GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

FUNCTIONAL REQUIREMENTS SPECIFICATION OF AIR SPRING ASSEMBLY (160KN) FOR NON AC LHB COACHES FOR FIAT TYPE BOGIES

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CONTENTS

FOREWORD

This Schedule of Technical Requirements (STR) spells out the schedule of technical requirements of Air Spring of 160 kN Capacity and Metal Bonded Emergency Rubber Spring for BG (1676mm) Non AC LHB coaches having FIAT type bogies.

This Schedule of Technical Requirements consists of Section-A and Section-B. Section-A is concerned with the entire Air Spring Assembly whereas the Section-B contains details of the requirements and tests for the Emergency Springs.

(SECTION - A)

SCHEDULE OF TECHNICAL REQUIREMENTS OF AIR SPRING ASSEMBLY FOR NON AC LHB COACHES FITTED WITH FIAT TYPE BOGIE

1. SCOPE:

1.1 This schedule lays down the technical requirements for the design and supply of air spring assembly for fitment in the existing two axle FIAT(Y - frame) Bogie of mainline coaches having end on generation or self generation system fitted with LHB type coaches of Indian Railways. Scope of supply shall generally be as per clause 4 of this Schedule of Technical Requirements (STR). However, if the supplier feels that certain additional items are necessary for improved working performance of the system, he may quote for the same. In any case, purchaser will be at liberty to buy all or part material from the offer.

1.2 Control equipment for the air spring assembly should be supplied to RDSO's STR C-K407 (Latest Revision). The air spring assembly should be compatible with the control equipment described in the above STR. The purchaser will be at liberty to buy any part or complete control equipment to STR C-K407 (Latest Revision) and air spring assembly to this STR from different source of supply.

2. OPERATING CONDITIONS:

2.1 Each coach fitted with air spring assemblies would have a feed pipe and one brake pipe. Normally up to twenty six coaches form a train. These coaches would have a maximum speed of 180 kmph and negotiate curves upto a minimum radius of 175 meter and carry payload upto 24 t.

2.2 Compressed air supply to the air spring assemblies shall be maintained through a compressor provided in the Locomotive. The Locomotive compressor charges the Feed pipe at 6 Kg/cm². Provision of air-drying does not exist in some of the compressed air supply system. Pneumatic circuit of air spring assembly system is connected to the Feed pipe.

2.3 Each coach shall be fitted with four air spring assemblies (two per bogie) and each air spring assembly shall be controlled by an independent levelling valve (4-point control system). Two air springs of the same bogie shall be connected through a duplex check valve set to act at a pressure differential of 1.5 $\pm$ 0.12 Kg/cm².

2.4 To maintain continuous supply of compressed air to the air spring assembly system, a 150-litre auxiliary air reservoir has been provided.

2.5 Track-ballast during train operation may occasionally hit the air spring assembly and control equipments.

3. ENVIRONMENTAL CONDITIONS:

3.1 Air suspension fitted in Fiat (Y- frame) Bogie of mainline having end on generation or self generation system fitted with LHB type coaches shall be subjected to following environmental conditions:

Max. Temperature under sun	: 60ºC.
Ambient temperature	: 0º to 45ºC in shade.
Average relative humidity	: 70% to 90%, 100% on several days.
Rainfall	: Fairly heavy, maximum being 200mm in 24 hours, typical to the coastal areas.
Atmosphere	: Dusty for several months of the year.

3.2 Air spring assembly system may also come in contact with the following, during coach maintenance operation:

- Chemical products (like cleaning compound of coach cleaning)
- Cotton waste smeared with oil and paint etc.
- Disinfectants.
- Oils & lubricants used in coach bogies.

4. SCOPE OF SUPPLY:

4.1 The scope of supply covers the following items:

i) For each air spring assembly:

S.No.	Item	Quantity
1	Air spring (Rubber bellow)	1
2	Top interfacing plate with bolster, with spigot	1
3	Sealing O-rings	2
4	Base plate	1
5	Emergency spring	1
6	High tensile hex. socket Head screws with spring washers	4 sets

ii) Any other item, which in the view of the supplier is considered essential for operation or enhances the performance of the system, may also be offered.

5. PROCEDURE FOR VENDOR REGISTRATION:

5.1 Vendors willing to supply air spring assembly for the use of Indian Railways shall register themselves with Research Designs and Standards Organization, Ministry of Railways, Lucknow-226011 (RDSO) and should be ISO approved.

5.2 The Vendor shall have a well-documented 'Internal Quality Assurance System' to ensure sustained quality of product being manufactured. The Quality Assurance System' shall generally cover the following:-

5.2.1 System to ensure that correct raw material is being used. The type of rubber used for the air spring bellow shall be specified by the OEM.

5.2.2 System to ensure that components having manufacturing defects are identified and destroyed so that such components are not used during assembly of air spring.

5.2.3 System to ensure that bought out components are strictly as per requirements laid down in the STR / drawing.

5.2.4 System to maintain strict control of dimensions and workmanship of components and assembled product.

5.2.5 System to test and establish that the air spring assembly manufactured by the firm meets all the requirements laid down in STR / drawing.

5.2.6 System of periodical calibration of equipments/gauges to ensure accuracy of product.

5.2.7 System to ensure cleaning & removal of dust/rust and moisture by dry air.

5.2.8 System to ensure that air spring assembly is properly packed to meet the requirement of Clause-12 of this STR.

5.2.9 System to ensure traceability at least up to guarantee period.

5.3 Special Conditions:

a) Air spring vendors shall be recognized on the basis of the OEM design. An OEM for this purpose shall be defined as a company having the facilities for designing the air spring and the necessary infrastructure to carry out detailed type tests at their own facility. Their air spring designs should have been approved over other railway systems and been in regular passenger service.

b) Application for registration shall therefore be considered from OEMs or from companies entering into a valid MOU/Agreement with OEM air spring manufacturers as defined above. The MOU should clearly state that the OEM undertakes to fulfill the warranty and support obligations with respect to technology upgradations as and when required for the air spring assembly, even in case the MOU is rescinded at some later stage.

c) Since air springs are a safety related suspension element, in-service trials shall be necessary for each OEM design before full clearance is given for supply.

d) OEMs whose air springs have completed five years satisfactory service on other Railway Systems on at least two hundred fifty coach sets shall only be considered. Vendors shall be required to submit verifiable documentary proof of satisfactory performance of the same. The air springs of a particular design shall be subjected to in-service trials on a minimum of ten coach sets for one year on IR's system. An OEM air spring design shall be treated as developmental during the period of service trials.

e) In case of any failure during service trials attributable to poor design or material, the service trials shall be repeated. RDSO shall decide the cause of failure after investigation in this regard.

f) After completion of service trial period, a sample of the air spring shall be subjected to the tests laid down at paras 10.2, 10.3 and 10.4. In case these values are beyond permissible limits, the air spring design shall be deemed to have failed the service trials.

g) Vendors providing a particular OEM design as defined at (a) above shall be provided part-II status on successful completion of service trials as defined above. A Vendor shall be considered eligible for upgradation to Part-I status on completing successful supply of a minimum of 100 coach sets of the particular type of air spring and also after a minimum period of 18 months after issue of first Inspection Certificate as a Part-II vendor.

h) A vendor considered eligible for upgradation to Part – I status shall undertake manufacturing of minimum one of three critical/major components of Air Spring assembly i.e. either Air Bellow or Emergency Spring or Top Plate assembly inhouse or at allied/sister concern. Facilities and process of manufacturing (indigenous) shall be validated by OEM. At this stage fresh type test shall be essential. The sample air spring assembly shall be picked up by RDSO. Vendor shall arrange the detail type testing of sample air spring assembly at his own cost at OEM's own type test facilities.

- The vendor has to submit the fresh drawing and modified QAP for approval before undertaking inhouse manufacture of these components.
- For grant of Part – I status after the acceptance of fresh Type test report by RDSO a minimum of 50 coach sets of air spring fitted with indigenous manufactured component as per para. (l) above must have been supplied by vendor. First lot of minimum 10 coach sets of such air spring assembly shall have inspected by Carriage (VDG) Directorate, RDSO, Lucknow.
- Essential documents as per clause 5.3.b above shall be submitted for review.

i) In case any part of the air spring assembly is manufactured outside India, a certificate of country of origin shall be provided with each supply clearly establishing the source of manufacture. Source of manufacture of each component shall be provided by the vendor at the time of design approval.

j) After type tests of a particular OEM design are approved by RDSO, vendors shall ensure that air springs to the particular specification are supplied with components manufactured from the sources as indicated at the time of design approval and used for type testing.

k) The type test shall be witnessed by authorized representative of RDSO at the time of design approval of the OEM at OEM's own test facility.

Any additional tests if considered necessary shall also be arranged by vendor free of cost. All necessary arrangements for witnessing the type test of air spring assembly at OEM premises shall be done by the vendor. RDSO reserves the right to witness the type test again if changes in approved design/drawings are carried out which are likely to alter design / performance characteristics of the air spring.

l) In case design of critical component i.e. Rubber Bellow, top plate or emergency spring is changed, fresh type test and service trial shall be required. However service trials can be dispensed with by RDSO considering the reasons for change and extent of modification.

m) In case, source of any component of air spring assembly is changed or any additional new source is introduced, fresh type tests shall be required. The OEM/vendor should provide the detail information of the source changed/ additional source introduced along with the documentary evidences for the record of this office. OEM shall validate the source in all respects i.e. material, manufacturing process, quality control and inspection & testing etc. to conform to originally approved design and process. Compliance to all obligations including guarantee/warrantee (as per para. 8/Section - A) shall remain the responsibility of OEM.

6. TECHNICAL REQURIEMENTS:

6.1 Static load & pressure per air spring assembly:

6.1.1 The air spring assembly shall be capable of withstanding following range of static vertical loads by using compressed air with a limiting pressure value of 6 Kg/cm².

i) Minimum Tare load = 60 KN
ii) Maximum Full load = 160 KN

Further, the air spring assembly should be capable of meeting the maximum vertical load at an air pressure of 5.5-5.8 Kg/cm^2 to allow for minor pressure drops along the train length during run.

6.1.2 It shall be possible to inflate the proposed air spring assembly from its deflated condition when pre-loaded with a static vertical load of upto 160 KN (max.), simply by supply of compressed air through levelling valve without any other external assistance.

6.2 Deflection characteristics of air spring assembly:

6.2.1 During dynamic (running) condition of coaches, the air springs shall be subjected to the following deflections at frequencies of upto 3Hz. The design of the spring should be able to cater for the same:

i) Max. Vertical deflection of spring (dz.) = ± 30 mm
ii) Max. Lateral deflection of spring (dy.) = ± 80 mm

6.3 Air spring assembly shall be designed for use with an additional air reservoir of volume 60 dm^3 permanently connected to air spring.

6.4 Vertical stiffness of air spring assembly:

6.4.1 Minimum air cushion provided under minimum tare load condition shall be 25 to 30 mm, with installed height of 294^{+0}_{-5} mm.

6.4.2 At dz ± 20 mm at constant speed of 5mm/sec, the vertical stiffness (Cz) shall be:

Load in KN (Static)	Vertical stiffness Cz IN N/mm With Additional Volume 60dm^3
60	350±25 N/mm
90	400±50N/mm
120	500±75N/mm
160	Will be decided

6.5 Lateral spring stiffness of air spring assembly:

At dy ±20 mm at constant speed of 5 mm/sec, the lateral stiffness (Cy) shall be:

Load in KN (Static)	Lateral stiffness Cy IN N/mm
60	175±30 N/mm
90	
120	
160	Will be decided

6.6 The spring should be able to withstand an occasional 50% dynamic augment over the maximum static load.

6.7 Bursting strength of the air spring:

Air spring shall be capable of withstanding a minimum bursting pressure of 30 Kg/cm². Test procedure for check bursting strength of air spring should be as follows.

This test shall be performed with water at an ambient temperature above or around 20^0C.

- Install the air spring assembly that was subjected one million cycles endurance test at design height.
- Inflate the air spring assembly with minimum 30 kg/cm^2 internal pressure and hold the air spring assembly at this pressure for a minimum of 5 minutes.
- Observe if there is any damage or visible crack.

6.8 In case of accidental deflation of the air spring assembly during dynamic condition of the coach due to reasons other than leakage/bursting/puncture etc. of the air spring, when the coach sits on emergency springs (Clause 6.9.3), there shall be no damage to air spring assembly under normal operating conditions.

6.9 Emergency spring:

6.9.1 During train operation, deflation of an air spring due to depletion of pneumatic pressure either on account of leakage or disruption in air supply cannot be ruled out.

6.9.2 To counter such situations, an emergency rubber spring shall be required to be installed in the air spring assembly, which shall act as suspension element during such happenings.

6.9.3 This spring shall be capable of safely carrying the affected vehicle as above (either fully or partially loaded) for a minimum distance of about 1000 Km at speed of at least 60 kmph under normal operating conditions without suffering any self-damage or any further damage to the air spring which will make them unfit for further use. This situation is likely to arise occasionally in the service life of the air spring.

6.10 Space Constraints:

Air spring assembly consisting of top plate with spigot (for air connection), air spring bellow, rim, external emergency rubber spring, base plate etc. in inflated condition shall be within the space envelope shown in RDSO Drawing CG-K5065. Some of the leading parameters of air spring assembly in inflated condition shall be:

i)	Installed height without spigot	= 294^{+0}_{-5} mm.
ii)	Maximum permissible diameter of air spring,	= Ø 700 mm.
iii)	Maximum permissible external diameter of top plate of air spring	= Ø 700 mm.
iv)	Min. height of air spring under full load with no air and without spigot	= 240 mm

6.11 Pneumatic supply connection:

Air inlet connection point to the air spring shall be located at the centre of top plate through a spigot made air tight by using minimum two rubber O-rings. The dimension of spigot shall be as under:

i) Outer diameter = Ø $85^{-0.036}_{-0.071}$ mm.
ii) Height = 35 ± 0.5 mm.
iii) Diameter of "O" ring = 5.7 ± 0.1 mm.

6.12 Mounting arrangement:

The base plate of air spring assembly shall be to RDSO's drawing CG – K5057, which is enclosed. The material of the base plate shall be stainless steel or corrosion resistant steel Grade Fe 410 Cu WB to IS : 2062 (latest year of issue) or equivalent even if this arrangement is an integral part of the emergency spring to avoid intermetallic corrosion. The base plate shall be provided four countersunk M22 bolts as indicated in the above drawing.

6.13 Other Details:

All metal parts of the air spring assembly shall be of stainless steel or corrosion resistant steel Grade E 250 Cu Fe 410 WB to IS: 2062 (latest year of issue) or equivalent duly painted in red. The fasteners shall be of high tensile steel to IS: 2269 (ISO 898) and shall be zinc coated.

6.14 Physical tests of air spring bellow :

Physical tests of the air spring bellow as specified at para. 5 of Annexure "A" of this specification shall form a part of the type test report. These tests shall be confirmed at an Indian Laboratory at a maximum interval of three years. RDSO reserves the right to carry out these tests earlier. The cost of these tests shall be borne by the vendor.

7. SUBMISSION OF OFFER:

7.1 Vendors desirous of seeking approval from RDSO for supply of material as per this STR, shall submit their proposal accompanied by the documents containing the following information to RDSO :-

1) Dimensional drawing of air spring assembly and emergency spring.

2) Inner volume, effective area and effective diameter of springs.

3) Weight of one air spring assembly.

4) Whether proposed air spring is being used by any other rail-road system? If yes, details regarding quantity, type of stock, max. operating speed, type of service, average annual running kilometers, life cycle obtained by the user rail-road and maintenance cycle followed by them shall be furnished.

5) Details of deviation from the STR.

6) Content of indigenous and imported items in offered air spring assembly.

7) Expected life cycle in operating and environmental conditions enumerated in clause 2 & 3.

8) MOU / Agreement with the OEM permitting supply/manufacture of the offered springs. (For proposals from other than OEMS).

9) A write-up giving broadly the maintenance requirements on time/distance basis along with the facilities that would be needed for proper maintenance/upkeep of the offered air spring assembly.

10) A detailed write-up giving the details of "Quality Assurance System" being followed for manufacture of the offered items; and

11) Details of manufacturing and testing facilities available with the manufacturer.

7.2 The information as received above shall be used for preliminary evaluation of the firm's capability in meeting with the requirements of this STR.

7.3 The firm shall be required to submit a Type Test Report of a proposed design after the preliminary evaluation carried out as per para 7.2 is found satisfactory. Type Test Report shall be complying with Annexure “A” of this STR.

7.4 The premises of the firm shall be visited by RDSO's officials for on-the-spot assessment of the firm's capability after the Type Test Report is accepted by RDSO.

7.5 RDSO reserves complete right in granting approval or otherwise to a firm.

8. **GUARANTEE:**

8.1 Complete air spring assembly including emergency spring shall be guaranteed for satisfactory performance for a minimum period of 60 months from the date of actual commission in bogies or 72 months from the date of supply. Satisfactory performance for this purpose means that complete air spring assembly or any of its part shall neither show any kind of deterioration which is likely to render it unserviceable nor lose its characteristics as stipulated in this STR, during the guarantee period for reasons attributable to manufacturing/design defects.

8.2 In the event of 'non-satisfactory performance' of any of the items as indicated above, supplier will have to replace the same at his own expense without levying any cost involved in transportation, handling and replacement of such items on the Purchaser.

9. INSTALLATION, COMMISSIONING & MAINTENANCE:

9.1 On placement of order, supplier whose equipment will be purchased for the "First Time" for installation on the coaches, shall have to depute his representative at his own expense to associate with the purchaser in installation and commissioning of the equipment on the first five coaches. He shall also depute his representative during maintenance schedules undertaken on his equipment as per maintenance booklet supplied by him.

9.2 With every order for supply of the air spring assembly, the supplier shall have to supply maintenance instructions in the form of two booklets (hard copy) and one copy on Compact Disc (MS-Office compatible).

9.3 Maintenance booklet supplied by the supplier shall cover the following aspects in detail:

1) Specification of the air spring assembly.

2) Working principle based on the actual construction.

3) Constructional details giving sketches, drawings and photographs etc. identifying various items and their part numbers etc. for easy identification.

4) Procedure for dismantling using sequential steps with the help of sketches.

5) Procedure for assembly, using sequential steps with the help of sketches.

6) Jigs, tools, other materials and details of special set-ups etc., necessary for item 4 & 5 above.

7) Testing procedures and facilities required along with their details.

8) Comprehensive details containing legible sectional views of defects normally observed or may happen on air spring and emergency spring with clear remarks whether the defect is rejectable or non-rejectable.

9) List of other defects and their remedies.

10) Periodicity for various maintenance activities on time and distance basis.

11) Do's and Don'ts for maintenance officials.

10. INSPECTION AND TESTING:

10.1 General requirements:

During initial approval of a firm by RDSO (Clause 7) and later on when approval has been granted, RDSO for purpose of ensuring quality of purchased product may carry out periodic quality audit, inspection and testing of the equipment at the premises of the manufacturer. Purchase inspection shall be done at the premises of the manufacturer

by a representative of the Research Designs and Standards Organization or an agency authorized by RDSO. The supplier shall have to arrange for the following and associate with the same:

1) Access to all records considered relevant for such activity by inspecting officials.

2) Questioning of relevant personnel engaged in production, testing and quality checking activities etc. or related issues.

3) Testing of few samples of items already produced by the firm to ascertain the technical characteristics given in this STR.

4) Any other check considered necessary by the inspecting party.

5) The inspecting official shall carry out purchase inspection as per inspection check list attached at Annexure "B" of this STR.

10.2 Inspection and testing of air spring assembly (air bellow and emergency spring):

10.2.1 Dimensional check:

ITEM	REFERENCE DOCUMENTS
Air spring	As per Firm's assembly drawing approved by RDSO & technical requirements of clause 6 of this STR.
Top Plate with spigot	
"O" Ring	
Base plate	

10.3 Leak test of air spring bellow:

Leak test of air spring assembly shall be carried out as follows-

- Install the air spring assembly at design height.
- Gradually raise the air pressure to 9 kg/cm^2 and disconnect the air supply.
- Air spring assembly shall be checked for pressure drop at the following pressure and time intervals.
  a) After one hour at internal pressure 9.0 kg/cm^2.
  b) After 15 minutes at internal pressure 6.0 kg/cm^2. The above tests shall be conducted with the air supply and drain system of test device turned off.

  Drop of pressure at the completion of test shall be measured. The pressure drop is required to be within 1% of the test pressure i.e. 9.0 kg/cm^2 or 6.0 kg/cm^2 as applicable.

10.4 Characteristics tests:

10.4.1 Air bellow:

Air spring assembly at fixed installation height 294^{+0}_{-5} mm (with additional volume of air 60 dm^2) shall be tested at pressure starting from 1, 2, 3, 4, 5 and upto 6 kg/cm^2.
The recordings shall be done as given below:-

S.N.	Pressure in Kg/cm^2	Specified Load in kN	Observed Load in kN			
			Spg.No.	Spg No.	Spg.No.	Spg.No.

The Pressure v/s Load relationship of air spring assembly shall be same as given in type test report and approved by RDSO.

10.4.2 Emergency spring/ bumper:

Load vs. Deflection characteristics measured at vertical loads on Emergency spring/bumper given in approved type test report and approved by RDSO.

10.5 10% samples of the lot or a minimum 10 samples shall be picked up randomly for dimensional & other specified inspections as given in clause 10.2.1 of this STR.

10.6 For other specified inspections a given in clause 10.3 and 10.4 of this STR, samples shall be picked up randomly as under:

Lot size upto	10	25	50	75	100
No of samples	2	3	4	5	6

For lot sizes more than 100, 6% of the samples shall be picked up randomly for the above inspections.

10.7 In case any picked up sample fails, manufacturer/supplier shall re-offer, rectifying the defects. However, in such cases, double the quantity of samples shall be picked up and shall be checked for dimension and other specified testing. In case any one sample fails again, the entire lot shall be rejected.

11. MARKING:

Every item of the air spring assembly shall be legibly marked to indicate the following:

1) Manufacturer's initials.
2) Month and year of manufacture.
3) Identification marks, i.e. Part Number, Batch Number, etc.

12. PACKING:

The air spring assembly shall be suitably packed along with its loose parts and exposed threaded portion, to protect against any damage that may occur during transit and handling. The opening of the spigot of the spring shall be suitably covered with a plastic/rubber cap to prevent ingress of dust or foreign material in the air spring.

13. MAINTENANCE MANUAL:

The supplier shall provide at least one copy free of cost for each consignment, a detailed maintenance manual for maintenance and overhaul purpose.

14. GENERAL:

14.1 RDSO may draw samples for quality check to test any property mentioned in this specification at it's discretion. The vendor shall arrange testing of these samples at a reputed outside laboratory as decided between RDSO and the vendor. The testing charges should be borne by the vendor.

14.2 Additional information if required may be obtained from the office of the Director General (Carriage), RDSO, Manak Nagar, Lucknow – 226011.

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Annexure – A

REQUIREMENTS OF TYPE TEST REPORT

The type test report of air spring assembly shall consist of the following, clearly represented by graphs as well as in tabulation forms, with detailed test procedures and their results: -

1) Lateral characteristics measurement at 60,90, 120 & 160 KN vertical loads and lateral stroke dy = ±10, ±20, ±30, ±40, ±50, ±60, ±70 & ±80 mm, speed V= 5 mm/sec, using triangular wave form of vibrations in lateral direction.

2) Vertical characteristics measurement at 60,90, 120 & 160 KN vertical loads with additional volume of air 40, 60 & 80 liters, and vertical stroke dz = ±10, ±20, ±30mm, speed V= 5 mm/sec. using triangular wave form of vibrations in vertical direction.

3) Vertical force versus internal pressure characteristic measurements of air spring.

4) Effective area versus deflection curve of air bellow.

5) PHYSICAL TESTS

a) For Air Spring Bellow:

(i) Abrasion test as per para. 6.2.5 of EN 13597 : 2003 (E).

(ii) Resistance to “Oil and Petroleum Product” as per para. 6.2.3 of EN 13597: 2003 (E).

(iii) Adherences between plies as per para. 7.3.3 of EN 13597 : 2003 (E).

(iv) Resistant to ozone test as per para. 6.2.2 of EN 13597 : 2003 (E).

b) For Emergency Spring:

(i) Abrasion test as per para. 7.2.7 of EN 13913 : 2003 (E).

(ii) Resistance to “Oil and Petroleum Product” as per para. 7.2.5 of EN 13913: 2003 (E).

(iii) Heat ageing test as per para. 7.2.3.1 of EN 13913 : 2003 (E).

(iv) Resistant to ozone test as per para. 7.2.4 of EN 13913 : 2003 (E).

6) Durability test at 6 Kg/cm² internal pressure (Endurance Test) of air bellow as follows.

ENDURANCE TEST OF AIR SPRING ASSEMBLY:

a**)** The endurance test is conducted to access suitability of the air spring assembly provided at secondary stage suspension in coach bogie by simulating service conditions in the laboratory.

b) The test on air spring assembly shall be conducted only when the results of load deflection characteristics are obtained and found satisfactory.

c) The test shall be conducted in vertical and horizontal directions.

(i) Vertical Endurance Test:

a) The air spring subjected to a pre compressive load equal to gross static vertical load as specified in para 4.1(Section- B) on an endurance testing machine by maintaining the design height of 294 mm and pressure of 6 kg/cm^2.
b) With load given in para (a) above, the air spring assembly is subjected to vertical oscillation at sinusoidal frequency of 1.0 Hz and deflection of $\pm$ 30 mm.
c) Endurance test shall be conducted for a total 1 million cycles at a stretch with conditions stipulated in para (a) and (b) above.
d) At the end of 1 million cycles following measurements/ observations shall be recorded after 30 minutes from load release.

S.No.	Parameters	Result
1	Adhesion anomalies	
2	Obvious sign of failure	
3	Excessive wear or abrasion	
4	Any visible crack or rupture	

(ii) Shear Endurance Test:

a) The base plate of air spring assembly is clamped rigidly on a fixed horizontal table and subjected to a vertical compressive pre load which is equal to gross vertical load as specified in para 4.1(Section - B) acting at the geometric centre of top plate, by maintaining the design height of 294 mm and pressure of 6 kg/cm^2.
b) With load given in para (a) above, the air spring assembly is subjected to lateral displacement of $\pm$ 30 mm at a sinusoidal frequency of 1.0 Hz in lateral direction.
c) Endurance test shall be conducted for a total 1 million cycles at a stretch with conditions stipulated in para (a) and (b) above.
d) At the end of 1 million cycles following measurements/ observations shall be recorded after 30 minutes from load release.

S.No.	Parameters	Result
1	Adhesion anomalies	
2	Obvious sign of failure	
3	Excessive wear or abrasion	
4	Any visible crack or rupture	

(iii) Shear Endurance Test with lateral offset of 25 mm between top and bottom plate of air spring assembly shall be conducted as per the provision of BS EN 13597 : 2003 E (Annexure - C).

The test specified under 1, 2 and 3 above shall be carried out on the same air spring assembly. The air spring assembly shall not exhibit deterioration such as tearing, wear, cracks etc and shall be subjected to Burst Resistance Test as per para. 6.7 of part – A of this STR and leak test as per para. 10.3 of part – A of this STR subsequent of completion of endurance testing as above, and results reported.

7) Burst pressure test of air spring bellow after endurance test, as per para 6.7 of part "A" of this STR.

8) Load versus deflection characteristics of emergency spring in vertical and lateral mode as per paras 6 and 7 of part "B" of this STR.

9) Endurance test of emergency spring alongwith vertical and lateral characteristics for minimum 1 million cycles, as per para 8 of part "B" of this STR.

10) Hysterisis loops of emergency spring in vertical mode with vertical pre load of 60, 90 & 120 KN.

11) Lateral characteristics (Load Vs. Deflection) of air spring assembly in no-air condition.

12) Material test report (supported by standard test specifications).

13) Any other test felt necessary by the manufacturer.

14) The type test should be repeated at the time of renewal of registration after first time acceptance of a particular design of air spring assembly.

15) Leak test of air spring bellow as detailed at para 10.3 of part "A" of this STR.

16) Type test of emergency spring shall be carried out as detailed in Section – B of this specification and reports as per annexure I to VII of Section – B of this STR provided with the same.

17) Tolerance in different dimensions of air spring assembly should be as per IS 2102 (Part -I) and mentioned in Type Test Report and drawing.

18) Tolerance in measured values during characteristic tests should be mentioned in type test report given as under:

S.No.	Characteristic	Tolerance
1	Pressure Force Characteristic	$\pm$ 5%
2	Load Deflection Characteristic	$\pm$ 10%
3	Stiffness under sinusoidal motion	$\pm$ 15%

ANNEXURE - B

CHECKLIST FOR INSPECTION OF AIR SPRING

As per inspection and testing Clause no.10.0

1. **Dimensional Check (10% of the Lot Qty.)**

SN	Item	Firm's RDSO Approved Drg.No.
1.	Top Plate	
2.	Spigot	
3.	Base Plate with fixing holes	
4.	"O" ring	

2. **Leak Test of Air Spring:** As per Clause 10.3 of section A.

SN	Description	Check whether with in limit (√ / X)
1.	Pressure at 9 kg/cm^2 for 60 mins.	
2.	Pressure at 6 kg/cm^2 for 15 mins	

3. **Load v/s Pressure Testing of Air Spring assembly:** As per Clause 10.3 of section A.
Test should be carried out as per the formats as below:

S.N.	Pressure in kg/cm^2 or bar	Specified Load (kN)	Measured Load (kN)
1.	1		
2.	2		
3.	3		
4.	4		
5.	5		
6.	6		

4. **Test for Emergency Spring:** Load v/s Deflection Test.
Test should be carried out as per the formats as below:

S.N.	Specified Deflection in mm (As per Type Test Report)	Specified Load in mm (As per Type Test Report)	Measured Deflection in mm
1.			
2.			
3.			
4.			

Lot size for the tests at S. No. 2, 3 & 4 above ate given as under:

Lot Size upto	10	25	50	75	100	Above 100
No. of Samples	2	3	4	5	6	6% of Lot
Check						

(SECTION – B)

REQUIREMENTS FOR
EMERGENCY RUBBER SPRINGS USED IN AIR SPRINGS

1.0 SCOPE

1.1 This schedule of technical requirement (STR) Covers the technical requirements relating to material, constructions and tests for emergency rubber springs (metal bonded rubber bumpers) used in the air spring for BG EMU coach bogie having pneumatic suspension at secondary level. This does not include all the necessary provisions required for a supply contract.

1.2 This STR specifies the operating and performance requirement and method of testing the emergency spring. These Emergency rubber springs are used in conjunction with the air below and are an integral part of air spring acting in series with the load and stiffness provided by compressed air inside the air bellow.

1.3 The emergency rubber springs are subjected to static and dynamic loading in compressive and shear modes simultaneously during operating conditions. The maximum compressive and shear loads are given in subsequent paragraphs.

1.4 The Emergency rubber spring shall be capable of withstanding wide climatic variation prevailing in the country without physical deterioration and change in compressive and shear stiffness characteristics.

2.0 REQUIREMENTS:

2.1 **Material**

2.1.1 **Rubber:**
The Emergency rubber bumper used in the air spring should be manufactured from natural rubber suitably compounded to conform to the requirements stipulated in STR.

2.1.2 **Steel**:

a) The end mounting plates and inter leaves, shall be of steel conforming to IS 2062 Gr. Fe 410 Cu WB or stainless steel.
b) In the preparation process of metal plates or inter leafs it shall be ensured that all sharp edges and burrs are removed and they are chemically treated and cleaned before shot grit blasting as per IS: 9139-GM30.

2.1.3 **Bonding of Metal to Rubber:**

a) Before applying primer coat for achieving the required bond strength between metal part and rubber, the metal parts which are ready for use should be stored suitably to avoid contamination on the surface.

b) The process and bonding agent adopted for bonding of rubber to metal plates shall be of proven quality.

c) The temperature and moulding time shall be optimized for proper curing of rubber.

d) The rubber should be smooth and free from pinholes, blister and other visual flaws.

2.2 **Operating conditions:**

2.2.1 The emergency rubber spring is an integral part of Air spring and acts in series with the compressed air provided inside the air bellow, taking full load.

2.2.2 The maximum dynamic load on the air spring is 50% more than the static gross vertical load.

2.2.3 Under deflated condition of air spring the Emergency rubber spring acts as bumper / suspension and supports the full operating vertical and shear load at such lower speed which is considered safe as per standing criteria.

2.3 **Environmental conditions:**

2.3.1 Emergency spring being an integral part of air spring which is provided at secondary stage in mainline coaches is subjected to following environmental conditions:

Maximum temperature at sun	60^0 C
Ambient Temperature	0^0 C to 45^0 C in shade
Average relative humidity	70% to 90%, 100% on several days
Rail fall	24 hrs. typical to coastal areas
Atmosphere	Dusty for several months of the years

.

3.0 **STIFFNESS CHARACTERISTICS:**

3.1 The vertical and lateral stiffness of emergency rubber spring can not be specified precisely as it acts in series with the vertical and lateral stiffness provided by compressed air inside air bellow, under inflated condition of air spring and their reciprocal equivalence determines over all stiffness characteristics which is guided by STR for air spring system.

3.2 Under the deflated condition of air spring, the stiffness and damping of emergency spring is decided on transmissibility considerations which should be as minimum as possible at higher frequencies. However as a guide line the vertical deflection of Emergency rubber spring should not exceeded 10.0 – 15.0 mm under gross static load.

4.0 TESTING OF EMERGENCY RUBBER SPRING:

The emergency rubber spring unit (Bumper) comprising of bonded metal interleaf/ plates shall be subjected to following tests independently.

a) Bonding strength test.
b) Vertical load Vs deflection test. (Before and after endurance test)

c) Shear load Vs deflection test. (Before and after endurance test)
d) Endurance test (vertical & lateral)
e) Creep test.

Test (b) and test (c) are required to be conducted before and after test (d)

4.1 **Load conditions:**

4.1.1 **Static Vertical Loads**
The tare and gross vertical loads, on each air spring for different type of BG coaches are given as under.

S.No.	Coach Type	Tare Load	Gross Load
1	Mainline / Rajdhani LHB Coaches (ICF Bogie)	60KN	160KN

4.1.2 **Shear Loads**

The maximum operating shear load on each air spring for different types of BG coaches should be calculated as under:

a) Max shear load = Maximum load (160 KN) X Max. friction coefficient

Max. friction coefficient should be calculated in deflated condition.

OR

b) Max. Shear Load = Max. value of (Lateral stiffness of air spring x Corresponding def.)

Lateral stiffness should be calculated upto lateral deflection of 80 mm.

For shear endurance test and shear load vs deflection test, the value of maximum shear load may be obtained by both the above methods and used that value of shear load whichever is higher.

5.0 BONDING STRENGTH TEST:

The objective of this test is to determine bond strength between metal plate and rubber, under pre-determined load or deflection. This test is conducted as per IS: 3400 (Part – XIV). The bond should be capable of bearing a minimum stress level of 35 Kg/cm^2.

6.0 VERTICAL LOAD vs DEFLECTION TEST: (Before Endurance test)

The rubber bumper should be subjected to three successive load cycles up to 150% of gross static vertical load as specified in para 4.1 at quasistatic frequency of 0.1Hz. for pre conditioning. In the fourth cycle the bumper shall be compressed with a load of 0.50 KN and the deflection taken as zero at this point. The fourth cycle is completed to record force Vs deflection curve in the form of hysterisis loop for a deflection range as obtained

during initial three load cycle (loading and unloading). The load and deflection values shall be recorded digitally and the values shall be provided in the form of X – Y plot and digital table. (Ref. Annexure – 1). The following geometric parameter shall be recorded:

SNo.	Parameters	Before Endurance Test	After Endurance Test *
1	Free height (mm)		
2	Outer dia (mm)		
3	Vertical axis orientation (mm)		

* Ref. Para 9.0

Vertical deflection in bumper should be given in tabulated form and with tolerance in value of deflection at different vertical loads upon which test had been done..

7.0 SHEAR LOAD vs DEFLECTION TEST: (Before Endurance test)

In this test the base plate of rubber bumper is rigidly clamped to a fixed horizontal plate and shear load is applied at the top of bumper to measure the shear load Vs shear displacement characteristics. The maximum lateral load shall be 150% of maximum shear load as specified in para 4.1 which shall be applied in both directions (Positive and Negative) from the mean position at a quasistatic frequency of 0.1 H_z . The pre-conditioning of bumper is done by giving three successive lateral load cycles and in the fourth cycle measurements are taken for applied shear load and corresponding shear displacement of bumper. The above test is conducted under gross vertical loads.

The measurements shall be done using digital methods and the measured data shall be provided in the form of hysterisis loop and tables (Ref. Annexure – II). The following geometric parameters shall be recorded as:

SNo.	Parameters	Before Endurance Test	After Endurance Test *
1	Free height (mm)		
2	Outer dia (mm)		
3	Vertical axis orientation (mm)		

* Ref. Para 10.0

Shear deflection in bumper should be given in tabulated form and with tolerance in value of deflection at different shear loads upon which test had been done.

8.0 ENDURANCE TEST:

a) The Endurance test is conducted to assess suitability of the rubber bumper for use in air spring provided at secondary stage suspension in coach bogie by simulating service conditions in the laboratory.
b) The test on bumpers shall be conducted only when the results of load deflection characteristics are obtained and found satisfactory.
c) The test shall be conducted in vertical and shear modes.

8.1 Vertical Endurance Test:

a) The bumper is subjected to a pre compressive load, which is equal to the gross load as specified in para 4.1 on an endurance testing machine. This load is taken as datum and further tests are conducted in load control mode.
b) With load datum as given in para (a) above, the plunger is made to oscillate vertically in sinusoidal manner at a frequency of 1.0H_z with 50 % of maximum gross load on the air spring such that the maximum compressive load on the plunger does not exceed 150% of the gross vertical load.
c) Endurance test shall be conducted for a total 1 million cycles at a stretch with conditions as stipulated in para (a) and (b) above.
d) During endurance test of 1 million cycle if the temperature build up in rubber bumper exceeds 7^CC with respect to the ambient air temperature in the surroundings, the oscillating frequency of the plunger can be reduced by 0.5H_z.
e) At the end of every 0.2 million cycles following parameters are required to be measured (Ref. Annexure III)
a) Hysteresis loop for 5 successive cycles of loads Vs deflections record (after every 0.2 million cycles of endurance testing)
b) Plunger oscillating frequency.
c) Bumper temperature rise.
d) Ambient/Room temperature.
f) At the end of 1 million cycles following measurements/observations shall be recorded after 30 minutes from load release.

S.No	Parameters	Results
1	Adhesion of bond.	
2	Obvious signs of failures.	
3	Excessive wear or Abrasions	
4	Free height	
5	Permanent set.	

8.2 Shear endurance test:

a) The base plate of bumper is clamped rigidly on a fixed horizontal table and subjected to a vertical pre compressive load which is equal to gross vertical load as specified in para 4.1 acting at the geometric centre of top plate. The test is conducted in load control mode and a horizontal force with sinusoidal frequency of 2.0H_z having peak load value as $\pm$ 150% of maximum shear load as specified in para 4.1 is applied simultaneously for 1 million cycles.

b) During endurance test of 1 million cycle as per para (a) above, if the temperature build up in the rubber bumper exceeds 7^0 C with respect to the ambient air temperature in the surroundings the horizontal Oscillating frequency of the plunger can be reduced by 0.5 H_z.

c) At the end of every 0.2 million horizontal oscillating cycles of the actuator plunger following parameters are required to be measured. (Ref Annexure IV)
   i) Hysteresis loop for 5 successive cycle of horizontal load vs horizontal displacement record. After every 0.2 million Cycle of endurance test

ii) Actuator plunger frequency.
iii) Bumper temperature rise.
iv) Ambient/room temperature.

At the end of 1 million horizontal cycle, following measurement /observations shall be recorded after 30 minutes from vertical and lateral load release.

i) Adhesion of bonds.
ii) Obvious sign of failures.
iii) Excessive wear/ abrasion.
iv) Free height.
v) Tilt angle of vertical axis.
vi) Permanent set.

9.0 VERTICAL LOAD vs DEFLECTION TEST.(after endurance test)

This Test is required to be conducted after satisfactory Endurance test and shall be carried out on the similar line as given in para 6.0.

10.0 SHEAR LOAD vs DEFLECTION TEST: (after endurance test).

The test is required to be conducted after satisfactory shear Endurance Test and shall be carried out on the similar lines given in para 7.0.

11.0 SUPERIMPOSITION OF ACQUIRED DATA :

The following data obtained before and after Endurance Test shall be superimposed over each other as details given below :

11.1 Vertical Load Vs Deflection test data

The object is to determine the loss in vertical properties/characteristics of rubber due to endurance test. The characteristics test obtained vide para 6.0 and 9.0 shall be superimposed over each other in the form of hysteresis loop and comparative digital table (Ref. Annexure – V).

11.2 Shear load vs deflection test data

The object is to determine the loss in shear properties/characteristics of rubber due to shear endurance test. The characteristic data obtained vide para 7.0 and 10.0 shall be superimposed over each other of hysteresis loop and comparative digital table. (Ref Annexure VI)

12.0 CREEP TEST

The Creep Test is conducted on an emergency rubber spring by applying a predetermined maximum vertical load, which is borne by the spring for a sufficiently long period to determine the magnitude of permanent set or loss in free height under the influence of load with respect to time.

The predetermined maximum vertical load (150% of gross static load should be applied) continuously for a period not less than 5 days. The following measurements are required to be taken.

1. Magnitude of applied vertical load.
2. Free height of rubber spring (before and after creep test)
3. Height of rubber spring with respect to time. The height of the spring should be measured after every 3 hrs for the first 2 days (48 hrs) and after every 6 hrs. thereafter.

The vertical deflection vs time curve should be drawn for the minimum period of 5 days. It can then be extrapolated depending on the expected working age of rubber spring (Ref. – Annexure VII).

13.0 GENERAL

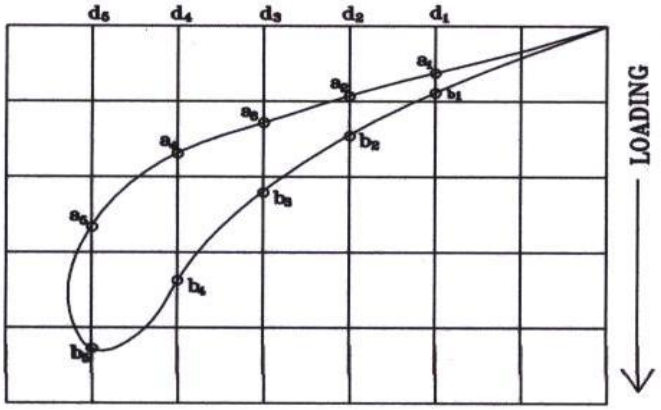
a) All the tests mentioned in this specification shall be conducted on the same specimen of Emergency rubber spring.
b) All measurements shall be given in SI units.
c) Lay out drawing of jigs and fixtures used in evaluating test parameters shall be provided in the report.
d) The test results shall be furnished by contractor in the form of a type test report.
e) Digital photographs /pictures of test rig should be provided by the contractor.
f) A list of instruments used in taking the measurements shall be supplied by the contractor.
g) Any other relevant details in support of accuracy of test shall be given in type test report.

****

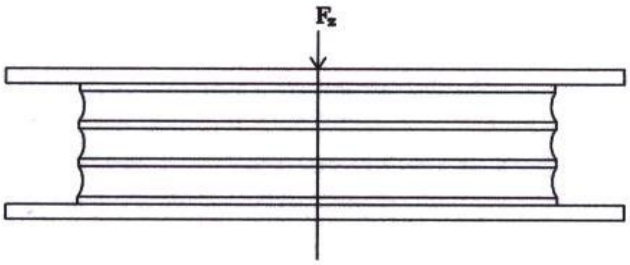
ANNEXURE–I

VERTICAL LOAD VS. DEFLECTION

(Before and After Endurance Test)



S.No.	Displacement	LOAD	
		Loading	Unloading
1.	d_1	a_1	b_1
2.	d_2	a_2	b_2
3.	d_3	a_3	b_3
4.	d_4	a_4	b_4
5.	d_5	a_5	b_5

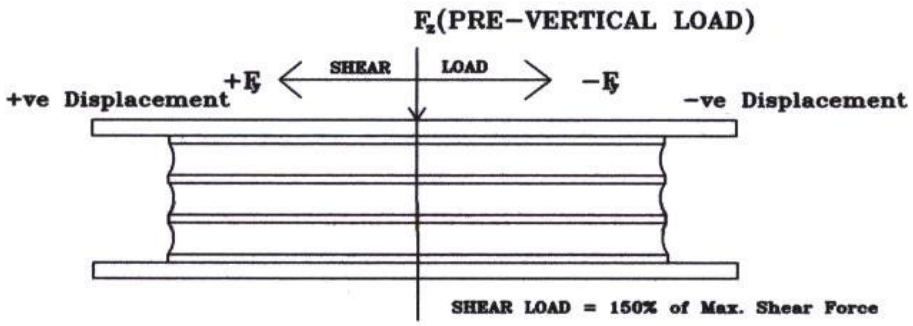


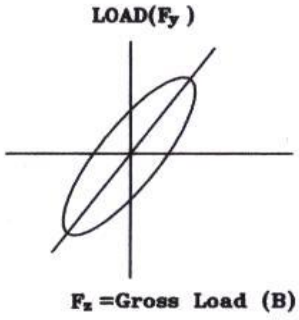
EMERGENCY BUMPER

ANNEXURE–II

SHEAR LOAD VS. DEFLECTION

(Before and After Endurance Test)

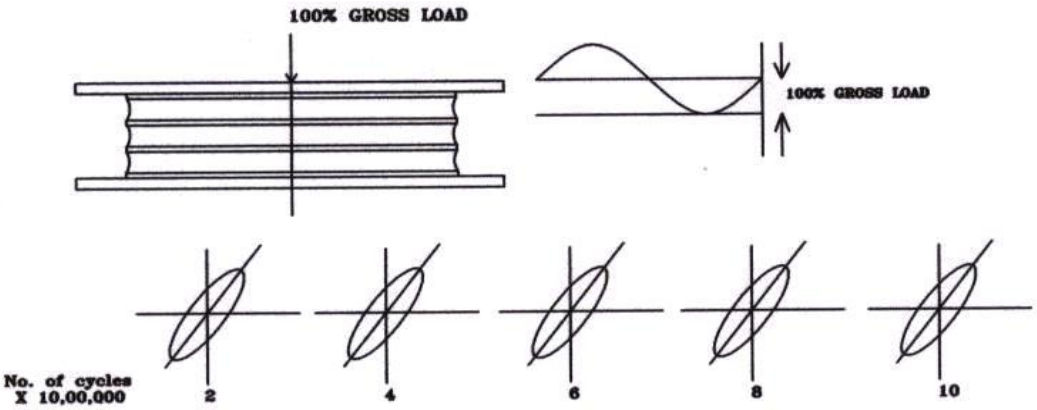




S.No.	Deflection (mm)	GROSS LOAD (B)	
		a	b
1.	$-d_1$		
2.	$-d_2$		
3.	$-d_3$		
4.	zero		
5.	$+d_1$		
6	$+d_2$		
7	$+d_3$		

ANNEXURE–III

HYSTERISYS LOOP (VERTICAL ENDURANCE TEST)



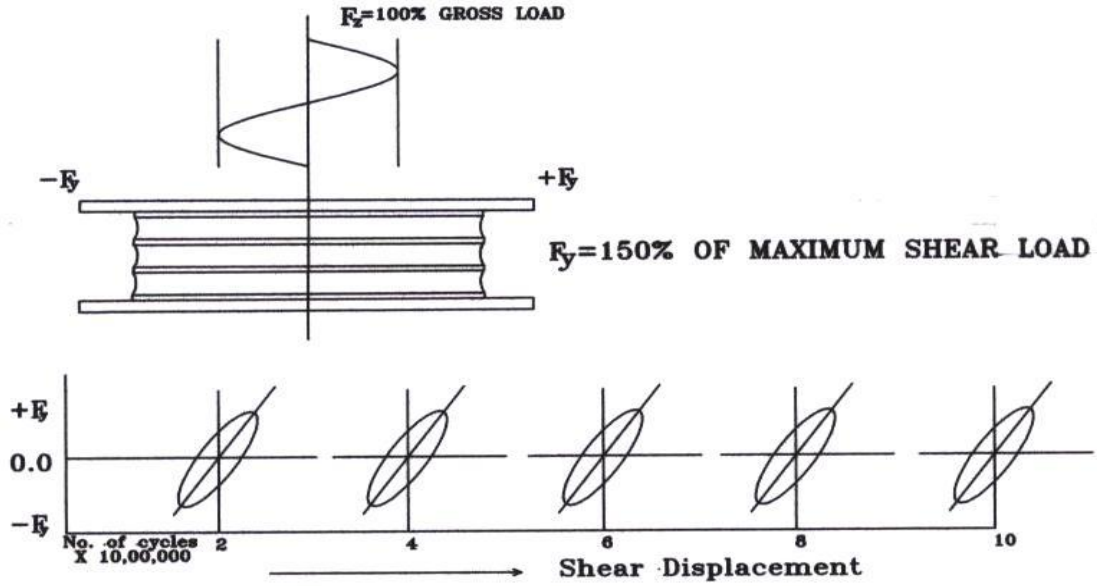
TEMPERATURE BUILD– UP (VERTICAL ENDURANCE TEST)

S.No.	PARAMETER	No. of CYCLE	FREQUENCY (H)	AMBIENT ROOM TEMP.	BUMPER TEMP.
1.	Temperature Build – Up	2,00,000			
2.		4.00,000			
3.		6,00,000			
4.		8,00,000			
5.		10,00,000			

S.No.	PARAMETER	OBSERVATIONS / MEASUREMENTS	Result
1.	Adhesion		
2.	Obvious sign of failure		
3.	Excessive wear & adhesion		
4.	Abnormal permanent set		
5.	Free height (mm)		

ANNEXURE–IV

HYSTERISIS LOOP (SHEAR ENDURANCE TEST)



TEMPERATURE BUILD–UP (SHEAR ENDURANCE TEST)

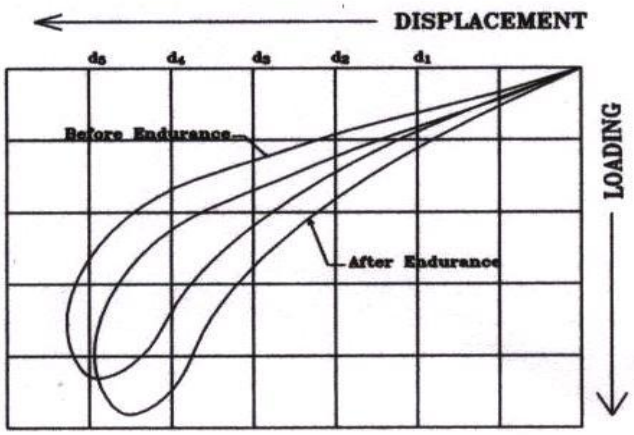
S.No.	PARAMETER	No. of CYCLE	FREQUENCY (H)	AMBIENT ROOM TEMP.	BUMPER TEMP.
1.	Temperature Build – Up	2,00,000			
2.		4,00,000			
3.		6,00,000			
4.		8,00,000			
5.		10,00,000			

S.No.	PARAMETER	OBSERVATIONS / MEASUREMENTS	RESULT
1.	Adhesion		
2.	Obvious sign of failure		
3.	Excessive wear & adhesion		
4.	Abnormal permanent set		
5.	Free height (mm)		

ANNEXURE–V

VERTICAL LOAD VS DEFLECTION TEST
(DATA SUPER–IMPOSED)

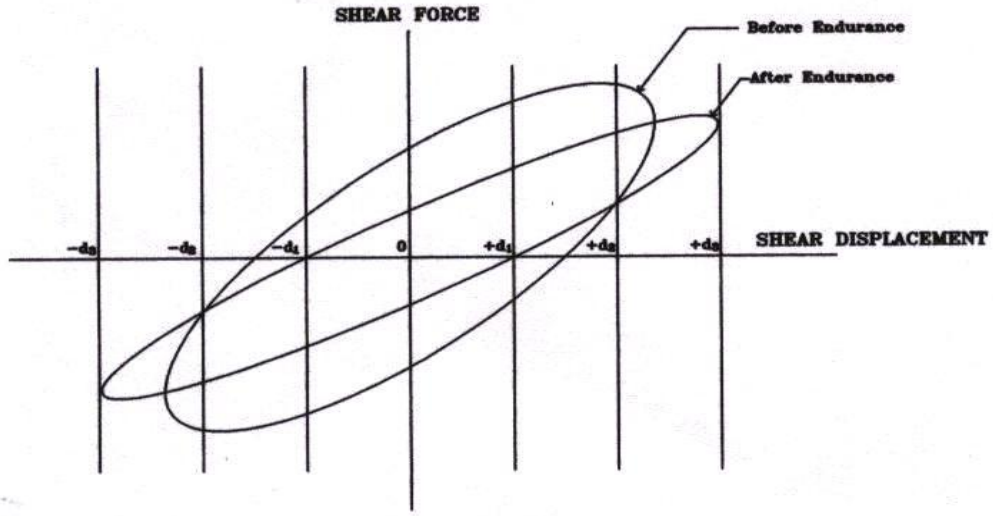
S.No.	BEFORE ONE MILLION CYCLES			AFTER ONE MILLION CYCLES		
	Displacement	Loading	Unloading	Displacement	Loading	Unloading
1.	d_1	a_1	b_1	d_1	a_1	b_1
2.	d_2	a_2	b_2	d_2	a_2	b_2
3.	d_3	a_3	b_3	d_3	a_3	b_3
4.	d_4	a_4	b_4	d_4	a_4	b_4
5.	d_5	a_5	b_5	d_5	a_5	b_5



ANNEXURE–VI

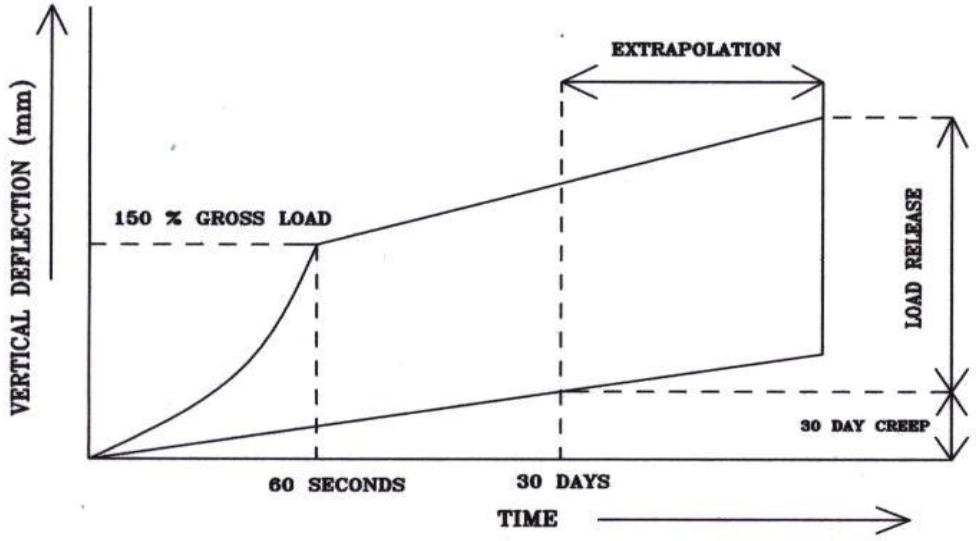
SHEAR LOAD VS DEFLECTION TEST
(DATA SUPER–IMPOSED)

S.No.	BEFORE ONE MILLION CYCLES		AFTER ONE MILLION CYCLES	
	Displacement (mm)	Force	Displacement (mm)	Force
1.	$-d_1$		$-d_1$	
2.	$-d_2$		$-d_2$	
3.	$-d_3$		$-d_3$	
4.	zero		zero	
5.	$+d_1$		$+d_1$	
6	$+d_2$		$+d_2$	
7	$+d_3$		$+d_3$	

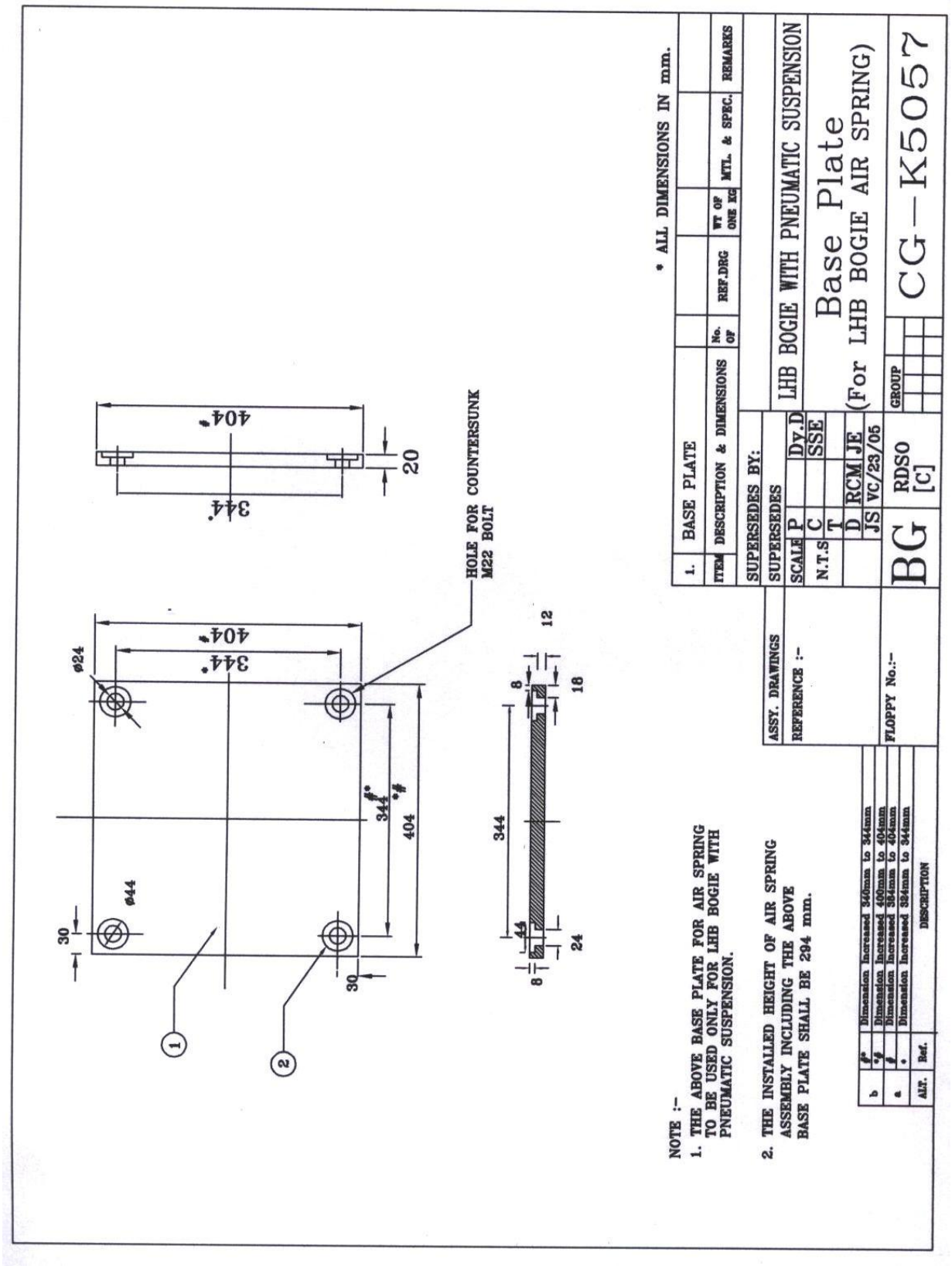


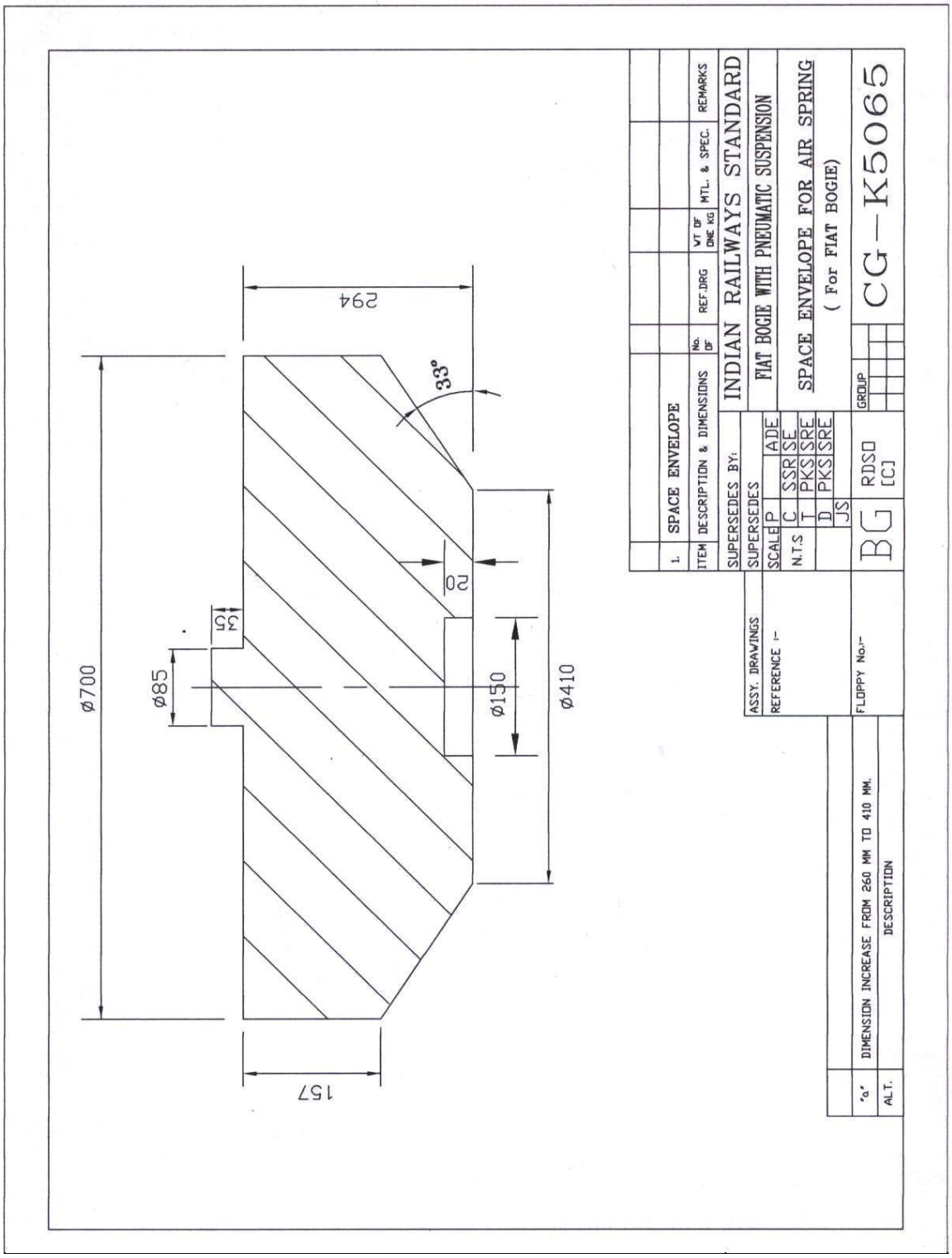
ANNEXURE–VII

CREEP TEST



S.No.	MEASUREMENTS	VALUE
1.	FREE HEIGHT BEFORE TEST	
2.	APPLIED LOAD	
3.	DEFLECTION AFTER 60 SECONDS	
4.	24 HOUR DEFLECTION (FIRST 15 DAYS)	USE SEPRATE SHEET
5.	48 HOUR DEFLECTION (REST 15 DAYS)	USE SEPRATE SHEET
6	DEFLECTION AFTER 30 DAYS	
7	FREE HEIGHT AFTER LOAD RELEASE (mm)	
8	30 DAYS CREEP VALUE (mm)	
9	180 DAYS CREEP VALUE (mm)	


* ALL DIMENSIONS IN mm.
1. BASE PLATE
ITEM DESCRIPTION & DIMENSIONS No. OF REF.DRG WT OF ONE KG MTL. & SPEC. REMARKS
SUPERSEDES BY:
SUPERSEDES
SCALE N.T.S
P C T
Dy.D SSE RCM JE
D JS VC/23/05
LHB BOGIE WITH PNEUMATIC SUSPENSION
Base Plate
(For LHB BOGIE AIR SPRING)
GROUP
BG
RDSO [C]
CG–K5057
ASSY. DRAWINGS
REFERENCE :-
FLOPPY No.:-
ALT. Ref. DESCRIPTION
a * Dimension Increased 384mm to 344mm
b # Dimension Increased 384mm to 404mm
a # Dimension Increased 344mm to 404mm
b $ Dimension Increased 400mm to 404mm
b * Dimension Increased 344mm to 344mm
NOTE :-
1. THE ABOVE BASE PLATE FOR AIR SPRING TO BE USED ONLY FOR LHB BOGIE WITH PNEUMATIC SUSPENSION.
2. THE INSTALLED HEIGHT OF AIR SPRING ASSEMBLY INCLUDING THE ABOVE BASE PLATE SHALL BE 294 mm.
HOLE FOR COUNTERSUNK M22 BOLT
404
344
20
ø24
ø44
30
404
344
344
404
30
12
8
18
44
8
24
1
2



Signature			
Name & Designation	Prepared By: Vinod Kr. Singh/ SSE/Design	Checked By: S. S. Raypa/DD/VDG	Approved By: Shivendra Singh /Dir./VDG