values) are to be reported. The results should also be plotted in the form of a transition curve.

4.6 Strain age testing

- a) Strain age testing is to be performed on material taken from the thickest sample product of one heat. Longitudinal Charpy V-notch tests from one end of the product are to be made for the material in the following conditions:
 - five percent strained
 - five percent strained and aged at 250°C for 30 minutes.
- b) Testing is to be made at the temperature prescribed in the Rules and at temperature increments of 20°C up to +20°C. Grade NV A with thickness up to maximum 50 mm is to be tested at 0°C and +20°C. The heat number, test conditions and absorbed energies (average and single values) are to be reported.
- c) The requirement for the tests is that the energy values comply with those specified in the Rules at the prescribed test temperature. Grade NV A with thickness up to maximum 50 mm is to comply with average energy 27 J at +20°C.

4.7 Metallographic examination

Photomicrographs showing the microstructure at 100x and 500x magnification are to be presented. One set to be taken near the surface and one set from the mid-thickness of the product. The ferrite grain size is to be reported, except for steel supplied in thermo-mechanical treated or quenched and tempered condition.

4.8 Drop weight testing

- a) Drop weight testing is required for plates for low temperature service where minimum design temperature is -55°C or lower, except for grade NV 9 Ni.
- b) Testing is to be performed in accordance with ASTM E 208 or similar standard, preferably using specimen type P1 or P2. The drop weight energy used and the hardness of the weld deposit is to be reported. Photographs of the tested specimens are to be submitted.
- c) The test specimens are to display a 'no break' performance when tested 5°C below the design temperature.

4.9 Weldability testing

- a) Weldability testing is required for plates with minimum specified yield stress 355 N/mm² or higher and for all steel grades impact tested at -40°C or lower, regardless of strength groups. Testing is not required for sections.
- b) Two butt weld assemblies with K-bevel or single-bevel (1/2V) are to be prepared with axis parallel to the final rolling direction in plate of the maximum thickness of one heat.

- c) Welds are to be made in the flat position with the SAW process, except that another welding process may be employed for the root pass. One weld is to be made at the lowest preheat, interpass temperature, and heat input recommended for production welding, the other at the highest. Welding parameters are to be recorded.
- d) Unless otherwise recommended for production welding, the heat input range should encompass at least 1,5 to 5 kJ/mm, the minimum preheat should not be greater than 100°C, and the maximum interpass temperature should not be less than 250°C.
- e) The weld assemblies are to be tested in both as-welded and stress relieved condition for:
 - structural plate when thickness exceeds 50 mm
 - boiler and pressure vessel plate when thickness exceeds 20 mm
 - low temperature plate in all thicknesses.
- f) The following tests are to be performed for each assembly:
 - one cross weld tensile test
 - five sets of Charpy V-notch impact tests with the notch positioned in the weld centre, fusion line (straight side of the weld) and in HAZ at distances 2, 5, and 20 mm from the fusion line, respectively
 - hardness tests (HV 5) across the weldment 1 to 2 mm beneath the surface with a minimum of three individual indentations made in the weld metal, in the HAZ (both sides) and in the unaffected base material (both sides).
- g) The requirements for the tests are:
 - The tensile strength is to meet or exceed the specified minimum value of the base material. The location of fracture is to be reported.
 - The Charpy V-notch test temperature and energy values, except for the weld metal, are to comply with the requirements specified for the base material.
 - Hardness values in as-welded condition, except for the weld metal, less than or equal to 350 HV5 are generally acceptable for steel with specified minimum yield stress 500 N/mm² or lower. For higher strength steel 400 HV5 is generally acceptable. When higher hardness values are recorded, the HAZ cracking susceptibility is to be additionally documented.

5. References

- 1) ASTM standard E 208.