

Technical Requirements Specification

Steel EN 1.4404 (316L) plates for non-DT in-vessel usage

This specification covers the supply of Grade 316L steel (EN 1.4404) plates for use by in-vessel components during non-DT operations.

Approval Process			
	Name	Action	Job Title / Affiliation
Signatory	Bao L.	23 Apr 2026:signed	First Wall Engineer
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Reviewers	Rem M.	24 Apr 2026:recommended (Short Cycle)	Quality Engineer
Previous Versions Reviews	Barabash V. Kim G.	15 Apr 2026:recommended v1.4 15 Apr 2026:recommended v1.4	IO/DG/ESD/NSE IO/DG/ESD/IMES
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<i>Change Log</i>			
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1 Scope

This specification covers the supply of austenitic stainless steel hot rolled quarto plates grade **X2CrNiMo17–12–2 (No. 1.4404 / 316L)** between 5mm and 100 mm thick for non DT in-vessel usage (VQC-1B application as per ITER Vacuum Handbook, [ITER_D_2EZ9UM](#)).

This specification is based on the European Standard EN 10088-2:2014 and includes some additional requirements established for the ITER application.

The amount of material to be procured shall be specified by the Contractor and shall include appropriate contingency to face unexpected difficulties, to remake rejected parts and to repair parts with insufficient quality.

2 Applicable Documents

The following EN, ISO and ASTM Standards shall be referred in this specification:

EN 10088-2:2014	Stainless steels. Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes
EN ISO 6892-1:2016	Metallic materials, Tensile testing, Part 1: Method of test at room temperature
EN ISO 6892-2:2011	Metallic materials, Tensile testing, Part 2: Method of test at elevated temperature
EN 10307:2001	Ultrasonic testing of austenitic and austenitic-ferritic stainless steels flat products of thickness equal to or greater than 6 mm
EN 10204:2004	Metallic products: Type of inspection documents
EN 10029:2010	Hot rolled steel plates 3 mm thick or above -Tolerances on dimensions, shape and mass
ASTM A342-14	Standard test methods for permeability of weakly magnetic materials
ASTM A380/A380M-17	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
EN 13018:2016	Non-destructive testing - Visual testing - General principles
EN ISO 3452-1:2013	Non-destructive testing - Penetrant testing - Part 1: General principles
EN ISO 9712:2012	Non-destructive testing. Qualification and certification of NDT personnel
CEN/TR 10261:2019	Iron and steel - European standards for the determination of chemical composition
ISO 9001:2015	Quality management systems - Requirements

In case of change of edition year or issuing standard which supersede above mentioned, the use of new standards is allowed only in case of demonstration of equivalency with prior written IO approval.

Other equivalent national or international standards and codes proposed by the Manufacturer may be acceptable with prior processing through Deviation Request (DR), provided conformity assessment to all criteria is verified. The justification section of the DR shall include the differences between the quoted standard of the present specification and the standard proposed.

Following documents are applicable for implementation of the contract:

- [ITER_D_82MXQK – General Management Specification for Service and Supply](#)
- [ITER_D_22MFG4 – Quality Requirements for IO Performers](#)
- [ITER_D_2LZJHB – Procedure for the management of Deviation Request](#)
- [ITER_D_22F53X – MQP L2 Procedure for Management of Nonconformities](#)
- Appendix 4 of ITER Vacuum Handbook, [ITER_D_2ELN8N v1.14](#)

3 Reference Documents

EN ISO 4288:1996 Geometrical Product Specifications (GPS) - Surface texture: Profile method - Rules and procedures for the assessment of surface texture

ITER Vacuum Handbook, [ITER_D_2EZ9UM v2.5](#)

4 Ordering Information and Deliverables

It is responsibility of the Contractor to specify the requirements for the material purchase order.

5 Manufacture

5.1 Manufacturing process

To meet requirements for structure and inclusion contents in this specification the melting of steel could be completed by a suitable secondary metallurgy treatment (argon-oxygen decarburization (AOD) or vacuum oxygen de-carbonised (VOD)).

5.2 Delivery conditions

The plates shall be delivered in a solution heat treated, pickled and passivated condition preferably as per ASTM A380/A380M, equivalent to 1D finish according to Table 6 of EN 10088-2.

Solution heat treatment shall consist of maintaining a temperature of between 1030°C and 1110°C followed by water cooling and possible air cooling for smaller thicknesses. The thermal cycles shall be recorded and the records shall be included in the material certificate.

6 Chemical Requirements and Physico-Chemical Characteristics

6.1 Chemical composition

The chemical analysis shall be carried out using the appropriate European Standard for the element being analysed. In the absence of an appropriate European Standard, the choice of a suitable physical or chemical analytical method for the analysis shall be at the discretion of the Manufacturer. The Manufacturer shall declare the test method used. The list of available European Standards on chemical analysis is given in CEN/TR 10261.

Chemical composition, as determined by ladle (cast) and product analyses, shall comply with the requirements given in Table 1.

The choice of a suitable physical or chemical analytical method for the analysis shall be at the discretion of the Manufacturer. The Manufacturer shall declare the test method used if required.

Table 1 Chemical Composition

Element	Content, wt. %	
	min	max
Fe	Base	
C		0.030
Mn		2.00
Si		1.00
P		0.045
S		0.015
Cr	16.50	18.50
Ni	10.0	13.0
Mo	2.00	2.50
N		0.10
Co*		0.20
Nb*		0.10
Ta*		0.05

* Radioprotection requirement

6.2 Magnetic permeability

The relative magnetic permeability at room temperature shall be lower than or equal to 1.03 in accordance with ASTM A342.

In case of the use of a permeability meter apparatus (Foerster, Ferromaster, etc.), the type and trademark of apparatus shall be included in the certificate with detailed information on the apparatus and calibration.

7 Mechanical Properties

7.1 Required values and records

Tensile tests shall be performed in compliance with EN ISO 6892-1 at room temperature and EN ISO 6892-2 at elevated temperature and comply with values given in Table 2.

Table 2 Mechanical properties

Test temperature, °C	Tensile Strength, (R _m) (MPa)	Yield Strength (0.2% offset), (R _{p0.2}) (MPa)	Yield Strength (1% offset), (R _{p1.0}) (MPa)	Total Elongation (in 50mm)	Reduction of area, %
Room	520 - 670	≥ 220	≥ 260	≥ 45%	For info
250	For info	≥ 127	≥ 157	For info	For info

If the material doesn't pass this test due to a physical defect in the test specimen (which does not affect the usefulness of the product) or if unsatisfactory test results are due to incorrect mounting of the specimen or testing machine malfunction, the test shall be repeated using another specimen after notification to IO. If the results of the second test are satisfactory, the material shall be accepted.

Where unsatisfactory results cannot be attributed to any above mentioned causes, two retests shall be performed for each unsatisfactory result obtained after notification to IO. The second set of test specimens shall be taken close to those which were defective.

If the material is not off the shelf, or if mechanical properties are obtained by additional testing, the engineering stress-strain curve shall be attached to the material certificate. The certificate 3.1 shall include all mechanical properties mentioned in Table 2.

7.2 Sampling and testing

Test samples shall be taken after the plate has been subjected to solution heat treatment. They shall be appropriately marked and show the final rolling direction.

Sampling and sample preparation shall be in accordance with the requirements of the section 7.3 of EN-10088-2.

For tests at room temperature and thickness above 20mm, proportional test pieces shall be prepared in compliance with Annex D of EN ISO 6892-1. For plates less than 20mm thick, non-proportional test pieces can be used.

For tests at elevated temperature, test pieces shall be prepared in compliance with EN ISO 6892-2.

Number of test pieces for tensile properties at room and elevated temperature as per Table 21 of EN 10088-2 (one test per batch).

8 Heat Retreatment

Rolled plates rejected on the basis of unsatisfactory results for one or more mechanical tests may be retreated (solution heat treatment as per Section 5.2 of this specification). A notification about this re-treatment shall be sent to IO prior to execution. Retreatment conditions shall be described in the material certificate.

No more than one retreatment shall be allowed.

9 Non-destructive Examination

The testing and inspection personnel as well as their supervisors shall be qualified and certified in accordance with EN ISO 9712. Certificates of Inspectors shall be provided together with the material certificate.

9.1 Visual Examination

100% of the surface of each plate shall be visually examined as per EN 13018.

Their surfaces shall be plain, uniform and free from wrinkles, buckles, blowholes, tears, cracks and inclusions.

After cutting to the delivery dimensions, the edges shall be visually examined. The absence of cleavage or lamination (for example comprised by a fine layer of inclusions drawn out during rolling) shall be checked. If in doubt, a liquid penetrant examination shall be performed in accordance with requirements of EN ISO 3452-1.

9.2 Ultrasonic Examination

100% Ultrasonic examination of all plates shall be carried out. The scanning shall cover 100% of volume.

The examination shall be carried out in accordance with the scanning plan and the criteria given in standard EN 10307, quality class S3 for plate body and quality class E4 for plate edges.

Test report compliant with the section 16 of EN 10307.

Ultrasonic testing shall be performed in accordance with an approved written procedure that shall be submitted for approval. A detailed description of the Ultrasonic Testing calibration blocks (including types, location sizes and depths of reference reflectors placed in each of the blocks including a sketch) to ensure the detection levels compliant with the minimum acceptable flaw shall be included in the procedure.

9.3 Removal of Unacceptable Areas

The Manufacturer may eliminate surface defects by grinding, provided the dimensional tolerances of the part in the as-delivered condition are respected.

After grinding, a liquid penetrant examination shall be performed taking into account the provisions described in Section 9.1 Visual Examination of this specification.

Examination criteria defined in Section 9.1 Visual Examination of this specification also apply at this stage.

Repair by welding is not allowed.

10 Dimensional Check

The tolerances for thickness, length, width, flatness, edge camber and out-of-squareness shall comply with EN 10029.

The following are requirements for tolerances:

- Thickness tolerance - Class C as in EN 10029
- Flatness tolerances - Class S as in EN10029
- Edge camber shall be limited to 0.2% of the actual length of plate and out-of-squareness limited to 1% of actual width (G), as specified in EN 10029

The main dimensions shall be recorded. The values shall be within the tolerances given on the drawing.

The roughness Ra of the surfaces shall be less than or equal to 6.3µm. Roughness measurement in accordance with the 16% rule as per EN ISO 4288 can be used.

11 Marking

The Manufacturer shall specify the identification and marking method used, in compliance Chapter 12 of EN 10269:2013.

The marking shall be performed by impression stamping or other acceptable means specified by purchaser. Marking shall include at minimum:

- The Manufacturer name or symbol
- Grade of material
- Plate number or unique identification number related to quality history
- Rolling direction
- Heat number
- Dimensions, total weight
- Order number

A picture of the marking of each plate shall be included in the material certificate.

Marking or code which provides clear reference to documents containing the information required for production control is acceptable.

12 Summary and Frequency of Required Tests

Table 3 Frequency of tests

Test	Frequency of test	Comments
Chemical composition	1 test per heat 1 test per plate	
Magnetic permeability	1 test per batch	Sampling as per ASTM A342
Visual examination	Per each plate	
Ultrasonic examination	Per each plate	
Tensile test at room temperature	Per each batch	As per EN 10088-2
Tensile test at elevated temperature	Per each batch	As per EN 10088-2
Dimensional check	Per each plate	

13 Cleanliness, Packaging and Transportation

Requirements for cleanliness, packaging and transportation shall be specified by the Contractor.

The package of plate(s) shall be legibly identified with the following information:

- The Manufacturer name or symbol
- Grade of material
- Dimensions: thickness, width and length
- Plate number or unique identification number related to quality history
- Heat number

The Manufacturer shall ensure that consignments comply with regulatory requirements applicable to transport and to the country of destination.

14 Acceptance

Material Test Report and certificate have to be provided to the Purchaser prior to delivery. Material and certification shall be in compliance with this specification. Material cannot be accepted if it does not comply with this specification.

Certification

A certificate, that the material was manufactured, sampled, tested and inspected in accordance with requirements of the material specification and has been found to meet those requirements shall be supplied to the purchaser.

15 Documentation and Material Certificate

The Manufacturer shall provide as well the Inspection Certificate type 3.1 in accordance with EN 10204. The certificate shall include all the reports of tests described in this specification (i.e. all tests and if any re-tests results with required values/criteria defined in this specification). Additionally, the following information is required:

- Material designation and marking
- The heat number and part reference number
- Identification of the Manufacturer
- Identification of purchase order number
- If relevant: Deviation Request, Non-Conformity Report, internal non-compliance, signed control plan

All documents shall be in the English language and all measures shall be given in the metric system SI. Each document shall be provided as an electronic file in PDF format.

16 Quality Assurance Requirements

The Quality class under this contract is QC2.

The Manufacturer shall have either an ITER Organization (IO) approved QA Program or an ISO 9001 certified Quality Management System.

The Manufacturer shall ensure that the quality of supply meets the requirements. In case of any questions, the Manufacturer shall seek clarification from the Purchaser prior to proceeding with the work.

The Manufacturer shall submit the reports according to chapter 15, including all required information.

For materials that are custom-made for this contract, i.e. materials that are not off-the-shelf, the Manufacturer shall also comply with the IO quality requirements specified in Table 4, including the following:

- submission of the Quality Plan (QP), describing the implementation of IO requirements, the Manufacturing and Inspection Plan (MIP), and the reports containing all required information for IO approval;
- conduct of the Manufacturing Readiness Review (MRR) as a gate review, and obtaining authorization for the manufacture of such materials prior to the start of manufacturing.

Table 4 IO Quality requirements

IO Quality Requirements	Associated IO Quality Documents
Overall quality requirements applicable throughout the implementation of the contract	<ul style="list-style-type: none"> ▪ Chapter 8 of “General Management Specification for Service and Supply” (ITER_D_82MXQK)

Prior to contract implementation: <ul style="list-style-type: none"> Obtain IO acceptance of a dedicated Quality Plan 	<ul style="list-style-type: none"> “Quality Requirements for IO Performers” (ITER_D_22MFG4)
Prior to start of manufacturing: <ul style="list-style-type: none"> Obtain IO acceptance and mark up of an Manufacturing and Inspection Plan (MIP) Complete MRR Gate review 	<ul style="list-style-type: none"> “Quality Requirements for IO Performers” (ITER_D_22MFG4), “Working Instruction for Manufacturing Readiness Review” (ITER_D_44SZYP) “Inspection Plan Template” (ITER_D_QV7GQF).
During manufacture: <ul style="list-style-type: none"> Notify IO representatives of any Inspection Points as marked up in the MIP Complete the relevant entries in the MIP as work progresses. 	<ul style="list-style-type: none"> “Quality Requirements for IO Performers” (ITER_D_22MFG4),
During contract implementation – issue as necessary: <ul style="list-style-type: none"> Deviation Request (DR) Non-Conformance Reports (NCR) 	<ul style="list-style-type: none"> “Procedure for the management of Deviation Request” (ITER_D_2LZJHB). “Procedure for Management of Nonconformities” (ITER_D_22F53X).
Contractor release note (CRN)	<ul style="list-style-type: none"> “Quality Requirements for IO Performers” (ITER_D_22MFG4)

The Manufacturer shall implement, in compliance with its Quality Management System, the monitoring activities including the quality audits and any inspections to verify the compliance with the requirements.

The IO reserves the right to perform the visits to any premises where the IO related work is being performed.

Documentation developed as the result of this supply shall be retained by the Contractor for a minimum of 5 years from the completion of this supply.