**TECHNICAL NOTE**

**RELATED TO THE OPE-1824 MARKET SURVEY ON**

**JT-60SA ACTIVELY COOLED DIVERTOR**

**TUNGSTEN RAW MATERIAL**

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# INTRODUCTION TO JT60SA

The Tokamak JT-60SA, which has been commissioned in 2023 in Naka, Ibaraki, Japan, is a nuclear fusion experiment aimed to research the technical and physical basis of future fusion power plants. Large superconducting magnets create a toroidal magnetic field, thus confining the high temperature plasma in a ring-like shape. The plasma can reach temperatures of up to 200 million degrees Celsius (20keV) at its centre. At these temperatures, nuclei of hydrogen isotopes have a high probability of fusing to helium nuclei.

All components exposed to the plasma inside the tokamak vessel (i.e. in-vessel components), must be able to withstand extreme heat fluxes (up to 10MW/m2 in steady state conditions, up to 20MW/m2 for short transients). Moreover, some specific components must act as a collector for the hot ashes coming from the plasma (i.e. the Divertor). The Divertor must be protected by a series of heat-resistant elements (i.e. high heat flux elements), made of actively cooled tungsten monoblocks.

# TUNGSTEN RAW MATERIAL

## Quantities:

Tungsten will be used to manufacture the high heat flux (HHF) elements tungsten monoblocks and bonded tiles:

* 25.920 monoblock blanks dimensions L x W x T = 32 (+0.1) mm x 32 (+0.1) mm x 11.5 (+0.1) mm
* 5.180 tiles blanks dimensions L x W x T = 11.5 (+0.1) mm x 32 (+0.1) mm x 5 (+0.1) mm

Values in brackets are positive dimensional tolerances (extra material)

## Manufacturing requirements

The raw tungsten material shall be manufactured according to state-of-the-art powder metallurgy methods, including:

- Pressing

- Sintering

- Forging/rolling

- Machining to final shape

- Surface treatment

- Chemical cleaning

Hot isostatic pressing can be proposed as an alternative.

The material shall be delivered in stress-relieved condition. Heat treatments might be used to obtain the mechanical and thermal properties.

The direction of the elongated grains of the tungsten material shall be clearly unequivocally indicated on the final products or in the products documentation and shall be:

* perpendicular to the 11.5 mm dimension and aligned to one of the 32 mm dimensions on the monoblock blanks
* perpendicular to the 11.5 mm dimension and aligned with the 5 mm dimension on the tile blanks

## physical properties

### Chemical composition

The tungsten material shall have the following chemical composition:

* Minimum W content: 99.94%
* Maximum Carbon content 0.01%
* Maximum Oxygen content 0.01%
* Maximum Nitrogen content 0.01%
* Maximum Iron content 0.01%
* Maximum Nickel content 0.01%
* Maximum Silicium content 0.01%

### Density

The density shall be tested in accordance with ASTM B311 and shall be > 19.0 g/cm3

### Grain size

The grain size shall be measured in accordance with ASTM E112, using samples cut perpendicular to the forging/rolling direction.

The maximum grain size shall be 3 (ASTM number). Micrographic examinations shall be made parallel and perpendicular to the forging/rolling direction, and pictures shall be provided. The microstructure shall be homogeneous.

### Hardness

Vickers hardness shall be measured in accordance with ASTM E92 or EN ISO 6507-1. The Vickers hardness of the material (HV30) shall be > 410.

### Tolerances

The tungsten material shall be provided in different sizes and shapes. Typical dimensional and geometrical tolerances are in accordance with ISO 2768 class fH. Typical surface roughness is 1.6 um to be obtained by grinding.

### Surface conditions

All finished products in tungsten material shall be free of visible oxides, scale, splits, laps, cracks, seams protrusions, gall marks, inclusions and any other kind of visible defects.

## Quality assurance

### Visual examination

All external surfaces of finished products shall undergo 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

### Ultrasonic examination

Ultrasonic test shall be performed in accordance with national or international recognized standards (e.g. ASME Section V Article 5, PED, etc.).

# PROCUREMENT STRATEGY

The procurement will be divided in ten batches each consisting of 2592 monoblock blanks and 518 tile blanks. The maximum time between deliveries shall be 60 calendar days. The lead time for the first delivery shall not exceed 90 calendar days. The supplier can deliver faster than the maximum requirement with no penalties.

# EXPECTED SKILLS/EXPERIENCE

The successful tenderer is expected to have, either internally or by its sub-contractors, the following skills/experience:

* Manufacturing/sourcing of refractory metals (pure tungsten)
* Access to material laboratories to verify the material properties of the base materials.
* Non-destructive examination of the blanks
* Sufficient precision machining/grinding of the blanks
* Well-developed quality control system, under an international quality standard (e.g. ISO9001)

# MARKET SURVEY

To establish an optimum contract strategy, F4E needs to develop its understanding of the market with a comprehensive list of possible interested EU suppliers.

In the frame of the Market Survey, interested suppliers are invited to submit information. This information will be visible to F4E only and will not be communicated to other parties, except if agreed upon by the respondent(s).

Please answer to the F4E Market Survey. You can access the survey by clicking on this link:

<https://ec.europa.eu/eusurvey/runner/JT-60SA_Tungsten_Monoblocks_And_Tiles_Supply>