TERMS OF REFERENCE FOR THE R&D PROJECTS

Title of the Project: Study of grades, chemical, mechanical and physical properties and applications of Pure Molybdenum and Molybdenum alloy plate, sheet, strip, and foil

1. Background:

1.1. Rationale for the commissioning of the project:

India though is endowed with rich mineral wealth, there are several critical minerals that it lacks and one of them is molybdenum. In India, molybdenum is associated generally with copper, lead and zinc ores. The internal demand for molybdenum and its products is met mostly through imports. There is limited/no manufacturing of molybdenum and its alloys and other semi-finished products such sheets, strips, foils rods, wires etc. which are used in many electrical and electronic components and as resistance element in electric furnaces and other equipment which are operated at extremely high temperatures.

Given the limited manufacturing base for molybdenum products in the country research project is being commissioned for collecting the details of the users, suppliers, import/export data testing laboratories, grades being imported and used by Indian users and their properties and its prospective applications. While the Indian Standard, *IS 12245: 1988- Specification for molybdenum plate, sheet, strip and foil* covers the requirements of **unalloyed molybdenum plate, sheet, strip and foil** for diverse applications such as discharge lamps, electron tubes, semiconductors, electrical contacts, high temperature furnaces, chemical processing equipment, etc. of unalloyed, it **lacks the composition and properties of alloys of molybdenum** sheet plate, strip and foil being used in the country.

In alignment with legal developments, the Government of India has identified 30 critical minerals, designating molybdenum as one of the critical and strategic minerals through the MMDR Amendment Act, 2023. Notably, one of the four molybdenum blocks in Tamil Nadu is being auctioned for a mining license.

It is for these reasons that a need was felt to undertake a research for study of grades, chemical, mechanical and physical properties and applications of Pure Molybdenum and Molybdenum alloy plate, sheet, strip, and foil and upgrade the Indian standard IS 12245:. 1988
This standard can be accessed from https://standardsbis.bsbedge.com/

2. Objective

To collect relevant data and information, from both primary and secondary sources, on variety of grades of Pure Molybdenum and Alloyed Molybdenum plate, sheet, strip and foil, their chemical, physical, mechanical properties and application of these grades and validation of the properties of these grades.

3. Scope

3.1 Literature review including study of various national and international standards such as ASTM, JIS, EN, ISO etc. available on the subject, research papers, any study conducted by other organizations, company brochure etc. and collection of data on raw

materials/ingots grades mainly their chemical composition which will be used for manufacture of these grades that is identification of the grades; chemical and physical properties of the grades such as : typical supply dimensions and tolerances for each grade; the Temper conditions in which the grades of molybdenum and molybdenum alloy are supplied for each grade; and collection on data on mechanical properties like tensile strength, bend test requirements for sheet and strip for each grade ; and other properties which are essential for the grades being supplied to ensure quality and performance characteristics of the product (plate, sheet, strip and foil). The following international standard(s) are accessible on the subject. Nevertheless, the literature review should not be confined solely to these standards. Additional international standards related to the subject may be available and must be identified and examined.

ASTM B 386 – 03 Standard Specification for Molybdenum and Molybdenum Alloy Plate, Sheet, Strip, and Foil

GB/T 3876-2007 Molybdenum and molybdenum alloy plate and sheet

GB/T 3877-2006 Molybdenum Foil

3.2 Collect data on manufacturing base of the product in India.

3.3 Visit the manufacturers of the product and collect data/information on the following:

a) Raw materials/ingots (Grades of raw materials) mainly their chemical composition which will be used for manufacture of these products.
b) Manufacturing processes.
c) Varieties/grades manufactured.
d) Types of products Manufactured (Plate/Sheet/Strip /Foil) and their typical supply dimensions and tolerances.
e) Terminologies used in Indian Industry of plates sheets and strips;
f) Temper Conditions in which the grades of molybdenum and molybdenum alloy are supplied.
g) Quality parameters (chemical, physical and mechanical properties) of different grades.
h) Safety requirements
i) In-process quality checks
j) Testing facilities and test methods undertaken.
k) Marking and labelling being done
l) Packaging requirement
m) Tests being undertaken.
n) Addressing sustainability in processes such as using energy efficient process, using renewable energy sources,
o) Steps taken to address 3R - reduce, reuse and recycle.
p) Waste recycling

3.4 Collect data on testing laboratories and testing infrastructure available in the country and visit to the testing laboratories.

3.5 Identify exporters/importer/supplier of the product (Plate/Sheet/Strip/Foil and the raw materials (if raw materials are being imported such as ingots/bars/billets of Molybdenum and Molybdenum alloys), countries of origin, prospected users of the product/raw materials. Also check if any technical regulations exist for this product in these countries. Take data of the foreign specification as per which the product and raw material is being imported or exported.

3.6 Identification of user base in India and visiting the users of the product, take data on, the quantity being consumed by them per year, varieties/grades, type of product (Plate/sheet/strip/foil/any other type) used by them, specification/standards followed for procurement and testing, tests undertaken by them on the product received, applications of the product and also the information as applicable given in **3.3**. Also, 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 and the prospected applications of the product.

3.7 Drawl of samples of the grades from the users, (if there are not enough manufacturers are available for the product) and get it tested in In-House/BIS recognized/NABL Accredited/Any Govt. laboratories for validating the desired chemical, mechanical and physical properties of the grades identified. (The physical properties for which the sample may be tested may be derived from literature survey and after discussion with the user).

3.8 Analysis of the data collected as above which includes collection of data on raw materials/ingots grades mainly their chemical composition which will be used for manufacture of these grades; the terminologies used in Indian Market for plate, sheet, strip and foils and their typical supply dimensions and tolerances and then comparison with International Standards available for each grade; Temper conditions in which the grades of molybdenum and molybdenum alloy are supplied ; collection on data on mechanical properties like tensile strength, bend test requirements for sheet and strip and other properties which are essential for the grades being supplied and used in India and comparative study with National/International Standard/Journals and finally the testing and validation of grades being suggested for incorporation in the standard.

3.9 Analysis and consolidation of data and preparation of a comprehensive analytical report of the data collected above.

4. Methodology

4.1 Study the literature and analyze the findings.

4.2 Visit the manufacturing unit and

a) observe the manufacturing process,
b) examine in-process control measures,
c) conduct focused group discussion with quality personnel.
d) collect the data as mentioned in the scope through a questionnaire.
e) Draw samples from the grades manufactured and get it tested in In-House/BIS recognized/NABL Accredited/Any Govt. laboratories for validating the desired chemical, mechanical and physical properties of the grades identified (The physical properties for which the sample may be tested may be derived from literature survey and after discussion with the manufacturer)

4.3 Visit the identified importers/exporters/traders/suppliers and collect data as mentioned in the scope through a questionnaire.

4.4 Visit the users of the product and collect data as mentioned in the scope through a questionnaire. If required (in case there are limited/no manufacturers), draw the samples for the grades used and get it tested in In-house lab /BIS recognized/NABL Accredited/Any Govt. laboratories for validating the desired chemical, mechanical and physical properties of the grades (The physical properties for which the sample may be tested may be derived from literature survey and after discussion with the user)

4.5 Visit laboratories and make report on

a) test equipment required.

b) test method being used, and Standards being followed by labs for testing the product.

c) testing charges

d) testing time required.

e) Witness the tests being conducted the samples drawn on

f) Findings of the tests conducted on the samples drawn.

4.6 Analyze the data and test reports from diverse sources and include the same in the project report as given in the scope.

5. Sampling plan:

The person/institution/organization undertaking the project shall develop a comprehensive sampling plan. This plan should specify the number of manufacturers to be visited, encompassing each category (large, medium, small, and micro-scale if applicable), along with the designated number of users and traders/importers/exporters/suppliers. The purpose is to gather the requisite data outlined in the project scope. This entire plan shall be submitted for approval to BIS.

6. Deliverables:

6.1 Final project report, in hard copy format as well as in digital format, covering all aspects mentioned in the scope.

6.2 Questionnaire, discussion, visit reports, test reports to be appended with the final project report.

7. Timeline and Method of Progress Review:

The duration of the project is 3 months from the date of award of the project. The proposed indicative timeline stage-wise is given below:

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	2 months
3	Preparation and submission of first draft report to BIS	2.5 month
4	Submission of final project report	3 months

Note: The proposer may submit the draft report to BIS without waiting for test report from independent laboratories if the test is of long duration test.

8. Support BIS will provide:

BIS will provide access to latest available editions of Indian standards and/ or international standards relevant to the project, on request.

9.Relevant sectional committee and Nodal officer from BIS

Sectional committee: MTD 09 (Ores and Feed Stock for Non-Ferrous Industry, their Metals/ Alloys and Products (Excluding Aluminium and Copper) Sectional Committee)

Nodal officer: Mr Saaqib Raahi, Scientist B/ Assistant Director – Member Secretary MTD 09
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