Schedule of Technical requirements for cast steel bogie frame
For locomotive

STR No. MP.STR.VL-01.04.12 (Rev-00)
October 2012
1.0 SCOPE

This schedule covers the technical and infrastructural requirements for manufacturing, testing and quality control of three axle cast steel bogie frame and bolster assemblies used under Locomotives.

2.0 REFERENCE DOCUMENTS AND STANDARDS

The firm shall have a copy of latest version of following specifications & standards/ codes:

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<th>Sl.</th>
<th>Spec. No.</th>
<th>Description</th>
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<td>1.</td>
<td>ASTM A -370</td>
<td>Test Methods and Definitions for Mechanical Testing of Steel Products Practice for Steel Castings, Welding, Qualification of Procedures and Personnel</td>
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<td>2.</td>
<td>ASTM A -488</td>
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<td>3.</td>
<td>ASTM E -125</td>
<td>Reference Photographs for Magnetic Particle Indications on Ferrous Castings</td>
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<td>4.</td>
<td>ASTM E -186</td>
<td>Reference Radiographs for Heavy Walled (2 to 4½ Inch) Steel Castings (51 to 114 mm)</td>
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<td>5.</td>
<td>ASTM E -390</td>
<td>Standard Reference Radiographs for Steel Fusion Welds</td>
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<td>6.</td>
<td>ASTM E -446</td>
<td>Reference Radiographs for Steel Castings up to 2 inch (51 mm) in Thickness</td>
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<td>7.</td>
<td>IS: 1608</td>
<td>Mechanical Testing of Metals – Tensile Testing</td>
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<td>8.</td>
<td>IS: 1757</td>
<td>Method for Charpy Impact Test (V Notch) for Metallic Materials</td>
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<td>9.</td>
<td>IS: 2074</td>
<td>Ready Mixed Paint, Air Drying, Red Oxide Zinc Chrome, Priming - Specification</td>
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<td>10.</td>
<td>IS: 2932</td>
<td>Enamel, Synthetic, Exterior: (a) Under Coating (b) Finishing - Specification</td>
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<td>11.</td>
<td>IS: 4163</td>
<td>Method for Determination of Inclusion Content in Steel by Macroscopic Method</td>
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<td>12.</td>
<td>IS: 4897</td>
<td>Deviations on Untoleranced Dimensions &amp; Mass of Steel Castings</td>
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<td>13.</td>
<td>IS: 5530</td>
<td>Recommendations for Production, Rectification And Repair of Steel Castings by Metal Arc Welding Process</td>
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<td>14.</td>
<td>IS: 7310 Part I</td>
<td>Approval Tests for Welders working to Approved Welding Procedures</td>
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<td>IS: 7318 Part I</td>
<td>Approval Tests for Welders when Welding Procedure Approval is not required</td>
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<td>16.</td>
<td>IS: 12117</td>
<td>Norms for Classification of Steel Foundries for Quality Assurance</td>
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<td>17.</td>
<td>ETI 827</td>
<td>Metallurgical requirements for the qualification of castings for general use</td>
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<td>18.</td>
<td>EDPS 184</td>
<td>Engineering Design Performance specification</td>
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<td>19.</td>
<td>IS 4606</td>
<td>Specification for quality and size of shots / grits</td>
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3.0  GENERAL REQUIREMENTS

Vendors seeking approval for manufacture and supply of Cast steel bogie frame and bolster Assembly for different locomotives as per drawings attached in Annexure A shall satisfy the requirements for Class ‘A’ foundry as per IS: 12117 (latest version), and shall have their foundry certified as such.

The firm shall have valid ISO-9000 certification for the manufacture of cast steel bogie frame assembly. The scope of certification shall clearly cover manufacture and inspection of cast steel bogie frame.

All the testing and measuring equipments shall be duly calibrated as per the standard procedure with calibration status properly displayed.

The firm shall have a system of easy traceability of the product from manufacturing stage to finished product stage. Stamped identification marking with serial number of beam shall be used for this purpose.

3.2  INFRASTRUCTURE AND MANUFACTURING FACILITIES

3.2.1  GENERAL INFRASTRUCTURE

The manufacturer shall have covered shed with sufficient area and height, provided with atleast one EOT crane of sufficient capacity, as per requirement for handling the material, in each bay. EOT crane capacities for lifting of ladle and bogie frame shall not be less than 15 t and 10 T respectively.

1 The firm shall have a covered shed with sufficient height and space provided with at least one number EOT Crane of sufficient capacity in each bay as per the requirement for handling the material for the following activities:

   a) Melting
   b) Moulding, & Fettling
   c) Heat Treatment
   d) Gauging
   e) Shot/ Grit Blasting
   f) Grinding
   g) Machining Facilities
   h) Storage of Finished Items
   i) Proof Load Testing
   j) Painting

2 The firm shall have sufficient covered area with sufficient space for handling raw material like sand, scrap etc. The scraps stacking areas shall be properly classified so that different categories of scraps are stored into designated areas.

3 The firm shall have all the required material handling facilities like Mobile Crane, Pay loader, Fork lifter, Tram beam, Pillar Crane, Magnetic Chuck etc. of adequate capacity as required.

3.2.2  SAND AND MOULD PREPARATION

The manufacturer shall have the following facilities
.1 Sand drier of at least 1 t/hour capacity with conveyor and cooling arrangement with intermediate hopper shall be available.

.2 Automatic sand continuous mixer machine of adequate capacity for making ‘Mould’ and ‘Core’ shall be available. The mixer shall be intensive type with calibrated dozing of important ingredients.

.3 Jolt and Squeeze machine or mechanized moulding line shall be available with firm in case green sand moulding is done.

.4 In case no bake sand is used for bogie frame molding, the system for preparation of no bake sand mixing in the required proportions shall be well established in the factory.

.5 Pneumatic rammer and sand slinger with adequate capacity.

.6 Mould cavity and core shall be painted with mould wash Alkali base in order to reduce mould metal reaction.

.7 Facilities for preparation of cores by ‘No bake’ method.

.8 A system for testing of prepared sand as per the following minimum frequency shall exist:
   a) Moulding sand 1 in every 5 batches.
   b) Core sand 1 in every 20 batches.

3.2.3 MELTING & POURING

.1 The firm shall have at least one number tilting type Electric Arc Furnace of minimum 10 t capacity having ladle-refining facility.

.2 The firm shall have minimum three numbers of Charging Buckets of suitable capacity for scrap and foundry returns.

.3 A ladle of minimum 10 tonne capacity shall be available.

.4 Facilities for preheating of ladle shall be available. Ladle lining shall be of Kaltex or High Alumina bricks. In case of use of cold ladle board, it shall be ensured that there is no drop in temperature of molten metal and it is used one time only.

.5 Separate identified area for different grade of scrap and foundry returns shall be available for avoiding wrong charging.

.6 Facilities shall be available for Argon Purging for removal of entrapped gases.

.7 Weighing machine of adequate capacity for weighment of ferro alloys charge and finished casting shall be available.

.8 Refractory pouring cups and down sprue shall be available.

3.2.4 HEAT TREATMENT FURNACE

.1 Heat treatment facilities capable of handling the entire product shall be available. The heat treatment furnace shall be continuous state-of-the-art electrically heated / Gas or oil fired type and must be capable of maintaining an even heat distribution within +/- 10°C throughout the furnace. Verification must be established by performing a minimum of six zone survey on monthly basis. A minimum operating space of 7.0m x 3.0m x 1.5m with 6 burners each side.

.2 The furnace shall have automatic temperature controller, and shall be fitted with thermocouples or temperature sensors to measure temperature of different regions of the furnace. There shall be multi point continuous temperature recording arrangement for each point. “These temperature recorders shall have the facility of getting sealed for making them tamper-proof”.
.3 Record of heat treatment process shall be maintained with following attributes.

- Type of casting
- Prescribed heat treatment
- Serial numbers and the heat numbers of the castings

.4 Arrangement of proper sealing of doors of heat treatment furnace shall be available to avoid oxidation / scale formation on the surface of the casting. There shall be positive pressure inside the furnace to avoid entry of air from outside.

.5 Positioning of the nozzles of oil fired furnace shall be such that the flames do not make direct contact with the castings.

.6 The heat treatment furnace must be calibrated using sufficient number of thermocouples for assessing temperature at different zones at various temperature ranges. The calibration shall be done at least once in a year.

.7 Thermocouples and temperature indicators shall be calibrated at least once in six months.

### 3.2.5 MACHINING FACILITIES

The firm shall have a machine shop equipped with the following minimum facilities:

- a) Computer Controlled Plano-Miller and vertical boring and with probing facilities. The machine must have at least three axes machining facility and shall have adequate size and stroke length to machine truck frame of size 6.4m x 3m x 1.3m in single setting.
- b) Portable Grinding machine
- c) Lathe machine.
- d) Air Compressor.
- e) Drilling machine.
- f) Sawing grinder.
- g) Welding transformer
- h) Welding rectifier
- i) Electrode heater
- j) Power saw
- k) Surface table of size adequate for inspection & taking measurement of truck frames of dimensions upto 6.4mX3m. It shall be at sufficient height to facilitate taking measurements.
- l) Vernier calipers (minimum 0 to 50 mm range), Micrometers, Inside and Outside Calipers, Height gauges (minimum 0 to 500 mm), measuring taps 10000 mm and all other gauges required during machining operations and dimensional checks.

### 3.2.6 SHOT / GRIT BLASTING MACHINE

Suitable mechanized shot/grit-blasting machine of adequate size shall be available to do shot blasting of bogie frame of size 6.4m X3.0mX1m. Shot blasting shall not be done manually. The facility shall be such that after the bogie frame is put in the shot blasting
chamber, the shots can be blasted on all parts of the bogie frame uniformly by appropriate mechanism, without the necessity of a man going inside the shot blasting chamber. Suitable strainers shall be provided in the shot blasting system to ensure that shots of only appropriate sizes are used.

.2 Casting to be shot/grit blasted before and after heat treatment using steel shots of Grade S-S 1000 to IS: 4606.

3.3 TESTING FACILITIES

3.3.1 SAND TESTING

.1 All incoming sand must be tested before acceptance as per frequency set by Quality Control Department of the firm. The following properties must be checked:

a) AFS grain size
b) Clay content
c) Moisture content
d) Loss of Ignition
e) Compression strength
f) Permeability
g) Sand composition and quality

.2 For testing incoming virgin sand, moulding sand & core sand, at least one number each of the following equipment shall be available:

a) Permeability tester
b) Sand Rammer
c) Quick moisture teller
d) Chemical balance
e) Sand sieve shaker
f) Sand Muller
g) Shatter Index tester
h) Dry compression strength tester.
i) Sand mould ability / Compatibility tester
j) Sand flow ability tester
k) Mould/Core hardness tester
l) Methylene blue test equipment for clay
m) Portable hardness tester.

The calibration of above equipments shall be done at least once in a year.

3.3.2 METALLURALGICAL AND CHEMICAL LABORATORY

.1 Emission Spectrometer with necessary standard for routine calibration and automatic printer shall be available for analysis and recording of steel composition at different stages of manufacture.
2. Wet analysis facilities including Stroheli en apparatus for carbon analysis, conducting chemical test of incoming raw materials, refractories, ferro alloys etc. shall be available in addition to Spectrometer.

3. Die Penetrant Test (DPT) facilities for checking surface welding cracks shall be available.

4. Magnetic Particle Inspection (MPI) facilities for crack detection shall be available.

5. Radiographic examination facilities with well-equipped standard room and qualified staff shall be available.

6. Relevant ASTM E-446 and ASTM E-186 Standard Reference Radiographs for Steel Castings for comparing levels of radiographic quality shall be available.

7. Ultrasonic testing facility with appropriate capacity

8. Metallurgical Microscope with up to 1000X magnification shall be available along with metallographic sample preparation facilities.


10. Muffle furnace having temperature range of 0-1200 degree C and provided with recorder shall be available for chemical analysis and Jominy test with calibration at least on yearly basis.

11. Ultrasonic thickness gauge shall also be available.

3.3.3 PHYSICAL LABORATORY

1. Universal testing machine of 40 t capacity with graphical recording facilities for conducting tensile test of sample from each heat shall be available. The machine shall be calibrated at least once in a year.

2. Direct reading hardness tester of capacity 95-500 BHN shall be available.

3. Impact Testing Machine (Charpy V-notch) of 0-300 Joules capacity for conducting impact test at room temperature and at 0°C temperature shall be available.

4. Shadowgraph facilities for assuring correct notch profile and dimension for impact test specimen shall be available.

3.3.4 PROOF LOAD TESTING

1. The arrangement for carrying out proof load test with total load upto at least 125T applied hydraulically shall be available.

2. At least six numbers of dial gauges for recording of deflection shall be available.

3.4 QUALITY CONTROL REQUIREMENTS

3.4.1 The firm shall have a well established methodizing section equipped with appropriate methodizing software and trained staff to use the software.

3.4.2 The firm shall have a system of easy traceability of the product from casting stage to finished product stage.
3.4.3 Quality Assurance Plan (QAP) for the product detailing various aspects and duly approved by RDSO shall be available. The QAP shall include the following:

a) Organization chart  
b) Flow process chart  
c) Stage Inspection details  
d) Various parameters to be maintained to ensure control  
e) Policy of disposal of rejected castings  
f) Casting repairs  
g) Casting Process Control  
h) Identification Marking

The record of implementation of QAP shall be maintained for documentary evidence.

3.4.4 The calibration of the Testing/ Measuring Equipments shall be done at least once in a year unless stated otherwise.

3.4.5 The firm shall have a Quality Manual indicating the extent of control over production of casting and testing.

3.4.6 The firm shall have a system of regular submission of foundry returns detailing rejection rate, cause of rejection, corrective action taken etc. on quarterly basis.

3.4.6 The firm shall have a system of documentation in respect of rejection at customer end, warranty replacement and failure of castings in service.

3.4.7 The firm shall have a system of recording plant, machinery and control equipments remaining out of service, nature of repairs done etc.

3.5 QUALIFICATION AND TRAINING

3.5.1 Training needs for all personnel shall be identified. Regular training shall be organized covering personnel identified for a particular period.

3.5.2 The Inspection / Quality Control Section shall be headed atleast by a graduate Engineer with at least 5 years experience or a Diploma holder with at least 10 years experience exclusively for inspection of castings.

3.5.3 Inspection staff conducting non-destructive testing shall be adequately trained and qualified by recognized agency and should have adequate experience.

3.5.4 Welders engaged in welding rectification / reclamation work of castings shall be qualified as per IS: 7318 and shall be revalidated at least once in 2 years.

3.5.5 Person in charge of the metallurgical section shall at least be a Graduate in metallurgy with not less than 5 years experience.

3.5.6 Staff conducting test like Chemical Analysis, Mechanical Properties and Sand Testing shall have adequate skill and competence and have under gone sufficient training to give reasonably reliable test results. Skill of such staff shall periodically be qualified by making them carry out test on blind samples.

3.6 DOCUMENTATION

The firm should have a system for documentation for the following:

a) Test results of incoming raw material with reference to Test Certificate issued by the supplier and the results of internal tests carried out by the firm for verification.
b) Stage inspection and test results.
c) Calibration records.
d) Casting records serial no. wise, Item wise, Month wise.
e) Records of heat treatment indicating charge wise, loading serial no. wise and time-temperature graph.
f) Weightment records of bogie frame and bolster.
g) Records of rejections in different stages of manufacture
h) Records of rejection at customer ends
**Annexure**

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<tr>
<th>S.No.</th>
<th>Type of Bogie</th>
<th>Drawing No.</th>
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<tr>
<td></td>
<td>Three Axle cast steel Tri-mount Co-Co bogie frame and bolster for locomotives</td>
<td>RDSO Drg No.SK.DL-3812 &amp; SK.DL-3813</td>
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<tr>
<td>1.</td>
<td>Flexi coil bogie frame &amp; bolster</td>
<td>RDSO Drg. No. 29.04. 03, 29.04. 04,29.04. 01,29.04. 02</td>
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<td>2.</td>
<td>Truck frame assembly for EMD locomotives</td>
<td>EMD part No. 40074880/DLW Part No. 17020189</td>
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