

## TERMS OF REFERENCE FOR R&D PROJECT

**Title:** Study of quality requirements of carbon steel forgings for shipbuilding industry.

### **1. Background:**

- 1.1 Forging is metal formation involving repeated pressing, where heat is used to increase the metal's temperature. The carbon alloy steel forgings are widely used to make up the parts of ships. In shipbuilding, carbon steel is mainly used for its high tensile strength and its resistance to abrasion so that it can sustain the marine environments.
- 1.2 All shipyards conduct extensive inspections on newly constructed ship structures and during various stages of the building program with the purpose of assuring a structurally sound ship capable of withstanding the operational and environmental loads to be imposed on it during its service life. Further, a vessel built under classification is required to undergo extensive process with surveys and inspections that cover every stage of the ship's construction starting from plan approval, to certification of materials and components and finally entering into the register of the classification society. So there is a need to ensure that the grades of forgings mentioned in Rules and Regulations for shipbuilding industry specified by IR Class were to be covered under IS 3261.
- 1.3 Moreover, with advancement in steel making technologies, to improve the cruising range of ship and to reduce the building cost of ship, more grades or delivery conditions might have been developed over the years for maintaining high strength and structural integrity under challenging marine environments with improved weldability and workability.
- 1.4 Indian Standard 'IS 3261:1980 'Carbon Steel Forgings for Shipbuilding Industry' is available for forgings used in shipbuilding industry. But this specification presently specifies requirement of only six grades.
- 1.5 This R&D project is devised for collection of data on grades, their properties (chemical, mechanical, physical and metallurgical) and verification of specific requirements therein, which would be helpful in revision of Indian standard on 'carbon steel forgings for shipbuilding industry'.
- 1.6 Indian standards can be accessed following the link <https://standardsbis.bsbedge.com/>.

**2. Objective:** To collect relevant data and information on quality requirements and their verification for carbon steel forgings for shipbuilding industry.

### **3. Scope**

3.1 Study the available literature, national and international standards/ sector specific standards such as ASTM, JIS, EN, GB/T, ISO and SAE available on the subject, research papers, any study conducted by other organizations and companies' brochure. Identify the grades of steel forgings for ship building, their chemical, physical, metallurgical and mechanical properties and any other requirements which can be included in the standard.

3.2 Identification of manufacturers of the product.

- 3.3 Visit manufacturers of the product and get the following information:
- a. Raw material used,
  - b. Grades of carbon steels manufactured,
  - c. Condition of supply (with various types of heat treatment),
  - d. Quality parameters (chemical, physical, metallurgical and mechanical properties) of different grades in various conditions,
  - e. Manufacturing process,
  - f. Recommended heat treatment,
  - g. In-process quality checks,
  - h. Test facilities and test methods,
  - i. Tests undertaken,
  - j. Routine tests for accepting lots,
  - k. Mill test certificates issued,
  - l. Delivery conditions,
  - m. Coatings, if any,
  - n. Surface finishes
  - o. Sampling plan for accepting a lot,
  - p. Marking, labelling and Packaging requirement &
  - q. Steps taken for addressing sustainability.
- 3.4 Identification and visit to the laboratories for collection of relevant data and witnessing the testing of the samples drawn, if required, for verification of quality requirements.
- 3.5 Check the quantity of the product imported and exported and countries with which the trade for this product is occurring. Also check if any technical regulations exist for this product in these countries. Take data of the specification as per which the product is being traded.
- 3.6 Identification of users of the product and take data of quantity being used by them, specification used, check for the test certificates received by them and study the chemical and physical properties chemical, physical, electrical, magnetic, coating and mechanical properties mentioned in the TC. Also understand from the user the optional properties required by them for the product.
- 3.7 Examination of requirements of forgings for ship building industry stipulated by IR Class and recommendation on quality requirements for steel forgings accordingly.
- 3.8 Preparation of comprehensive project report incorporating the points mentioned above.

#### **4. Methodology:**

4.1 Study the literature and analyse the findings.

4.2 Visit any two manufacturing unit(s) and

- a. Observe the manufacturing process,
- b. Examine in-process controls,
- c. Conduct focussed group discussions with quality/production personnel
- d. Collect the data as mentioned in the scope through a questionnaire.
- e. Draw samples of the grades and get it tested in BIS approved laboratories//**BIS MoU partner educational institutes**
- f. Gather information on requirements for Regulatory compliance

4.3 Visit laboratories and make report on

- a. Test equipment required,
- b. Test methods used,

- c. Testing charges,
- d. Testing time required,
- e. Sample size.
- f. witness testing of samples drawn from manufacturers/users/importers  
(not all tests but to the extent possible shall be witnessed)

4.4 Visit importers and exporters and collect data as mentioned in the scope through a questionnaire.

4.5 Visit users of the product and collect data as mentioned in the scope through a questionnaire. Also, emphasis should be laid on gathering information pertinent to requirements for Regulatory compliance.

4.6 Relevant Information on such steel forgings also to be gathered from IR class.

4.7 Analyse the above data and test reports and include the same in the project report.

## 5. Sampling plan:

5.1 Two manufacturers, each from large and MSME scale shall be visited.

5.2 Samples for testing may be drawn from manufacturer, user, importer or market.

5.3 Two heats for each grade shall be drawn for testing of chemical, physical, metallurgical and mechanical properties as mentioned in the standard and as identified in the literature survey/information gathered from manufacturers or users.

5.4 Two users of the product shall be visited.

5.5 Two NABL accredited laboratories, preferably one in government sector and one in 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, visit reports, test reports, mill test certificates to be appended with the final project report.

## 7. Time lines

The duration of the project is 4 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 finalization of the 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	3.5 months
4	Submission of final project report	4 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 (> 1 month).

## **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 16- Alloy Steels and Forgings Sectional Committee Sectional Committee

### **Nodal officer :**

- Mr Arun Pucchakayala, Scientist D/ Joint Director – Member Secretary MTD 16,
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