

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**



**TECHNICAL SPECIFICATION FOR
1745 LPM OIL LUBRICATED COMPRESSOR
FOR
ELECTRIC LOCOMOTIVES**

Specification No: RDSO/2018/EL/SPEC/0137, Rev. '0'1

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1.0 Scope

- 1.1 This specification is for 1745 lpm oil lubricated main compressor for Electric locomotive for 25kv AC 50Hz system.
- 1.2 The inlet air for the compressor shall be filtered air at ambient temperature available in the machine room of the electric locomotives for onboard arrangement and shall be unfiltered in under slung mounting arrangement for electric locomotives.
- 1.3 The tenderers/ suppliers are required to familiarize themselves with the layout of the equipment of the locomotives, including the pneumatic circuit and pipe layout. Adequate clearance from adjacent equipments of the locomotives shall be maintained for maintenance purposes.

2.0 Climate and environment conditions.

Maximum atmospheric temperature : under sun : 70 °C
: In shed : 50 °C

Humidity : 100% saturation during. rainy season

Locomotive and equipment will be designed to work in coastal areas (humid and salt laden atmosphere) and in desert areas (externally dust atmosphere):

3.0 STANDARDS:

In preparing this specification, assistance has been drawn from the following specifications.

3.1 The following publications are applicable to the equipment in general: -

S. No.	Specification No.	Description
1.	IS 5456 : 2006 (Reaffirmed 2016)	Code of practice for Testing of Positive Displacement Type Air Compressors and Exhausters.
2.	IS10431 : 1994 Reaffirmed 2008 2018	Measurement of air flow of Compressors and Exhausters by Nozzles
3.	ISO 1217: 2009 or latest	Displacement compressors-Acceptance tests
4.	CLW's Spec.No. CLW/ES/3/0100 Alt 'E'	Main compressor including motor for WAG-9 (COCO) Electric locomotives

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5.	RDSO's Specification No. E-10/3/09 Motor Part-II. August 1997 with Amendment 1,2,3 & 4 or latest.	Technical specification and test schedule for single phase/three phase induction Motors for driving blowers, Compressors and pumps for three phase drive electric locomotives
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3.2 Latest version/revision of the standards and specifications etc shall be followed, unless specifically mentioned otherwise.

4. Technical data:

4.1 Compressor

Number of compressor per loco – Two

Drive : AC electric 3-phase motor, Totally Enclosed Surface Cooled(TESC)/Totally Enclosed Fan Cooled (TEFC).

Mounting : Mounting at three points.

Free Air Delivery : 1745 LPM \pm 5 % as per IS 5456 : 2006 (Reaffirmed 2016) or higher.

Delivery pressure : 10 bar (10.2 kg/cm²) nominal

Compressor motor speed (rpm): Not more than 1500rpm

Voltage (V) : 415 \pm 10%, 50 Hz AC nominal

Power(kW) : Not more than 18 Kw

Volumetric efficiency (%) : 70 minimum

4.2 DESIGN FEATURES

4.2.1 The equipment offered shall preferably be :

- Simple in design
- Good workmanship
- Easy for maintenance and operation
- Robust and rugged in construction, suitable for traction duty application.

4.2.2 Inter Cooling and after Cooling of air shall be provided with the compressor so as to limit the final delivery air temperature which shall not be more than 23 °C above ambient when working at a pressure of 10.2 kg/cm².(To be measured during Mechanical tests as per clause 7.3.1)

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4.2.3 Flexible pipe for use on the delivery side should be of Reinforced Rubber Hose to SAE 100 R1/R2 standard shall be capable of withstanding the delivery of hot air temperature.

5.0 DRIVE:

5.1 The motor shall be as per the RDSO specification no. E-10/3/09 (Motor) with latest amendments for 3 phase induction motors for driving auxiliary machines of Electric Locomotives. Motors used to drive Compressor shall be of make and type approved by RDSO. Class of protection for motor compressor set should be IP 55 and for Terminal Box it should be IP 65.

5.2 The drive to the compressor shall be either direct or through a suitable flexible coupling.

5.3 Flexible coupling shall be selected to suit the arduous duty encountered in normal service without the necessity of renewing any wearing part. It shall be of simple design and shall require minimum attention during operation. It shall be possible to replace the wearing components of the coupling in situ without disturbing the machine alignment.

5.4 The tolerance of angular, radial and axial alignments of the coupling of compressor and motor for which unit should be capable of withstanding, shall be submitted to RDSO and their approval to be obtained.

5.5 The coupling shall be required to withstand shocks due to frequent starting, stopping and variation of load on compressor motor set. Manufacturer shall advise technical details including breakaway torque of the coupling.

6.0 Lubrication for main compressor:

Compressor oil : Lubricants is to be used as per RDSO technical circular no. RDSO/2006/EL/TC/0034 (Rev.'4') dtd.21-7-2008 or latest.

7.0 Test

7.1 Test condition:-

All measurements are made using 50 Hz sinusoidal 415 ± 10% voltage for AC electric motors during type test. Supplier shall submit the test protocol and get its approval from RDSO before commencing the tests.

7.2 Type test for motor : The motor should be from RDSO/CLW approved sources conforming to RDSO's Specification No. E-10/3/09 Motor with Amendment 1,2,3 & 4 or latest.. In case sources of motor are not approved

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by RDSO/CLW then it should be comply with RDSO spec and type test shall be carried out by RDSO.

7.3 Type test for compressor –

The type tests shall constitute the following tests and measurements.

- Mechanical tests - Clause 7.3.1
- Capacity (output) measurements test - Clause 7.3.2
- Starting tests - Clause 7.3.3
- 400 hrs. Endurance test - Clause 7.3.4
- Tests at higher environmental temperature - Clause 7.3.5
- Tilted Condition Test - Clause 7.3.6
- Weight measurement - Clause 7.3.7

7.3.1 MECHANICAL TESTS

The mechanical tests are intended to ascertain the reliability of the machine and its accessories. Prior to the starting of this test, essential working parts of compressor and its accessories shall be checked for accuracy with the manufacturer's drawings. All mechanical parts shall also be checked for proper functioning when assembled, in operation and after the test.

The duration of the separate stages of type tests shall be as given in the table below:

Tests	Duration
Running of compressor on discharge pressure of	
i) 8 kg/cm ²	5 Hours
ii) 9 kg/cm ²	7 Hours
iii) 10.2 kg/cm ²	10 Hours

The power supply shall be from a source of 415 V, 3 phase at 50 Hz. During these tests line voltage, phase currents, power input, frequency and time to attain to full speed shall be measured. Following measurements shall be made during the mechanical tests at intervals of one hour:

- (i) Delivery pressure
- (ii) Ambient temperature.
- (iii) Air filter inlet temp, Deg C
- (iv) Speed (rpm).
- (v) LP and HP cylinder head Temp, Deg C

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- (vi) Crankcase Temp, Deg C
- (vii) Intercooler and After cooler inlet & outlet temperatures.
- (viii) LP inlet & out let air temperatures.
- (ix) HP inlet & outlet air temperatures.
- (x) Final Delivery air temperature.
- (xi) Temperature of cylinder heads (L.P & H.P) & Valve caps, where fitted.
- (xii) Motor body temperature

7.3.2 CAPACITY (OUTPUT) MEASUREMENTS

During the above tests arrangement shall be made to measure Free Air Delivery (FAD) when the compressor is working against pressure of 8 kg/cm², 9 kg/cm² & 10.2 kg/cm². After all parts have attained the maximum temperature, FAD should not be less than 1745 LPM ($\pm 5\%$ as per IS 5456 or latest).

Measurements of FAD shall be done when the unit is operating at rated pressure of 10.2 kg/cm² and when the motor is supplied with 373 volt at 50 Hz. The method of test and measurement shall be recorded. Free Air Delivery (FAD) shall be recorded and Volumetric Efficiency shall be calculated.

Note: At frequent intervals during the testing of the compressor, listen carefully in the vicinity of each roller bearing, if there is any excessive noise then the compressor must be stopped.

Following measurements shall be made during the capacity tests at intervals of one hour:

- (i) Ambient Dry bulb and wet bulb temperature.
- (ii) Barometric pressure
- (iii) Air filter inlet temp, Deg C
- (iv) Air inlet pressure in mm of H₂O
- (v) Air discharge pressure in kg/cm²
- (vi) Condensate flow rate in Kg/Hr
- (vii) Nozzle inlet pressure in mm of H₂O
- (viii) Nozzle out let pressure in mm of H₂O
- (ix) Temperature .Before Nozzle in Deg. C
- (x) Speed (rpm).
- (xi) Voltage ,Volts
- (xii) Current
- (xiii) Power input to motor (kW)
- (xiv) Free Air Delivery (lpm)
- (xv) Volumetric Efficiency (%)
- (xvi) Specific power consumption, kW/m³/hr

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(xvii) After cooler delivery temperature, Deg. C

7.3.3 STARTING TESTS (COMBINED UNIT TEST)

Starting test is to be carried immediately after completion of the tests under clause 7.3.2 at delivery pressure of 10.2 kg/cm². The compressor motor unit shall be run as follows.

- 10 minutes under 90% rated voltage.
1 minute stop
- 5 minutes under 110% rated voltage
1 minute stop
- 10 minutes under 90% rated voltage
1 minute stop
- 10 minutes under 110% rated voltage
1 minute stop
- 10 minutes under 90% rated voltage

7.3.4 ENDURANCE TESTS

Endurance test is a continuous test and shall be carried out by running the compressor with compressor delivery pressure at 10.2 kg/cm² running at rated speed. The test shall be of 400 hours duration. Following measurements shall be made during the endurance tests at intervals of one hour:

- (i) Delivery Pressure
- (ii) Ambient temperature.
- (iii) Suction air temperature.
- (iv) Speed (rpm).
- (v) Inter cooler pressure
- (vi) Intercooler and After cooler inlet & outlet temperatures.
- (vii) LP inlet & out let air temperatures.
- (viii) HP inlet & outlet air temperatures.
- (ix) Temperature of cylinder heads (L.P & H.P) & Valve caps, where fitted.
- (x) Temperature of crank case.
- (xi) Motor body temperature
- (xii) Voltage ,current, Power & Frequency (Hz)

7.3.4.1 Before and after completion of the endurance tests, the compressor shall be opened and dimensions of all wearing parts shall be recorded.

7.3.4.2 Before and after Endurance test, Free Air Delivery (FAD) test shall be done.

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7.3.4.3 Before and after completion of the endurance tests, the oil filled and oil extracted shall be measured and oil consumption in ml per hour shall be calculated.

7.3.4.4 During endurance test of 400 hrs, the compressor shall be run at 10% over load of 10.2 kg/cm² for 10% of the time distributed over the entire run of the test in period of every 8 hrs.

7.3.5 TESTS AT HIGHER ENVIRONMENTAL TEMPERATURE

A test run of 48 hours shall be conducted at inlet temperature of 60°C. The compressor shall run at 10.2 kg/cm² pressure for 8.00 hours and will be stopped for half an hour for cooling under prevailing atmospheric conditions. Six such cycles shall be performed. During these tests measurements as for endurance tests (7.3.4) shall be made.

7.3.6 RUN IN TILTED POSITION TEST:

With the oil filled up to the minimum level of oil sump, the unit shall be mounted on a platform of 1 in 20 inclination with the compressor raised. The platform shall also have a side tilt of 1 in 10. The compressor shall be worked at the rated capacity and 10 kg/cm² pressure for 12 hours in this position. At the end of the test, the parts shall be examined for any starvation of oil etc.

7.3.7 WEIGHT:

The weight of the complete set of compressor and Motor shall be taken.

8.0 ROUTINE TESTS:

These tests shall be carried out on all the compressors before acceptance by the purchaser. The supplier shall also supply a copy of the internal test report with every machine. Following tests shall be conducted.

8.1 Compressor shall be run at maximum rated speed at 10.2 kg/cm² pressure for two hours to check the general mechanical and electrical condition with 415 V supply at 50 Hz. The discharge air temperature shall be recorded at half an hour's interval.

FAD of the compressors at the rated maximum speed and 10.2 kg/cm² delivery pressure shall be recorded. This shall be done in one compressor unit in a batch of fifteen.

8.2 At least 10% of the total lot of compressor on order, selected at random, shall be subjected to a run of 48 hours with 30 minutes shut off at 8 hours interval, at the maximum rated speed and 10.2 kg/cm² pressure.

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9.0 Volumetric efficiency test:

Run the compressor at its rated voltage. Measure and record speed, current, barometric pressure and air delivery flow.

The displacement and volumetric efficiency shall be calculated taking into account the barometric pressure.

10.0 GENERAL CONDITIONS FOR INSPECTION & TESTS

- 10.1 The manufacturer shall arrange all tests at places where facilities are available in consultation with RDSO. RDSO official will inspect all type tests required for approval of prototype.
- 10.2 RDSO or their representative shall have access for stage inspection, to those portions of the manufacturer's works in which production is being carried out and where the testing is taking place. This also applies to the items procured from Sub Contractors by the manufacturers/suppliers.
- 10.3 The inspecting officer shall have the authority to exercise suitable check to ensure proper materials and parts specified are actually used during the manufacturing of the unit.
- 10.4 The supplier / manufacturer shall provide free of charge the labour or appliances required by the inspecting officer for inspection and testing of the whole unit and its components, or any additional tests if required.
- 10.5 If any part of the compressor unit requires alteration or any defect appears during the tests or trials, the supplier shall without any extra charge, make such alterations or rectify the defects to the satisfaction of the purchaser / engineer/RDSO officials.
- 10.6 Any modification or alteration to the components during the supply of the order shall be made only after the approval of RDSO. The unit after such modifications / alterations shall be subjected to such tests and field trials as considered necessary by the RDSO.
- 10.7 **The equipment shall withstand satisfactorily the vibration and shock normally encountered in service as per IEC 61373 Category-1 Class - A and FEA analysis.**

11.0 MAINTENANCE MANUALS

- 11.1 The supplier/manufacturer shall supply copies of exhaustive, fully illustrated maintenance manuals covering among other items, the following vital details, to the "Purchaser". The maintenance periodicity of unit should

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match with specified maintenance schedules periodicity of electric locomotives.

- Description and arrangement.
- Technical data.
- Dismantling and assembly instructions.
- Commissioning instructions
- Particulars of recommended lubricants.
- Periodical inspection schedules.
- Periodical maintenance instructions along with trouble shooting instructions.
- Testing procedure for the equipment and other auxiliaries like oil pump etc, if applicable.
- Wear limits for vital components.
- Detailed parts catalogue with description of items. The parts shall be detailed by sketches to facilitate ordering.
- Instructions for reclamation of worn out components.
- List of special tools with instruction for use.
- List of all the components with their average life.
- Preventive maintenance procedure and overhauling kits with list of equipments and man-hours required for various activities.
- Average life of overall equipment

11.2 Two copies of the above Maintenance Manual shall be supplied to RDSO.

11.3 One copy of the manual shall be supplied with every 10 compressor sets or a part thereof to the purchaser.

12.0 TRAINING:

The supplier shall provide facilities for free training to the Railway maintenance staff at their works on aspects of maintenance, overhaul and testing of the equipment as and when necessary.

13.0 SPECIAL CONDITIONS:

13.1 At the time of approval of the prototype unit the manufacturer / supplier shall furnish the list of names and addresses of their vendors/Sub supplier of the main items of the equipment and important raw materials which they have used in the prototype unit and shall not make any change in the sources of supply without prior approval of RDSO. For example sources of supply for motors, couplings, bearings, insulating varnishes, lubricating oil, enameled wires etc.

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- 13.2 **Field Trial:** After successful completion of the type test the compressor shall be subjected to extended field trial for a period of six months before according the prototype approval. type testing of prototype, the oil lubricated compressors will be put to field trial. The field trial shall be carried out for quantity and period as per extant ISO guide line. The performance format is included in Annexure. Prototype approval will be provided after such successful field trials.

14.0 MOUNTING AND LIFTING ARRANGEMENTS :

- 14.1 Three point mounting arrangement is required with proven damping design preferably of metallic helical coil type in under slung condition and four point mounting arrangement with proven damping design in onboard condition. The mounts shall be suitable for absorbing the vibration generated on the compressor and motor size.
- 14.2 The compressor and its mounting arrangement shall be of robust design for traction duty and shall withstand satisfactorily the vibration and shocks normally encountered in service. Mounting arrangement of the compressor motor set shall be suitable for mounting in the existing electric locomotives.
- 14.3 The supplier has to ensure that the height of the lowest part of the compressor motor unit after mounting on the locomotive under frame should not be less than 176 mm above rail level for new wheel conditions.
- 14.4 The compressor unit to be fitted in existing footprint with interchangeability. Unit should not infringe with adjacent equipment of locomotive and have adequate clearance from rolling stock.
- 14.5 Adequate numbers of lifting hooks shall be provided to facilitate lifting of the compressor motor set.
- 14.6 The compressor shall also be provided with suitable safety slings to prevent it from falling down in case of failure/ breakage of the under slung mounting arrangement as per RDSO SMI No. RDSO/2006/EL/SMI /0242, Rev '1' 2 dated 03.05.2016 31.12.2018 or latest.
- 14.7 The overall dimensions for mounting in Electric locomotives shall be preferably fall within the limits of
- Length = 1475 mm
- Width = 955 mm
- Height = 836 mm

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15.0 Consistency test: Consistency tests shall generally cover those tests which provide valuable information on the reasons of failures and/or can establish the efficacy of the design changes. The periodicity and scope of such a test shall be decided by RDSO. In case compressor-motor sets are running successfully then Consistency test shall be conducted at 5 years intervals.

16.0 ISO CERTIFICATION:

Indian Railways reserves the right to procure the item from ISO certified manufacturers only.

17.0 HARDWARE:

Hardware like high tensile fasteners, spring washer etc shall be from RDSO's or CLW's approved sources. Prior approval shall be taken from RDSO or CLW, if other makes are proposed to be used.

18.0 FINISH:

The compressor motor set shall be suitably treated to remove rust and should be coated with antirust primer and finished with two coats of paint as per IS 5:2007 or latest.

Compressor cylinders are required to be painted by special heat resisting enameled paint formulated on a modified silicon resin to withstand temperature up to 350° C.

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Annexure

S.No.	Model Name & Serial No.	Date of Commissioning	Date of Failure	Details of failures	Action taken	Remarks if any
1						
2						
...						
...						
...						

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