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EXTERNAL REFERENCE

## Technical Specification Alloy 718 for Blanket

This specification covers the supply of precipitation-hardenable nickel alloy 718 (UNS N07718, formerly Grade 718, also referred to as Inconel 718) rod, bar and forgings for Blanket components.

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Alloy 718 for Blanket (G7N74Y_v1_2)	v1.2	Approved	07 Nov 2013	Inclusion of additional ASTM standards inclusion of section 3.1 ordering information Section 5 addition of picture of micro structure clarification of table 2 Additional comments described in the attachment track change document
Alloy 718 for Blanket (G7N74Y_v1_1)	v1.1	Approved	06 Jun 2013	clarification to table 2 & 3 heading  Elongation in 50 mm or 4D, min, %  replaced with  Elongation in 50 mm or 4 x Diameter, min, %
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## 1 Scope

This specification covers the supply of precipitation-hardenable nickel alloy 718 (UNS N07718, formerly Grade 718, also referred to as Inconel 718) rod, bar and forgings for Blanket components.

This specification is based on ASTM standard B637 – 12 and includes additional requirements. The used terminology and definitions are as per ASTM B637 – 12.

The amount of the rods/bars 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 total quantity of products ordered;
- b) Organisation of quality at works. Elaboration of all procedures required for the manufacturing, inspection (including analyses), 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.

## 2 Referenced Documents

The following Codes and Standards shall be referred (latest editions of standards shall be used):

### 2.1 ASME Code 2013:

Section V, Article 5	Ultrasonic Examination Methods for Materials and Fabrication
Section V, Article 6	Liquid Penetrant Examination
Section V, Article 9	Visual Examination

### 2.2 ASTM Standards:

B637 – 12	Standard Specification for Precipitation-Hardening Nickel Alloy Bars, Forgings, and Forging Stock for High-Temperature Service
A1014/A1014M - 10	Standard Specification for Precipitation-Hardening Bolting Material (UNS N07718) for High Temperature Service
E8/E8M-11	Standard Test Methods for Tension Testing of Metallic Materials
E1473-09	Standard Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys
B880 -03	Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

And all relevant standards referenced in ASTM B637 and in A1014/A1014M.

**Additional standards:**

E112 – 10	Standard Test Methods for Determining Average Grain Size
E21 - 09	Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials
E10 - 12	Standard Test Method for Brinell Hardness of Metallic Materials
E45 - 10	Standard Practices for Determining the Inclusion Content of Steel

**2.3 EN Standard:**

EN 10204:2004      Metallic products: Type of inspection documents

Other equivalent national or international standards and codes may be acceptable subject to written approval by the ITER Organisation (IO), after demonstration that all the prescribed requirements are satisfied.

**3 Definitions, manufacture, heat treatment and delivery condition****3.1 Ordering information**

It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Examples of such requirements include, but are not limited to the following:

- Alloy UNS N07718
- Condition (temper, heat treatment)
- Shape — Rod or bar
- Forging (sketch or drawing) if applicable
- Dimensions, including length and tolerances
- Quantity (mass or number of pieces)
- Ultrasonic examination method ASME Section III NB-2542 rod/bars or NG-2580 for bolting (fasteners)

**3.2 Definitions**

A heat is a single melt of material used to cast one or several ingots.

A remelt ingot is an ingot that has been produced using VAR (Vacuum Arc Remelting) or ESR (Electroslag Remelting) method.

A lot for product analysis and other tests shall be as defined in ASTM B637. A lot shall consist of not more than 500 kg of material from the same remelt ingot and produced in the same size and processing condition (temper).

**3.3 Manufacture, heat treatment and delivery requirements**

Melting Process—Alloy shall be multiple melted using consumable electrode practice in the remelt cycle or shall be induction melted under vacuum. If consumable electrode remelting is not performed in vacuum, electrodes produced by vacuum induction melting shall be used. In order to meet the required properties specified in this specification, the alloy shall be refined using VAR (Vacuum Arc Remelting) or ESR (Electroslag Remelting) methods.

Rods, bars and forgings shall be supplied at following condition:

- Solution treated condition, suitable for subsequent age hardening;

The heat treatment shall be specified in Purchase order.

The material to be used for qualification as defined in this specification shall be in the solution treated and precipitation hardened state.

Heat treatment (as defined in ASTM B637):

- Recommended solution treatment: 924 to 1010°C, hold 1/2 h min, cool at rate equivalent to air cool or faster
- Precipitation hardening treatment: 718 ± 14°C hold at temperature for 8 h, furnace cool to 621 ± 14°C; hold until total precipitation heat treatment time has reached 18 h, air cool.

## 4 Chemical Composition

The material shall conform to the requirements as to chemical composition prescribed in Table 1 measured in accordance with ASTM 1473.

One sample per remelt ingot shall be selected for chemical analysis. For The permitted variations of compositions for product analysis relative to the specified chemical requirements of Table 1 are defined in ASTM B880.

**Table 1 Chemical composition requirements**

Element	Content in wt. %
C	0.08 max
Mn	0.35 max
Si	0.35 max
P	0.015 max
S	0.015 max
Cr	17.0 – 21.0
Mo	2.80 – 3.30
Nb + Ta	4.75 – 5.50
Ti	0.65 – 1.15
Al	0.20 – 0.80
B	0.006 max
Fe	Remainder *
Cu	0.30 max
Ni	50.0 – 55.0
Co #	0.20 max
Ta #	0.05 max

\* The element shall be determined arithmetically by difference.

# Radiation protection requirements

## 5 Grain size, microstructure and inclusions requirements

The microstructure shall be free of freckles, white spots and Laves phases. Structure shall be homogeneous; picture of microstructure shall be supplied.

The average grain size shall be determined in accordance with ASTM E112 and found to be ASTM No 5 or finer. The average grain size shall be homogeneous within the range of  $\pm 1$  equivalent grain size number around the true average value.

The amount and definition of inclusions per lot shall follow method D of ASTM E45.

- Micro inclusions (indigenous inclusions detectable by microscopic test methods): method D is applicable. Severity level number shall be at most 2 for types A, B, C and D.
- Macro inclusions (exogenous inclusions from entrapped slag or refractories) are not permitted.

## 6 Mechanical Properties

### 6.1 Tensile and hardness requirements

The material in solution treated condition followed by precipitation hardening treatment (Section 3) shall conform to the tensile properties shown in Table 2. Testing methods are ASTM E8/8M at room temperature and ASTM E21 at 250°C. Hardness test is in accordance with ASTM E10-12.

Number of tests - two tensile tests per lot at ambient and elevated temperatures, one test for hardness at RT.

**Table 2 Requirement for tensile properties and hardness**

Temperature, °C	Tensile Strength, min MPa	Yield Strength, 0.2% min MPa	Elongation in 50 mm or 4 x Diameter, min, %	Reduction of Area, min, %	Brinell Hardness
20	1275	1034	12	15	331 min
250	1187	946	*	*	-

\* Data shall be supplied for information.

### 6.2 Stress-rupture requirements

The material in solution treated condition followed by precipitation hardening treatment (Section 3) shall conform to the stress rupture requirements shown in Table 3. Testing method is ASTM E139.

**Table 3 Stress rupture requirements**

Test Temperature, °C	Stress, MPa	Minimum hours	Elongation in 50 mm or 4 x Diameter, min, %
649	690	23	5

The supplier shall demonstrate that the material will meet fully heat-treated properties after full heat treatment in accordance with Table 2.

Number of tests - one test per lot.

## **7 Dimensions and Permissible Variations**

The material shall conform to the dimensions and permissible tolerances shown in Specification ASTM B637 or as specified in purchase order.

## **8 Workmanship, Finish, Appearance, Sampling, Number of test, Specimen Preparation and Test Methods**

Workmanship, Finish, Appearance, Sampling, Number of test, Specimen Preparation and Test Methods are as specified in corresponding sections (8, 9, 10, 11 and 12) of Standard Specification ASTM B637.

## **9 Non-destructive examination**

### **9.1 Visual Examination**

All external surfaces shall be examined by a visual examination in accordance with ASME Section V, Article 9. The surfaces shall be plane, uniform and free from wrinkles, buckles, blowholes, tears, cracks and inclusions.

### **9.2 Liquid penetrant**

All external surfaces shall be examined by a visual examination in accordance with ASME Section V, Article 6. The surfaces shall be plane, uniform and free from wrinkles, buckles, blowholes, tears, cracks and inclusions. The acceptance criteria shall be in accordance with ASME Section III, NB-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 standard shall be in accordance with ASME Section III, NB-2542 for product intended for rod/bars (cartridges blanket support elements) and NG-2580 for bolting (fasteners) application.

The type of examinations shall be specified in the purchase order.

## **10 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.

## 11 Summary and Frequency of Required Tests

**Table 4 Frequency of tests**

Test	Frequency of test	Comments
Chemical composition	1 test per remelt ingot 1 test per lot	
Grain size, inclusions and micrograph	1 test per lot	Samples taken close to mechanical test specimens
Tensile properties	2 test per lot	2 specimens: 2 testing temperature
Hardness	1 test per lot	-
Stress rupture test	1 test per lot	-
Dimensional check	Per each rod/bar	In accordance with purchase order
Visual examination	Per each rod/bar	-
Liquid penetrant examination	Per each rod/bar	-
Ultrasonic examination	Per each rod/bar	-

## 12 Documentation

The Supplier 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 method
- Heat number/remelt ingot number
- Identification of Supplier
- Identification of order
- Result of chemical analysis (heat and product)
- Record of heat treatment
- Records of microstructure examination, inclusions and grain size
- Results of mechanical property tests (tensile, hardness and stress rupture)
- Results of non-destructive examination
- Dimensional check
- Packaging data

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 Packaging and marking

Packaging, marking, and loading for shipment shall be in accordance with Practices A700 and in accordance with the requirements of the Purchaser.

The products or the bundles or boxes shall be legibly be marked in a suitable way such that it is possible to determine the cast, the grade and the origin of the delivery.

Marking shall include:

- Manufacturer name or symbol
- Grade of material
- Specification number
- Product number or unique identification number related to quality history
- Heat number
- Heat treatment condition

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

## **14 Quality Assurance Requirements**

The quality organisation shall comply with the requirements defined in Annex A of the Procurement Arrangement.

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 \(22MDZD\)](#).