

- 7.10.3.3 The turn interval is to be held so exactly that no additional contact at any other point on the spring upto load given in Para 7.10.3.2 occurs.
- 7.10.3.4 Under 85% of nominal free to solid deflection, the maximum spacing between any two adjacent active coils shall not exceed 40% of the nominal free coil spacing. The nominal free coil spacing is equivalent to the specified total travel divided by the number of active turns.
- 7.10.3.5 The length of contact line during testing at load as per A.4 of Annexure 'A' of EN 13298 shall be equal to or more than 20% of mean coil diameter but not less than 20 mm for both primary and secondary outer & inner coil springs. The beginning of the line of contact may not be further than  $60^\circ$  from the end at load  $F_A$  (minimum operational force).
- 7.10.3.6 The measurement of the contact length must be carried out on a spring testing machine, dully calibrated according to the relevant standards by an independent institute. For the measurement of the contact length between first active and the end coil, 02 thickness gauges with thickness 0.10 mm shall be used.

**7.10.4 Dimensional and other Characteristic Parameters under load (As per Spring Drawings/Specifications):**

**7.10.4.1 Vertical height at loads (mm):**

Tare: As per the relevant drawings at this load.

Other loads: Nominal  $\pm 6\%$  of nominal deflection at this load.

**7.10.4.2 Solid/Block length in mm (as per Annexure A.6.2 of EN 13298):**

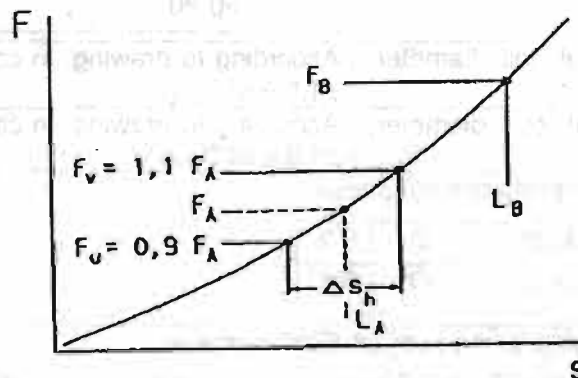
$$L_c \leq d \times (N_t - 0.3),$$

Where  $N_t$  = Total no. of coils,

$L_c$  = Solid/Block length (in mm)

$d$  = Diameter of rod in mm.

**7.10.4.3 Vertical Rigidity (N/mm):**



- 7.10.4.3.1 For Axial stiffness test of FIAT Coil Springs, the following formula may be used with their usual notations:

$$K_s = \frac{1.1 \cdot F_A - 0.9 \cdot F_A}{L_{0.9 F_A} - L_{1.1 F_A}}$$

- 7.10.4.3.2 For Axial stiffness test of Vande Bharat Coil Springs, the following formula may be used with their usual notations:

$$K_s = \frac{F_B - 0.9 \cdot F_A}{L_{0.9 \cdot F_A} - L_{F_B}}$$

- 7.10.4.3.3 The tolerance on the axial stiffness (vertical rigidity) shall be according to drawings. In case not specified in the drawings, the axial stiffness (vertical rigidity) shall be within  $\pm 5\%$  of nominal value.

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**7.10.4.4 Lateral Rigidity (N/mm) (for Springs Classified as 'A'):**

Tare	±15% of nominal value
Gross	±15% of nominal value
Max. load	±15% of nominal value

**7.10.4.5 Chasse Value (For Springs Classified as 'A'):**

Chasse value at normal gross load condition must not exceed the following limit:

$$C = 0.018L + 0.0072 L^2/D \text{ Where,}$$

L = Nominal free length of spring in mm

D = Nominal mean coil dia. in mm

C = Chasse in mm

**7.10.5 Mechanical Characteristics:**

The mechanical characteristics such as yield point, breaking strength, elongation, hardness and through hardening capacity must be guaranteed according to following norms (valid for tempered state):

Material	Norm
52Cr Mo V4	ISO 683-14 or EN10089

**7.10.6 Shot Peening:**

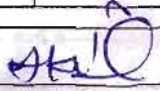
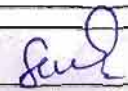
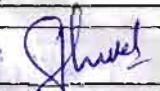
Following values must be guaranteed after shot-peening operation of springs.

Almen value (mm):	0.40 - 0.60 mm on A-Stripe
Blasting medium Ø (mm):	According to EN13298 Annex C. Rounded jet grains of size 0.45 - 1.0 as per IS:4606 shall be used.

**8.0 TESTING:**

8.1 Tests for ascertaining various requirements as stipulated on this specification shall be done as per relevant specifications/standard in the table below:

S. No.	Test	Relevant Specification/Method to be followed
1.	Chemical composition of raw material and products i.e. bars & rods	EN10089 or ISO 683-14
2.	Hardness of surface	ISO/TR 10108/ EN ISO 18265
3.	Inclusion contents	EN13298 Annex D/ ASTM E45/IS: 4163
4.	Depth of decarburization & structure	EURONORM 104//ASTM E-1077/ IS:6396
5.	Grain size	EURONORM 103/ASTM E-112
6.	Visual checks for defects	EN13298
7.	Macro-examination	EURONORM 103/ASTM E-381/IS:7739
8.	Magnaflux testing	EN 10228-1/ASTM E 709. Alternatively, DIN EN ISO 9934-1, DIN EN ISO 9934-2, DIN EN ISO 9934-3, DIN EN ISO 3059 & DIN EN ISO 9712.
9.	Surface finish of rods	EN ISO 4298
10.	Dimensional and other checks of finished spring	EN13298 or as defined in this specification.
11.	Vertical stiffness tests	The stiffness value is obtained from the load difference and the length difference by increasing the load from $F_u$ to $F_v$ and recording the respective length $L_u$ and $L_v$ . (As defined in EN 13298). $K_s = (F_v - F_u) / (L_v - L_u)$

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12.	Transverse stiffness test (for group 'A' classification spring only, and chasse evaluation (See Para 7.2 & 7.3)	The transverse static stiffness is calculated by following formula $K_t = 1/2 \{ [(Q_{B1} - Q_{A1}) / (r_{B1} - r_{A1})] + [(Q_{B2} - Q_{A2}) / (r_{B2} - r_{A2})] \}$ , refer EN13298
13.	Tests to verify quality of shot peening (Almen test)	EN13298 Annex C
14.	Tests to verify quality of phosphatizing	AS per clause 7.9.2 of this specification.
15.	Breaking strength	EN 10083-1
16.	Elongation at breaking load	EN 10002-1
17.	Creep Test	Para 7.2.3 of EN 13298
18.	Fatigue Testing	As per Para 8.4

Note:

- (i) Hardness of surface of springs shall be in accordance to EN 13298 and this specification.
- (ii) Inclusion contents, Grain size, Macro examination, Breaking strength and Elongation at breaking load of material shall be verified at raw material stage only. These tests shall be verified on black bars/bright bars. For the test for breaking strength & elongation, EN 10089 (latest) shall be referred.
- (iii) The total depth of decarburization, partial plus complete on the finished spring in the quenched and tempered condition shall not exceed 0.5% of the bar diameter.
- (iv) During macro-examination, surfaces of the springs shall be free from harmful defects namely seams, cracks and non-metallic inclusions.

8.2 Special test for measurement of lateral rigidity (for group 'A' classification springs) and Chasse evaluation according to the EN13298 and Para 7.10.4.5 of this specification.

8.3 Special test for evaluation of chasse value, direction and rotation etc. of FIAT Coil Springs (Group 'A') shall be according to the EN13298/Para 7.10.4.5 of this specification.

#### 8.4 **CREEP TEST:**

The purpose of creep test of hot coiled helical spring is to ascertain that the value of creep under the gross load ( $F_2$ ) shall not exceed 1% of the gross height ( $L_2$ ) of spring after 96 hours. The clearance between the coils shall remain within the limits as defined in Annex A.6 of EN 13298. The creep test shall be performed on Creep Test Fixture for 96 hours as per Para 7.2.3 of EN 13298. The Creep Test shall be done on any one spring randomly selected from first lot of any type of spring in every six months.

#### 8.5 **FATIGUE TEST:**

The purpose of fatigue testing of hot coiled helical spring is to ascertain that the springs meet the expected life during service. Fatigue testing of the spring shall be done during the initial approval of a manufacturer for the spring by RDSO. It shall subsequently be done on any one spring randomly selected from first lot of any type of spring in every alternate year.


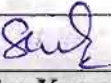

In case of new spring manufacturer not registered in RDSO Vendor Directory, fatigue testing during the initial approval shall be carried out at RDSO on any one spring randomly selected from first lot of any type of spring.

##### 8.5.1 **Test and Measurements:**

8.5.1.1 All spring samples should be marked before commencing the fatigue test.

8.5.1.2 The following parameters of the springs are to be measured before and after the fatigue test.

- a) Free height of spring as specified in drawings/specification.
- b) Actual height at the gross load specified in the drawing.
- c) Actual load for the gross height specified in the drawing.
- d) Load verses height graph from free height to gross height and free height to solid height.

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- 8.5.1.3 The fatigue test is to be displacement controlled from the height under gross load of the spring. The alternating displacement of the test is  $\pm 30\%$  of the static deflection (Free height – height under gross load) of the spring or as specified in the drawings.
- 8.5.1.4. In case the minimum height due to stroke is less than solid height of the spring, the range of deflection for the springs should be limited to [Height under tare load  $\pm$  Deflection amplitude specified in the drawing]. In case deflection amplitude is not specified in drawing, the range of deflection for the springs should be limited to [Height under tare load  $\pm 30\%$  of the static deflection] i.e. [Height under tare load  $\pm 30\%$  of (Free height – height under gross load)].
- 8.5.1.5 The frequency of the test should be maximum obtainable safely as per actual displacement and fatigue test machine capability, (But not less than 1.5 Hz). The frequency at which spring is fatigue tested should be recorded.
- 8.5.1.6 The springs shall be fatigue tested for two million cycles. Test set up should be monitored at least once a day to ensure the setup is performing well. Actual height of spring at static load should be recorded at every 2.5 lakh cycles.
- 8.5.1.7 After completion of fatigue testing, spring shall be checked by magnaflux testing for any crack/indication of cracks. The spring shall not develop any crack for the performance to be considered satisfactory.

## 8.6 METALLURGICAL & CHEMICAL TEST:

For new spring manufacturer not registered in RDSO Vendor Directory, metallurgical & chemical testing during the initial approval shall be carried out at RDSO on any one spring randomly selected from first lot of any type of spring.

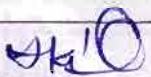
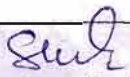
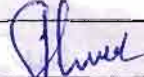
## 9.0 INSPECTION:

### 9.1 General:

- 9.1.1 The material to be used in the manufacture of Spring Steel (SS) Rounds and the finished springs shall be subjected to inspection by inspection agency mentioned in Purchase Order (PO) or any other agency nominated by the RDSO for the purpose to ascertain the quality of the material and the characteristics of the finished springs. The inspection agency for the purpose shall be permitted to carry out all the checks necessary to ensure that all the conditions specified for the manufacture of the material and of the springs are adhered to.

In case of foreign manufacturer of springs, not having any RDSO approved vendor for raw materials (Spring Steel Rounds) in the country in which springs are being manufactured, raw material shall be sourced from the sources approved in QAP only. Moreover, as Railway officials posted in foreign countries can also conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

- 9.1.2 The Inspecting official or the Purchaser shall have free access to the works of the manufacturer at all reasonable times. He shall be at liberty to inspect the manufacture of the springs at any stage and to reject any material that does not conform to the specification.
- 9.1.3 The manufacture shall afford the Inspecting official, free of charge, all reasonable facilities, by way of labour appliances and necessary assistance for such test as may be carried out on his premises in accordance with this specification. Where facilities are not available at manufacturer's works, the manufacturer shall bear the cost of carrying out such tests elsewhere.
- 9.1.4 The finished spring shall be presented for inspection in batches of 1000 or Part thereof. The springs shall be presented for inspection after the application of the protective coating against corrosion. The Inspecting official is free to have the sample springs shot peened for various tests.

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**9.1.5 Raw material Traceability:**

Material consumed in offered lot to be mentioned on original invoice by IE conducting inspection.

Ledger for ensuring accountal of raw material showing co-relation between raw material received and consumption for each lot of inspection must be maintained by the supplier which will be endorsed by IE and record kept of inspection documents.

- 9.1.6 In case of foreign manufacturer of springs, not having any RDSO approved vendor for raw material (Spring Steel Rounds) in the country in which springs are being manufactured, raw material shall be sourced from the sources approved in QAP only. Moreover, as Railway officials posted in foreign countries can also conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

**9.2 STAGE-I (ROLLED BARS) AT SPRING STEEL MANUFACTURER PREMISES:**

- 9.2.1 The steel and rolled bar manufacturer shall submit to the spring manufacturer necessary test certificates of the following tests, carried out by him apart from the documents pertaining to the steel manufacture and refining details, ingot shape and size of the rolled product, cropping yield etc.

- Chemical composition of the ladle analysis and product analysis.
- Inclusion contents in bars
- Reduction Ratio.
- Depth of decarburization
- Surface hardness
- Grain size
- Dimensions
- End quench hardenability test for each heat/lot (As per ISO 683-14 & EN 10089)
- Surface Integrity (Auto MFL & Auto UT)

In case of foreign manufacturer of springs, Railway officials posted in foreign countries can conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

- 9.2.2 While carrying out the inspection of rolled bars at spring steel manufacturer's premises, the Inspecting official would pay special attention to the following: -




- Size of ingots/billets used as verified from the records of the steel manufacturer.
- Dressing of complete billet by general surface grinding and freedom from surface defects.
- Discarding of end portions at both ends of each billet and freedom from piping.
- The size of ingot used shall be checked, recorded and verified that minimum reduction ratio of 16:1 is ensured for the rolled bars offered for inspection.

In case of foreign manufacturer of springs, Railway officials posted in foreign countries can conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

- 9.2.3 The Inspecting official shall examine various registers and records maintained by the spring steel manufacturer to verify heatwise checks carried out by them on various parameters and manufacturing practice like production of ingots with wide end up and hot top cropping of each ingot/primary rolled billet etc.

In case of foreign manufacturer of springs, Railway officials posted in foreign countries can conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

- 9.2.4 The Inspecting official shall carry out the following minimum checks as per sampling given in Para 9.2.5 and maintain records. Testing method as per Para 8.1 shall be followed. He may draw any additional number of samples and carry out tests at his

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discretion. He shall also have the right to cross check any of the above parameters by actual tests at his discretion and at the cost of the spring steel manufacturer.

In case of foreign manufacturer of springs, Railway officials posted in foreign countries can conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

#### 9.2.5 Sampling (Random):

S. No.	Test	Sampling
1.	Chemical analysis	2 samples per heat per section.
2.	Hardness	10 bars per heat.
3.	Macro-examination	0.5% subject to min. of 5 bars per heat.
4.	Depth of decarburization	3 bars per heat per section.
5.	Inclusion content	3 samples per heat per section.
6.	Grain size	3 bars per heat per section.
7.	Visual checks for defects	2% of bars per heat per section.
8.	Verification of dimensional tolerances	5 samples per heat per section.

In case of foreign manufacturer of springs, Railway officials posted in foreign countries can conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

- 9.2.6 Records for all the above tests shall be made available for scrutiny of inspector. Sample and records of the above tests shall be preserved for atleast three months for counter check by Inspector, if he so desires.

In case of foreign manufacturer of springs, Railway officials posted in foreign countries can conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

- 9.2.7 Inspecting official may pick up two samples per 1000 tonnes of material offered and send the same to approved agency for confirmatory test for chemical and metallurgical properties at Spring Steel Manufacturer's expense. This test should not form part of purchase acceptance test but will only serve as a counter check on Spring Steel Manufacturer's quality control practice.

In case of foreign manufacturer of springs, Railway officials posted in foreign countries can conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

#### 9.3 STAGE II (DURING MANUFACTURE OF RODS):

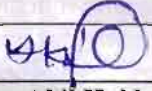
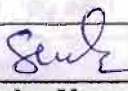
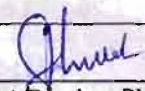
- 9.3.1 During manufacture, records pertaining to checking of 100% of the rods for minimum material removal, surface finish, dimensional checks and cracks and crack detection by magnaflux testing shall be kept by the spring manufacturer.

- 9.3.2 The Inspecting official shall be allowed to examine various records and registers maintained by the spring manufacturer to verify checks carried out by them in respect to clause 9.3.1.

- 9.3.3 In addition, spring manufacturer should submit a certificate certifying that "Magna-flux test & Ultrasonic Test (UT) as per clause 6.2.1.2 & 6.2.1.3 has been carried out on full length of 100% of the centreless ground /polished bars against particular purchase order". This certificate should be submitted to the Inspecting Authority as well as consignee railway.

#### 9.4 STAGE III (SPRINGS):


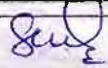
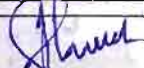
- 9.4.1 For each batch of finished springs or part thereof presented for inspection, tests as per Para 9.4.2 shall be carried out on springs randomly selected by the purchaser's inspector.

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## 9.4.2 Sampling from the batch of finished springs:

S. No.	Description of check	Sample size	Equipment used
1.	Spring surface	As per Table 6 of EN 13298	Visual as finished Visual after shot peening
2.	Stamping	As per Table 6 of EN 13298	Visual
3.	Free height measurement	As per Table 6 of EN 13298	Gauge/Vernier calipers (Digital type)
4.	Perpendicularity/Squareness	As per Table 6 of EN 13298	Surface Table, Try Square & Filler Gauge
5.	Parallelism	As per Table 6 of EN 13298	Parallelism Gauge
6.	End preparation	As per Table 6 of EN 13298	Visual
7.	Tip thickness	As per Table 6 of EN 13298	Vernier caliper
8.	Scragging	As per Table 6 of EN 13298	Scragging machine
9.	Static load test- stiffness	As per Table 6 of EN 13298	Spring testing machine
10.	Static load test- working height	As per Table 6 of EN 13298	Spring testing machine
11.	**Transverse Stiffness	As per Table 6 of EN 13298	Spring testing machine
12.	Maximum spacing between two active coils under 85% deflection	As per Table 6 of EN 13298	Spring testing machine
13.	Uniformity of pitch	As per Table 6 of EN 13298	Spring testing machine
14.	Crack detection	As per Table 6 of EN 13298	MPI Machine
15.	Shot peening/Almen Test	Internal test records. But, Almen gauge to clamped on 01 spring and reading to be noted.	Shot peening machine
16.	Core hardness	1 Sample per heat	BHN hardness tester
17.	Surface hardness	As per Table 6 of EN 13298	
18.	Chemical composition	1 Sample per heat	Spectrometer/chemical testing equipment
19.	Depth of decarburization	1 Sample per heat	Photo Microscope & Computer Analyzer
20.	*Grain Structure	1 Sample per heat	Photo microscope
21.	*Inclusion Rating	1 Sample per heat	Photo microscope
22.	*Macro etching	1 Sample per heat	Photo microscope
23.	Paint quality	As per Table 6 of EN 13298	There should be no sign of any sagging, blistering, checking, chalking, flaking, spotting, peeling and mechanical damage when checked on finished coated spring.
24.	Grouping and colour coding	As per Table 6 of EN 13298	Spring testing machine
25.	Dimensional Checks & **Chasse check (loaded)	As per Table 6 of EN 13298	Spring testing machine
26.	Length of contact line	As per Table 6 of EN 13298	Spring testing machine

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		13298	
27.	Salt Spray Test	One sample of any type of spring (primary or secondary), randomly selected by inspecting official, shall be subjected to salt spray test once in every year or after supply of every cumulative quantity of 25000 coil springs as per this specification, whichever is later.	Internal test reports to be reviewed.
28.	Creep Test	At any one spring randomly selected from first lot of any type of spring in every six months.	Creep Test Fixture. Internal test reports to be reviewed.
29.	Fatigue Test	During the initial approval and subsequently on any one spring randomly selected from first lot of any type of spring in every alternate year.	Fatigue Testing machine. Internal test reports to be reviewed.
30.	***Tensile strength of springs	1 sample per heat	As per EN 13298 (latest). The Test bar of 1 - 1.5 meter length shall be given same heat treatment as to springs of the lot which will be certified by the firm.
31..	***Ductility of springs	1 sample per heat	As per EN 13298 (latest). The Test bar of 1 - 1.5 meter length shall be given same heat treatment as to springs of the lot which will be certified by the firm.

\* Verified at raw material stage only.

\*\* For spring of Group 'A' & Vande Bharat coaches only.

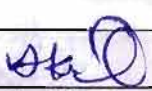
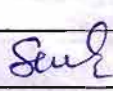
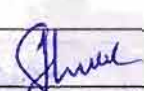
\*\*\* The test pieces shall be taken from the bar, utilized for the manufacture of the spring and heat treated according to the identical process as the spring.

In case of foreign manufacturer of springs, Railway officials posted in foreign countries can conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

9.4.3 Records of individual test results as above will be kept by the spring manufacturer for a period of 5 years following delivery and can be viewed upon demand. The cut samples used for the destructive tests shall also be preserved for one year for counter check along with the records.

## 9.5 REJECTION:

9.5.1 During the sampling inspection, if any spring is found to be defective, another sample of twice the size of the earlier sample should be selected for inspection. If there is any rejection in the sample, the whole batch stands rejected. After inspection, the inspecting officer shall affix his stamp/seal on each spring as token of the spring having been passed by him.

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- 9.5.2 The rejected springs shall be either gas cut or cross marked on one of the effective coils with the help of grinding cutter so that the rejected springs do not get mixed up with good springs at any stage. This should be done in the presence of the inspecting officer immediately after the spring has been rejected.

#### 10.0 QUALITY RECORDS:

The recorded individual test result will be kept by the manufacturer for a period of 5 years following delivery and can be viewed upon demand.

#### 11.0 GUARANTEE:

The springs shall be guaranteed for a period of six years against any defect imputable to manufacture from the date of delivery of the spring as stamped on end coil or for a period of five years from date of actual fitment whichever is earlier. Springs that show, during the guarantee period, defects making them either unfit for service or reduce the effectiveness of the life and which defects may be imputable to manufacture shall be replaced free of cost by the manufacturer.

#### 12.0 FINAL ACCEPTANCE OF SPRINGS:

Final acceptance of the springs is reserved exclusively to RDSO or any other agency nominated for the purpose.

#### 13.0 PACKING & TRANSPORTATION:

Spring is to be placed first in "Ethylene Vinyl Acetate" Sheet of 1.5 mm thick bag or bubble sheets. The open end of the bag shall be sealed and folded in the spring ensuring that no portion of the spring remains exposed or likely to get exposed during handling.

The inner and outer springs each should be suitably wrapped with bubble sheet and suitable separator shall be inserted between inner and outer springs placed concentric. Suitable separators shall also be used between each outer springs.

The springs must be packed and transported in such a way that the coating lacquer is protected from any damage.

Transportation of spring shall be done in wooden pallets /boxes. Any other precaution in packing as may be deemed fit for safe transportation shall be taken by the spring manufacturer to avoid damage during transportation.

The general arrangement of wooden boxes shall be as per Annexure-II, III & IV. Arrangement may be modified as per requirement after taking approval from RDSO.

The packing should be as per with the one provided by overseas suppliers.

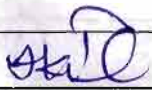
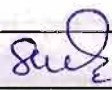
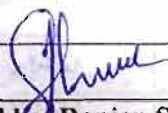
Any other packing arrangement better than above may be approved by RDSO depending on case to case basis.

#### 14.0 FIELD TRIALS:

For considering a new vendor for registration as a vendor for developmental order, field trial shall be done in minimum 50 coach sets. Approval may be considered after fitment and satisfactory field performance of the springs on LHB & Vande Bharat coaches separately for 06 months as per guideline. Field performance shall be monitored as per format at Annexure- V. One outer and one inner spring shall be removed from coach after 06 months from fitment and subjected to tests as per specification for functionality.

#### 15.0 VENDOR CHANGES IN APPROVED STATUS:

A vendor shall be considered eligible for up-gradation as "Approved Vendor" on completing successful supply of a minimum of 250 coach sets of the particular type of spring along-with the fulfillment of conditions mentioned in latest apex ISO document of RDSO for "Vendor changes in approved status" (document no. QO-D-8.1-11 Version No. 2.7 (or latest).

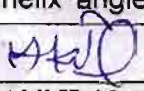
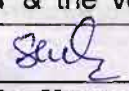
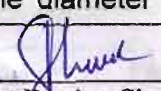
Signature			
Name & designation	Akil Haider, SSE/Design/Carriage Prepared by:	Satyendra Kumar, ADE/VDG/ Carriage Checked by:	Prabhat Ranjan Shukla Director/VDG/Carriage Approved by:



**16.0 MANUFACTURING FACILITIES (MINIMUM):**

The following manufacturing facilities shall be available with the firm:

- (1) Bar Straightening Machine equipped with rollers and capable of straightening the bars to the accuracy of 1mm per meter having suitable arrangement for handling of bars.
- (2) At least two sets of Gauges for measuring straightness of bars.
- (3) Bar Peeling Machine equipped with cutter head, rod clamping and unclamping device capable of removing upto minimum 2.5 mm material on diameter in a single pass.
- (4) Centreless Grinding m/c with should be capable of removing up to minimum 0.25 mm material on diameter in a single pass with maximum Ra value of the surface not exceeding 2.5 µm Ra.
- (5) At least one Surface Tester and two sets of Surface Finish Comparators for checking of surface finish of the ground bars.
- (6) At least an overhead crane/fork lifter/mobile crane with 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 shall be ensured that no dents / pitting marks occur on these bars.
- (7) At least one Magnetic Particle Testing Machine for Crack Detection of bars in accordance with Appendix 'B' of Specification UIC-822/ASTM E-709 (latest), for detection of both longitudinal as well as transverse cracks / seams by wet method capable of accommodating bars upto 6 metre in length and detecting open seams as well as sub surface defects upto 1mm from the surface. The machine shall have suitable device for rotation of bars in position to facilitate testing of entire surface of the bar in single setting. MPT machine and components shall be suitably calibrated.
- (8) At least one End Heating Furnace of indirect heating type having Conveyors to transport the bars ensuring first-in-first-out system equipped with temperature indicators and controller with recording type pyrometer.
- (9) At least one Taper Rolling Machine (if ends are tapered) equipped with dies of suitable size having adjustable feature to produce required taper on ends. The machine shall have provision for stamping of the required particulars on the tapered ends of the bar. There shall be some arrangement to ensure that only the required lengths of the bars after end heating are tapered.
- (10) At least one walking beam indirect type heating furnace of sufficient length to accommodate the length of bar from which the spring is to be manufactured, but the length of the furnace shall not be less than 8500 mm equipped with hydraulic adjustable walking beam. There shall be no flame impeachment on bars in the furnace, and the furnace shall be closed type to ensure a neutral atmosphere to prevent decarburization. The furnace shall be equipped with temperature indicator, automatic temperature controllers and recorders with adequate number of thermostats. The rods shall enter from one side and come out from another side following first-in-first-out principle. It shall be possible to adjust gradual heating and soaking times as per the predetermined values depending upon the bar dia. or type of spring. The temperature inside the furnace shall be such that decarburization on any rod during heating remains well within the specified limits. The temperature difference between different zones of the furnace shall not exceed 15 degrees centigrade. At least three thermocouples shall be provided to sense temperatures of different zones of the furnace, and the same shall be recorded.
- (11) High speed Coiling Machine: At least one automatic high speed coiling and pitching machine with inbuilt end closing and three axis control features viz. linear axis, the helix angle of the guiding roller & the vertical axis to follow the diameter of the

Signature			
Name & designation	Akil Haider, SSE/Design/Carriage Prepared by:	Satyendra Kumar, ADE/VDG/ Carriage Checked by:	Prabhat Ranjan Shukla Director/VDG/Carriage Approved by: