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Technical Specification

Aluminium bronze rods, bar and shapes Procurement Specification for ITER Blanket System

Material Specification for the supply of rod, bar and shapes offor the ITER Blanket System

Approval Process			
	Name	*Action*	*Affiliation*
Signatory	**Eaton R.**	**21 Apr 2016:signed**	**IO/DG/COO/TED/INC/BKT**
Co-signatories	**Barabash V.**	**21 Apr 2016:signed**	**IO/DG/COO/CIO/AS**
Reviewers	**Chappuis P.** **Jung C. Y.** **Raffray R.**	**02 May 2016:recommended** **02 May 2016:recommended** **28 Apr 2016:recommended**	**IO/DG/COO/TED/INC/BKT** **IO/DG/RCO/QAA** **IO/DG/COO/TED/INC/BKT**
Approver	**Merola M.**	**03 May 2016:approved**	**IO/DG/COO/TED/INC**
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Change Log			
Aluminium bronze rods, bar and shapes Procurement Specification for ITER Blanket System (PS569U)			
Version	***Latest Status***	***Issue Date***	***Description of Change***
v1.0	Approved	01 Aug 2014	
v1.1	Approved	21 Apr 2016	Title change to allow use on blanket system Clarification of ASME Edition 2013 EN standards added for tensile testing EN ISO 6892-1:2009 and EN ISO 6892-2:2011 Heat treatment clarification Record of heat treatment requirement added Revision of table 1 for impurities Ta, Nb added to typical list of impurities to be analysed Visual, Liquid penetrant and Ultrasonic examinations shall be carried out for each product - section 9 EN 13018 added to section 9.1 LP examination moved to section 9.2

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1 Scope

This specification covers the supply of rod, bar and shapes of Aluminum bronze (known also as Nickel-aluminium, NiAl bronze), UNS No.C63200 for the ITER Blanket System.

Material shall be produced in accordance with ASTM B150/B150M - 12 with additional requirements for chemical composition and testing.

The amount of Aluminum bronze material to be procured shall be specified by the concerned Domestic Agency (DA) and shall include appropriate contingency to face unexpected difficulties, to remake rejected parts and to repair parts with insufficient quality.

The supply covers the following items:

a) Manufacture of Aluminium bronze rod, bar and shapes;
b) Organisation of quality at works. Elaboration of all procedures required for the manufacture, inspection (including analysis), packaging, storage and delivery. Time schedules and documentation;
c) Perform all the inspections and tests during and after manufacturing envisaged in this specification;
d) Storage, packaging and delivery.

2 Referenced Documents

The following Codes and Standards shall be used (referred applicable version is the latest released versions as of 1 Jan 2016, unless agreed by the IO and DA). Other equivalent national or international standards and codes may be acceptable with prior written ITER approval, provided all criteria are satisfied.

ASME Edition 2013, Section V, Article 6	Liquid Penetrant Examination
ASME Edition 2013, Section V, Article 9	Visual Examination
ASME Edition 2013, Section V, Article 5	Ultrasonic Examination Methods for Materials

ASME Edition 2013, Section III, Division 1, Subsection NG-2580, Examination of Threaded Structural Fasteners:

- Subsection NG-2584, Examination of Threaded Structural Fasteners: Ultrasonic examination

ASME Edition 2013, Section III, Division 1, Subsection NG-2540, Examination and Repair of Forgings and Bars:

- Subsection NG-2546, Liquid Penetrant Examination

ASTM B150/B150M - 12	Standard Specification Aluminum Bronze Rod, Bar and Shapes
ASTM B249/B249M - 12	Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings
ASTM E478 - 08	Test Methods for Chemical Analysis of Copper Alloys
ASTM E8M - 15a	Standard Test Method for Tension Testing of Metallic Materials
ASTM E21 - 09	Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials

EN ISO 6892-1:2009	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 13018:2004	Non-destructive testing: Visual testing
ISO 3452-1:2013	Non-destructive testing - Penetrant testing - Part 1: General principles
ASTM E112 - 13	Standard Test Methods for Determining Average Grain Size
ISO 9712:2012	Non-destructive testing - Qualification and certification of NDT personnel
AST/ANSI SNT-TC-1A:2011	– Recommended Practice for Personnel Qualification and Certification of Nondestructive Testing
EN 10204:2004	Metallic products: Type of inspection documents

3 Ordering Information

It is responsibility of the DA to specify the requirements for the purchase order quantity, total weight, footage, or number of pieces and dimensions and permissible variations as relevantly described in ASTM B150/B150M, Chapter 4.

4 Manufacture

The product shall be produced by hot working, cold working, or both, and finished by such cold working, annealing or heat treatment and straightening as may be necessary to meet the properties specified as described in ASTM B249/B249M.

Definition of lot – see ASTM B249/B249M:
An inspection lot shall be max 500 kg, of the same mill form, alloy, temper, and nominal dimensions, subject to inspection at one time.

The General Requirements: See chapter 3 of ASTM Specification B249/B249M.

5 As Delivered Heat Treatment

Rod, bar and shapes shall be delivered in the heat treated condition to obtain desired mechanical properties:

- Hold at 850°C minimum for 1 hour minimum at temperature and quench in water or other suitable medium
- Temper anneal at 700 +/- 15°C for 3 to 9 hours

The heat treatment process shall be recorded with diagram (time and temperature) and shall be included in the Material Test Report specified in Section 12 of this Specification.

6 Chemical Requirements and Physical Characteristics

6.1 Chemical composition

The chemical composition has to satisfy the requirement given in Table 1. Method of testing is ASTM E478 or methods agreed between Supplier, DA and IO.

The chemical analysis shall be performed for each heat and each lot of material in accordance with definition of ASTM B150/B150M-12.

Table 1. Chemical composition requirements of Aluminium bronze C63200

Element	Composition (range or maximum value), wt.%
Cu	Remainder
Al	8.7 – 9.5
Fe	3.5 – 4.3[A]
Ni	4.0 – 4.8
Mn	1.2 – 2.0
Si	0.10
Pb	0.02
Zn	0.02
Total (sum) Impurities *	0.10 Including: Co ≤ 0.050

[A] Iron content shall not exceed nickel content.
* The list of typically analysed impurities shall also include (e.g.Cd, S, Ag, Pb, Bi, S, Sb, Ta, Nb and other elements typically recorded by supplier) shall be measured. These elements shall be recorded and reported in test certificate.

In cases of disagreement, determine the composition in accordance with requirements of ASTM B150/150M, Chapter 12 - Test methods.

6.2 Grain size

Grain size shall be tested in accordance with ASTM E 112. Micrographs shall be used to examine the structure of the material as well as to establish grain size. Grain size number shall be equal of finer than 2. One sample shall be tested per lot.

7 Mechanical Properties Requirements

Tensile strength requirements: product furnished under this specification shall conform to the tensile requirements in Table 2. Tensile test should be performed according to ASTM E8M and ASTM E21 or EN ISO 6892-1:2009 and EN ISO 6892-2:2011.
The following values shall be recorded:
- Yield Strength at 0.2% offset, in MPa
- Tensile Strength , in MPa
- Total Elongation after fracture, %

The minimum tensile properties, after heat treatment as defined in Section 5, shall meet the requirements given in the following table 2. Two samples per lot shall be tested.
Temper designation codes TQ50 as it is described in ASTM B150/ASTM B150M.

Table 2. Requirements for tensile properties

Temperature, °C	Tensile strength, min MPa	Yield strength, Offset 0.2% min MPa	Total elongation, min %	Product Form	Diameter mm
20	620	300	15	rod, bar	≤125
250	530	260	8	rod, bar	≤125
20	620	245	15	rod, bar	Over 125 to 300
250	530	212	8	rod, bar	Over 125 to 300

The round proportional tension test specimens as in ASTM E8M or EN ISO 6892-1 shall be used correspondingly.

8 Dimensions and Permissible Variations

Requirements of ASTM B249B/249M and those defined in the purchase order shall be fulfilled.
Results of dimensional measurements and roughness shall be presented in Material Test Report.

9 Non-Destructive Examination

Visual, Liquid penetrant and Ultrasonic examinations shall be carried out for each product.
The NDT personnel shall be qualified in accordance with ISO 9712:2012 or recommended practice AST/ANSI SNT-TC-1A:2011.

9.1 Visual examination

All external surfaces of rod, bar and shapes shall be examined by a visual examination in accordance with ASME Section V, Article 9 or in accordance with EN 13018. The surfaces shall be smooth, plane, uniform and free from wrinkles, buckles, laps, burrs, blowholes, tears, cracks and inclusions.

9.2 Liquid penetrant examination

100% of liquid penetrant examination of each product independently on size shall be provided in accordance with methods of ASME Section V, Article 6 or ISO 3452-1: 2013. The surfaces shall be plane, uniform and free from cracks, pittings, wrinkles, buckles, blowholes, tears.
Examination procedure, evaluation of indications, acceptance standards and time of examination shall be in accordance with ASME Section III, Division 1, Sub-section NG-2546.

9.3 Ultrasonic examination

100% of ultrasonic inspection of each product independently on size shall be provided in accordance with ASME Section V, Article 5. The examination procedure and acceptance standards shall be in accordance with ASME Section III, Division 1, Sub-section NG-2584.

10 Summary and Frequency of Required Tests

Table 3. Frequency of tests

Test	Number of test samples / lot
Chemical analysis	1 test per heat and 1 test per lot
Grain size	1 test per lot
Tensile test	2 tests per lot at room and 2 tests per lot at elevated temperature
Visual examination	Each product, 100%
Ultrasonic examination	Each product, 100%
Liquid penetrant examination	Each product, 100%

11 Acceptance

Material Test Reports 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.

12 Documentation

The Supplier shall provide the Inspection Certificate type 3.1 in accordance with EN 10204:2004 and the Material Test Report shall include at least the following information:

- Material designation: Aluminum bronze C63200
- Identification of Supplier
- Heat/Lot number
- Melting process method
- Mill product manufacturing method
- Record of heat treatments
- Results of chemical analysis
- Results of grain size measurement
- Results of mechanical property tests at specified treatment
- Indication from where the specimens have been taken for all specified analyses/tests
- Dimensional check
- Records of Visual examinations

- Records of Liquid penetrant examinations
- Records of Ultrasonic examinations

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.

13 Marking

Each product, or batch of products, as appropriate, shall be legibly marked to show:
- the manufacturer's name or trade mark
- alloy designation
- heat number
- the identification reference numbers of other identification marks by which the products can be related to the manufacturer's certificate

The mark shall be placed in the area indicated on the forging drawing as indicated in purchase order.

Markings or codes which provide clear reference to documents containing the information required for production control will always be acceptable.

14 Cleanliness, Packaging and Transportation

Requirements shall be specified in the purchase order.
Packaging and package marking shall be in accordance with ASTM B249/B249M.

Packaging: The material shall be separated by size, composition, and temper, and prepared for shipment in such a manner as to ensure acceptance by common carrier for transportation and to afford protection from normal hazards of transportation.

Package marking: Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation, temper, size, shape, gross and net weight, and name of supplier or manufacturer. The specification number shall be shown when specified.

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

15 Quality Assurance Requirements

The quality organisation shall comply with the requirements defined in Annex A of the Procurement Arrangement as specified in the contract and purchase order.

A manufacturing and inspection plan (MIP) shall be provided for each lot in accordance with Requirements for Preparing and Implementing a Manufacturing and Inspection Plan (22MDZD).

16 Access of Inspectors

Representatives of the IO, DA and/or Third Party Inspectors (TPI) shall at reasonable notice have the right to check at the Supplier's premises or at those of the sub-contractor the progress and status of the work forming the subject matter of the procurement and to witness specified tests. The supplier shall hold

at the disposal of the IO, DA and TPI and make available to them such information and documents as are necessary to determine the progress and status of the work.