Government of India
Ministry of Railways

Document content	**Technical Specification**	**Yes**
	Schedule of Technical Requirement	**Yes**
Description of item	**Hot Coiled Cylindrical Springs for use in Suspension having FIAT Design Bogies & Vande Bharat Coaches of I.R.**	
Remarks	Nil. ~~Clause 7.9.3 of this Specification shall be applicable after 06 months from the date of issue. Till implementation date of this clause, painting scheme stipulated in Specification No. RDSO/2017/CG-01 (Rev.01), Corrigendum No.01 shall be applicable.~~	

S. No.	Month/Year of issue	Revision / Amendment	Page No.	Reason for Amendment/Revision
1.	February, 2017	Nil	-	First issue
2.	August, 2019	Revision-01	-	Technical changes done and some new Clauses incorporated.
3.	October, 2019	Corrigendum No.-01	27	In Clause no. 20.0, typographical error "18 months" is corrected to "06 months".
4.	February, 2023	Revision-02	-	Technical changes done and some new Clauses incorporated.
5.	January, 2024	Revision-03	-	Technical changes done and new Clauses included for Coil Springs of Vande Bharat Coaches

Issued by:
Carriage Directorate
Research Designs and Standards Organization
Manak Nagar, Lucknow - 226011.

CONTENTS

Technical Specification for Hot Coiled Cylindrical Springs for use in Suspension having FIAT Design Bogies & Vande Bharat Coaches of I.R.

1.0 PREAMBLE:

Indian Railways had entered into Transfer of Technology (TOT) agreement with M/s LHB, Germany for procurement of 24 numbers of all Stainless Steel Light Weight, High Speed Coaches suitable for operations at 160 kmph on existing Indian Railways track and upgradable to 200kmph. These coaches used FIAT design bogies which are provided with helical coil springs in primary and secondary suspension. ~~This specification is meant for these helical coil springs~~.

This specification is developed for manufacturers of coil springs for FIAT Bogie & Vande Bharat Coaches. The specification may be altered or upgraded in future on the basis of experience gained.

2.0 GENERAL:

2.1 Scope:

2.1.1. This specification is applicable for high performance cylindrical springs used in the suspension of IR coaches of LHB design having FIAT bogies, Vande Bharat Coaches and similar other applications. Described springs are manufactured out of circular section hot wound round bars.

2.1.2. Procurement of Spring Steel to be used in the manufacture of these springs shall be done only from reputed manufacturers approved by RDSO or any other agency nominated by the RDSO for the purpose.

2.1.3. Spring Steel bars duly inspected and passed by RDSO or any other agency nominated by the RDSO for the purpose shall be used for manufacture of springs.

2.1.4. The technical conditions for the delivery and supply of cylindrical springs shall be as follows:

- As per special technical provisions as appear on the drawings.
- As per technical provisions of this specification, in as much as these do not conflict with the special provisions mentioned in the drawings.

2.1.5. Following shall be applicable when this item appears in RDSO's vendor directory:

"All the provisions contained in RDSO's ISO procedures laid down in Document No. QO-D-8.1-11, Version No. latest ~~2.5 (or latest)~~ with title "Vendor-Changes in approved status" and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways."

2.1.6. The Government of India policy on 'Make in India' shall apply.

2.2 List of Reference Specifications:

S. No.	Standard	Description
(i)	ISO 683-14	Heat Treatable steels, alloy steels and free cutting steels; Part-14: hot rolled steels for quenched and tempered springs.
(ii)	ISO 1462	Metallic coatings; Coatings other than those anodic to the basis metal; Accelerated corrosion tests; Method for the evaluation of the results.
(iii)	ISO 2162-1	Technical product documentation; springs; part-1; simplified representation.
(iv)	ISO 2162-2	Technical product documentation; springs; part-2; presentation of data for cylindrical helical compression

		springs.
(v)	ISO 2162-3	Technical product documentation; springs; part-3; Vocabulary.
(vi)	ISO 3887	Steel, non-alloy and low-alloy; determination of depth of decarburization.
(vii)	ISO 4288	Rules and procedures for the measurements of surface roughness using stylus instruments.
(viii)	ISO TR 4949	Steel names based on letter symbols.
(ix)	ISO 4540	Metallic Coatings; Coatings cathodic to the substrate; Rating of electroplated test specimens subjected to corrosion tests.
(x)	ISO 4967	Steel; determination of content of non-metallic inclusions; Micrographic method using standard diagrams.
(xi)	DIN EN ISO 9227	Corrosion tests in artificial atmospheres- Salt Spray Tests.
(xii)	ISO/TR 10108	Steel, conversion of hardness values to tensile strength values
(xiii)	ISO 10209-1	Technical product documentation; vocabulary; Part-1; terms relating to technical drawings; general and types of drawings.
(xiv)	IS: 3618	Specification for phosphate treatment of Iron and Steel for protection against corrosion.
(xv)	ICF/MD SPEC-155	STR for Procurement of Bright Spring Steel Rounds Peeled & Centerless Ground
(xvi)	ASTM E 709	Standard Guide for Magnetic Particle Testing.
(xvii)	UIC Code 822	Technical Specification for the supply of helical compression springs, hot or cold, for tractive and trailing stock.
(xviii)	BS EN:10089	Hot Rolled Steels for Quenched and Tempered Springs - Technical delivery conditions.
(xix)	BS EN:10060	Hot Rolled Round Steel bars for General Purposes – Dimensions and tolerances on shape and dimensions.
(xx)	EN 13298:2003	Railway applications-Suspension Components-Helical Suspension Springs, Steel
(xxi)	EN 13906-1:2013	Cylindrical Helical springs made from round wire and bar-Calculation an Design
(xxii)	M&C/PCN/132/2021	RDSO Specification for Painting of Helical Coil Springs of LHB Coaches and Similar Applications (Single Pack)
(xxiii)	EN 45545-2	Railway Applications-Fire properties on Railway Vehicles-Part 2: Requirements of Fire behavior of materials and components
(xxiv)	DIN EN ISO:9443	Surface Quality Classes for Hot Rolled bars and wire rod
(xxv)	DIN EN ISO:9934-1	Non-destructive Testing-Magnetic Particle Testing-Part 1: General Principles
(xxvi)	DIN EN ISO:9934-2	Non-destructive Testing-Magnetic Particle Testing-Part 2: Detection media
(xxvii)	DIN EN ISO:9934-3	Non-destructive Testing-Magnetic Particle Testing-Part 3: Equipment
(xxviii)	DIN EN ISO:3059	Non-destructive Testing-Magnetic Particle Testing-Penetrant Testing and Magnetic Particle Testing –Viewing Conditions
(xxix)	DIN EN ISO:9712	Non-destructive Testing- Qualification and certification of personnel
(xxx)	DIN EN ISO:2409	Paints and varnishes- Cross-cut Test

The reference to various specifications as above quoted herein shall generally be taken as reference to the latest version of the specification concerned.

Specific provisions in this document will take precedence over those contained in the above specifications where these are not in conformity with one another. Any special requirements given in the drawings will over ride this specification.

3.0 SPRING CLASSIFICATION:

3.1 Depending upon their loading condition, springs have been ~~grouped into classes denoted by the following letters:~~ divided into two categories shown in the Table below:

~~A - Springs used mainly in axial compression.~~
~~B - Springs used in axial compression and lateral bending and fitted according to Chasse Value and direction (Flexi-coil)~~

Category A	Category B
Axial and transverse stiffness and/or bowing defined	Only axial stiffness defined

4.0 RAW MATERIAL:

4.1 Choice:

The following grade of steel may be chosen for use by spring manufacturers:

Finished Rod Diameter 'd' (mm)	Material Grade	Norm No.
25 mm to 65 mm dia.	52 Cr Mo V4	ISO 683 Part-14 Or EN10089

For rod diameter over 65 mm, the material must be explicitly stated on the drawing.

4.2 Chemical Composition:

4.2.1 Since the duty cycle of springs covered by this specification will be very tough, following restrictions are considered essential for the raw material composition:

Maximum Sulphur (S) content - 0.015% by weight
Maximum Phosphorous (P) content - 0.015% by weight
~~For 52CrMoV4~~, Vanadium (V) content - 0.14 to 0.20% by weight
~~For 52CrMoV4,~~ Molybdenum (Mo) content - 0.20 to 0.30% by weight

4.3 Manufacture:

4.3.1 Steel shall be manufactured by Blast furnace/DR (Direct Reduction) followed by Basic Oxygen for primary steel making and secondary refining in ladle refining furnace/ladle furnace with vacuum degassing facility followed by continuous casting. Appropriate electromagnetic stirring to be used to ensure homogeneity in the material with reduced gas levels **Nitrogen** content **70.0 ppm (max**.), **Oxygen** content **20.0 ppm (max**.) and **Hydrogen** content **2.0 ppm (max.)** in liquid steel.

Steel manufacturers shall use Hydris and Cylox tubes in liquid stage to ensure specified contents of **Hydrogen** & **Oxygen.** Proper arrangement for this is to be done by manufactures in VD stage. For nitrogen content and confirmation of H_2 & O_2 content in liquid steel, vacuum tubes and spectrometry may be used. Suitable chilling media should be used to chill the samples taken in vacuum tubes.

Any other method instead of vacuum degassing used during the secondary metallurgy process is also acceptable provided that it has not any negative influence on the final product.

4.3.2 All the Spring Steel bars/rods manufacturers shall have Integrated Steel Plant for manufacturing of Spring Steel (SS) Rounds used for manufacture of springs.

4.4 Marking on Billets:

Following information shall be hot stamped/pasted on stickers on one cross section of each billet by the steel manufacturer:

- Code of the Steel manufacturer
- Cast number
- Month & Year
- Size

Any deviation or exception from above may be accepted if vendor establishes alternate method will not have any negative implication on quality and traceability.

5.0 BLACK BARS (AS ANNEALED):

5.1 Manufacture:

5.1.1 The bars shall be manufactured by hot rolling process and the size of the ingots, billets or continuous cast billets (raw material) for any given size of bar shall be such that a minimum rolling reduction ratio of 16:1 from the minimum cross sectional area of the ingot or continuous cast billets to the maximum cross-sectional area of the product is ensured, to have freedom from "Primary" dendritic structure.

5.1.2 Spring steel rounds may be manufactured through Ingot- forging- rolling route also by maintaining minimum reduction ratio of 16:1. Hydrogen content shall be limited to 1.5 ppm (Max.) and nitrogen content shall be limited to 0.007% (Max.).

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.

5.2 Properties:

5.2.1 Surface:

5.2.1.1 Visual checks should indicate that bars are smooth and free from distortion, twist, kinks and harmful defects namely seams, folds, laps, cracks, ~~deep rooted seams~~, holes, deep pits, grooves & excessive scaling ~~and non-metallic inclusion~~ which may lead to impairing of their serviceability.

5.2.1.2 The permissible depth of seams and laps in the bars shall not be more than 1% of the bar diameter or 0.3 mm whichever is less.

5.2.1.3 Auto MFL (Magna-flux Leakage) testing on 100% annealed black bars to be ensure surface completely free from cracks, seam, inclusions, lap, etc. For sub surface crack detection, Auto Ultrasonic Test (UT) on 100 % bars to be done. Test method and test infrastructure for Auto MFL and Auto UT should be as per applicable EN standard or any other equivalent standard. The Qualification of testing personnel shall be min level-II from ISNT/ASNT. Probing surface shall be from curved surface and not from the end surface. Black bars duly passed in Auto MFL and Auto UT shall only be supplied by bar manufacturers.

5.2.1.4 Proper record of bars failed in Auto MFL/UT and further disposal should be recorded.

5.2.2 Hardness:

~~Hardness of 'bar' material may be mutually agreed upon between supplier and purchaser.~~ Hardness of as annealed bars shall be 248 BHN (Max.) as per Table 6 of EN 10089 (latest).

5.2.3 Geometric Condition:

5.2.3.1 ~~Tolerance on hot rolled bars diameter shall be within the following limits as per EN 10060 (latest) referred in EN 10089 (latest).~~ Diameter of as annealed black bars shall be such that which enables reduction in its diameter after peeling and centerless grinding/polishing by at least 3% of nominal bar diameter or 1 mm whichever is more. For placing the purchase order for black bars, spring manufacturer should ensure proper allowance for above operations so that the finished diameter of rods must be as per Para 6.2.2.2.

5.2.3.2 Ovality of the bars should be controlled in such a manner so as to ensure minimum removal of the material ~~as per the requirements contained in Para 6.1.2~~ by at least 3% of nominal bar diameter or 1 mm whichever is more.

5.2.3.3 Bars shall be supplied in straightened condition and the limit for out of straightness shall be 1.5 mm/metre length (maximum).

5.2.4 Metallurgy:

5.2.4.1 Macro-etching:

In the cross-section (micro-section surface), no microscopic defects such as cavities, pores cracks or liquidations are permitted. Macro etch level shall not be worse than C2, R2, S2, of ASTM -381 Plate I for blooms and billets.

5.2.4.2 Microscopic:

- Entire cross-section should have even annealed structure with depth of rim decarburization not more than 0.4mm.
- Average grain size of the bar shall be as per ASTM no.6 or finer.
- In longitudinal section, non-metallic inclusion rating shall not be worse than 1.5 A, B, C, D for both thick and thin series when compared to the chart for determining the inclusion content of secondary refined steels (Fig.2) of IS:4163 (latest). Alternatively, non-metallic inclusion at every heat may be checked by the steel procedure in accordance to ASTM E45.

5.3 Marking on Black Bars (As Annealed):

Following information shall be hot stamped/pasted on stickers at the one extreme end ~~ends~~ of each bar:

- Name and trademark of the manufacturer
- Type of steel
- Smelt number
- Nominal diameter
- Nominal length
- Year

Any deviation or exception from above may be accepted if vendor establishes alternate method will not have any negative implication on quality and traceability.

6.0 RODS (PEELED, GROUND & POLISHED AS ANNEALED BARS):

6.1 Manufacture:

6.1.1 ~~Rods shall be manufactured out of bars described in Para 4 above.~~ Rods (peeled, ground & polished as annealed bars) shall be manufactured out of bars described in Para 5 above.

6.1.2 Bars of such size shall be selected for rod manufacture which enables reduction in its dia. after peeling and centreless grinding/polishing by at-least 3% of nominal rod diameter or 1 mm whichever is more.

6.1.3 Generally, the bars should be procured in exact lengths so that cropping of bars does not become necessary. In case of multiple /excess lengths, bars may be cut to lengths by shearing /cutting carefully.

6.1.4 Bars as per Para 5.2.3.3 shall be straightened in bar straightening machine before undertaking peeling and centreless grinding operation.

6.1.5 Straightened and as annealed black bars shall be peeled, ground & polished to make rods used for manufacture of springs. Peeling and ~~grinding/~~polishing of as annealed black bars is mandatory requirement. As annealed black bars should be procured from raw material suppliers and should be ~~centerless ground~~/polished on ~~centerless grinding~~ polishing machine available with the spring manufacturers just before spring manufacturing. For any deviation, approval of RDSO must be taken with detailed technical justification.

6.1.6 **Properties:**

6.2.1 Surface:

6.2.1.1 On the surface, defects which can be seen by the naked eyes (e.g. cracks, wrinkling, longitudinal grooves, ~~inclusions~~, burned spots, tool marks & dent marks) or depressions from handling and transport are not permitted.

6.2.1.2 Auto MFL (Magna-flux Leakage) testing on 100% annealed rods to be ensure surface completely free from cracks, seam, inclusions, lap, etc. For sub surface crack detection, Auto Ultrasonic Test (UT) on 100 % rods to be done. Test method and test infrastructure for Auto MFL and Auto UT should be as per applicable EN standard or any other equivalent standard. The Qualification of testing personnel shall be min level-II from ISNT/ASNT. Probing surface shall be from curved surface and not from the end surface. Rods duly passed in Auto MFL and Auto UT shall only be supplied by the manufacturers.

6.2.1.3 Proper record of rods failed in Auto MFL/UT and further disposal should be recorded.

6.2.1.4 The surface quality of the rod shall be as per Clause 5.3.2.1 of EN 13298. The maximum R_a value of the surface of the bar before coiling shall not exceed **2.5** µm.

6.2.2 Shape & Dimensions:

6.2.2.1 The limit for out of straightness of rods shall be within 1mm/m length maximum.

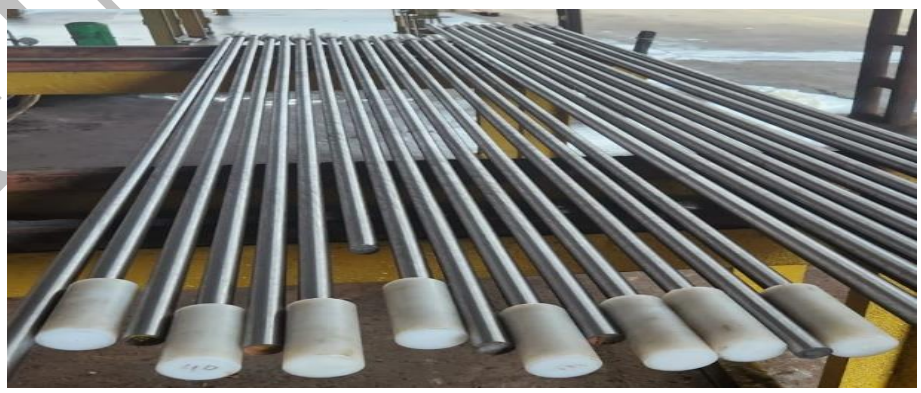
6.2.2.2 The diameter of straight rods must be within the following limits:

Diameter of Rods in mm	Tolerance in mm
~~06 - 10~~	~~± 0.075~~
~~10 - 18~~	~~± 0.090~~
18 - 30	± 0.105
30 - 50	± 0.125
50 - 80	± 0.150

6.3 CORROSION PROTECTION OF BARS/RODS:

6.3.1 A thin corrosion protection layer shall be provided on the bars/rods before dispatch. Corrosion protection of the bars/rods shall be as per Clause 3.0 of ICF/MD/Spec-155 issue 01, Rev.01 (or latest). The bars/rods shall be coated with Lacquer, cellulose, pigmented, finishing, glossy to IS:5691-1970 (or latest) to a Dry Film Thickness of 3-5 microns. After the application, coating is dried up, bio-degradable material shall be used for packing. If any plastic material is used for packing, necessary government guidelines should be followed.

6.3.2 Corrosion protection shall be adequate to last for period of two months under storage in covered place. This shall not be in the form of oil/grease to prevent rods slippage during end tapering operation. The chemical used be such as to burn off or vaporize during heating at a temperature of 150 ^{0}C & above leaving no residue. To avoid metal to metal contact, plastic caps shall be provided on each bars/rods as shown in Figure below:



6.3.3 Sample check of bars/rods should be carried out for checking of rusting and straightness of bars/rods before manufacturing process. The stacking of bars/rods may be done according to the production schedule. The long storage of bars/rods should be avoided as it leads to loss of straightness and initiation of rusting.

6.4 PACKAGING & TRANSPORTATION OF BARS/RODS:

The bars/rods are very sensitive item and need to be packed and transported very carefully. The following guidelines to be followed while packaging & transportation of bars/rods:

6.4.1 Spread the bars/rods on the inspection table before packaging & transportation. Check for any process defects in the bars/rods like lobbing, pitting, bend, tool marks, scratch lines, chips or dent marks etc. and segregate them with proper identification. If the segregated defective bars/rods are in recovery condition, recover them by passing through centerless grinding or cutting operations. Ensure that bars/rods ends are free from burrs.

6.4.2 Ensure proper coating of corrosion protection layer on full face of bars/rods as per Para 6.3 of this specification.

6.4.3 Weigh the bundles and identify them with tags detailing size, grade, length, heat no., P.O. no., weight etc. Bundle weight should be approximate in between 1200 Kg to 1300 Kg. Pack the bars/rods in the bundle so that bars/rods are in the center of the bundle as shown in the figure.

Put at least four straps on the bundle with strapping clips. Put two straps each at approximately 600 mm from the end of both sides of bundle. The other two straps shall be placed by proper spacing from the end straps. Tight the straps by a manual/pneumatic tensioner and tight the clip to clamp the bundle.

6.4.4 Tie the Tag on the Tag Wire and ensure that the following:

- Colour Code is matching with bundle.
- Heat No. is matching with bundle.
- Stamping details of bars/rods are matching with Tag details (Heat No., Grade & Size).

6.4.5 Insert the Hollow Polyurethane tube to cover the entire bundle so that moisture should not enter inside the packed bundle. Thereafter, wrap with HDPE cloth and strap with steel straps on 5 locations for 6-meter material.

6.4.6 Weigh the bundles and identify them with tags detailing the size, grade, length, heat no., P.O. no., weight etc. record the readings in the Internal inspection format/job card with

the details of P.O. no., heat no., grade, quantity etc. Stack the packed bundles (prime & reject) in the designated location and handover to Logistic for dispatch. Non-conforming bars/rods, if any generated during the operation shall be kept separately with identification.

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

6.4.7 Any other precaution in packing as may be deemed fit for safe transportation shall be taken by the bars/rods suppliers to avoid damage during transportation.

7.0 SPRINGS:

7.1 General:

7.1.1 **Environment Condition:**

Range of environmental temperature:	-10 ^{0}C to + 50 ^{0}C (average + 35 ^{0}C)
Parking temperature:	70 ^{0}C
Humidity range:	up to 100% (for max. 5 months)
Rainfall:	up to 2500 mm, very heavy and continuous
Maximum altitude:	up to 1000 m (salty environment)
Shock and vibrations:	Extremely dusty, humid and salty along-with industrial pollutants

7.1.1.1 The coil springs shall function in accordance with this specification when subjected continuously to an atmosphere containing dust in concentration up to 1.6 mg/m^3.

7.1.1.2 The coil springs shall function in accordance with this specification when subjected continuously to a humid and salt laden atmosphere with maximum pH value of 8.5, sulphate content of 7 mg per litre, maximum concentration of chlorine 6 mg per litres and maximum conductivity of 130 micro Siemens/cm.

7.1.1.3 The coil springs shall function in accordance with this specification when subjected to high wind in certain areas with wind pressure reaching 150 kg/m^2.

7.1.1.4 The coil springs shall function in accordance with this specification when exposed to solar radiation in the range from 0 Kw/m^2 to 1 Kw/m^2.

7.1.1.5 Special care shall be taken to ensure no damage to coil springs due to deposition of atmospheric salts and industrial pollutants. Supplier shall enclose the details of specific measures adopted to ensure the satisfactory working of coil springs against the deposition of salts & industrial pollution.

7.1.2 **Reliability and Maintenance:**

Mean Time Between Failures (MTBF):	3 years
Mean Distance Between Failures (MDBF):	2 000 000 km
Recommended maintenance schedule:	90 days. 180 days, 18 months

Failure rate: L-10

7.1.2.1 The coil springs shall be so designed to run at 8 Km/h through water up to 203 mm above rail level, allowance to be made in addition for increase in the height of water level due to wave effect. Considering wave effect, flood proofing height shall be 400 mm from rail level. However, even in case of flood levels more than the mentioned above, the coil springs shall not get damaged and it should be possible to rejuvenate the springs with minor attention without any adverse effect on their performance.

7.1.2.2 Expected service life of coil springs to be determined by the manufacturer, but not less than 6 years.

7.1.2 Manufacturing Sequence of Springs:

Manufacturing sequence shall include the following operations, in order given below:

S. No.	Process
1.	*Formation of ends & Stamping
2.	Hot coiling
3.	Quenching
4.	Tempering
5.	Scragging
6.	End grinding
7.	Cleaning
8.	Crack Testing (Magnetic Particle Testing)
9.	Shot Peening
10.	Crack Testing (Magnetic Particle Testing)
11.	Phosphating
12.	Load Load-Deflection Testing & Marking
13.	Painting
14.	Load Load-Deflection Testing (if required) & Marking
15.	Colour Coding & Packing

* Formation of ends & Stamping:
Alternate method apart from mentioned in the specification for end formation & marking/stamping may also be accepted subject to prior approval of Carriage Directorate, RDSO.

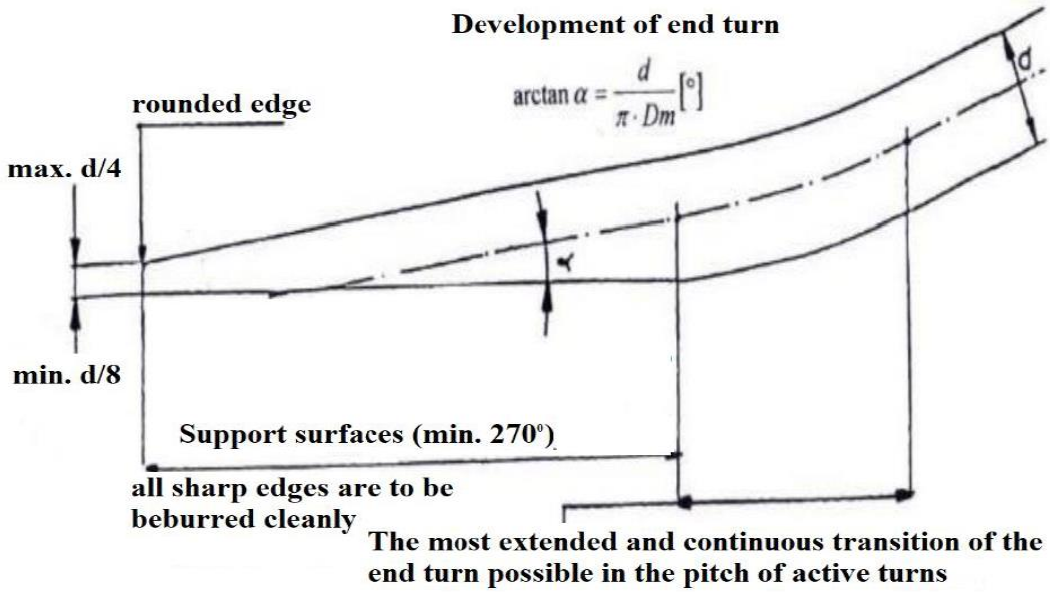
7.1.3 The surface of the springs shall not have any defects (lamination, grooves, machining marks, cracks, crevices etc.) which may be detrimental to spring performance or life. Any surface and sub-surface defects identified during the electromagnetic crack detection test shall not be permitted.

7.2 Formation of Ends:

7.2.1 Both the ends of the rod shall be tapered by Taper rolling to a length which shall be equivalent to an arc angle of 270º (minimum) formed by end coils of the spring. This is meant to ensure a firm bearing of about 75% of the mean coil circumference at support surfaces of the finished springs. Formation of ends by hammering is totally unacceptable. The tapered faces should not have steps, pits or crack. The rod should be heated up to 910 ^{0}C to 920 ^{0}C during end tapering operation and the stamping operation must be completed before 850 ^{0}C. Temperature controlling system equipped with sensors shall be installed compulsorily in spring manufacturing units for 100% effective controlling of process temperature for bars and springs.

7.2.2 End taper the rod in such way that tip thickness is d/3 $\pm$ 1 mm and then making coil spring perfectly in parallelism and squareness and after grinding, its tip thickness should be in the

range of minimum d/8 to maximum d/4 as shown in figure below subject to the condition that it shall not be less than 3 mm in any case.



7.2.3 Proper care should be taken during the formation of ends of the springs. Correct ends formation shall be ensured as shown in Figure below:

7.2.4 To avoid spring end biting on first active coil at exactly 1.0 turn, 02 steps end tapering process may be adopted.

7.3 Stamping:

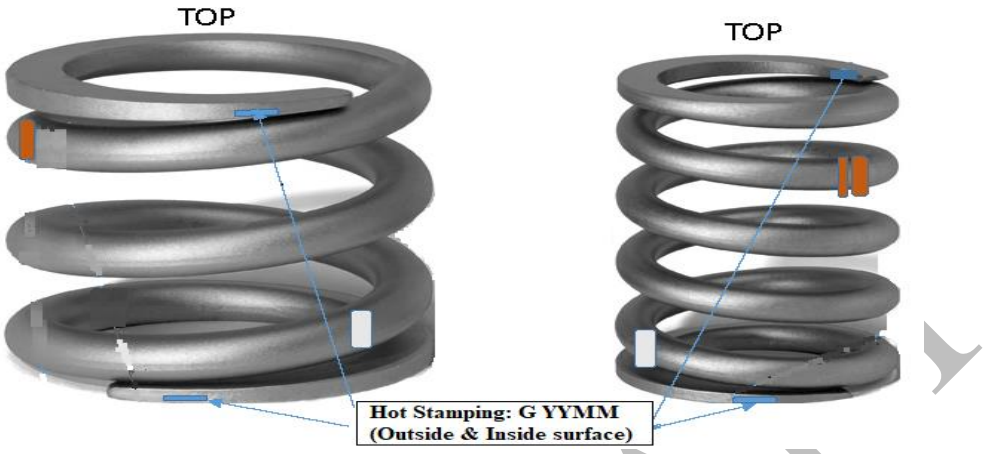
7.3.1 The ends of rods (Para 7.2) shall be heated in an electric, oiled or LPG fired indirect heating furnace which are equipped with temperature controller and recorders. Temperature to which these ends shall be heated should be predetermined according to composition of the material. The stamping operation must be completed before 850 ^{0}C. Temperature controlling system equipped with sensors shall be installed compulsorily in spring manufacturing units for 100% effective controlling of process temperature for bars and springs.

7.3.2 After the ends have attained desired temperature, following particulars shall be legibly hot stamped on both tapered ends (outer & inner side) in serial order.

	**	***	****	****	*****
	Manufacturer's Code	Month & Year of Production	Drawing Code	Heat Code (in three letters/digits)	Raw Material Supplier's Code (In two digits)
e.g.	- - -	MMYY	- - -	- - -	- -

The location of stamping particulars on springs must be in the middle of the dead-end coils as shown in figure below, so that the chances of initiation of fatigue do not occur.

The material code shall be legibly hot stamped on both tapered ends of each spring in such a way that the particulars are visible on the outer & inner surface of the ineffective coils and they do not get erased during end grinding or interfere with the performance of the spring. For drawing codes of springs Annexure-I may be referred.



Any deviation or exception from above may be accepted if vendor establishes alternate method will not have any negative implication on quality and traceability.

~~7.3.3 Materials Code for the various materials shall be as under:~~

~~51 Cr V4 - CV~~
~~52 Cr Mo V4 - CM~~
~~52 Si Cr Ni5 - SN~~

7.3.3 Stamping shall be done on the outer & inner surface of the ends in the tapered end area.

7.3.4 The stamping depth must be adequate to ensure that the stamping particulars remain legible even after grinding and finish coating/painting of the springs.

7.3.5 Tool used for stamping must be rounded.

7.3.6 Size of letters of stamping shall be 5 mm on rods having diameter above 20 mm and 3 mm for bars having diameter 20 mm or less. No marking shall be done on springs made from rods of diameter of 9.5 mm and below.

7.4 <u>Hot Coiling</u>:

7.4.1 Rods with tapered ends shall be heated in electric, oil or LPG fired indirect heating furnace of minimum 10 metres, equipped with automatic temperature indicators, controllers and recorders and soaked sufficiently at that temperature in a controlled atmosphere (Soaking/Heating time = approximately 0.83 x Bar Dia. minute).

After clamping of rod for coiling, the formation of adjacent active coil should be formed very smoothly by controlling at least 10 different points on coiling machine by experimenting and putting different values. After getting perfection, these values should be stored for future usage and references.

7.4.2 With minimum time lag, rod shall be removed from the heating furnace and coiling end pitching done in a high speed automatic coiling and pitching machine. Bar temperature before coiling operation should be 890-920ºC. Temperature controlling system equipped with sensors shall be installed compulsorily in spring manufacturing units for 100% effective controlling of process temperature for bars and springs.

7.4.3 Pre heated mandrel to minimum temperature of 80 ^{0}C shall be used for coiling and water shall not be allowed to come in contact with heated rod. Temperature controlling system equipped with sensors shall be installed compulsorily in spring manufacturing units for 100% effective controlling of process temperature for bars and springs.

7.4.4 Coiling machine used for the purpose shall have in-built features to maintain uniformity of pitch and gap between end coil and adjacent coil without the need for any manual adjustment. The coiling machine shall be CNC/Computer/ PLC or PIV controlled.

7.4.5 Development of end turn of spring shall be as per Para 7.2.2 figure. Transition from the end turn to the active turn shall be in a most extended and continuous manner possible i.e. the gap between inactive coil and first active coil should gradually increase.

7.4.6 It shall be ensured at the time of end closing of the spring that the end gap between the tip and the adjacent effective coil is such that the tip does not bite the effective coil under load as well as under no load conditions. Closing of the end coil should be in built feature of coiling machine and no manual adjustment should be required.

7.4.7 During hot coiling process, temperatures in different chambers and soaking time for different types of coil springs should be digitally displayed on furnace along-with rod diameter automatically.

7.5 Heat Treatment:

7.5.1 Temperature of the coiled spring just after coiling and before quenching should be 830 ^{0}C - 860 ^{0}C. With minimum time lag, coiled rods (called springs) as per Para 7.4 shall be oil quenched in a suitable quenching medium. The temperature of which is maintained within 40 ^{0}C - 70 ^{0}C in order to ensure optimum quenching conditions. Temperature controlling system equipped with sensors shall be installed compulsorily in spring manufacturing units for 100% effective controlling of process temperature for bars and springs.

7.5.2 The quenching oil shall be kept at constant temperature range of 40 ^{0}C - 70 ^{0}C. The content of the quenching pool shall be adequately dimensioned with ~~more than~~ minimum ~~10,000~~ 20,000 liters of quenching oil and should be checked regularly for water and dirt content and filter it by centrifuge etc. and top up by fresh oil, if required. Record for the same checking shall be kept ready. The properties of quenching oil i.e. appearance, density, kinematic viscosity, flash point, cooling rate etc. should also be checked regularly.

7.5.3 After quenching operation, tempering of springs shall be done in a continuous conveyor type tempering furnace. For producing required level of temper and hardness, springs shall be heated to pre-determined temperature range for sufficient length of time. The temperature of the spring just before entering the tempering furnace should be 80 ^{0}C – 120 ^{o}C. Temperature controlling system equipped with sensors shall be installed compulsorily in spring manufacturing units for 100% effective controlling of process temperature for bars and springs.

7.5.4 Furnace used for tempering shall be electric, oil or LPG fired indirect heating type equipped with independent pyrometer for each zone to control temperature within ± 10 ^{0}C. The tempering should be done in temperature range of 400 ^{0}C - 500 ^{0}C. Temperature controlling system equipped with sensors shall be installed compulsorily in spring manufacturing units for 100% effective controlling of process temperature for bars and springs.

During tempering process, temperatures in different chambers and soaking time for different types of coil springs should be digitally displayed on furnace along-with rod diameter automatically.

7.5.5 Since the heat treatment is carried out with the aim to achieve a homogenous fine grain structure, the tempered martensitic distribution across the complete cross-section of the active coil should be as under for various steel materials.

The tempered martensitic distribution across the complete cross-section of the active coil should be uniformly distributed and hardness difference from core to surface should not be more than 20 BHN. The hardness shall be as per ISO 683-14 or EN 10089 (latest). The values for the surface hardness shall be between 419 - 486 BHN**.

** *Conversion of hardness from HRC to BHN is taken from conversion table.*

7.5.6 Springs should be water cooled after tempering to approximately 100 ^{0}C. Temperature controlling system equipped with sensors shall be installed compulsorily in spring manufacturing units for 100% effective controlling of process temperature for bars and springs.

7.6 Scragging:

7.6.1 Each and every spring shall be hot scragged three times in quick succession. Scragging load/height should be as laid down in the drawing. In case there is no indication in the drawing, the springs shall be scragged home. The scragging load in such cases should not exceed 1.5 times the theoretical axial load, corresponding to home length. The hot scragging temperature should be more than 90 ^{0}C.

7.6.2 Long duration scragging is to be introduced as a process check at regular intervals and necessary documents of the test results are to be maintained. For long duration scragging, the spring shall be compressed three times, holding it at the home load for two minutes in the first two strokes and for 48 hours at the last stroke.

7.6.3 The scragged spring should not show further permanent set on subsequent loading.

7.6.4 Permanent set shall not exceed 2 mm of free height of primary spring, which is measured before scragging. Similarly, permanent set shall not exceed 3.5 mm of free height of secondary spring, which is measured before scragging.

7.7 End Grinding:

7.7.1 Both the end surfaces of the spring should be ground to ensure square seating of the spring. The ends should not have any sharp edge/burrs. The actual ground end surface shall be atleast 75% of the mean coil circumference of the spring. The end faces of the spring should not have blue marks due to end grinding as the same leads to temper brittleness.

7.7.2 The springs shall be grounded on automated grinding machine in enclosed chamber with effective cooling system. It is important that cooling during the grinding process is carried out flawlessly. Tip cutting should never be done as it will reduce the number of coils. End grinding machine fixture to hold coil spring should be checked daily with right angle. End grinding machine should be equipped with adequate coolant facility, controlled speed, feed rate, concentration etc. to prevent burning of end coils during grinding. The details of equipment used to check the temperature, quantity, frequency & feed rate of coolant etc. should be shown to inspection authority during inspection.

7.7.3 The grinding angles at the ends of the springs shall be $270^0 + 15^0/- 0^0$. For grinding angles measurement, calibrated gauges should be available with the spring manufacturers.

7.7.4 End grinding feed rate shall be decided on the basis of mean coil diameters & rod diameters of coil springs. Chart for deciding the feed rate should be displayed and shown to the inspection authority during inspection.

7.8 CRACK DETECTION:

100% of the springs shall be tested for crack detection in accordance with EN 10228-1/ASTM E 709 (latest) for both longitudinal and transverse cracks. Alternatively, magnetic particle testing of the springs for crack detection may be carried out in accordance with DIN EN ISO 9934-1, DIN EN ISO 9934-2, DIN EN ISO 9934-3, DIN EN ISO 3059 & DIN EN ISO 9712.

7.9 SURFACE TREATMENT AND PROTECTION:

7.9.1 **Shot Peening:**

Before shot peening process, all springs should be thoroughly cleaned followed by Magnetic Particle Testing (MPT) process. ~~All~~ The springs shall be shot peened in a continuous type shot peening machine, preferably with self-sieving arrangement in

accordance with EN 13298 Annex C to improve fatigue life of the spring. During shot peening, it should be ensured that the springs are shot peened uniformly over the entire area of the springs. The intensity and coverage should be checked with the help of Almen strip in accordance with EN 13298 Annex C. Almen Intensity should be checked minimum two times per shift of production. The minimum coverage (When checked visually) should be 90% and intensity when checked with Almen strip Type - A in accordance with EN 13298 Annex C should be between 0.4 mm and 0.6 mm.

7.9.1.1 The characteristics of the Almen test samples shall comply the Table C.1 of Annex C of EN 13298 (latest).

7.9.1.2 The number of samples to be mounted on the "sample carrying spring" depends on the free length (L_o) of the spring and shall be as follows:

Free length (L_o) of the Spring	Nos. of Almen test samples & Locations
$L_o \geq 500$ mm	6 samples to be mounted, 3 on the inside of the spring, the 3 remaining samples on the outside of the spring, the samples shall be located at the two ends and in the middle section of the spring.
$500 > L_o \geq 300$	4 samples to be mounted, 2 on the inside of the spring, the 2 remaining samples on the outside of the spring, the samples shall be located at the two ends of the spring.
$L_o < 300$ mm	2 samples to be mounted, 1 on the inside of the spring, the other one sample on the outside of the spring, the samples shall be located in the middle section of the spring.

7.9.1.3 To ensure effective shot peening on more critical inside of the spring, the mounting locations of 4 Almen strip holders shall be, 2 on bottom inside & outside and remaining 2 on top inside & outside of the springs. The Almen strip holder shall be fixed between in-active coil and first active coil at approx. 0.1 turn from the end tip of the spring.

7.9.1.4 Ensure use of rounded jet grains for effective shot peening. Rounded jet grains of size 0.45 -1.0 mm as per IS:4606 shall be used.

7.9.1.5 Speed chart of rotational speed and linear movement of coil spring based on wire diameter, mean coil diameter and other relevant parameters for shot peening operation should be displayed.

7.9.2 Phosphatizing:

All the springs shall be phosphated by using zinc phosphate within 30 minutes. after shot peening. The thickness coat shall be more than 5 µm of fine crystalline nature and it can be evaluated as per method given in IS: 3618 (latest). The class of phosphate coating shall be Class C, as per IS: 3618 (latest).

7.9.3 Final Painting:

7.9.3.1 After phosphate treatment, all the springs shall be painted as per RDSO Specification No. M&C/PCN/132/2021 (latest) for Painting of Helical Coil Springs of LHB Coaches and Similar Applications (Single Pack).

7.9.3.2 Any other proven painting scheme, may also be permitted with approval by RDSO, depending on case to case basis subject to complying at least the following tests requirements:

S. No.	Tests	Requirements
1.	Resistance to Salt Spray Test (1000 hours) according to EN ISO 9227	No rusting, cracking, flaking, blistering & corrosion
2.	Evaluation of Degree of Rusting	Ri1 or better

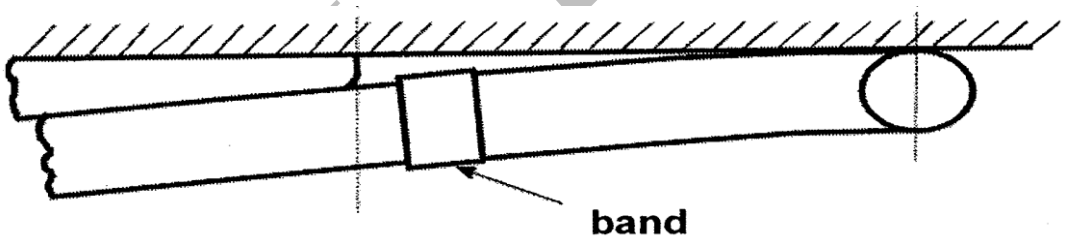
	according to EN ISO 4628-3	
3.	Evaluation of Degree of Cracking according to EN ISO 4628-4	1(S3) or better
4.	Evaluation of Degree of Flaking according to DIN EN ISO4628-5	0(S0) or better
5.	Evaluation of Degree of Blistering according to EN ISO 4628-2	2(S2) or better
6.	Evaluation of Detachment and corrosion around the scratch according to EN ISO 4628-8	≤ 3 mm, no delamination
7.	Evaluation of Adhesion according to EN ISO 2409	Cross-cut Rating (GT): ≤ GT0-1
8.	Fire Protection according to EN 45545-2	Hazard level- HL3 R9

7.9.3.3 The Type and Acceptance Test Reports of brand and make of paint, which are applied on springs shall be kept ready during Inspections. As quality control measure, type tests of brand and make of paint which is used for applications on springs, shall be conducted once in a year from NABL certified Lab and report of the same shall be kept ready during Inspections.

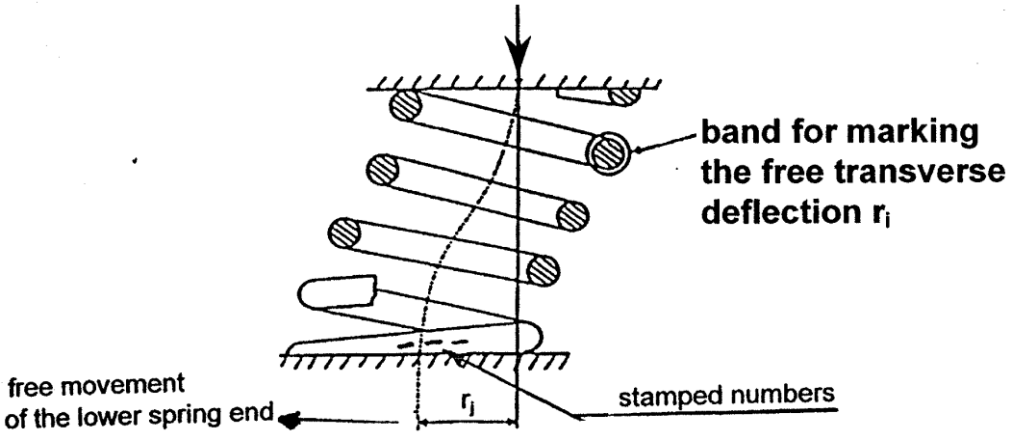
7.9.4 Special Spring Marking (Besides Stamping) on FIAT Coil Springs:

7.9.4.1 In addition to the stamping at end coil of the spring (Para 7.3), each spring is to be marked with a band of bronze, copper or brass. The band is secured with a cyanogen acrylate adhesive (e.g. Loctite Js 496), or with a compression joint. The following are to be stamped on the band:

- Spring length under test load corresponding to tare condition in mm
- Value "$\mathbf{r_i}$" of the free transverse deflection in (mm) under test load corresponding to tare condition (only for category 'A' Springs).



Further, the direction of free transverse deflection "$\mathbf{r_i}$" of every flexi-coil spring (category 'A') is to be marked with a band of aluminum adhesive tape (e.g. Tesaflex 171). The band is to be attached to the painted spring as in the sketch below:



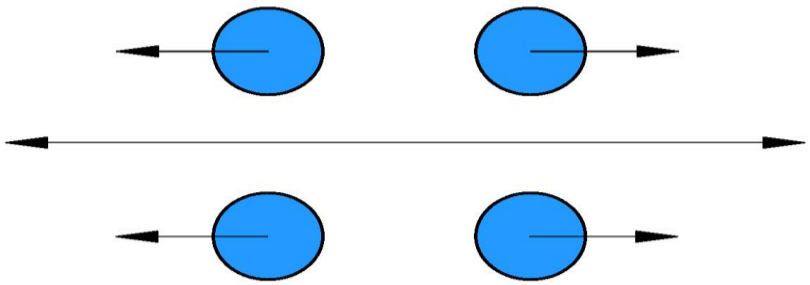
7.9.5 Marking (Besides Stamping) on Coil Springs of Vande Bharat Coaches:

7.9.5.1 Coil spring must be marked with a band fixed in the direction of the bowing with following information:

- Serial No., L_A/F_A and Angle engraved. The bands are placed in the direction of the deflection.
- Angle between bowing directions of a spring submitted to axial force F_{C0} (usually equal to Tare Load F_A) on one hand and to an axial force F_{C1} (usually equal to a static axial force F_j corresponding to a functioning mode of the vehicle which it belongs) on the other hand shall be $\leq 30^0$.

Bowing (angle, force, direction) for primary outer & inner springs shall be as per Cause 9 of EN 13298:2003.

7.9.5.2 During assembly of spring set, ensure that bowing marks on the springs shall be directed parallel to riding direction and oriented to the outside of the bogie.



7.9.5.3 Copper (Cu) band adhesion should be such that it last through the life of coil spring in service.

7.9.5.4 In addition to Copper (Cu) band, a one-inch-wide translucent strip of yellow colour over the entire height of coil spring & a band of aluminum adhesive tape (e.g. Tesaflex 171) shall also be provided to indicate bowing direction.

7.9.6 Grouping and Colour Coding of ~~FIAT~~ Coil Springs:

~~Grouping and Colour Coding of FIAT bogie springs for identification shall be as per RCF letter no. MD23151 dated 31.03.2015.~~ For identification of springs to be used in different types of LHB & Vande Bharat coaches, paint the middle coil of following springs with colour indicated against each group as shown below:

Group	Primary springs		Secondary springs		Colour to be done on the middle coil
	Outer spring	Inner spring	Outer spring	Inner spring	
1.	1267411	1267412	1269514	1269513	Green
2.	---------	---------	1277146	1277145	Blue
3.	1277142	1277143	1268836	1268837	Yellow
4.	LG01100	LG01101	LG05101	LG05100	Black

5.	RDSO/CG0DRG-23012	RDSO/CG0DRG-23013	---------	---------	Red

7.9.7 Coupling of ~~FIAT~~ Coil Springs:

- Coupling for Category 'A' Flexi Coil Springs of FIAT Bogies will be carried out as per FIAT Technical Specification No. 17.471.101 Version 01 or latest.

7.9.6 Salt Spray Test:

A salt spray test shall be carried out to verify the quality of paint system. For springs fully painted as per painting scheme permitted with approval by RDSO, the test piece shall be passed in salt spray test performed according to ISO 9227 for minimum 1000 hours and shall not indicate any sign of corrosion & deterioration up to duration indicated in the specification.

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. It shall be process check point. In event of failure any sample in salt spray test, process shall be considered as failed.

7.10 Properties:

7.10.1 **General:**

The shape dimensions and direction of coiling should conform to the drawing. When it is not specified in the drawing, direction of coiling shall be to the 'right'.

7.10.2 **Dimensional Accuracy of Springs (before painting):**

It should conform to the following tolerances:

S. No.	Parameter	Tolerance
1.	Free height (L_0)	According to drawing. In case not specified in drawing, it shall be as per Clause 7.1 of DIN 2096 Part 1 (latest).
2.	Height of Spring (L_1) at Tare Load (F_1)	According to drawing. In case not specified in drawings then $\pm$ 1% of the nominal value of (L_1).
3.	Axial static forces (F_1, F_2, …) applied on the spring	According to drawing. In case not specified in drawings then $\pm$ 1% with reference to the nominal value.
4.	Perpendicularity (e_1) or Squareness	As per drawings. In case not specified in drawing, it shall be: i. For Springs with a free length of (L_0) > 150 mm, should be $\leq$ 1.5% of (L_0). ii. ii.For Springs with a free length of (L_0) $\leq$ 150 mm, should be $\leq$ 2% of (L_0).
5.	Parallelism (e_2)	As per drawings. In case not specified in drawing, it shall be: $\pm$1.5% of D_{outer}
6.	Wire Diameter (d)	The diameters of the straightened rods must be within following limits: Dia. of rods (mm) / Tolerance (mm) 18-30 / $\pm$ 0.105 30-50 / $\pm$ 0.125 50-80 / $\pm$ 0.150
7.	External coil diameter, D_{outer}	According to drawing. In case not specified in drawings then $\pm$1.5% of D_{outer}
8.	Internal coil diameter, D_{inner}	According to drawing. In case not specified in drawings then $\pm$1.5% of D_{inner}

9.	Concentricity of wound rods: Rod Ø≤30 O 0.2 Rod Ø>30 O 0.4
10.	Planeness of the support (End) surface: Turn Diameter Dm ≤ 250 mm 0.5 Turn Diameter Dm > 250 mm 1.0

7.10.3 Behaviour of Spring under Load:

7.10.3.1 The Pitch of the coils shall be sufficiently uniform so that when the spring is compressed to a height representing a deflection of 85% of nominal free to solid deflection, none of the coils shall be in contact with one another, excluding the inactive end coils.

7.10.3.2 In the remaining vertical load zone i.e. upto about 85% of the block length load (Para 7.10.4.2), the contact between end coil and first active coil at both the ends must follow in a continuously rolling manner and may not be toppling over support points and no 'kinks'.

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 60^0 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 $\pm^{6\%}_{4\%}$ of nominal deflection at this load.

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

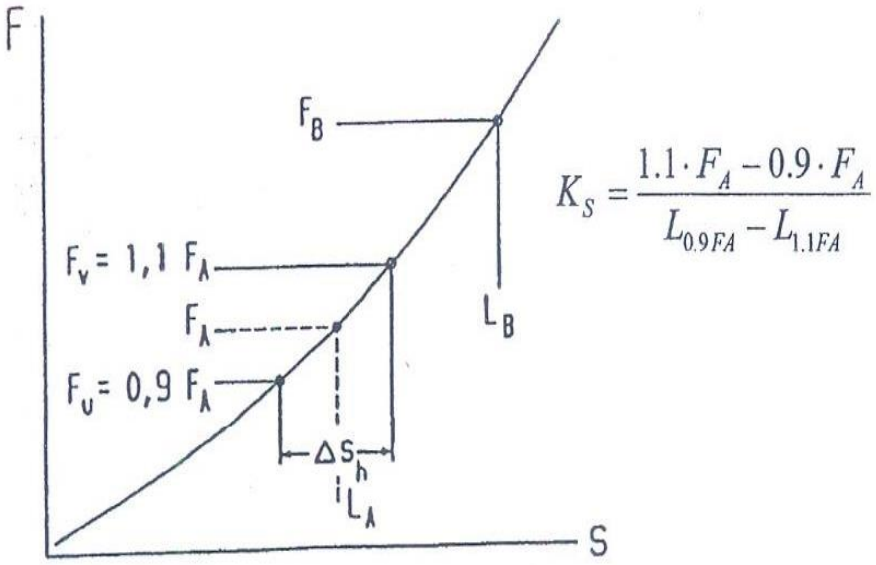
$L_c \leq d \times (N_t - 0.3)$,

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):



The lengths for the vertical stiffness are to be measured in the relief phase between two horizontal plates.

The axial stiffness (vertical rigidity) shall be within ±5% of nominal value.

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:

$C = 0.018L + 0.0072 L^2/D$ 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
~~51Cr V4~~	ISO 683-14
52Cr Mo V4	or EN10089
~~52SiCrNi5~~	

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 mm 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). Ks =$(F_v-F_u)/(L_u-L_v)$
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 Kt=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. 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.
a) Load verses height graph from free height to gross height and free height to solid height.

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 ± 30% of the static deflection (Free height – height under gross load) of the spring or as specified in the drawings.

8.5.1.4. ~~The Range of deflection for the springs shall be [Height under gross load ± 30% of the static deflection] i.e. [Height under gross load ± 30% of (Free height – height under gross load)] or [Height under gross load ± Deflection amplitude specified in the drawing]~~. 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 ± 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 ± 30% of the static deflection] i.e. [Height under tare load ± 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 H_z). 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 ~~springs~~ Spring Steel (SS) Rounds and the finished springs shall be subjected to inspection by the RDSO Inspector to ascertain the quality of the material and the characteristics of the finished springs. He 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 ~~500~~ 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.

9.1.1 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.

9.1.2 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.

a) Chemical composition of the ladle analysis and product analysis.
b) Inclusion contents in bars
c) Reduction Ratio.
d) Depth of decarburization
e) Surface hardness
f) Grain size

g) Dimensions
h) End quench hardenability test for each heat/lot (As per ISO 683-14 & EN 10089)

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: -

a) Size of ingots/billets used as verified from the records of the steel manufacturer.
b) Dressing of complete billet by general surface grinding and freedom from surface defects.
c) Discarding of end portions at both ends of each billet and freedom from piping.
d) 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 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 <u>Sampling (Random)</u>:

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) with automation method 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.

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%	As per Table 6 of EN 13298	Spring testing machine

	deflection		
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
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' 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.

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. latest ~~2.5 or latest~~).

16.0 MANUFACTURING FACILITIES (MINIMUM):

The following manufacturing facilities shall be available with the firm:

(1) At least two Bar Straightening Machines 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) At least two Bar Peeling Machines 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) At least two Centreless Grinding for grinding of capable of removing upto 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 mandrel, to provide accurate control of pitches and bar positioning. The coiling machine shall be CNC /computer / PLC or PIV controlled, and shall be able to produce springs with uniform pitches and end coils as per the specification/drawing. The coiling machine shall be so located that the time lag between heating in the furnace to coiling is very small, so that the red hot bar does not remain in contact with air for long, and the temperature drop from furnace to the coiling machine is not more than 50 ^{0}C. Further functional details, of coiling machine shall be as given below:

(i) Bars shall be clamped by clamping jaw (preferably hydraulically operated) with appropriate force to ensure that no any mark is left on the bar. The clamping arrangement shall be able to prevent slippage of bars during coiling.

(ii) Complete coiling operation till closure of the second end of the bar shall be automatic once coiling is initiated by the operator.

(iii) The closing mechanism shall ensure that the end of the tapered bar does not protrude outside the coil diameter.

(iv) The spring shall be automatically released from the mandrel after the second end is closed. The released spring shall land softly into the chute leading to the quenching tank without any impact.

(v) There shall be a proper mechanism to ensure that the coiled spring is quenched before the spring temperature drops below a certain temperature.

(vi) The Machine shall be provided with a temperature sensing device to sense the temperature of bar coming to the coiling machine, and there shall be a full proof system to ensure that coiling is carried out at appropriate temperature only within a certain range.

(vii) The coiling machine shall have plane mandrel.

(viii) Closing of end coils shall be an inbuilt feature of the coiling machine.

(12) At least a Quenching Tank with ~~more than~~ minimum ~~10,000~~ 20,000 liters of quenching oil equipped with temperature indicator and provision of strainer / filters, agitation pumps, heat exchangers and cooling towers etc. to prevent oil temperature going beyond 70 ^{0}C at any time.

The quenching tank shall be located adjacent to the coiling machine so that the movement of springs after coiling to the quenching tank is minimum. The quenching tank with ample volume of oil having a conveyor system with variable speed settings shall be provided so that the springs once taken out from the coiling machine are placed directly in the tank and then conveyed immediately through the conveyor to the tempering furnace. There shall be an appropriate arrangement to ensure proper maintenance of temperature of the oil bath in the range 40 ^{0}C to 70 ^{0}C. The quenching tank shall have the following features:

- Suitable agitating mechanism shall be provided in the tank to ensure uniform temperature of the quenchant.
- A suitably designed chute to receive spring coils from coiling machine w/o shock or impact.
- Temperature indicator to indicate temp. of quenching oil, along with alarm in case the quenched temperature goes beyond set values; to be provided at prominent location.

(13) At least one Indirect Convective Heating Continuous Type Tempering Furnace equipped with variable speed conveyor, temperature controllers, recorders and indicators. There shall be no flame impeachment on the springs. The tempering furnace shall be in line with quenching tank conveyor. The furnace shall have multiple thermocouples to facilitate measurement of temperature in the furnace at different locations. The temperature in the furnace shall be uniform with temperature variation in different zones not more than 15 ^{0}C. The temperature of different zones of the furnace shall be recorded. At least three thermocouples shall be provided to sense temperatures of different zones of the furnace, and the same shall be recorded. The furnace shall be covered by non-conducting material at entry and exit location of springs. The springs shall enter into the furnace and come out from it following first-in-first-out principle to ensure proper heat treatment time for each spring. There shall be an arrangement in the furnace, to ensure the required soaking time for each type of spring depending on the bar diameter.

(14) Facility for water cooling after tempering of springs.

(15) At least a Continuous/Batch Type Shot peening machine equipped with automatic spring transportation system and rotation during shot peening to achieve the required Almen intensity as per the specification and to ensure that the springs are shot peened uniformly over the entire area of the springs. Blasting medium as per Annexure 'C' of EN 13298 shall be used. Shot peening machine shall have self-sieving arrangement to ensure that the shots of only the required size remains in operation and remaining shots or powders are removed from the machine.

(16) At least One End Grinding Machine equipped with adequate coolant facility, controlled speed, feed rate etc. to prevent burning of end coils during grinding.

(17) At least One Magnetic Particle Testing Machine with adjustable current to cater to the requirements for different diameters of springs having a provision for detection of cracks in longitudinal as well as in transverse directions. Provision for automatic loading / unloading of springs shall be preferred. The test facility shall have a suitable automatic device for rotation of the spring in position to facilitate testing of entire surface of the spring in one setting. The facility shall also have provision for demagnetization of springs after crack detection. The effectiveness of demagnetization shall be verified by checking that the spring exerts no attraction on a non-magnetized piece of ferro-magnetic steel, or with the aid of a device such as a field strength meter as per UIC Code 822.

(18) At least one Scragging Machine capable of scragging the springs in quick succession. The capacity of the machine shall be sufficient to scrag the springs to solid height and shall be capable of applying the load for long duration of 48 hours as described in UIC–822.

(19) ~~Adequate setup for painting as per specification/powder coating of springs to suit the powder coating requirements as per the stipulations for FIAT bogies springs (as per RCF letter No. MD23151 dated 31.03.2015).~~ Adequate setup for painting of springs to suit the surface protection requirements as per the specification.

(20) Adequate number of pallets for storing / handling of springs at various intermediate stages of manufacturing. The springs shall be transported using pallet type trolleys.

16.1 Proper preventive maintenance of different machines used in manufacturing process is essential for ensuring its reliable outputs. For this purpose, machine-wise maintenance schedule to be defined and displayed at machines with done & due date.

17.0 INSPECTION & TESTING FACILITIES:

The firm shall have at-least the following inspection & testing facilities:

(1) A chemical laboratory to conduct Wet Analysis of all types of alloy steels required as per this specification. Emission Spectrometer along with printer for analysis and recording of chemical composition of spring steel rounds / bars and finished springs shall be also available.

(2) The facilities for preparation of Metallographic specimen as per IS: 7739 (latest).

(3) One Metallographic Microscope with image analyzer with minimum magnification of 1000X and photographic attachment to meet requirements of IS: 4163 and IS: 6396.

(4) Two Brinell Hardness Testers, one in the laboratory and other in the shop floor.

(5) Three Eye pieces / low power microscopes.

(6) One computerized load-deflection testing machine of minimum 20t capacity with a least-count of 5 kg and accuracy of ±1% on load measurement which is calibrated against standard proving ring. Apart from facility to measure the deflection of the springs using digital meter, the machine shall also have an inbuilt arrangement for drawing the load-deflection characteristics graphs for the springs. It must be suitable for flexi-coil springs having lateral stiffness as well.

(7) Adequate setup for checking the painting as per specification of springs to suit the painting requirements as per the stipulations in relevant RDSO drawing including Elcometer for measuring Dry Film Thickness (DFT) shall be available.

The facility shall be periodically checked at monthly intervals for Gun characteristics, DFT and paint quality to suit the requirements.

(8) Fatigue Testing machine for carrying out the fatigue testing of springs as per the relevant test scheme.

(9) A surface table of size at least 1200 mm x 1800 mm and one set of gauges (Vernier Caliper, Micrometer, Scale, Square, Feeler Gauges, etc.) duly calibrated for purchase inspection.

(10) At least three sets of gauges for checking of the following parameters of springs:

- Steel Bar Diameter (peeled & ground bar)
- Outer Diameter of spring
- Inner Diameter of spring
- Free Height
- End Taper
- Out-of-squareness
- Parallelism

Two sets of gauges shall be available at the work place for carrying out necessary checks at various stages during manufacturing and one set of gauges shall be

available in the Inspection Section for carrying out checks on finished springs by the internal inspecting officials & Authorized Inspecting Agency.

(11) Any other measuring instrument/gauge/testing machine if required for testing springs/raw material as per specification but not covered/mentioned in any clause of this specification shall also be provided.

18.0 QUALITY CONTROL REQUIREMENTS:

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

(1) Measurement of straightness, surface finish and dimensions of the peeled & ground bars and maintenance of their records.

(2) Measurement and recording of as-quenched hardness of the springs.

(3) Magnetic Particle Testing Machine for crack detection of springs shall be calibrated in accordance with IS: 3703/ASTM E 709 (latest) or any other relevant ASTM specification to ensure 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 shall be in conformity with the permissible limits.

ASNT/ISNT Level II certified operator for Magnetic Particle Testing shall be deployed. Alternatively, magnetic particle testing of the springs for crack detection may be carried out in accordance with DIN EN ISO 9934-1, DIN EN ISO 9934-2, DIN EN ISO 9934-3, DIN EN ISO 3059 & DIN EN ISO 9712.

(4) The Pre-determined temperatures at which the ends of the ground bars of various springs are to be heated, along with their heating/soaking times shall be clearly mentioned in the QAP, and also displayed at the work place. Similarly, the temperatures and soaking times for different types of springs for bar heating, as well as tempering operations shall also be mentioned in QAP, and displayed at the work place.

(5) Checking of oil in Quenching Tank and topping up / replenishment as required shall be done compulsorily at pre-decided periodic intervals, and the records for the same shall be available.

(6) The traceability of the product from raw material stage to finished product stage shall be maintained. The system shall help in identifying the raw material details – Heat No., Supplier, Inspection details from the finished product stage.

(7) There shall be proper stacking of raw material heat wise and the record detailing Dispatch Memo No., Quantity, Heat No., Inspection, the Purchase Order details of the products against which the raw material has been procured shall be available.

(8) A Quality Assurance Plan for the product detailing various aspects shall be available:

- Organization Chart
- Flow Process Chart
- Stage Inspection details
- Various parameters and to ensure control over it.

(9) There shall be at least one full time technical expert 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 shall be free from day-to-day production, testing & quality control responsibility. He shall be mainly responsible for development for product, analysis of products, analysis of stage rejections, failure analysis, planning corrective and preventive action, control over raw material, devising actions in case of difficulties in achieving the parameters etc.

(10) The in-charge of the Quality Control Section shall 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 shall be actively involved in day-to-day activities of quality control / stage inspection / compliance of QAP etc.

(11) The Quality Manual of the firm shall clearly indicate at any stage the control over manufacturing and testing of Hot Coiled Cylindrical Springs for use in suspension of I.R. coaches having FIAT Design Bogies.

(12) There shall be a system of statistical quality control. There shall be a system of monitoring of rejections at various stages of manufacture, and corrective and preventive actions for containing those rejections, and redressal of customer complaints.

(13) Proper record of complaints received from users (Railways) and corrective and preventive actions taken, shall be maintained.

(14) The latest versions of EN/ASTM / IS / UIC Specifications given in the specification shall be available with the firm.

19.0 QUALITY ASSURANCE PLAN:

(1) The firm shall submit two copies of Quality Assurance Plan (QAP) for manufacture of Hot Coiled Cylindrical Springs to RDSO for approval.

The QAP shall include the following:

(i) Organization Chart emphasizing Quality Control Setup.

(ii) Qualification of key personnel and the officials deployed in Quality Control Cell.

(iii) Calibration Policy for Testing Equipments, Gauges, Measuring Devices etc.

(iv) Process Flow Chart indicating process of manufacture for an individual product or for a family of products if the process is same.

(v) Stage wise details of spring Manufacture, Testing & Inspection.

(vi) Record of finished product as per Identification Markings & Quality Assurance System - Inspection & Testing Plan.

- This shall cover the following:
- Incoming material
- Process control
- Product control
- System control

(vii) Policy of disposal of rejected product

(2) The manufacturer shall proceed for manufacturing of Hot Coiled Cylindrical Springs only after approval of QAP. The firm shall strictly follow the stipulations of QAP.

The firm shall maintain a record of QAP implementation for documentary evidence.

(3) Renewal of QAP shall be required after three years. Any changes in the manufacturing procedure/Machinery and Plants associated with the manufacture of Hot Coiled Cylindrical Springs shall be duly incorporated in QAP and approved by RDSO.

20.0 PROFORMA FOR FIELD TRIAL SCHEME:

Field performance of hot coiled helical spring used in FIAT Bogies of LHB & Vande Bharat Coaches shall be monitored for 06 months as per proforma at Annexure –V.

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ANNEXURE- I

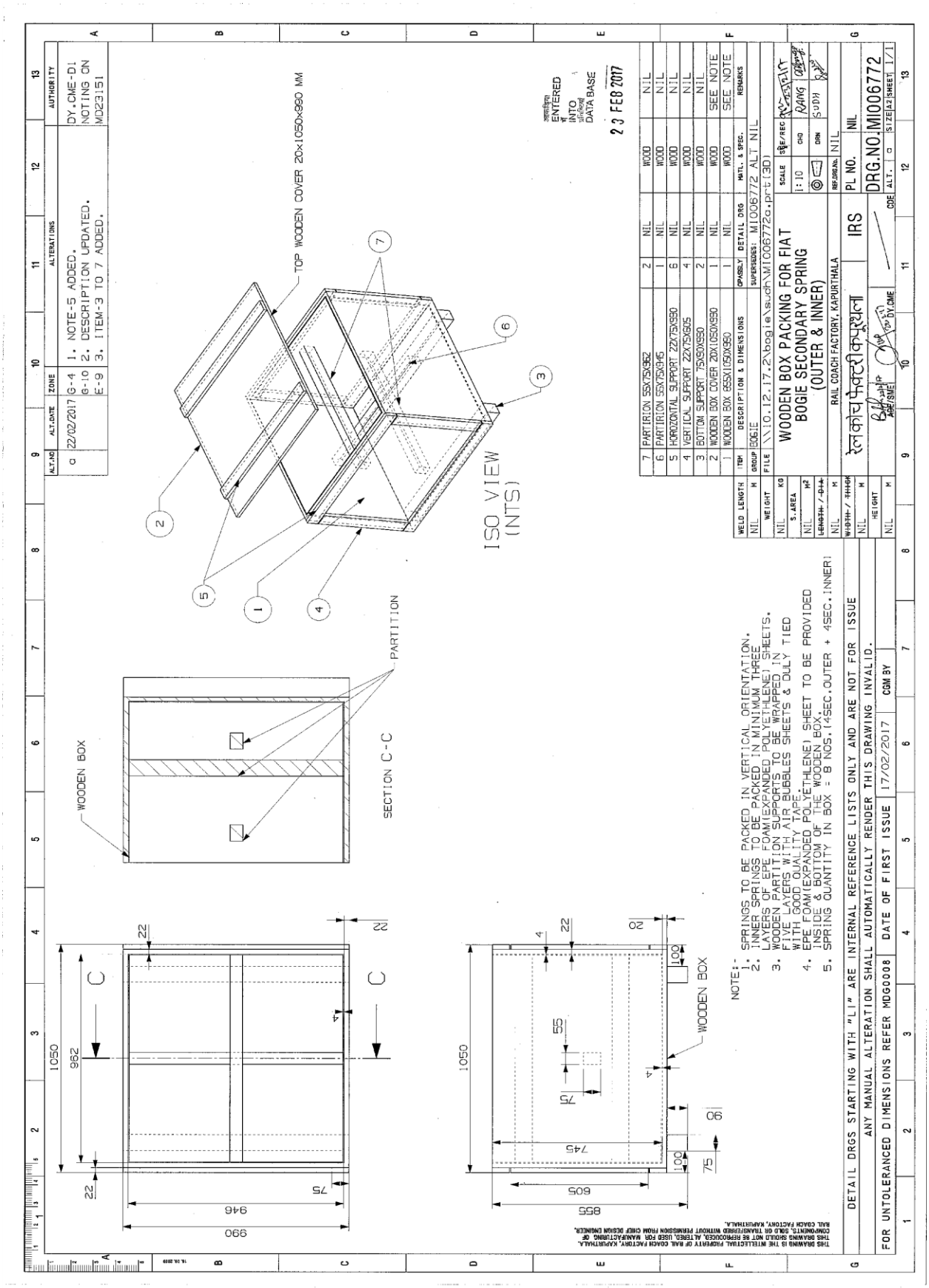
A) LIST OF FIAT SPRINGS DRAWINGS

S. No.	Drawing No.	Description	Code	Wire Dia. (mm)	Free Height (mm)	Mean Dia. of Spring (mm)	Outer Dia. of Spring (mm)
1.	1267412	FIAT Coach Primary Chair Car (Inner)	F02	26	324.5	138	164
2.	1267411	FIAT Coach Primary Chair Car (Outer)	F03	38	324.5	219	257
3.	1277143	FIAT Coach Primary Generator Car (Inner)	F04	27	337	138	165
4.	1277142	FIAT Coach Primary Generator Car (Outer)	F05	40	337	219	259
5.	LG01101	FIAT Primary GS (Inner)	F06	27	313	138	165
6.	LG01100	FIAT Primary GS (Outer)	F07	40	313	219	259
7.	LG05100	FIAT Coach Secondary GS (Inner)	F08	36	593	245	281
8.	LG05101	FIAT Coach Secondary GS (Outer)	F09	55	637	376	431
9.	1277146	FIAT Secondary Gen Side -1 (Outer)	F14	57	708	372	429
10.	1277145	FIAT Secondary Gen Side -1 (Inner)	F15	38	664	243	281
11.	1268836	FIAT Secondary Gen Side -2 (Outer)	F16	55	702	372	427
12.	1268837	FIAT Secondary Gen Side -2 (Inner)	F17	37	658	243	280
13.	1269514	FIAT Secondary Chair Car (Outer)	F18	50	707	368	418
14.	1269513	FIAT Secondary Chair Car (Inner)	F19	34	663	246	280

B) LIST OF COIL SPRINGS DRAWINGS OF VANDE BHARAT COACHES

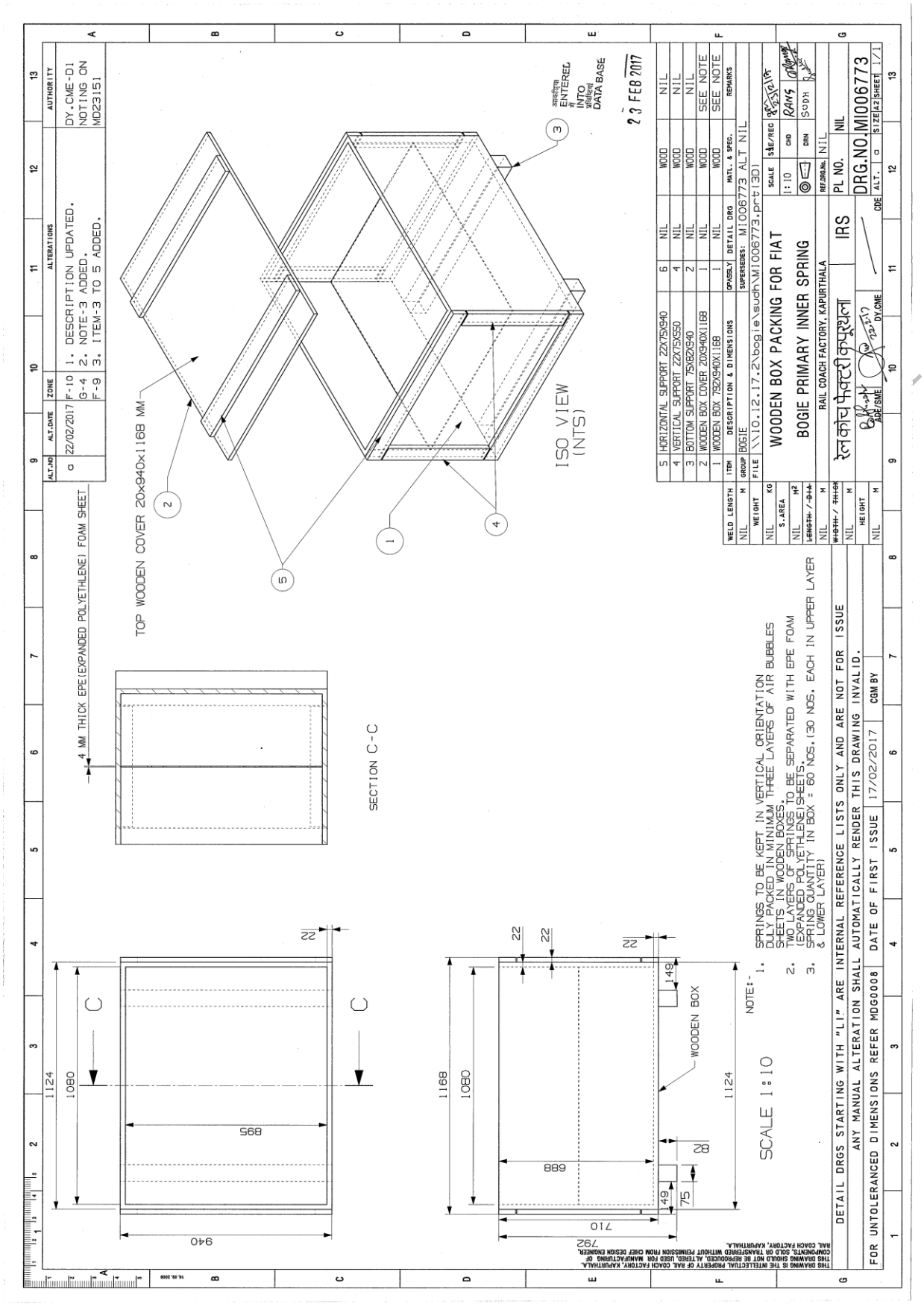
S. No.	Drawing No.	Description	Code	Wire Dia. (mm)	Free Height (mm)	Mean Dia. of Spring (mm)	Outer Dia. of Spring(mm)
1.	RDSO/CG/DRG-23012	Primary Spring Outer	V01	41.4	335.6	237	278.4
2.	RDSO/CG/DRG-23013	Primary Spring Inner	V02	29.6	335.6	148	177.6

ANNEXURE- II



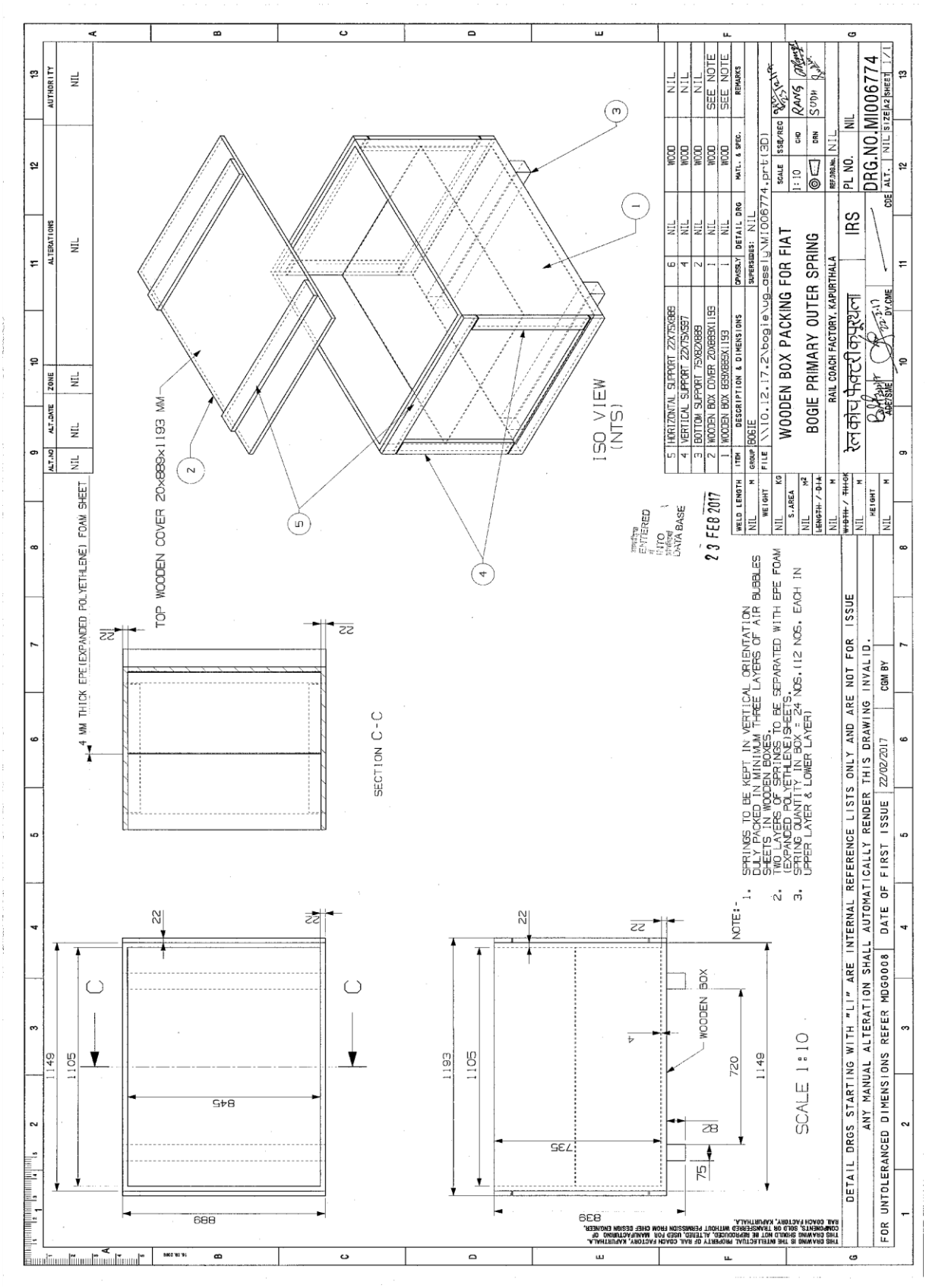
ANNEXURE- III

Signature			
Name & designation	Akil Haider, SSE/Design/Carriage Prepared by:	Satyendra Kumar, ADE/VDG/ Carriage Checked by:	Shobhit Pratap Singh Director/VDG/Carriage Approved by:



ANNEXURE- IV

Signature			
Name & designation	Akil Haider, SSE/Design/Carriage Prepared by:	Satyendra Kumar, ADE/VDG/ Carriage Checked by:	Shobhit Pratap Singh Director/VDG/Carriage Approved by:



Signature			
Name & designation	Akil Haider, SSE/Design/Carriage Prepared by:	Satyendra Kumar, ADE/VDG/ Carriage Checked by:	Shobhit Pratap Singh Director/VDG/Carriage Approved by:

ANNEXURE –V

PROFORMA FOR FIELD TRIAL SCHEME OF HOT COILED HELICAL SPRING USED IN FIAT BOGIES OF LHB & VANDE BHARAT COACHES:

S. No.	Coach No.	Make of spring	Date of putting in service in Coach	Railway	Springs stamping particulars	Detection of any crack during visual check including sound tapping test		Date of failure for any reason (if any)	Reason for failure	Remarks
						Date	Crack location			

Note: *1. Visual inspection of springs shall be done in every schedule.*
2. Field performance of the springs shall be monitored for 06 months after fitment.
3. Metallurgical & chemical Investigation Report, if any.

Signature			
Name & designation	Akil Haider SSE/VDG/Carriage Prepared by:	Satyendra Kumar ADE/VDG/Carriage Checked by:	Shobhit Pratap Singh Director/VDG/Carriage Approved by: