

TERMS OF REFERENCE FOR R&D PROJECT

TITLE OF THE PROJECT: Study and Validation of chemical, mechanical, metallurgical and physical properties of Tungsten based Heavy alloys.

1. BACKGROUND:

- 1.1** As pure tungsten is expensive and difficult to manufacture and machine, alternative materials were sought that would maintain some of the useful characteristics of tungsten, such as density and X-ray shielding capabilities, but that would be easier to machine and less expensive. The result of this quest is Heavy Tungsten Alloys.
- 1.2** Tungsten heavy alloy (WHA) is a tungsten-based alloy that contains at least 90% tungsten and 10% other metals such as nickel, iron, and copper. The addition of nickel/copper (or nickel/iron) matrix improves the machinability and ductility of these alloys over pure tungsten. These alloys are manufactured by sintering of metallic powders. Tungsten alloy is much easier to machine than traditional pure tungsten.
- 1.3** Tungsten Heavy Alloy Applications covers Ballast, Vibration and kickback reduction, X-ray shielding, Ion beam apertures, Aircraft bucking bars, Forging dies etc.
- 1.4** Hard metals, also known as Heavy alloys/tungsten carbides, have emerged as indispensable materials in the defence sector due to their exceptional hardness, wear resistance, and strength. The defence sector relies heavily on materials that can withstand extreme conditions and deliver superior performance. Heavy metals are ideal for a range of critical applications in defence, including armour-piercing projectiles, cutting tools, wear-resistant components, and ballistic protection.
- 1.5** As mentioned above, the tungsten based heavy alloys have many advantages and are widely used, but there is no standard on the same. This R&D project is aimed at collecting and validating data of the chemical and physical properties for the various grades of tungsten based heavy alloys manufactured, imported, and used in India and will form a basis for the development of a new standard on Tungsten based heavy alloys.

2. OBJECTIVE:

To collect and validate data of the chemical, mechanical, metallurgical, and physical properties for the various grades of tungsten based heavy alloys.

3. SCOPE:

- 3.1** Study the available literature like national and international standards such as ASTM, JIS, EN, ISO etc., available on the subject, research papers, any study conducted by other organizations, and companies brochures and collect data on the different types of tungsten based heavy alloys and their chemical, mechanical, metallurgical and physical properties.
- 3.2** Identify the manufacturing base of the product and testing facilities of the product.
- 3.3** Visit the manufacturers of the product and get the information on the following:

- a) Raw materials. (any reference to Indian/international standard)
- b) Best manufacturing procedure/process.
- c) Variety of Grades.
- d) Grade Designation.
- e) Test methods and specifications:
 - Density, grams/cubic centimeter
 - Chemical analysis (Method of testing, in case of wet analysis is used)
 - Hardness testing
 - Strain rate
 - Porosity
 - UTS, PSI/MPA
 - Yield strength, 0.2% Offset; PSI/MPA
 - Elongation, % in 1 inch
 - Coefficient of Thermal Expansion
 - Magnetic Properties, if any
 - Any other tests, if necessary
- f) Physical/dimensional limitations:
 - Sheet/plate: (length, width, & height/thickness)
 - Rod: (Dia., & length)
 - Bar: (length, width, & height/thickness)
 - Any other shapes
- g) Safety requirements and Disposal of waste generated.
- h) Packing and quantities to be packed.
- i) Hazards identification and safety requirements during work. (First-Aid Measures)
- j) Stability and Reactivity of the product.
- k) Marking and labelling are being done.
- l) Any other requirements.

- 3.4** Check the quantity of the product imported and exported. The countries with which the trade for this product is occurring. Also check if any technical regulations exist for this product in these countries. Study and collect the test certificates received.
- 3.5** Identify the users of the product and take data of the quantity being used by them, specification used, check for the test certificates received by them and study the chemical and physical properties mentioned in the TC. Also understand from the user the main properties required by them in the product.
- 3.6** Test the grades in government/private laboratories accredited to IS/ISO/IEC 17025 to validate the chemical and mechanical requirements of the grades.
- 3.7** Prepare project report incorporating the points mentioned above.

4. METHODOLOGY:

- 4.1** A thorough literature survey and analyze the findings.
- 4.2** Visit the manufacturing unit(s) and
 - Observe the manufacturing process;
 - Examine in-process control measures;
 - Conduct focused group discussions with quality/production personnel;
 - Collect the data as mentioned in the scope through a questionnaire;
 - Collect available testing data to be collected from the manufacturing unit;
 - Draw samples of the grades and get it tested in government/private laboratories accredited to IS/ISO/IEC 17025.
- 4.3** Visit laboratories and make report on
 - Test equipment required
 - Test method being used
 - Testing charges
 - Testing time required
 - List routine tests for accepting lots and long-term tests
 - Optional tests carried out for specific users
- 4.4** Visit the identified importers and exporters. Collect the data with the help of a questionnaire as mentioned in scope.
- 4.5** Visit the identified users and collect the data with the help of a questionnaire as mentioned in scope.
- 4.6** Analyse the data and test reports from diverse sources and include the same in the project report.

5. SAMPLING PLAN

- 5.1** Three manufacturers from large/medium/small/micro scale shall be visited.
- 5.2** Samples for testing may be drawn from the manufacturer/user/importer/market.
- 5.3** Three samples for each grade shall be tested.
- 5.4** Two users of the product shall be visited.
- 5.5** Two laboratories accredited to IS/ISO/IEC 17025, preferably one in the government sector and one in the private sector shall be visited.

6. DELIVERABLES:

- 6.1** Final project report, in hard copy format as well as in editable soft copy, covering all aspects mentioned in the scope.
- 6.2** Questionnaire, discussion, visit reports, and test reports to be appended with the final project report.

7. **TIMELINE:**

The upper limit of the time for the project is 6 months. The proposed timelines, stage wise are as follows:

Sl No	Stage	Time from date of award of project (cumulative)
1	Literature review and identification of manufacturing base, testing laboratories, user/user industry, and discussion with BIS for the finalization of sampling plan	1 month
2	Visit to manufacturers, testing laboratories, users and importers and exporters and data collection	3 months
3	Preparation and submission of first draft report to BIS	5 months
4	Submission of final project report	6 months

8. **Support from BIS:**

- National /international standards relevant to the project.
- Details of BIS labs and BIS approved laboratories testing similar products.

9. **Relevant sectional committee and Nodal officer from BIS**

MTD 25-Powder Metallurgical Products and Processes Sectional Committee

Nodal Officer:

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