SPECIFICATION
FOR
HYDRAULIC DAMPERS FOR WAP-7
3-PHASE ELECTRIC LOCOMOTIVES OF
INDIAN RAILWAY

SPECIFICATION NO.: CLW/MS/3/SPEC/ELDO-Bogie/002 ALT. '1'

ISSUE DATE: . .2025

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DETAILS OF ALTERATIONS

SL. No.	Date of Amendment	Alt. No.	Description	Remarks	Authority
1.	30.07.2025	1	1. In Para 5.1, values of i) 140 KMPH, j) 160KMPH & n) (-10) /70^{0}C were 130KMPH, 145 KMPH & (-10)/50^0 C respectively. Sub para k) added. 2. In Para 5.5, values of acceleration for Primary Vertical & Secondary Lateral/ Yaw Damper at lateral Location +/-10 g & +/- 10 g were +/- 5 g & +/- 3 g respectively. 3. In Para 5.5, Axial & Tensile load 4 tonnes ≈ 40KN was 3 tonnes. 4. Para 12, Overhauling Interval deleted. 5. Para 12, Guarantee added at page no. 14. 6. Drawing No. 1209-01.215-014 Alt. 2 added as Annexure-III at page no. 17.		
2.					
3.					
4.					
5.					

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TECHNICAL SPECIFICATION FOR DAMPERS FOR USE ON WAP-7 ELECTRIC LOCOMTIVES

1.0 FORWORD:

Railways have reported large number of failures of dampers being provided on 3-phase locomotives. While analyzing the failure data, it is observed that the FRPCPY of the dampers is more in WAP-7 compared to WAG-9 locomotives due to higher vibration level. This specification covers test as per international standards, to be conducted on dampers to suit the requirement in 3-phase locomotive.

2.0 SCOPE:

This document covers the technical requirements for hydraulic dampers to CLW Drawing No. 1209-01.215-014 used in WAP7 locomotives.

3.0 SCOPE OF SUPPLY:

Quantity one (1) set shall comprise Quantity/loco as indicated below:

SN	Type of Damper	Quantity	Drawing No.
1	Axle Damper	8 per loco	1209-01.215-014/1
2	Vertical Damper	4 per loco	1209-01.215-014/2
3	Horizontal Damper	4 per loco	1209-01.215-014/3
4	Yaw Damper	4 per loco	1209-01.215-014/4

4.0 DEVIATION(s):

If deviations from original design, dimensions etc. are desired by the tendered, specific proposals with reason shall be submitted to the purchaser. Commencement of manufacture shall not be done till the purchaser grants clear authorization for acceptance of the deviation(s).

5.0 TECHNICAL REQUIREMENTS:

5.1 The dampers shall be designed by the manufacturer to suit the following features of WAP7 locomotives.

a) Spring weight of the loco body : 78200 Kg.
b) Possible upgrade of the loco body : 90200 Kg.
c) Sprung weight of the bogie (without motors) : 7700 Kg.
d) Unsprung mass of one axle : 3900 Kg.
e) Weight of the axle including the motors : 4900 Kg.
f) Wheel set mass (without motor) : 2750 Kg.
g) Expected annual activity : 6570 hours
h) Gauge (1676 mm) : Broad gauge
i) Maximum service speed : 140 KMPH
j) Maximum test speed : 160 KMPH
k) Maximum speed considering safety factor 1.5 : 210KMPH
l) Type of suspension : Coil Springs
m) Type of damping : Hydraulic
n) Min. /Max. Operating Temperature : (-10)/70^0 C

5.2 DIMENSIONS & DAMPING CAPACITIES:

The Hydraulic Damper shall conform to the latest version of the concerned CLW Drawing including dimensions, damping capacities at room temperature condition. The damper capacity shall be adjustable and repairable.

5.3 OPERATING ENVIRONMENTAL CONDITIONS:

1. The damper shall be resistant to the following operating environmental conditions to which it may be exposed during service:
   - Projection of ballast.
   - Exposure to oil or petroleum.
   - Exposure to organic waste.
   - Wind, rain snow, coal dust, sand storms.
   - Sand, brake and ferric oxide dust (abrasion of wheels, brake blocks and tracks).
   - Saline spray.
   - Washing plant agent (both acids and alkalis).
   - 100% humidity.
2. The damper shall be required to function safely at temperature extreme in the range from -10^0C to 70^0C. After operating in these extremes, the damper shall be required to fully recover its functionality. Furthermore, the damper shall not display any fluid leaks or any sign of failure or cracking in the damper components.

5.4 SURFACE PROTECTION:

All the parts of the damper in contact with the ambient air shall be protected from corrosion. The protection shall be ensured either by the nature of materials used or by suitable painting / surface treatment. Damper material shall be compatible with following paints.

Primer: High solid epoxy primers, High solid alkyd primers.
Paint : Aliphatic polyurethane enamels or two part epoxy paint, total thickness 200 µ m.

5.5 STRENGTH:

The construction of Hydraulic Damper shall be such as to withstand the static compressive axial load of 4 tonnes (when fully closed) and a tensile load of 4 tonnes ≈ 40 KN (when fully extended) without any failure, damage or permanent change in damping characteristic. All welded joints of the Hydraulic Damper shall be free from welding defects and shall be sufficiently strong to withstand the loads intended.

Damper shall function under exceptional accelerations given below:

Locations	Primary Vertical	Secondary Lateral/yaw
Vertical	+/- 50 g	+/- 6 g
Lateral	+/- 10 g	+/- 10 g
Longitudinal	+/- 5 g	+/- 5 g

5.6 RELIABILITY:

Reliability of the component shall meet the following locomotive reliability goals. Failure per locomotive year needing warranty replacement shall also not exceed 0.010. Failure per locomotive year causing the failure and unscheduled replacement shall not exceed 0.007. Failure means leakage of oil, deterioration in damper, performance by 30% or more, breakage of any part of damper.

5.7 FORCE DISPLACEMENT CHARACTERISTICS:

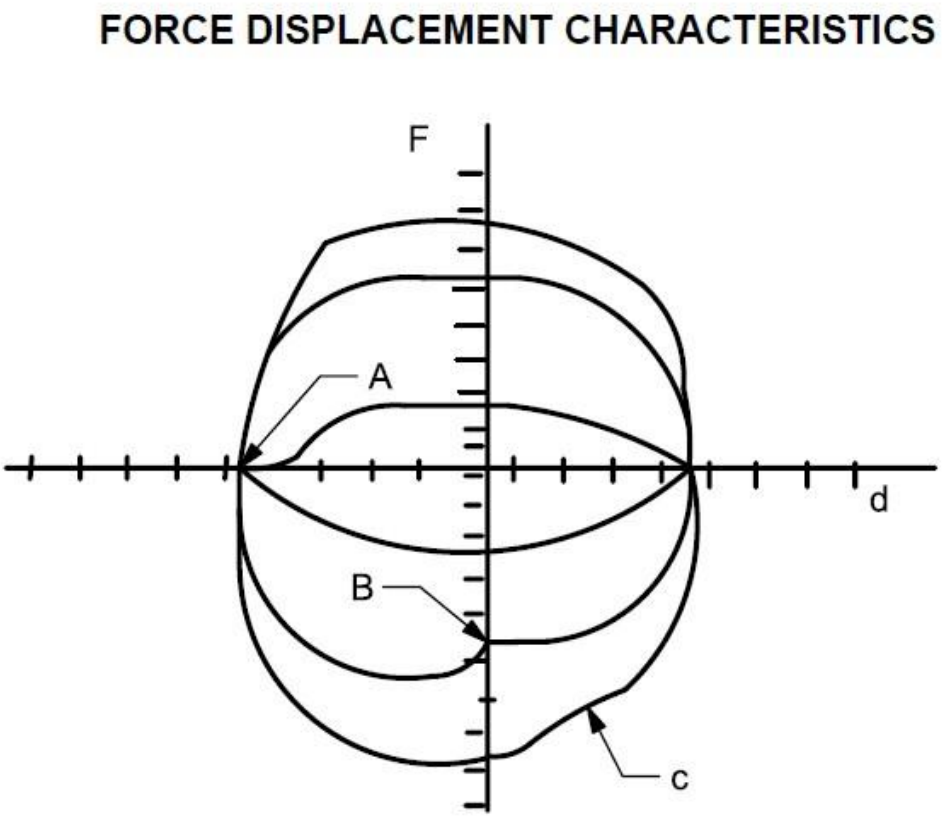


FIGURE-1

The shape of the Force – Displacement curve or Hysteresis Cycle (see above figure), shall be regular and symmetrical, and in particular shall be free from:

- Flux as shown in above figure with letter A, B and C.
- Local vibration phenomena.
- Jumps and sudden change in the shape of the curve.

5.8 OVERALL DAMPING CHARACTERISTICS:

The overall damping forces on the compression and extension strokes of the damper, taken separately, shall be as specified in the drawing(s).
The Hydraulic Damper shall be assembled in such a manner that the damping shall be uniform throughout the stroke i.e. the damping characteristics shall not have any sudden deviation or changes throughout the strokes. Damper forces during the extension and compression stroke shall be symmetrical.

The stipulated tolerances and requirements shall apply at all points within the required working stroke of the Hydraulic Damper.

5.9 TWISTING AND CARDANIC ANGLES AND RADIAL STIFFNESS OF SPHERIBLOC:

The twisting and cardanic angles of damper shall be as per specified in the drawings.

5.10 DAMPER OIL:

The details of damper oil including type, viscosity and amount of the damper oil shall be provided by the supplier.

5.11 DUST COVER AND CASING TUBE:

The joint shall be proven strong enough between piston eye and dust cover shall be done to prevent breakage at the joint. Casing tubes shall be made of steel by accurate and precision welding process or of seamless tube and similarly protection cover also be sufficiently strong and similarly protection cover shall also be strong to increase the life of dampers.

5.12 POSITIVE LOCKING OF PISTION AND PISTON ROD:

Due to higher forces encountered at higher operating speeds, there is a possibility that piston can rotate and free itself from piston rod. Therefore, proper locking of piston with piston rod shall be ensured by appropriate method.

5.13 SEALING ARRANGEMENT:

The damper shall be protected against ingress of dust along with piston rod by using low friction multiple sealing arrangement with better wiping properties, provision of additional dust lip etc.

5.14 INTERNAL DESIGN:

It shall have all the constructional features to reduce friction, provide protection against dust and ensure long life. The internal mechanism shall have provision so that in any odd situation, the fore of oil goes beyond a prescribed limit, the system shall take action automatically to prevent the failure of the damping system. The valve system shall be noise free and there shall also be arrangement to ensure absence of metal to metal contact in the piston & guide.

5.15 VIBRATION CHARACTERISTIC:

The damper shall be able to withstand the vibration levels of the intended application in primary/ secondary suspension stages of locomotive bogie. Particularly yaw damper shall be specially designed to control small amplitude sinusoidal bogie rotational movements.

5.16 LEAKAGE:

The damper shall operate without excessive loss of oil throughout its operating life. Oil loss shall be considered excessive when there is visible evidence of accumulation of oil in the form of drip on the body of the damper.

5.17 TORSIONAL AND CARDANIC STIFFNESS TEST:

The test is to be carried out for attachment to the damper as explained in Annexure-I

6.0 TYPE TEST:

6.1 TESTING QUANTITY AND TESTING PLAN:

6.1.1 MINIMUM REQUIREMENT EN 13802 – In addition to the tests specified in this document, the following test as per EN 13802 must be also performed as given below:

Item	Defined	Testing
Operational environment requirement	4.2	5.2
Operating temp. range	4.2.2.1	5.2.2.1 (Table-2)
Temp. Extreme	4.2.2.2	5.2.2.2 (Table-3)
Vibrational exposure	4.2.4	5.2.4
Physical characteristic	4.3	5.3
Strength	4.3.1	5.3.1
Leakage	4.3.6	5.3.6 (Table-5)
Length and stroke	4.3.7	5.3.7
Overall dimensions and interface	4.3.8	5.3.8
Functional requirements	4.4	5.4
Orientation	4.4.1	5.4.1
Nominal force and nominal velocity	4.4.2	5.4.2
Max. Force and max. velocity	4.4.3	5.4.3
Force-Velocity characteristic	4.4.4	5.4.4 (Table-6)
Target values	4.4.4.2	5.4.4.2
Force – Displacement characteristic	4.4.5	5.4.5 (Table-7)

If something is not specified in this document, then values and description in EN 13802 are valid. Values of test parameters pertaining to different clause of EN 13802 are as follows:

6.1.2 CLAUSE NO. 4.4.2 NOMINAL VALUE AT NOMINAL VELOCITY:

Damper	Drawing	Fcn	Fen	Vn
Axle Damper	1209-01.215-014/1	9000+/-15%	9000+/-15%	0.3 m/s
Vertical Damper	1209-01.215-014/2	11000+/-15%	11000+/-15%	0.1 m/s
Horizontal Damper	1209-01.215-014/3	7000+/-15%	7000+/-15%	0.1 m/s
Yaw Damper	1209-01.215-014/4	3000+/-15%	3000+/-15%	0.01 m/s

6.1.3 CLAUSE NO. 4.4.3. VALUES AT MAX. TESTED VELOCITY:

Damper	Drawing	Fc max	Fe max	V max
Axle Damper	1209-01.215-014/1	9800+/-15%	9800+/-15%	0.5 m/s
Vertical Damper	1209-01.215-014/2	20000+/-15%	20000+/-15%	0.3 m/s
Horizontal Damper	1209-01.215-014/3	14000+/-15%	14000+/-15%	0.3 m/s
Yaw Damper	1209-01.215-014/4	18500+/-15%	18500+/-15%	0.2 m/s

6.1.4 Clause No. 5.2.2.1, the test velocity is nominal velocity as specified in clause no. 4.4.2.

6.1.5 Clause no. 5.2.2.2, the test velocity is nominal velocity as specified in clause no. 4.4.2.

6.1.6 Clause no. 5.3.6, the test velocity is nominal velocity as specified in clause no. 4.4.2.

6.1.7 Clause no. 5.4.4, the nominal velocity and nominal forces as specified in clause no. 4.4.2. The tolerance is +/- 15%.

6.1.8 The characteristics test is to be performed as mentioned in the table below:

Damper	Drawing	0.01 m/s	0.02 m/s	0.05 m/s	0.1 m/s	0.2 m/s	0.3 m/s	0.5 m/s
Axle Damper	1209-01. 215-014/1	---	---	2500 +/-15%	5000 +/-15%	---	9000 +/-15%	9800 +/-15%
Vertical Damper	1209-01. 215-014/2	---	---	5500 +/-15%	11000 +/-15%	---	20000 +/-15%	---
Horizontal Damper	1209-01. 215-014/3	---	---	4800 +/15%	7000 +/-15%	---	14000 +/-15%	---
Yaw Damper	1209-01. 215-014/4	3000 +/-15%	5800 +/-15%	12800 +/-15%	15360 +/-15%	18500 +/-15%	---	---

6.1.9 Clause no. 5.4.5, values specified in table under clause no. 6.1.8 to be followed.

6.2 Tests specified in below will be made for 2 dampers according table below.

Damper number	EN 13802 tests	Performance test	Endurance test	Performance test
1	√	√	√	√
2	√	√	√	√

Note: '√' indicates test to be conducted.

Performance test must be made at the beginning, between tests and after all tests are completed. Damping values between first test and last test may not change more than 15%/-25%. No visible leakage is allowed.

6.2.1 PERFORMANCE TEST:

Damper is mounted to computer controlled servo hydraulic test machine. Damper is tested as complete damper (with or without rubber bushings) in vertical position or according to the real position in bogie. Damper must be tested in nominal velocity (specified in drawing) and one higher velocity. Stroke to be kept as mentioned in the table below.

Damper	Drawing	Test Stroke
Axle Damper	1209-01.215-014/1	+/-15 mm (30 mm)
Vertical Damper	1209-01.215-014/2	+/-25 mm (50 mm)
Horizontal Damper	1209-01.215-014/3	+/-25 mm (50 mm)
Yaw Damper	1209-01.215-014/4	+/-12.5 mm (25 mm)

Four cycles are performed and datas from the fourth cycle is recorded.

6.2.2 ENDURANCE TESTING OF HYDRAULIC DAMPERS:

Endurance Testing of Hydraulic Damper shall be done during the initial approval of a supplier as RDSO approved source for supply of Hydraulic Dampers to Railways/ PUs, or when a new design is introduced or when there is any significant design alteration.
Endurance Testing of Hydraulic Dampers shall be undertaken as per the "Endurance Testing Procedure" enclosed in the **Annexure-II.**

6.2.3 SALT SPRAY TEST:

Surface treatment must have durability against minimum 240 hours salt spray test (ISO 9227). Result of test, against rusting according to ISO 4626-3 must be Ri 1 Adhesion of paint according to ISO 2409 is 0 until 1 (any squares may not come off).

7.0 SAMPLING FOR ROUTINE TEST BY EXTERNAL AGENCY SAMPLING FOR ROUTINE TEST BY EXTERNAL AGENCY (AS PER CLW DRAWING):

Routine test will be carried out as per CLW Drawing No. and sampling for routine test will be as below:

Dimensional check as per drawing : 10 Nos. from every Batch of 100 no. or 5 nos. per batch of 50 or less.

Physical testing : 5 per Batch of 100 nos. or 3 nos. per batch of 50 nos. or less.

Selected dampers must be tested with nominal velocity and max. tested velocity (max. velocity specified in 6.1.3).

8.0 MANUFACTURING AND TEST RESULTS:

Each produced damper is tested with the velocities (nominal and max. tested velocity which is specified in 6.1.3). The manufacturer shall submit internal test results in support of various performance characteristics. The Hydraulic Damper shall be manufactured, assembled and tested at the manufacturer's own works.

9.0 DELIVERABLES:

Manufacturer shall supply maintenance/instruction manuals, indicating dimension of critical items and its permissible wear, specification, quantity of oil, sectional features etc. to the user Railways.

10.0 MARKING:

Marking shall be done as specified in EN13802.

11.0 PACKING:

The manufacturer shall ensure that Hydraulic Dampers are suitably packed in polyethylene covers using suitable cartons to prevent ingress of foreign matter and damage during handling and storage.

12.0 GUARNATEE:

12.1 The manufacturer/ supplier shall have guarantee for dampers and its satisfactory performance for the period of five (5) years from putting into service or six (6) years from the installation whichever is earlier. All aspects of workmanship and material will be covered with this guarantee. The dampers which fail during the guarantee period shall be replaced by the supplier free of cost.

12.2 The manufacturer shall nominate expected minimum reliability in terms of operating hours or distance travelled between failures. The reduction or increase of the damping force by more than 30% will be considered as a failure.

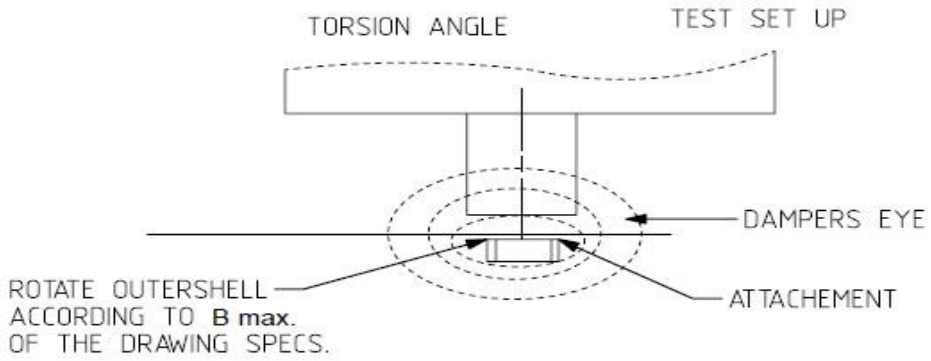
12.3 'Reliability' is defined as the mean kilometers between serious engineering faults. Such as engineering fault occurs when a defect of an engineering nature develops which is of sufficient importance to require the locomotive to be repaired before return to revenue service.

ANNEXURE-I

METHOD FOR CONDUCTING TORSIONALAND CARDANIC STIFFNESS:

- A test set up is to be arranged as per figure 1 & 2.
- Clamp the attachment trunnion or bolt through holes in trunnion.
- In total apply 3 load cycles in one rotation direction. Rotate the inner part related to the outer shell starting at no preload up to the required angle.
- Test velocity approx. 60^0/min. for maximum angles see specification drawing.
- Apply the first cycle and record the maximum angles as specified on the drawing as characteristic in a form of curve.
- Apply two preload cycles and record the characteristic in a form of Torque (Nm) and Rotation (^{0}) curve during the 3rd cycle.
- Plot the graph of the first measurement of the Torques versus the Torsional and Cardanic angle and determine the Torque at maximum angle. Compare with maximum allowed Torques (in Nm).
- Plot the graph of the second measurement of the Torque versus the Torsional and Cardanic Angles and determine the Torque according to the method prescribed in fig. 1 & 2. Compare with maximum allowed torques (in Nm/^{0}).
- Press the attachment out of the calibrated eye and record the force.
- Max. torque on attachment a) Axle damper : 225Nm, b) Vertical damper : 225Nm, c) Horizontal damper : 225 Nm, d) Yaw damper : 300 Nm.

FIGURE 1



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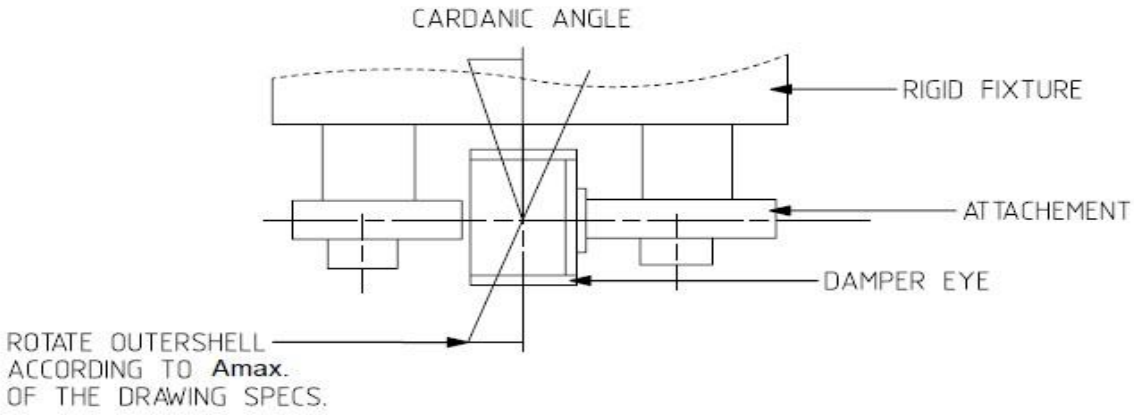

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FIGURE 2

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ANNEXURE-II

ENDURANCE TESTING PROCEDURE FOR HYDRAULIC DAMPERS OF WAP-7ELECTRIC LOCOMOTIVES

After ascertaining the damping characteristics and strength test, the hydraulic damper samples to be tested shall be subjected to endurance testing as follows:

PROCEDURE:

Two samples that have passed the tests under Para 6.0 to 6.1.9 shall be randomly selected for endurance testing.

The hydraulic dampers shall be tested in their normal plane of operation. The hydraulic damper shall be connected to the testing machine with its flexible end mountings in the same manner as it is done on the locomotives. No additional flexible elements shall be used for this purpose. However, in the case of hydraulic dampers where such installation is not possible, flexible elements suitable for installing the hydraulic damper on testing machine (having characteristics identical to that of flexible element provided on the hydraulic damper), shall be allowed to be used provided prior approval of RDSO has been obtained for this purpose.

The damper shall undergo a life/ wear test at least 50,00,000 cycles as per the table given below:

Cycle	Frequency(Hz)	Amplitude(mm)	Peak Velocity(m/s)
1	2	35	0.11
2	10.0	2	0.126

Peak Velocity (Sum) (m/s)	RMS Velocity (Sum) (m/s)	Run Time (Hours) Approx.	Strokes
0.236	0.118	116	50,00,000

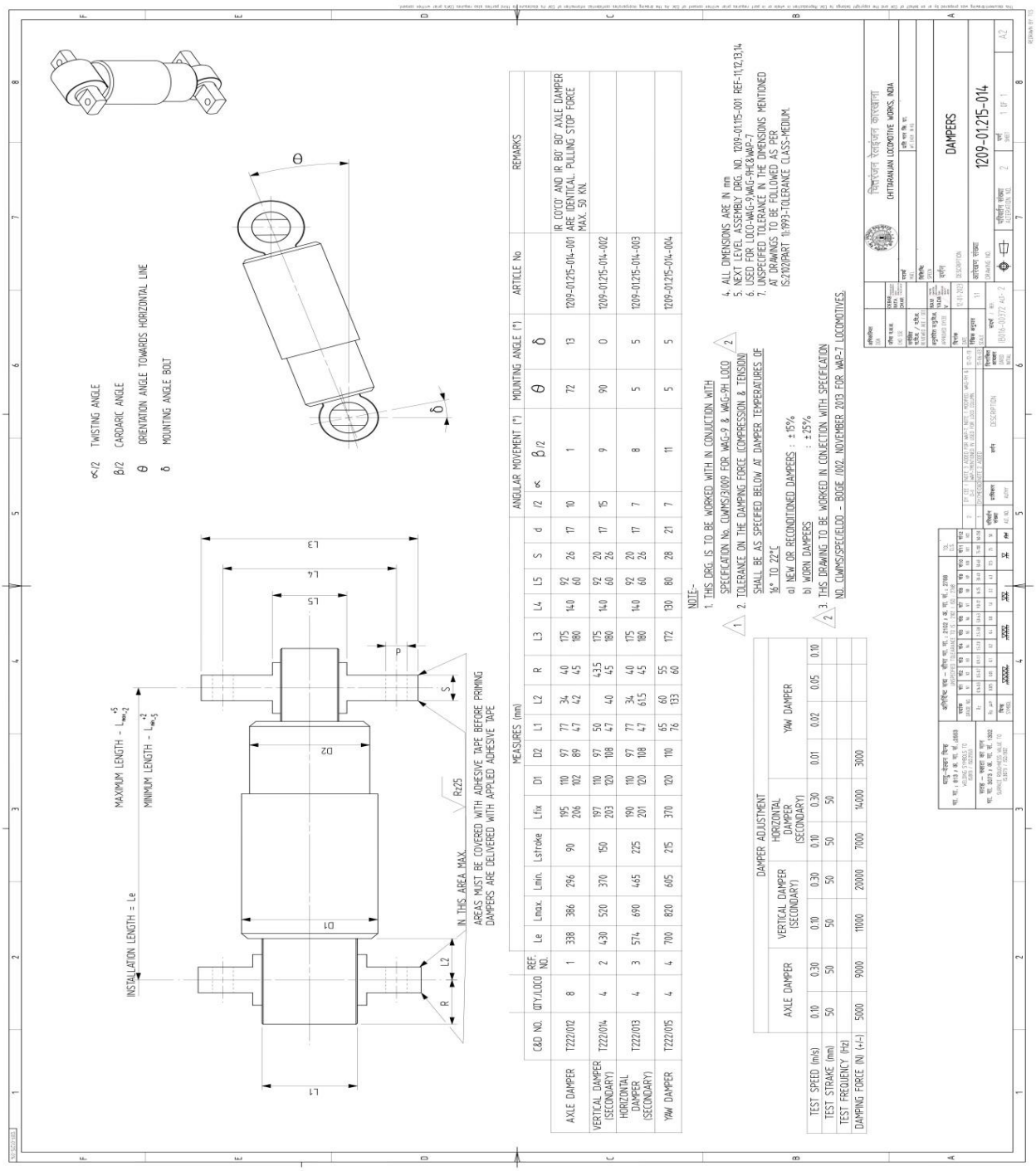
After completion, the hydraulic damper shall be removed from endurance testing machine and re- tested for overall damping characteristics as mentioned above after it cools to room temperature so that the damping characteristics test is carried out with the hydraulic damper at a temperature between 27^0C to 33^0C inclusive.

After the endurance test, damper should fulfill the following requirement:

- No visible leakage.
- No cracks in welding.
- Verification of the damping performance a decay of +15%/ -25% is allowed.

The cyclic working on endurance testing machine shall preferably be continuous except for circumstances are beyond the control of testing agency e.g. power failures etc.

DRAWING No. 1209-01.215-014 Alt. 2 **ANNEXURE-III**



C&D NO.	QTY./LOCO	REF. NO.	Le	Lmax.	Lmin.	Lstroke	Lfix	D1	D2	L1	L2	R	L3	L4	L5	S	d	∝/2	β/2	θ	δ	REMARKS
AXLE DAMPER T222/012	8	1	338	386	296	90	195 206	110 102	97 89	77 47	34 42	40 45	175 180	140	92 60	26	17	10	1	72	13	IR CO'CO' AND IR BO' BO' AXLE DAMPER ARE IDENTICAL. PULLING STOP FORCE MAX. 50 KN. 1209-01215-014-001
VERTICAL DAMPER (SECONDARY) T222/014	4	2	430	520	370	150	197 203	110 120	97 108	50 47	40	43.5 45	175 180	140	92 60	20 26	17	15	9	90	0	1209-01215-014-002
HORIZONTAL DAMPER (SECONDARY) T222/013	4	3	574	690	465	225	190 201	110 120	97 108	77 47	34 61.5	40 45	175 180	140	92 60	20 26	17	7	8	5	5	1209-01215-014-003
YAW DAMPER T222/015	4	4	700	820	605	215	370	120	110	65 76	60 133	55 60	172	130	80	28	21	7	11	5	5	1209-01215-014-004

DAMPER ADJUSTMENT	AXLE DAMPER	VERTICAL DAMPER (SECONDARY)	HORIZONTAL DAMPER (SECONDARY)	YAW DAMPER		
TEST SPEED (m/s)	0.10	0.30	0.10	0.30	0.10	0.30	0.01	0.02	0.05	0.10
TEST STRAKE (mm)	50	50	50	50	50	50				
TEST FREQUENCY (Hz)										
DAMPING FORCE (N) (+/-)	5000	9000	11000	20000	7000	14000	3000			

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