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**Government of India
Ministry of Railways**

**QMS-17:2009
(Revision 1)**

Infrastructure, manufacturing, testing & quality control requirements
For
**Hot Coiled Helical Springs for Freight, Coaching
&
Locomotive**

Specn. No. WD-01-HLS-94 Rev 3 – Freight & Coaching
MP.0.4900.12 Rev – 01 – Locomotives

**Inspection & Liaison Directorate
Research Designs & Standards Organisation
Manak Nagar Lucknow – 226011**

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(Price Rs. 700/-)

1. SCOPE

- 1.1 The schedule of infrastructural requirements for manufacturing, testing and quality control requirements covers the norms for manufacture of high coiled helical springs for carriage, wagon and locomotive.

2. GENERAL & MANUFACTURING FACILITIES

- 2.1 Ensure that in addition to the covered area for housing of manufacturing & testing facilities, adequate space for storage of raw material i.e. spring steel rounds and bars is available.
- 2.2 Minimum 2 Nos. Bar Straightening Machine equipped with rollers and capable of straightening the bars to the accuracy of 1 mm per metre should be available. The bar-straightening machine should have the automatic arrangements for handling of bars.
- 2.3 Ensure that minimum three sets of gauges are available to measure the straightness of bars
- 2.4 Minimum 2 Nos. bar peeling machine equipped with cutter head, rod clamping and unclamping device capable of removing 2.5 mm material on dia in a single pass should be available.
- 2.5 Minimum 2 Nos. centreless grinding machine for grinding of the bars capable of material removal of minimum 0.25mm on dia in a single pass should be available. The machine should be capable of giving the surface finish of 5 micron Ra.
- 2.6 To ensure the desired surface finish of the ground bars, surface finish tester should be available in addition to two sets of surface finish comparators.
- 2.7 Minimum 1 No. Magnetic Particle Crack Detection Machine in accordance with Appendix 'B' of Specification UIC-822, to detect longitudinal and transverse crack/seams on bars by wet method should be available. The machine should be capable of accommodating the bars upto 6 mt in length and suitable arrangement shall be available for magnaflux tests of rods for Coaching stock/EMU up to 10.5 mt length to detect the open seams as well as sub surface defects upto 1 mm from the surface. The testing facilities should be such that the 6.0 M length of spring bars can be accommodated for testing in one setting and the bars can be rotated with a suitable device in position to facilitate testing of entire surface of the bars in one setting.
- 2.8 A system shall exist to ensure that magnetic crack detection machine is calibrated for current, intensity of magnetic particles in accordance with IS:3703.
- 2.9 Ensure that 1 No. End Heating Furnace is available. The furnace should be of indirect heating type having Conveyors to transport the bars ensuring *first-in first-out* system, temperature indicators, controller with recording type pyrometer.

- 2.10 Ensure that there is a system to predetermine the temperature to which the ends of the ground bars are to be heated according to chemical composition. Also gradual heating & soaking time as defined.
- 2.11 Ensure that minimum 1 No. Taper Rolling Machine equipped with suitable size dies having adjustable feature and having provision of adjusting it to produce require taper extension is available. The machine should have provision for stamping of the required particulars in it.
- 2.12 One no. walking beam furnace equipped with hydraulic adjustable walking beam should be available. The furnace should be of indirect heating type. Flame impeachment should not be there. The furnace should have a provision of temperature indicator, automatic temperature controller and recorder with adequate number of thermostats. The rods should enter from one side and come out from another end following first-in first-out principle. Gradual heating & soaking time should be defined and ensured The temperature inside the furnace should be such that decarb on any rod during heating is much less than the specified.

Required Length of Walking Beam Furnace

For Coaches	10114 mm
For Freight	4560 mm
For Locomotives	7550 mm

- 2.13 **A. For Freight & Coaching Stock** - The firm should have high speed coiling and pitching machine. Closing of end coils should be the inbuilt feature of the coiling machine. The machine should be equipped with replaceable lead screws and mandrels to suite different type of springs design or should be a full CNC machine having facilities for pitching and length.
- B. For Locomotives** - **One** fully automatic computer controlled CNC coiling and pitching machine shall be mandatory. This CNC coiling and pitching machine shall have facilities for coiling and producing constant pitch according to spring design with inbuilt end closing feature, three axis control feature viz. the linear axis, the helix angle of the guiding roller & the vertical axis to follow the diameter of the mandrel to provide the accurate control of pitches and bar positioning.
- 2.14 Ensure that the quenching tank is located adjacent to the coiling machine. The movement of springs after coiling to the quenching tank should be minimum and no transportation should be required.
- 2.15 The quenching tank should be of adequate capacity to prevent temperature rise above 80°C at any time. There should be a provision of strainer/filters, agitation pumps, heat exchangers and cooling towers etc. to prevent oil temperature going beyond 80°C.
- 2.16 Ensure that a system exists to check the oil and topping up/replenishment is done as per the requirement stipulated in advance.
- 2.17 Ensure that the quenching tank is equipped with temperature indicator.

- 2.18 The quenching tank should have a provision of conveyorised system so that the springs once taken out from the coiling machine are placed in the tank and then conveyed immediately through the conveyor. The conveyor system should have a provision of variable speed settings.
- 2.19 Ensure that one number indirect convective heating type tempering furnace without any flame impeachment on the product is available. The furnace should be continuous type & should be equipped with variable speed conveyor, temperature controllers, recorders, indicators. The tempering furnace should be in line with quenching tank conveyor. The furnace should have multiple thermo couples to facilitate measurement of temperature in the furnace at different locations.
- 2.20 Ensure that a heat-treatment cycle is pre-determined product-wise and is ensured during tempering.
- 2.21 A continuous type shot peening machine should be available. The machine should be equipped with automatic spring transportation system and rotation during shot peening to achieve required almen intensity.
- 2.22 Minimum two nos. end grinding machines equipped with adequate coolant facility to prevent burning of end coils during grinding, should be available.
- 2.23 Minimum two nos. Magnetic particle testing machine with adjustable current to cater the requirements for different dia of springs should be available. The machine should have a provision of automatic loading/unloading of springs and detection of cracks in longitudinal as well as in transverse directions.
- 2.24 Minimum two nos. scragging machines capable of scragging the springs in quick succession should be available. The machine should be of adequate tonnage to scrag the springs to solid height. It should be capable of applying the load for long duration of 48 hours as described in UIC-822.
- 2.25 There should be a proper facility for painting of the springs. A Paint Booth for painting of springs with a suitable system for drying of the paint. The handling of springs during painting and after painting should be such that the dirt and dust does not get embedded with the paint.
- 2.26 An overhead crane / fork lifter and suitably designed lifting tackles for transportation of ground bars to avoid any probability of formation of dents / pitting marks on ground bars. If handling of bars is done manually, it should be ensured that no dents / pitting marks occur on these bars.
- 2.27 Ensure that adequate number of pallets are available for storing/handling of springs at various intermediate stages of manufacturing and the springs are transported using pallets only.

3. TESTING FACILITIES

- 3.1 Ensure that adequate no. of gauges (atleast three sets) for checking of following parameters of different type of springs are available:
- End taper
 - OD of spring
 - ID of spring
 - Free Height
 - Out of squareness
 - Wire dia
- 3.2 A system shall exist to measure the as-quenched hardness of the springs and it should be recorded.
- 3.3 Suitable device for checking of lateral deflection of the spring should be available.
- 3.4 A minimum one number load deflection testing machine upto a load of 20 t capacity with a least count on load measurement of 5 kg. and the accuracy of $\pm 1\%$ which is calibrated against standard proving ring should be available. The machine should have an inbuilt arrangement to draw the chart/graphs for load deflection characteristics of the springs. The facility to measure the deflection of the springs using digitalmeter should be available.
- 3.5 Emission Spectrometer with sufficient number of channels along with printer should be available for analysis and recording of chemical composition of spring steel rounds.
- However A full fledged chemical laboratory equipped suitably to conduct analysis of all types of carbon and alloy steels required as per specification is also preferable additionally.
- 3.6 Ensure that the facilities for preparation of Metallographic specimen as per IS:7739 is available.
- 3.7 Atleast one number Metallographic Microscope with minimum magnification of 100 and photographic attachment to meet the requirement of IS:4163, IS:6396 and IS:2853 should be available.
- 3.8 Ensure that minimum 2 nos. brinnel hardness testing machine are available. These two machines should be located one each in the laboratory and on the shop floor.
- 3.9 Adequate number of Eye pieces/low power microscopes (minimum three) should be available.
- 3.10 Fatigue-testing machine for carrying out the fatigue testing of the springs shall be available.
- 3.11 A suitable place equipped with adequate illuminations, large size surface table (6'x8'), one set of gauges duly calibrated shall be nominated for purchase inspection.

- 3.12 Facilities of checking of Paint quality as per IS: 2074 & IS: 2932: Adequate setup for checking the powder coating of springs to suit the powder coating requirements as per the stipulations in relevant RDSO drawing including Elcometer for measuring Dry Film Thickness (DFT) should be available. The facility should be periodically checked at monthly intervals for Gun characteristics, DFT and paint quality to suit the requirements.

4. QUALITY CONTROL REQUIREMENTS

The Quality Control Systems given below shall exist and strictly followed:

- 4.1 Measurement of straightness, surface finish and dimensions of the peeled & ground bars and maintenance of their records.
- 4.2 Measurement and recording of as-quenched hardness of the springs.
- 4.3 Magnetic Particle Testing Machine for crack detection of springs should be calibrated in accordance with IS: 3703 or relevant ASTM specification for insuring correct level of Ultra Violet illumination and appropriate wavelength, sensitivity level of penetrant and magnetizing current. The calibration frequency shall be decided and undertaken by the manufacturer which shall in no case be more than a year and a proper record thereof shall be maintained. The calibration results should be in conformation to the permissible limits. ASNT/ISNT Level II certified operator for Magnetic Particle Testing should be deployed.
- 4.4 Pre-determine the temperature to which the ends of the ground bars are to be heated according to chemical composition and a method of gradual heating & required soaking time as defined.
- 4.5 Checking of oil in Quenching Tank and topping up / replenishment as required.
- 4.6 Pre-determining heat-treatment cycle product-wise during tempering.
- 4.7 Ensuring the traceability of the product from raw material stage to finished product stage. The system should help in identifying the raw material details – Heat No., Supplier, Inspection details from the finished product stage.
- 4.8 Proper stacking of raw material heat wise and the record detailing Despatch Memo No., Quantity, Heat No., Inspection, the Purchase Order details of the products against which the raw material has been procured.
- 4.9 A Quality Assurance Plan for the product detailing various aspects shall be available:
- Organisation Chart
 - Flow Process Chart
 - Stage Inspection details
 - Various parameters and to ensure control over it

- 4.10 There should be at least one full time spring technologist having a minimum bachelor's degree in relevant field with 5 years experience or a person with diploma in relevant field with 12 years experience. He should be free from day-to-day production, testing & quality control responsibility. He should be mainly responsible for development for product, analysis of products, control over raw material and corrective action in case of difficulties in achieving the parameters. Technical Specification of Hot Coiled Helical Springs Used In Locomotives Motive Power Directorate (VDG), RDSO, Lucknow Specification No. MP.0.4900.12 (Rev.01) of July 2008 Page No. 8 of 25
- 4.11 The in-charge of the Quality Control Section should have a minimum bachelor's degree in the relevant field & have minimum 5 years experience or a diploma holder with minimum 12 years experience. He should be actively involved in day-to-day activities of quality control / stage inspection / compliance of QAP etc.
- 4.12 The Quality Manual of the firm should clearly indicate at any stage the control over manufacturing and testing of the helical coil springs for locomotives.
- 4.13 Proper analysis to be done on monthly basis to study the rejection at various internal stages and it is documented.
- 4.14 Proper record of complaints received from users (Railways) shall be maintained and corrective action is taken.
- 4.15 The latest versions of ASTM / IS / UIC Specifications given at Para 4 of this specification shall be available with the firm.
