1.0 This specification covers the technical requirements for manufacture of tamping tools for use with on-track tamping machines deployed on Indian Railways. Either 16 or 32 or 48 tamping tools are used on one tamping machine depending upon its model. The shape of tamping tool differs from machine to machine for which relevant drawings should be referred to.

2.0 This specification is provisional and subject to modification based on experience gained during service performance. This specification supersedes specification no. TM/HM/6/26 of April 2001 on the subject.

3.0 REFERENCES:
- IRS-SL.NO.R-16/95 Specification for steel axles for carriage and wagons.
- IS: 228 – 1959 Method of chemical analysis of pig iron, cast iron and plain carbon and low – alloy steels
- IS:1500-1983 Method for Brinell Hardness tests for steel (first revision) .
- IS: 9862-1981 Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, water and chlorine resisting.

4.0 MANUFACTURE OF STEEL AND TAMPING TOOL:-

4.1 Manufacturer should have the essential facilities required for manufacture of the above components as appended below. In case steel making facilities are not available with the manufacturer, he will furnish a certificate having obtained raw material of requisite quality from a reputed source, conforming to the stipulated chemical composition and manufacturing process of steel.
4.2 PROCESS OF MANUFACTURE OF STEEL:- The tamping tool shall be manufactured from steel made by electric or Basic oxygen process. The steel shall be of killed quality. However for continuously cast steel and for steel in specially treated condition i.e. vacuum degassed secondary refined, etc., the steel making process shall be as agreed at the time of inquiry & order.

“The hydrogen content in the liquid steel shall not exceed 3 ppm.”
“The Nitrogen content in the liquid steel shall not exceed 0.007%.

4.3 CHEMICAL COMPOSITION:- The Ladle analysis of the steel, when carried out by the method specified in the relevant para of IS:228-1959 or any other established instrumented/chemical method, shall conform to the chemical requirements of composition stipulated for Gr40Ni6Cr4 Mo2 to IS:5517-1993.

Table-1

<table>
<thead>
<tr>
<th>Constituent (of steel to be used for making tamping tool)</th>
<th>Percent</th>
<th>Permissible variations in product Analysis (%) (tamping tool)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.35 to 0.45</td>
<td>+ 0.02</td>
</tr>
<tr>
<td>Mn</td>
<td>0.40 to 0.70</td>
<td>+ 0.04</td>
</tr>
<tr>
<td>Si</td>
<td>0.10 to 0.35</td>
<td>+ 0.03</td>
</tr>
<tr>
<td>Ni</td>
<td>1.20 to 1.60</td>
<td>+ 0.05</td>
</tr>
<tr>
<td>Cr</td>
<td>0.90 to 1.30</td>
<td>+ 0.05</td>
</tr>
<tr>
<td>Mo</td>
<td>0.10 to 0.20</td>
<td>+ 0.05</td>
</tr>
<tr>
<td>S</td>
<td>0.035 to max</td>
<td>+ 0.005, -0.000</td>
</tr>
<tr>
<td>P</td>
<td>0.035 max</td>
<td>+0.005, -0.000</td>
</tr>
</tbody>
</table>

(*) (Vanadium to the extent of 0.15 to 0.25% may be added for achieving the desired mechanical properties).

4.3.1 CHEMICAL ANALYSIS:-

The manufacturer shall supply a complete chemical analysis of each cast of the steel and batch of forged and heat-treated tamping tool, whenever required to do so by the purchaser or the inspecting authority.

4.3.2 PRODUCT ANALYSIS:-

Product analysis shall be carried out on the finished product i.e. tamping tool. Variation in case of such product analysis from the Ladle analysis shall be within permissible variation as stipulated in table I of clause 4.3.
4.4 **DISCARD:-**

Sufficient discard shall be made from either end of each ingot to ensure freedom from piping, harmful segregation in case of forging manufactured from ingot route.

4.5 **MANUFACTURING PRACTICE:-**

4.5.1 The forged tamping tool shall be manufactured from steel ingots rolled or forged down to bloom size but shall be finally shaped to profile by forging only, under a hammer or a press. Pneumatic / Electro-hydraulic / Belt Drop Forge hammers / hydraulic forge press of adequate capacity capable of delivering minimum energy or force required for deformation during closed die forging of tamping tools should be available. The profile shall follow the contour of the tamping tool.

4.5.2 The minimum cross section of the ingots shall not be less than twice the maximum cross section of bloom and the minimum cross section of bloom shall not be less than thrice the maximum cross section of the forged tamping tool.

4.5.3 For continuously cast bar/billets a minimum reduction ratio of 6:1 between the cast product and the final product is essential. However, higher reduction ratio may be mutually agreed upon between the manufacturer and the purchaser at the time of inquiry and order.

4.5.4 The tamping tool shall be profile forged and then machining shall be done to dimensions wherever required according to relevant drawing.

4.5.5 **BRANDING:-**

All forged tamping tools shall be branded with manufacturer’s code at appropriate location on the forging. Cold punching on the forging shall not be permitted. Hot stamping for year and sl. no. of manufacture of tamping tool shall be done.

5.0 **SHOT BLASTING PROCESS:-**

All forged tamping tool shall be shot blasted to ensure cleanliness of the surface. Shot blasting shall be done by use of sand or iron shots of size 0.75-1.0 mm size.

6.0 **HEAT TREATMENT:-**

The forged tamping tool shall be hardened (quenched) and tempered to achieve the desired mechanical properties throughout the cross section of the component. Duration of quenching will depend on amount of quenching oil. It should be designed in such a way that it is able to achieve desired mechanical properties and tempered martensite micro-structure. Duration of travel from
furnace to quenching should be such that the hardening temperature remains within stipulated range. Heat treatment parameters shall be as under:

- **Hardening temp**: 830 °C to 850 °C
- **Quenching medium**: Oil (servo quench 107 or equivalent)
- **Tempering temp**: 550 °C to 660 °C

7.0 **QUALITY OF MATERIAL:**

The tamping tool shall be free from surface and internal forging defect i.e. laps, seams, bursts, cracks, pits, porosity, improper edges etc. which may impair the end use. The tamping tool shall be supplied to the prescribed dimensions and tolerances as per drawing.

8.0 **SAMPLING FOR TEST:**

8.1 Random sampling shall be done in accordance with clause 14 of IS:5517-1993. Each component found suitable after visual inspection shall be checked for their dimensional characteristics as per relevant drawings. Tamping tools found satisfactory with regard to all these dimensional characteristics shall be accepted subject to testing as per clause 9.0 and 4.3 of this specification.

8.2 Forged and properly heat treated tamping tools shall be submitted in identifiable batches of maximum 100 nos. and each batch shall contain forging from only one cast. The selection of forged tamping tools for testing as specified in clause 9.0 and 4.3 shall be at the rate of one forging per one batch or part thereof. The sampling frequency shall be one test per cast per heat treatment batch.

8.3 One additional sample for each 500 forging manufactured shall be selected for macro examination.

9.0 **TESTING:**

9.1 **TENSILE STRENGTH:**

Tensile test shall be carried out in accordance with IS:1608-1995. The test piece shall be taken from the central portion of the tamping tool. The tensile strength, yield strength and percentage elongation obtained from test piece shall be as under:

- **Tensile strength**: 1100 – 1250 N/mm²
- **0.2% proof stress**: 880 N/mm²
- **Elongation % min**: 11 %
9.2 IMPACT STRENGTH (U Notch):-

Impact test shall be carried out in accordance with the requirement of IS:1598-1977. Sample test piece shall be prepared from the tamping tool. The minimum impact strength obtained through Izod impact test shall be 41 J at 20° C.

9.3 METALLURGICAL ANALYSIS:-

9.3.1 MICRO EXAMINATION:-

Micro examination sample shall be taken from the tensile test specimen. The microstructure shall be tempered martensite and shall be uniform and typical of the heat treatment imparted to the forging. The sampling frequency shall be one test per cast per heat treatment batch.

9.3.2 GRAIN SIZE:-

The sample shall be drawn from the same location of the tensile test specimen. The grain size, determined as per requirements of IS: 2853, shall not be coarser than 5. The sampling frequency shall be one test per cast per heat treatment batch.

9.4 CLEANLINESS OF STEEL:-

Inclusion rating of the steel shall be determined in accordance with IS: 4163-82 from the tensile test specification. The inclusion rating shall not be worse than 2.5 ABCD (thin series) to IS:4163-1982.

9.5 MACRO EXAMINATION:-

9.5.1 Macro examination shall be carried out on the transverse section of the forged Tamping tools. After polishing, the transverse cross sectional surface of the forged tamping tools, on examination with a magnification factor 5 or less, must not reveal any harmful discontinuity. The sampling frequency shall be one test per cast per heat treatment batch.

9.5.2 The macro examination shall indicate the presence of grain flow, which shall follow the contour of the forging.

9.6 NON DESTRUCTIVE EXAMINATION:-

9.6.1 VISUAL EXAMINATION:-

All tamping tools shall be inspected visually for presence of harmful surface defects arising out of manufacturing operation. The forging shall be free from defects mentioned at clause 7.0
9.6.2 MAGNETIC PARTICLE TEST:-

All tamping tools shall be tested by magnetic particle method, both in longitudinal and circular magnetization and shall not reveal any harmful surface cracks / defects. The forging revealing harmful surface defects shall be rejected. All forging shall be demagnetized after the magnetic particle test.

9.6.3 HARDNESS TEST:-

Five percent of tamping tools of one heat treatment batch shall be tested for hardness in accordance with IS:1500-1983 'Method for Brinell Hardness Tests for Steel' and shall conform to hardness range of 330 to 380 BHN. If required, testing facilities shall be provided by the manufacturer. Hardness value shall be determined at three different locations of the tamping tool i.e. shank, middle and tamping blade of tamping tool.

10.0 INSPECTION:-

10.1 ACCESS TO FIRM PREMISES:-

The inspecting authority or purchaser shall have free access to the works of the manufacturer at all reasonable times. He shall be at liberty to inspect the manufacturer at any stage and to reject any material that does not conform to the terms of this specification. Inspecting authority or the purchaser shall have power to mark or deface in distinguishable manner all rejected tamping tools but shall not be marked in such a manner so as to render them un-saleable to other parties.

Power shall be reserved with the purchaser or the inspecting authority to be present at, and take such part as he thinks fit, in all analysis and physical / chemical/metallurgical examinations which manufacturer may undertake for his own purposes or under the terms of this specifications, both of the tamping tools and / or their materials in all stages of manufacturer.

10.2 TESTING FACILITIES:-

The manufacturer shall supply free of charge the material required for testing and shall at his own cost furnish and prepare necessary test pieces as per IS specification, and supply / arrange testing facilities, gadgets, instrumentation, appliances and labor for such testing as may be carried out on his own premises in accordance with this specification. Failing facilities at his own works for carrying out the prescribed tests, the manufacturer shall bear the cost of carrying the test elsewhere. The manufacturer shall provide necessary gadget required for dimensional checks.
11.0 ACCEPTANCE CRITERIA:-

11.1 CHEMICAL ANALYSIS:-

If the results of the product analysis do not meet the composition requirements given in table 1 of clause 4.3 of this specification, two new samples shall be taken on different pieces from the same batch. Should the two analysis satisfy the requirements, the lot represented shall be accepted. Should either of the test fails, the material shall be taken as not complying with the standard.

11.2 PHYSICAL AND METALLURGICAL ANALYSIS:-

If the results of the product analysis do not meet the requirements given in clause 9.0 of this specification, two new samples shall be taken on different pieces from the same batch. Should the two analysis satisfy the requirements, the lot represented shall be accepted. Should either of the test fails, the material shall be taken as not complying with the standard.

11.3 HARDNESS:-

If the sample selected fail to meet the requirement given in para 9.6.3 of this specification, two further samples shall be selected from same heat treatment batch. The consignment shall be considered to conform to the requirements if both the additional tests are satisfactory. Should either of the samples fail, the manufacturer shall have the right, if he so desires, to repeat the heat treatment of the product before two fresh samples are taken for testing. Should the two tests satisfy the requirements of this standard, the lot represented shall be accepted. Should either of the samples fail, the material shall be taken as not complying with the standard.

12.0 PROTECTION:-

The components shall be carefully protected with three coats of ready mixed paint, brushing bituminous black to IS:9862 or with any other equivalent antirust compound approved by the purchaser, allowing sufficient drying time between each coat.

13.0 QUALITY ASSURANCE PROGRAMME and COST OF COMPONENT:-

Cost of testing / QAP is for assurance of product - not always the cost of product. With introduction of stringent quality oriented specification, there is chances of raising of cost of tamping tool. Hence railways should go for bulk procurement of tamping tools clubbing their demand of one to three years.