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Technical Requirements Specification

Steel EN 1.4404 (316L) forgings or forged bars for non-DT in-vessel usage

This specification covers the supply of Steel EN 1.4404 (316L) forgings or forged bars for non-DT in-vessel usage

Approval Process			
	<i>Name</i>	<i>Action</i>	<i>Job Title / Affiliation</i>
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<i>Previous Versions Reviews</i>	Kim G.	22 Apr 2026:recommended v1.3	IO/DG/ESD/IMES
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<i>Change Log</i>			
Steel EN 1.4404 (316L) forgings or forged bars for non-DT in-vessel usage (2WRMSW)			
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v1.0	Approved	23 Jun 2020	
v1.1	Approved	14 Sep 2020	Requirements for Co max 0.20%, Nb max 0.10% and Ta max 0.05% added
v1.2	Signed	14 Apr 2026	Update scope for non DT in-vessel usage (VQC-1B application)
v1.3	Signed	22 Apr 2026	Incorporating QARO's comments
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1 Scope

This specification covers austenitic stainless steel forgings or forged bars of grade **X2CrNiMo17-12-2, No. 1.4404 (316L)**, for non DT in-vessel usage (VQC-1B application as per ITER Vacuum Handbook, [ITER_D_2EZ9UM](#)).

This specification is based on standard EN 10250-4, plus additional requirements arising from the features of the non DT in-vessel usage. General information on technical delivery conditions is given in EN 10021.

The dimensions and quantity of forgings or forged bars are specified in the purchase order.

The supply covers the following items:

- a) Manufacture of the total quantity of stainless steel forgings or forged bars of grade X2CrNiMo17-12-2
- b) Organisation of quality at works. Elaboration of all procedures required for the manufacturing, inspection (including analysis), packaging, storage and delivery. Time schedules and documentation.
- c) To perform all the inspections and tests during and after manufacturing envisaged in this specification.
- d) Storage, packaging and delivery.

Note: The forgings may be supplied in accordance with the standard EN 10222-5 with additional requirements specified in this technical specification with prior written IO approval, provided conformity assessment to all criteria is satisfied.

2 Applicable documents

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

EN 10250-1:1999	Open die steel forgings for general engineering purposes: Part 1: General Requirements
EN 10250-4:1999	Open die steel forgings for general engineering purposes: Part 4: Stainless steels
EN 10222-5:2017	Steel forgings for pressure purposes Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels
EN 10021:2006	General technical delivery requirements for steel products
EN 10204:2004	Metallic products: Type of inspection documents
EN 10228-2:2016	Non-destructive testing of steel forgings, Part 2: Penetrant testing
EN 10228-4:2016	Non-destructive testing of steel forgings, Part 4: Ultrasonic testing of austenitic and austenitic-ferritic stainless steel forgings
EN ISO 9712:2012	Non-destructive testing - Qualification and certification of NDT personnel
ASTM A342 - 2014	Standard Test Methods for Permeability of Weakly Magnetic Materials
ISO 3452-1:2013	Non-destructive testing. Penetrant testing - General principles

EN ISO 9712:2012	Non-destructive testing. Qualification and certification of NDT personnel
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 this 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 Steelmaking process and Heat treatment

The steel shall be produced by an electric process or one of the basic oxygen processes. The steel shall be fully killed.

The forgings or forged bars shall be delivered in solution annealed condition in accordance with EN 10250-4. Solution annealing temperature shall be 1020-1120 °C.

4 Chemical composition requirements

The chemical analysis may be carried out using appropriate European Standards. The choice of a suitable physical or chemical analytical method for the analysis shall be at the discretion of the Manufacturer. The chemical compositions shall comply with the requirements given in Table 1.

Permissible deviations between the product analysis and the limiting values given in Table 1 for the cast analysis are given in Table 4 of EN 10250-4.

Table 1 Chemical composition

Element	Chemical composition, wt.% X2CrNiMo17-12-2 (No. 1.4404)	
	Min.	Max.
C	-	0.030
Mn	-	2.00
Si	-	1.00
P	-	0.045
S	0.015	0.030
Cr	16.50	18.50
Ni	10.00	13.00
Mo	2.00	2.50
N	-	0.11
Co*		0.20
Nb*		0.10
Ta*		0.05

* Radioprotection requirement

5 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 trade mark of apparatus shall be included in the certificate with detailed information on the apparatus and calibration.

6 Mechanical properties

Mechanical properties in the solution annealed condition for forgings or forged bars shall comply as per the requirements in Table 2.

Test methods, sampling, selection and preparation of samples for mechanical tests shall be in accordance with EN 10250-1. See Section 12 for number of tests.

Table 2 Mechanical properties for forgings or forged bars

Test temperature, °C	Tensile Strength, (R _m) (MPa)	Yield Strength (0.2% offset), (R _{p0.2}) (MPa)	Yield Strength (1.0% offset), (R _{p1.0}) (MPa)	Transverse Elongation, min, %	Impact Energy, (KV) min, Joules ⁽¹⁾
Room	500-700	≥ 190	≥ 225	≥ 35	100 - Longitudinal 60 - Transverse
250	≥ 385	≥ 137	≥ 150	For information	-

Note: ⁽¹⁾ Impact test is not performed when elongation determined at room temperature ≥ 45%.

7 Non Destructive Examinations

All forgings or forged bars shall be subjected to non-destructive examinations as described in the following sections.

The testing and inspection personnel as well as their supervisor must possess the necessary skill and competency which are qualified and certified in accordance with EN ISO 9712.

7.1 Visual examination

All forgings or forged bars shall be subjected to visual examination.

The forgings or forged bars shall be sound and free from such segregation, cracks, laminations or defects that preclude their intended use.

7.2 Liquid penetrant examination

All external surfaces of forgings or forged bars shall be examined by a liquid penetrant examination in accordance with EN 10228. The recording level and acceptance criteria shall be as per quality class 3 in accordance with EN 10228.

Products used for the penetrant tests shall be compliant with the Appendix 4 of the ITER Vacuum Handbook regardless of the over-thickness considered for the forging.

The content of the test report shall be compliant with the section 9 of ISO 3452-1.

7.3 Ultrasonic examination

All forgings or forged bars shall be subjected to ultrasonic examination in accordance with EN 10228-4. The recording level and acceptance criteria shall be as per quality class 2 in accordance with EN 10228-4.

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.

7.4 Removal of surface defects

Before forgings or forged bars are despatched or presented for acceptance, surface defects shall be removed. Surface defects shall be removed by chipping and/or grinding providing the residual thickness meets the minimum tolerance and that the resulting depression does not undercut the rest of the surface.

8 Dimensions - tolerances

The dimensions and tolerances of forgings or forged bars are specified in the purchase order. The surface roughness Ra shall be less than or equal to 6.3 µm.

9 Retests, re-heat treatment and marking

Retests, re-heat treatment and marking shall be in accordance with section 13 and section 15 of EN 10250-1.

10 Cleanliness-packaging-transportation

Requirements are specified in the purchase order.

11 Acceptance

Material test reports have to be provided to the purchaser prior to delivery as well as Inspection Certificate type 3.1 in accordance with EN 10204:2004. Material and certification shall be in compliance with this specification. Material cannot be accepted if it does not comply with this specification.

12 Summary and Frequency of Required Tests

Table 3 Frequency of tests

Test	Frequency of test	Comments
Chemical composition	1 test per each cast for ladle analysis 1 test per each batch* for product analysis	-
Tensile test at ambient temperature	1 test per each batch*	-
Tensile test at high temperature	1 test per each batch*	-
Impact test	1 test per each batch*	-
Magnetic Permeability	1 test for each batch*	-
Dimensional check	Per each materials	In accordance with purchase order
Visual examination	Per each materials	
Liquid Penetrant Examination	Per each materials	
Ultrasonic Examination	Per each materials	

Note:

* See EN 10250-1 for definition of batch, sampling and preparation of test pieces.

13 Certification

The Manufacturer shall certify that the material supplied has been manufactured, inspected, sampled and tested in accordance with the requirements of this specification and that the results of chemical analysis, mechanical and other tests meet the requirements of this specification.

14 Documentation

The Manufacturer shall provide the Inspection Certificate type 3.1 in accordance with EN 10204:2004, which include at least the following information:

- Material designation and marking
- Melting process and manufacturing methods
- Heat number/ingot/billet number
- Identification of Manufacturer
- Identification of order
- Results of chemical analysis
- Records of heat treatment, where applicable
- Results of magnetic permeability test
- Results of mechanical property tests
- Results of non-destructive examinations
- Dimensional check

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.

15 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 14, 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.