Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels

Object to Amendment

Guidance for the Survey and Construction of Steel Ships Part K
Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use

Reason for Amendment

At the 106th meeting of the Maritime Safety Committee (MSC 106) held in November 2022, amendments to the IGF Code and IGC Code were adopted as Resolutions MSC 523(106) and 524(106) to incorporate requirements for high manganese austenitic steels. Such steels as a tank material equivalent to nickel steel is expected, it will start being allowed by both codes on 1 January 2026.

The properties of high manganese austenitic steels and the requirements for approval tests and shipping tests to verify them are specified in MSC.1/Circ.1599/Rev.2, which is referred to in the above resolutions. IACS, in turn, adopted IACS Recommendation No. 169 in September 2021 to prescribes a more specific treatment with reference to the IACS Unified Requirement (UR) W11 and other UR related to rolled steel for ship hulls which have an established track record of application.

The Society plans to revise Part GF and Part N of the Rules for the Survey and Construction of Steel Ships, which incorporate the IGF Code and the IGC Code, in response to these amendments to both codes, but in order to be able to respond to each test application at the time when the two MSC resolutions enter into force, the Society decided to revise Part K of the Rules for the Survey and Construction of Steel Ships and the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use, and develop related requirements ahead of time.

Accordingly, related requirements are amended in reference to IACS Recommendation No. 169.

Outline of the Amendment

Specify requirements for approval of manufacturing methods and shipping tests of high manganese austenitic steels.

Effective Date and application

(1) Part K of the Guidance for the Survey and Construction of Steel Ships
    1. This draft amendment applies to steel plates for which the application for survey is submitted to the Society on or after the date of establishment.
    2. Notwithstanding the preceding 1, this draft amendment may be applied to steel plates for which the date of the application for survey is before the effective date upon request.

(2) Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use
    1. This draft amendment applies to steel plates for which the application for approval is submitted to the Society on or after the date of establishment.
    2. Notwithstanding the preceding 1, this draft amendment may be applied to steel

plates for which the date of the application for approval is before the effective date upon request.

ID: DH24-05

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS **Part K MATERIALS**	**GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS** **Part K MATERIALS**	
K1 GENERAL	**K1 GENERAL**	
K1.1 General	**K1.1 General**	
K1.1.1 Application	**K1.1.1 Application**	
1 Stiffeners for boiler used the rolled steel bar are to comply with the **Annex K1.1.1-1** "**GUIDANCE RELATING TO ROLLED STEEL BAR FOR BOILERS**".	**1** Stiffeners for boiler used the rolled steel bar are to comply with the **Annex K1.1.1-1** "**GUIDANCE RELATING TO ROLLED STEEL BAR FOR BOILERS**".	
2 Seamless shells of boilers made of steel forgings are to comply with the **Annex K1.1.1-2** "**GUIDANCE FOR SEAMLESS FORGED STEEL DRUMS**" of this Part.	**2** Seamless shells of boilers made of steel forgings are to comply with the **Annex K1.1.1-2** "**GUIDANCE FOR SEAMLESS FORGED STEEL DRUMS**" of this Part.	
3 High manganese austenitic steels used for tanks and hull structures adjacent to tanks of liquefied gas carriers or ships using low-flashpoint fuels are to comply with **Annex K1.1.1-3** "**Guidance relating to High Manganese Austenitic Steel**" of this part.	(Newly added)	
4 In the application of **1.1.1-3, Part K of the Rules for the Survey and Construction of Steel Ships**, those pipes made from metallic materials other than steels (for example titanium pipes, including primary material of pipes) are to be accordance with **Chapter 2, Part 1 of the Guidance for the Approval and Type Approval of Materials and Equipment**	**3** In the application of **1.1.1-3**, **Part K of the Rules for the Survey and Construction of Steel Ships**, those pipes made from metallic materials other than steels (for example titanium pipes, including primary material of pipes) are to be accordance with **Chapter 2**, **Part 1 of the Guidance for the Approval and Type Approval of Materials and Equipment**	Moved

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
for Marine Use.	**for Marine Use**.	
Annex K1.1.1-3 GUIDANCE RELATING TO HIGH MANGANESE AUSTENITIC STEELS	(Newly added)	To specify in reference to IACS Recommendation No. 169.
1.1 High Manganese Austenitic Steels	(Newly added)	
1.1.1 Application	(Newly added)	
1 This annex specifies batch release testing of high manganese austenitic steels for cryogenic service.	(Newly added)	
2 This annex applies to steel plates with thicknesses between 6 *mm* to 40 *mm* or less. The requirements for steels plates having thicknesses exceeding 40 *mm* are at the discretion of the Society.	(Newly added)	
3 High manganese austenitic steels differing in chemical composition, deoxidation practice, condition of supply and mechanical properties may be considered, subject to special approval by the Society.	(Newly added)	
1.1.2 Definitions	(Newly added)	
1 "High manganese austenitic steel" means steel with a high amount of manganese in order to retain austenite as its primary phase at atmospheric and service temperatures.	(Newly added)	
2 "Piece" means the rolled product from a single slab, billet or ingot when rolled directly into plates.	(Newly added)	
1.1.3 Approval	(Newly added)	
1 High manganese austenitic steel plates, unless otherwise specially provided or deemed appropriate by the Society, are to be manufactured at steel works which have	(Newly added)	

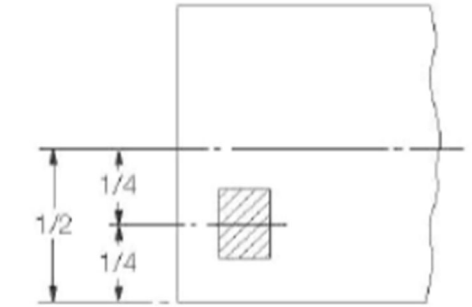
Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
been approved by the Society. The suitability of steel plates for forming and welding are to be demonstrated during the initial approval test at the steelworks. Approval of the steelworks is to follow a scheme given in **Chapter 1, Part 1 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.		
2 Manufacturers are responsible for assuring that effective quality, process and production controls during manufacturing adhered to manufacturing specifications. Manufacturing specifications are to be submitted to the Society at the time of initial approval.	(Newly added)	
3 Where non-conformities arise, manufacturers are to identify the cause and establish countermeasures to prevent recurrence. In addition, such non-conformities and countermeasures are to be documented and reported to the Society.	(Newly added)	
1.1.4 Deoxidation Practice and Chemical Composition	(Newly added)	
1 The deoxidation practice is to be fully killed for steel plates.	(Newly added)	
2 Steel plates are to be fine grain treated and have fine grain structures. The fine grain practice is to be as detailed in the manufacturing specification.	(Newly added)	
3 The chemical composition of samples taken from each ladle of each cast is to be determined by manufacturers in an adequately equipped and competently staffed laboratory and is to comply with the standards listed in **Table 1**.	(Newly added)	
4 Aim analysis is to be in accordance with manufacturing specifications, and all the elements listed in **Table 1** are to be reported.	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr><td>Table 1 Chemical Composition for High Manganese Austenitic Steel Plates
<table>
<tr><th rowspan="2">Grade</th><th colspan="9">Chemical composition (%)</th></tr>
<tr><th>C</th><th>Si</th><th>Mn</th><th>P</th><th>S</th><th>Cr</th><th>B</th><th>N</th><th>Cu</th></tr>
<tr><td>KHMA400</td><td>0.35–0.55</td><td>0.10–0.50</td><td>22.50–25.50</td><td>≤ 0.030</td><td>≤ 0.010</td><td>3.00–4.00</td><td>≤ 0.005</td><td>≤ 0.050</td><td>0.30–0.70</td></tr>
</table>
Notes:
(1) The content of other elements used for alloying and fine grain treatment may be specified by manufacturers, as appropriate.
(2) Silicon (Si) may be less than 0.1 %, provided total aluminium is 0.03 % or higher, or provided acid soluble aluminium is 0.025 % or higher.</td><td></td><td></td></tr>
<tr><td>1.1.5 Heat Treatment and Reduction Ratio</td><td>(Newly added)</td><td></td></tr>
<tr><td>1 The heat treatment for all material is to be hot rolled with subsequent controlled cooling if necessary. Other heat treatment are to be as deemed appropriate by the Society.</td><td>(Newly added)</td><td></td></tr>
<tr><td>2 The reduction ratio of slab to finished product thickness is to be not less than 3:1.</td><td>(Newly added)</td><td></td></tr>
<tr><td>1.1.6 Mechanical Properties</td><td>(Newly added)</td><td></td></tr>
<tr><td>Material specifications for high manganese austenitic steel plates are to be as listed in Table 2.</td><td>(Newly added)</td><td></td></tr>
<tr><td>Table 2 Conditions of Grade and Mechanical Properties for High Manganese Austenitic Steel Plates
<table>
<tr><th rowspan="3">Grade</th><th colspan="3">Tensile test</th><th colspan="3">Impact test</th></tr>
<tr><th rowspan="2">Yield point or proof stress (N/mm²)</th><th rowspan="2">Tensile strength (N/mm²)</th><th rowspan="2">Elongation (%) min</th><th rowspan="2">Testing temperature (°C)</th><th colspan="2">Minimum mean absorbed energy (J)</th></tr>
<tr><th>T</th><th>L</th></tr>
<tr><td>KHMA400</td><td>≥ 400</td><td>800–970</td><td>≥ 22</td><td>−196</td><td>≥ 27</td><td>≥ 41</td></tr>
</table></td><td></td><td></td></tr>
<tr><td>1.1.7 Test Sample Selection</td><td>(Newly added)</td><td></td></tr>
<tr><td>1 One test sample which test specimens are cut is to be taken from each piece.</td><td>(Newly added)</td><td></td></tr>
<tr><td>2 The samples of steel plates are to be treated together</td><td>(Newly added)</td><td></td></tr>
</table>

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
with and in the same way as the steel presented, and are not to be cut from the material until heat treatment has been completed.		
3 Test specimens are not to be heat treated separately from test samples in any way.	(Newly added)	
4 Unless otherwise agreed, test samples are to be taken from one end at a position approximately midway between the axis in the direction of the rolling and the edge of the rolled product according to **Fig. 1**.	(Newly added)	
Fig. 1 Test Sample Location 	(Newly added)	
1.1.8 Test Specimen Selection	(Newly added)	
1 Test specimens are not to be heat treated separately from test samples in any way.	(Newly added)	
2 Tensile test specimens are to be taken as follows. (1) One test specimen is to be taken from one test sample. (2) Test specimens are to be taken with their longitudinal axes normal to the final direction of rolling (*T* direction). (3) Test specimens of full product thickness are to be	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
used.		
3 Impact test specimens are to be taken as follows. (1) A set of test specimens is to be taken from one test sample. (2) Test specimens are to be taken with their longitudinal axes normal (*T* direction) to the final direction of rolling. When deemed necessary by the Society, however, they are to be taken with their longitudinal axes parallel (*L* direction) to the final direction of rolling. (3) When product thickness does not exceed 40 *mm*, test specimens are to be cut with their edges within 2 *mm* from the "as rolled" surface.	(Newly added)	
1.1.9 Verification of Dimensions	(Newly added)	
Unless otherwise specially provided or deemed appropriate by the Society, the thickness tolerances of high manganese austenitic steel plates are to be in accordance with **3.1.8, Part K of the Rules**.	(Newly added)	
1.1.10 Surface Quality and Internal Soundness	(Newly added)	
1 Steel plates are to be reasonably free from segregations and non-metallic inclusions.	(Newly added)	
2 The finished material is to have a workmanlike finish and is to be free from internal and surface defects prejudicial to the use of the material for its intended application.	(Newly added)	
3 The surface finishes of steel plates are to be in accordance with **3.1.9-1, Part K of the Rules**.	(Newly added)	
4 Manufacturers are responsible for verifying internal soundness, acceptance by a Society surveyor does not absolve manufacturers of this responsibility.	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
1.1.11 Retest Procedures	(Newly added)	
1 Where the tensile test fails to meet the requirements, retest procedures for tensile tests and Charpy impact tests are to be in accordance with **1.4.4, Part K of the Rules**.	(Newly added)	
2 For the impact test, retest may be conducted in accordance with **3.1.10-3, Part K of the Rules**.	(Newly added)	
1.1.12 Marking	(Newly added)	
1 Steel plates which have passed required tests are to be marked with identification marks in accordance with **1.5.1, Part K of the Rules**.	(Newly added)	
2 In the case of high manganese austenitic steels that have been corrosion tested for ammonia compatibility during manufacturing process approval testing and confirmed to be suitable for ammonia environments, "*A*" is added to the marking. (Example: *KHMA*400-*A*)	(Newly added)	Specify requirements for identification to distinguish steel plates when ammonia compatibility corrosion tests for optional compliance requirements have been performed.
EFFECTIVE DATE AND APPLICATION **1.** The effective date of the amendments is [the date of establishment]. **2.** Notwithstanding the amendments to the Guidance, the current requirements apply to the steel plates for which the application for survey is submitted to the Society before the effective date. **3.** Notwithstanding the provision of preceding 2., the amendments to the Guidance may apply to the steel plates for which the application for survey is submitted to the Society before the effective date upon request by the manufacturer.		

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
GUIDANCE FOR THE APPROVAL AND TYPE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE **Part I GENERAL**	**GUIDANCE FOR THE APPROVAL AND TYPE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE** **Part I GENERAL**	
Part 1 METALLIC MATERIALS	**Part 1 METALLIC MATERIALS**	
Chapter 1 APPROVAL OF MANUFACTURING PROCESS OF ROLLED STEELS	**Chapter 1 APPROVAL OF MANUFACTURING PROCESS OF ROLLED STEELS**	
1.1 General	**1.1 General**	
1.1.2 Materials Not Covered by this Chapter	(Newly added)	
Notwithstanding the preceding **1.1.1**, **Annex 1.3** correspondingly applies to the tests and inspections for the manufacturing process approval for high manganese austenitic steels.	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
Annex1.3 Manufacturing Approval Schemes for High Manganese Austenitic Steels	(Newly added)	
1.1 General	(Newly added)	
1.1.1 Scope	(Newly added)	
1 In accordance **1.1.2, Part 1**, this annex applies to tests and inspections for the manufacturing process approval for high manganese austenitic steels.	(Newly added)	
2 The manufacturing approval scheme specified in this annex is for verifying manufacturer capability to provide satisfactory products stably under effective process and production controls.	(Newly added)	
3 In cases where semi-finished products manufactured by other manufacturers are used, such semi-finished products are to be manufactured by the approved processes specified in **Chapter 1B, Part 1**.	(Newly added)	
1.2 Approval Application	(Newly added)	
1.2.1 Approval Application Form	(Newly added)	
Manufacturers who apply for manufacturing process approval for high manganese austenitic steels are to submit a copy of the appropriate application form (**Form 1-1**) filled in with the required data and information to the Society (branch office concerned).	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
1.2.2 Documents to be Submitted	(Newly added)	
1 The following **(1)** and **(2)** documents are to be submitted together with the appropriate application form specified in **1.2.1**. (1) Approval test plan (2) The following **(a)** through **(p)** technical data (a) Data on works i) Name and location of the works ii) General indications relevant to the background iii) Dimension and size of the works iv) Organisational chart and number of staff employed v) Estimated total annual production of finished and semi-finished products (for shipbuilding and for other applications) (b) Data on quality control system i) Organisation and number of staff employed by quality control department ii) Qualification of personnel involved in activities related to the quality of the products iii) Items and methods for quality control system iv) Outline of system used for identification of materials v) Outline of testing machines and relevant calibration procedures and records vi) Outline of equipment used for chemical analyses and metallography, and relevant calibration procedures	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
vii) Outline of equipment used for non-destructive tests and relevant calibration procedures viii) Inspection and test procedures and corresponding standards ix) Qualification of personnel involved in activities related to inspections and tests x) List of documents for equipment used for mechanical tests, chemical analyses and metallography, and non-destructive testing xi) Certification of compliance of the quality system with *ISO* 9001, if any xii) Where approval has already been granted for **viii)** by other classification societies, certification (a copy) of such approval (c) Data on steel plates i) Type of product, grade of steel and condition of heat treatment ii) Maximum manufacturing thickness or dimensions iii) Deoxidation practice and grain refining elements iv) Manufacturing control standard for each chemical composition (if system of constituent depends on grade, thickness, heat treatment, etc., the different ranges are to be specified, as appropriate. In cases where grain refining, micro alloying and residual elements, including *Zr*, *Ca* or rare earth metals, are added, the manufacturing control standard for each element is to be specified		

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
along with the aim of addition. v) Actual manufacturing records within the specific period (chemical composition, mechanical properties and thickness or dimension are expressed in the form of histograms or statistics for each heat treatment) (d) Data on manufacturing process i) Origin and storage of raw materials ii) Flow chart of the manufacturing process iii) Outline of major manufacturing facilities (including control methods) iv) Storage of finished and semi-finished products (e) Data on steel making process i) Outline of steel making process ii) Type and capacity of steel making furnace and number of daily charges iii) Raw materials and sub materials iv) Deoxidation, grain refining, refining and secondary refining practice v) Type of desulphurisation, dehydrogenation, sulphide treatment, ladle refining or vacuum degassing installations vi) Casting methods (ingot casting or continuous casting) vii) Casting/Solidification cooling rate control viii) Scarfing and discarding procedures of ingot or semi-finished products ix) Size and weight of ingot or semi-finished products		

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
(f) Additional data in the case of applying continuous casting i) Outline of continuous casting machine (including type of casting machine, number of strand, casting practice, casting temperature, casting speed etc.) ii) Preventive methods for re-oxidation of charge iii) Reduction methods for non-metallic inclusions iv) Preventive methods for segregation v) Presence of electromagnetic stirring vi) Presence of soft reduction system (g) Data on ingot or semi-finished product reheating process i) Outline of heating furnace (including type and capacity) ii) Heating temperature and holding time (h) Data on rolling process i) Outline of rolling machine (including type and capacity of rolling machine and control methods of thickness and temperature) ii) Starting and finishing temperature of rough and finish rolling (if the temperature depends upon grade of steel and thickness, the differences are to be clearly indicated) iii) Reduction ratio (if the ratio depends upon grade of steel and thickness, the differences are to be clearly indicated) iv) Outline of descaling device (i) Additional data in case of applying *CR/NR* or		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
TMCP. i) Outline of *CR/NR* or *TMCP* process (including control methods of thickness and temperature and calibration method of the control equipment) ii) Re-crystallisation temperature, *Ar*3 temperature and its determination methods iii) Control standards for controlled rolling (including control ranges for thickness and temperature at the beginning and the end of rough and finish rolling) iv) Outline of Accelerated Cooling (*AcC*) (including outline of cooling system, cooling method, temperature range, cooling speed and cooling measure in a uniform way) v) Actual manufacturing records within the specific period (in addition to **(c)v)** above, description of relationship between tensile strength and carbon equivalent, and variation of mechanical properties in the direction of rolling, the direction of the steel plate width and the direction of thickness) vi) Recommendations relevant to cold and hot working after shipment (only cases where special attention is needed) vii) Range of available welding heat input (where the upper limit of welding heat input exceeds 30 *kJ*/*cm*) viii) Minimum and maximum heat input and recommended pre-heat/interpass temperatures for welding work		

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
(j) Data on heat treatment process i) Outline of heat treatment furnace (including type and capacity) ii) Methods used to determine austenitising temperature, re-crystallisation temperature and *Ar*3 temperature iii) Rate of temperature increase, heating temperature and unit holding time per *mm* (if these depend upon grade of steel and thickness, the differences are to be clearly indicated) iv) Cooling method and cooling rate (if these depend upon grade of steel and thickness, the differences are to be clearly indicated) v) Accuracy and calibration of temperature control device vi) Measurement methods of temperature for each process (k) Data on product surface inspection i) Acceptance criteria and applicable standards for surface inspections ii) Number of operators, personnel arrangement, distances between operators and products during inspection (including diagram) iii) Luminance of inspection site (l) Data on product internal soundness i) Test procedures and applicable standards for verification of internal soundness ii) Acceptance criteria and applicable standards for internal imperfections		

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
iii) Verification method of internal soundness (including frequency of internal inspections, and steel grade, thickness, etc., of applicable steel plates.) (m) Recommendations for working and welding in particular i) Cold and hot working recommendations if needed in addition to the normal practice used in the shipyards and workshops ii) Minimum and maximum heat input and recommended pre-heat/interpass temperature (n) Technical documents demonstrating that the percent of the ductile fracture surface at −196°C is 100 % by fractography (such as *SEM*) (o) Where approval has already been granted by other classification societies, documentation of such approval tests performed (p) Other data deemed necessary by the Society		
2 Where any part of manufacturing process is assigned to other works, additional information relevant to the name and address of the works in question together with the organisation and method of inspection for the materials of which the manufacturing process is assigned are to be included.	(Newly added)	
3 Notwithstanding the preceding **-1**, where documents are duplicates of ones submitted at a previous approval for the same product type, grade, deoxidation practice, etc., part or all of the documents may be omitted. However, the approval test specified in **1.4** is required, and the approval test plan specified in **-1(1)** is not be exempted from submission.	(Newly added)	

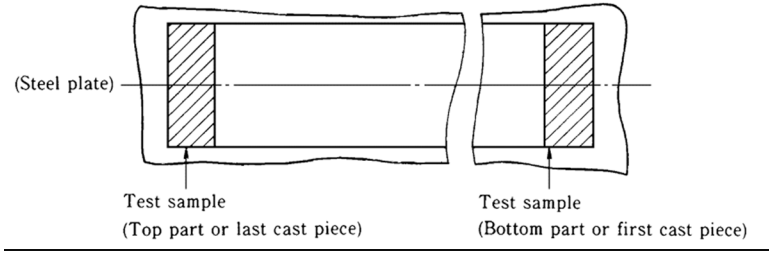
Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
1.3 Preliminary Examination	(Newly added)	
1.3.1 Test Plan Approval	(Newly added)	
Prior to approval tests, the Society is to examine approval test plans submitted in accordance with **1.2.2-1**, and where deemed appropriate, approve said plans and return them to manufacturers.	(Newly added)	
1.3.2 Manufacturing and Quality Control Procedure Confirmation	(Newly added)	
1 The Society may carry out surveys of the actual situations of works on the basis of the data submitted in accordance with **1.2.2**, as it deems necessary. In such cases, manufacturers are to provide the necessary information related to such surveys.	(Newly added)	
2 The timing of surveys required in accordance with the preceding **-1** is, in principle, to correspond to either the time of steel rolling or the time when the approval tests are carried out.	(Newly added)	
1.4 Approval Tests	(Newly added)	
1.4.1 Extent of the Approval Tests	(Newly added)	
1 Approval for any steel plates may also cover approval for any similar steel plates provided that the kind, deoxidation practice, heat treatment, steel making process, steel casting process, maximum manufacturing thickness or dimensions are same and the range of manufacturing control standards of chemical composition is similar to the test samples in cases	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
where deemed appropriate by the Society.		
2 Manufacturers manufacturing steel plates in accordance with the approved processes given in this annex are also considered to have obtained the approval of the Society based upon **Chapter 1B, Part 1** with regard to semi-finished products manufactured by approved processes.	(Newly added)	
3 In the case of manufacturing steel plates from semi-finished products manufactured by other works, manufacturers are to carry out approval tests in accordance with **1.4**, and the manufacturing processes using such semi-finished products are to be approved by the Society.	(Newly added)	
1.4.2 Test Sample Selection	(Newly added)	
1 Test samples used for approval tests are to be selected as follows: (1) Test samples are, in principle, to be selected for each grade and kind by each charge of rolled steels for which the deoxidation practice, grain refining and micro-alloying elements, heat treatment, steel making process and steel casting process are same, based upon typical chemical composition. (2) In the case of ingot casting, test samples are to be selected from steels corresponding to the top of the ingot, except where specially approved by the Society. (3) In the case of continuous casting, test samples are to be selected from steels directly rolled from semi-finished products. (4) Test samples of ingots or semi-finished products are also to be selected according to each casting process.	(Newly added)	
2 The plate thicknesses or dimensions of test samples are	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
to be maximum manufacturing thicknesses or maximum dimensions. Moreover, in cases where steel plates are manufactured from the continuous casting slabs, maximum manufactured thickness is to be determined with a reduction ratio of 3 as the standard.		
3 In addition to preceding **-2**, the Society requires the selection of two test plates of average thickness for initial approval.	(Newly added)	
4 Test samples are to be taken from one end at a position approximately midway between the axis in the direction of the rolling and the edge of the rolled product.	(Newly added)	
Fig. 1.3-1 Example of Test Sample Selection  	(Newly added)	
1.4.3 Test Details	(Newly added)	
1 Approval test items, test procedures and judgement standards are to be accordance with **Table 1.3-1**, **Table 1.3-2** and **Table 1.3-3**. However, when deemed necessary, the Society may request additional test pieces and additional test items (except for test items given in **Table 1.3-1**, **Table 1.3-2** and **Table 1.3-3** which are for tests related to hot workability, fatigue tests, weld cracking tests, *CTOD* tests of welded joints, etc.) and submission of proper technical information.	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
2 Tests which cannot be carried out at the works are to be carried out by proper test organizations after obtaining Society approval.	(Newly added)	
3 In the case of following **(1)** through **(3)**, the Society is to consider such content and may omit part or all of the approval tests. (1) Changes in the approval contents specified in **1.5.4**. (2) Manufacturing process and the test results have been approved by another classification society and the manufacturer has data showing actual manufacturing records within a suitable period (chemical composition, mechanical properties and thickness or dimension expressed in the form of histograms or statistics) (3) Where manufacturer uses slabs from multiple slab manufacturers or changes slab manufacturer, and the following **(a)** or **(b)** applies. (a) The rolled steel manufacturer has already been approved for the manufacturing process using other semi-finished products characterised by the same thickness, steel grade, grain refining and micro-alloying elements, steel making and casting process. (b) The semi-finished product manufacturer has been approved for the complete manufacturing process with the same conditions (steelmaking, casting, rolling and heat treatment) for the same type of steel.	(Newly added)	
4 Corrosion tests for ammonia compatibility carried out at the request of the manufacturer are to comply with *MSC*.1/*Circ*.1599/*Rev*.2.	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
1.4.4 Surveyor Attendance at Tests	(Newly added)	
A Society surveyor is, in principle, to be present when the test samples for approval tests are being identified and when approval tests are being carried out.	(Newly added)	
1.4.5 Test Reports	(Newly added)	
1 Manufacturers are to submit all tests results together with all information and manufacturing records relevant to the steel making, casting, rolling and heat treatment.	(Newly added)	
2 The reports specified in the preceding **-1** are to be appended with work records relating to the steel making, ingot-making (casting), rolling and heat treatment of test samples.	(Newly added)	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended

Table 1.3-1 Tests for Base Materials

Approval test item	Selected location of test samples	Length direction of test specimen	Notes
Tensile test	Top and Bottom	Parallel and Transverse	Yield point or proof stress, tensile strength, elongation and reduction in area are to include in test result. ・ Tensile test specimens are to be taken from one test sample. ・ Samples are to be taken from three heats of different compositions. ・ Tensile tests are to be carried out at room temperature and −165°C. ・ Result of tensile tests at −165°C are to be reported for reference. ・ Tensile tests are to be carried out with specimens of full thickness.
V-notch Charpy impact test	Top and Bottom	Parallel and Transverse	The test temperatures are to include at least those listed in **Table 1.3-2**. ・ The test samples are to be taken at a portion which is approximately 1/4 of the thickness from the surface. ・ One set of three *V*-notch Charpy impact specimens is required for each impact test. ・ In addition to the determination of the energy value, the lateral expansion and the percentage crystallinity are also to be reported. The percentage of the ductile fracture surface at −196°C is to be 100 % by fractography (such as *SEM*). ・ Results other than the test results at −196°C are to be treated as reference after verifying the properties at each temperature.
Impact test on strain aged specimens	Top and 1/4t	Parallel	The test temperatures are to include at least those listed in **Table 1.3-2**. ・ The test samples are to be taken at a portion which is approximately 1/4 of the thickness from the surface. ・ One set of three Charpy V notch impact specimens is required for each impact test. ・ The test specimens which have been maintained for one hour at 250°C after strain of 5 % have been applied are, in principle, to be used. ・ Results are to be reported for reference.
Drop weight test	Top	—	The test method is to comply with *ASTM E* 208:2019 or the equivalent thereto. ・ Two specimens for drop weight tests are to be taken from the surface of one test sample. ・ The test temperature is −196°C. ・ The test results are to show no-break performance at −196°C. ・ Photographs of the test specimens are to be taken and included with the test report.
Micro examination	Top	—	Grain size determination is to be carried out. ・ One test specimen for micrographic examination is to be taken from one test sample.

Original

Remarks

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended				Original		Remarks
				• Micrographs are to be taken at ×100 magnification and where austenite grain size exceeds *ASTM E* 112-2013 index 10 or the equivalent thereto, additionally at ×500 magnification. • Austenite grain size is to be measured and the non-metallic inclusions are to be examined. • Micrographs are to be representative of the full thickness. • Results are to be reported for reference.		
Chemical analysis	Top	—		The respective contents of *C*, *Mn*, *Si*, *P*, *S*, *Ni*, *Cr*, *Mo*, *Al*, *N*, *Nb*, *V*, *Ti*, *B*, *Zr*, *Cu*, *As*, *Sn*, *Bi*, *Pb*, *Ca*, *Sb*, *O* and *H* are to be reported. • One test specimen for chemical analysis is to be taken from one test sample. • Both the ladle and product analysis are to be reported. • Materials for product analyses are to be taken from tensile test specimens.		
CTOD test	Top	Transverse		Test methods are to comply with *ISO* 12135:2016, *ASTM E* 1820:2020, *BS* 7448-1:1991 or the equivalent thereto. • Test specimens for *CTOD* tests are to be taken from one test sample. • One set of three *CTOD* specimens is required for each test. • *CTOD* minimum values are to be in accordance with design specifications for testing at room and cryogenic temperatures as per the design conditions. As guidance, a minimum *CTOD* value of 0.2 *mm* is often required.		
S-N Fatigue test	Top	Transverse		Test methods are to comply with *ASTM E* 466:2015 or the equivalent thereto. • A number of test specimens sufficient to obtain *S-N* curves is to be taken from test samples. • The test temperature is room temperature. • *S-N* curves are to be established and the results are to be equal to or better than those obtained using the *FAT* 125-curve of the International Institute of Welding (*IIW*) or the *C*-curve specified in *DNVGL-RP-C* 203-2020. • In cases where appropriate records prepared by manufacturer are available, *S-N* fatigue tests may be waived.		
Fatigue crack growth rate test	Top	Transverse		Test methods are to comply with *ASTM E* 647:2015 or the equivalent thereto. • One test specimen for fatigue crack growth rate is to be taken from one test sample. • The test temperature is room temperature. • Results are to be reported for reference. • In cases where appropriate records prepared by manufacturer are available, fatigue crack growth rate tests may be waived.		
General corrosion test	Top	—		Test methods are to comply with *ASTM G* 31-21 or the equivalent thereto. • One test specimen for corrosion resistance is to be taken from one test sample. • Results are to be reported for reference.		

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks

Elastic modulus test	Top	—	Test methods are to comply with *ASTM E* 494:2015 or the equivalent thereto. · One test specimen for elastic modulus is to be taken from one test sample. · Test temperatures are to at least include room temperature and −165°C. · Results are to be reported for reference.
Stress corrosion crack (*SCC*) test	Top	—	Test methods are to comply with *ASTM G* 36:2018 and *G*123:2015 or the equivalent thereto. Test specimens are to comply with *ASTM G* 30:2016 or the equivalent thereto. · One test specimen for stress corrosion crack is to be taken from one test sample. · Results are to be reported for reference.
Sulphur print	Top	—	· Sulphur prints are to be taken from plate edges which are perpendicular to the axis of the ingot or slab. Said sulfur prints are to be approximately 600 *mm* long taken from the centre of the edge selected, i.e. on the ingot centreline, and are to include the full product thickness.
Intergranular corrosion test	Top	—	Test methods are to comply with *ASTM A* 262:2015 or the equivalent thereto. · One test specimen for corrosion resistance is to be taken from one test sample. · Results are to be reported for reference.

Notes:

(1) In the case of ingot casting, "top" means edge of the top side of the ingot for the length direction specified in **1.4.2-1(2)**, while "bottom" means the edge of the other side. In the case of continuous casting, any edge is available for both edges for the length direction specified in **1.4.2-1(4)**.

(2) "Length direction of test specimen" denotes the direction of the test sample to the direction of final rolling.

Table 1.3-2 Impact Test Temperatures for High Manganese Austenitic Steel Plates

Types of rolled steel plates	Strain aging	Direction of the test specimens	Test temperature (°C)			
High manganese austenitic steels	Non strain aging specimens	Parallel	−196	−165	−100	−65
		Transverse	−196	−165	−100	−65
	Strain aging specimens	Parallel	−196	—	—	—

Note:

(1) "Direction of the test specimens" denotes the direction of the test sample to the final rolling direction.

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks

Table 1.3-3 Tests on Weld Materials

Approval test item	Selected location of test samples	Length direction of test specimen	Notes
Transverse tensile test	Top	Transverse for welding direction	• Two tensile test specimens are to be taken from one test assembly. • Tensile tests are to be carried out at room temperature and −165°C. • The result at tensile test at −165°C is to be reported for reference. • Tensile tests is to be carried out with full thickness.
V-notch Charpy impact test	Top	Transverse for welding direction	Impact specimen notch locations are to be in accordance with **Fig. 1.3-2**. • One set of three *V*-notch Charpy specimens is to be taken. • The test samples are to be taken at a portion where the approximately 1/4 of the thickness from the surface. • The fusion boundary is to be identified by etching the specimens with a suitable reagent. • The impact test temperature is to at least include −196°C. • Additionally at each location, impact tests are to be carried out with appropriate temperature intervals (−196°C, −165°C, −100°C and 0°C) to verify the properties of toughness at each temperature for reference.
Ductile fracture toughness test *J1C*	Top	—	Test methods are to comply with *ASTM E*1820:2020, *ISO* 15653:2018 or the equivalent thereto. • One test specimen is to be taken from the test sample. • Test temperature is to include the cryogenic service temperature. • Test results are to show the satisfactory resistance to unstable ductile fracture. • In cases where appropriate records prepared by manufacturer are available, the test may be waived.
CTOD test	Top	Transverse for welding direction	Test methods are to comply with *ISO* 15653:2018, *ASTM E*1820:2020, or the equivalent thereto. • *CTOD* tests for three specimens transverse to the weld for each condition are to be carried out at a position in the coarse grained heat affected zone (*CGHAZ*). An additional set of *CTOD* tests with notch positions such as FL+1, FL+3, FL+5 may be required by the Society. • *CTOD* minimum values are to be in accordance with the design specifications for testing at room and cryogenic temperatures as per the design conditions. Unless otherwise specified, a minimum *CTOD* value of 0.2 *mm* is standardised.

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended				Original	Remarks
	Hardness test	Top	—	• Hardness tests *HV* 10 across the weldment. Indentations are to be made along a transverse line which is 1~2 *mm* beneath the plate surface on both the face side and the root side of the weld as follows: • Fusion line • *HAZ*: at each 0.7 *mm* from fusion lines into unaffected base material (6 to 7 minimum measurements for each *HAZ*) • Sketches of weld joints depicting groove dimensions, number of passes, hardness indentations are to be attached to test reports together with photomacrographs of the weld cross sections. • At least two rows of indentations are to be carried out in accordance with **Fig. 1.3-3**. • Results are to be reported for reference.	
	Stress corrosion crack (*SCC*) test	Top	Transverse for welding direction	Test methods are to comply with *ASTM G* 36:2018 or the equivalent thereto. Test specimens are to comply with *ASTM G* 58: 2015 or the equivalent thereto. • One test specimen is to be taken from one test assembly. • Results are to be reported for reference.	
	Micro and macro examinations	Top	—	• Micrographs are to be taken at ×100 magnification and where austenite grain size exceeds *ASTM E* 112-2013 index 10 or the equivalent thereto, additionally at × 500 magnification. • Austenite grain size is to be measured and the non-metallic inclusions are to be examined. • Micrographs are to be representative of the full thickness. • Three examinations are to be made at surface, one quarter and mid-thickness of the product. • Results, including metallurgical phases, are to be reported for reference. • One macroscopic photograph is to be representative of transverse section of the welded joint and is to show absence of cracks, lack of penetration, lack of fusion and other injurious defects.	
	Bending test	Top	Parallel for welding direction	• Longitudinal bend tests are to be carried out. • No fracture is to be acceptable after 180° bend over a former diameter 4 *times* test piece thickness.	
	S-N fatigue test	Top	Transverse for welding direction	• A number of test specimens sufficient to obtain *S-N* curves are to be taken from test samples. • The test temperature is room temperature. • *S-N* curves are to be established and their results are to be equal to or better than those obtained from the *FAT* 90-curve in *IIW* or the *D*-curve in *DNVGL-RP-C*	

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks

			203:2020. ・ At the discretion of the Society, *S-N* fatigue tests may be waived.
Fatigue crack growth rate test	Top	—	Test methods are to comply with *ASTM E* 647:2015 or the equivalent thereto. ・ One test specimen for fatigue crack growth rate is to be taken from one test sample. ・ Test specimen notches are to be parallel to welding seams. ・ The test temperature is room temperature. ・ Results are to be reported for reference. ・ As the discretion of the Society, fatigue crack growth rate tests may be waived.
General corrosion test	Top	—	Test methods are to comply with *ASTM G* 31-21 or the equivalent thereto. ・ One test specimen for corrosion resistance is to be taken from one test sample. ・ Results are to be reported for reference.
Intergranular corrosion test	Top	—	Test methods are to comply with *ASTM A* 262:2015 or the equivalent thereto. ・ One test specimen for corrosion resistance is to be taken from one test sample. ・ Results are to be reported for reference.

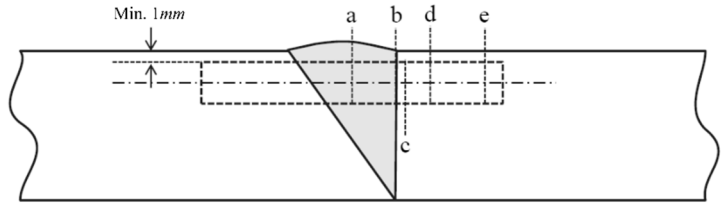
Notes:
(1) Bevel preparation is to be 1/2V or K related to thickness, and test samples are to be welded by procedures commonly used for relevant steel plates in consideration of the welding heat inputs specified in **Table 1.3-4**.
(2) Figures indicating edge preparation details, and layer or pass sequence are to be included in test records, in addition to welding parameters (amperage, voltage, welding speed, heat input, current, etc.), preheating temperatures and interpass temperatures.

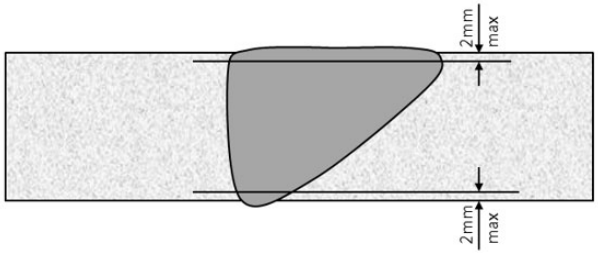
Table 1.3-4 Test Samples for Weldability Tests

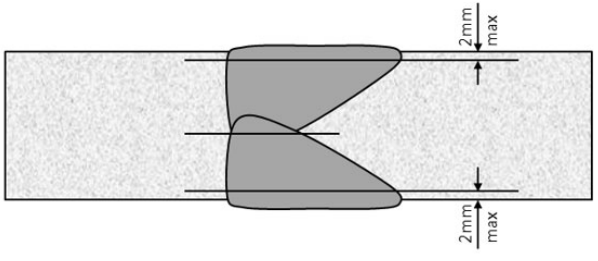
Kind of rolled steel plate	Welding direction of test samples to the final rolling direction of base metal	Test samples
High manganese austenitic steels	Parallel	In principle, the following test samples are to be prepared. (1) One butt weld test assembly welded with a heat input 15 *kJ/cm* ± 10 % (2) One butt weld test assembly welded with a heat input 30 *kJ/cm* ± 10 %

Notes:
(1) In cases where heat input levels higher than 30 *kJ/cm* are to be included in approval requested by, butt-weld test assemblies with the maximum heat input requested for approval are be added as test samples.
(2) Applicable maximum heat inputs are to be indicated in approval applications.
(3) Maximum approved heat input levels may be specified on approval certificates.

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr><td>
Table 1.3-5 Mechanical Properties for Butt Weld Tests
<table>
<tr><th rowspan="2">Tensile strength (N/mm^2)</th><th rowspan="2">Elongation (%)</th><th colspan="2">Charpy impact energy, average</th></tr>
<tr><th>Test temperature. (°C)</th><th>Average energy (J)</th></tr>
<tr><td>≥ 660</td><td>≥ 22.0</td><td>−196</td><td>≥ 27</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>
Fig. 1.3-2 Examples of Notch Locations for Butt Welding Impact Tests


Notch location:
a: Centre of weld metal
b: On fusion line
c: In HAZ, 1 mm from fusion line
d: In HAZ, 3 mm from fusion line
e: In HAZ, 5 mm from fusion line
</td><td></td><td></td></tr>
<tr><td>
Fig. 1.3-3 Examples of Hardness Tests with Rows of Indentations in Butt Welds


(1) Bevel preparation is to be 1/2V


(2) Bevel preparation is to be K
</td><td></td><td></td></tr>
<tr><td>1.5 Approval</td><td>(Newly added)</td><td></td></tr>
<tr><td>1.5.1 General</td><td>(Newly added)</td><td></td></tr>
<tr><td>Requirements regarding approval are to comply with 1.5, Part 1.</td><td>(Newly added)</td><td></td></tr>
</table>

Amended-Original Requirements Comparison Table
(Approval of Manufacturing Process and Shipping Tests of High Manganese Austenitic Steels)

Amended	Original	Remarks
1.6 Treatment after Approval	(Newly added)	
1.6.1 General	(Newly added)	
Requirements regarding treatment after approval are to comply with **1.6, Part 1**.	(Newly added)	
EFFECTIVE DATE AND APPLICATION **1.** The effective date of the amendments is [the date of establishment]. **2.** Notwithstanding the amendments to the Guidance, the current requirements apply to the steel plates for which the application for approval is submitted to the Society before the effective date. **3.** Notwithstanding the provision of preceding **2.**, the amendments to the Guidance may apply to the steel plates for which the application for approval is submitted to the Society before the effective date upon request by the manufacturer.		