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**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

एल्को टाइप डीजल इलेक्ट्रिक लोकोमोटिव पर लगे हुए वायु कम्प्रेसर/संपीडक की तकनीकी आवश्यकतायें एवं परीक्षण विशिष्टि (संवृद्धि विश्वशनीयता एवं एम-३६शिड्यूल)

**Technical Requirement and Test Specification of Air Compressor
(Enhanced Reliability and M-36 Schedule) used
on ALCO type diesel – electric locomotives**

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LIST OF AMENDMENTS

Amendment Date	Version	Revised Para	Remarks
March 2021	3	Spec title name edited	Changed to M-36 from M-24 because of change of maintenance schedule (Annex-ii)
		Para 1.4	Deletion of Para due to not relevant in the specification.
		Para 2.1.4, 2.1.6, 2.1.7, 7.1.5, 8.0 (S.No.6), 10.2.3.13, 10.2.11 and 10.5.3.11	Revision of Para's to incorporate Equivalent Indian Standards in compliance of MOM of the VC meeting on Specification/ STRs held on 29.08.2020
		Para 3.2.5,	DLW name edited to BLW as Diesel Locomotive Works changed to Banaras Locomotive Works.
		Para 7.3.1, 7.3.4, 7.3.5, 7.3.7 and Annexure-II	Revision of Para's in compliance to latest MP-Misc-141(schedule of standard examinations of ALCO Loco)
		Paras 8.6 sr.n0.6, Para 2.1.6, Para 10.2.11 and Paras 10..5.3.11	There was typographical error in quality class of compressed air as 4-4 instead of 4-3-4. Issue year of ISO specification amended as 2010 in place of 2001.Those corrections made and rearranged the write up where necessary.
		Para 10.1.4.1.1	Field trial Quantity & field trial period are defined as per MP-M-8.1-1 (Latest) & Field trial performance feedback format added in compliance of MOM of the VC meeting on Specification/ STRs held on 29.08.2020.
		Para 10.1.4.2	The requirement is already covered in RDSO ISO procedure available on website.
		Para 20	Addition of Para as per ISO document no- QM-RF-8.1.3 (latest)
		Para 21	Addition of Para no. 21 (Preference to Make In India) in compliance of directives issued by GOI for promotion of Make in India policy.
		Para 22	Addition of Para no. 22 (Vendor Changes in Approved Status) in compliance to Vigilance cell note no. 13/Vig/Policy dated 08.09.2016.
		Para 23	Addition of Para no. 23, date of enforcement as per Vigilance cell note no. 14/Vig/08/CT/46 dated 14.10.2015.

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1.0 Scope

- 1.1 This specification covers the general design features, standard technical requirements, schedule of testing & inspection of reciprocating type air compressors for use on main line ALCO type diesel electric locomotives used on the Indian Railways equipped with air brake system.
- 1.2 This specification also stipulates reliability growth, reliability verification, quality assurance and quality acceptance tests for air-cooled air compressor of ALCO type air brake locomotives.
- 1.2 This specification has been prepared for the guidance of locomotive production units and Zonal Railways in procurement of air compressor for ALCO type diesel-electric locomotives. This is a general test technical specification and does not cover all the necessary provisions of contract.
- 1.3 This is new specification, which takes into account the changes in compressor technology and experience of Indian Railway with earlier designs of expressor and compressor.

2.0 References

- 2.1 In preparing this specification, references have been taken from following specification and manuals.
 - 2.1.1 **I. S. 10431 - 1994** (Reaffirmed 1999) - Measurement of airflow
 - 2.1.2 **I.S. 5727 - 1981** (Reaffirmed 2001) - Glossary of terms relating to compressors
 - 2.1.3 **I.S. 5456 -2006** - Code for practice for testing of positive displacements type air compressor and exhausters.
 - 2.1.4 **EDPS-164** or Equivalent Indian Standards - General Motor Electromotive division's engineering design and performance specification for reciprocating air compressors and air compressors – exhausters (First issued date 12/23/70).
 - 2.1.5 RDSO specification no. MP.0.0700.10, (Revised April 1995) - Specification of air compressor for diesel electric locomotive
 - 2.1.6 **ISO-8573- 2010 (E)** or Equivalent Indian Standards – Compressed air for general use.
 - 2.1.7 **I.E.C. – 61373 –1991-01** or Equivalent Indian Standards - Railway applications – Shocks and Vibration tests

3.0 Terminology

- 3.1 The terms and definition given in I.S.: 5727 – 1981 (Reaffirmed 2001) 'Glossary of terms relating to compressors and exhausters shall apply to this specification.
- 3.2 The other abbreviations/terms used in this specification are as under:
 - 3.2.1 **R.D. S.O**-Research, Designs, and Standards Organization, Manak Nagar, Lucknow - 226 011.
 - 3.2.2 **I.S.** - Indian Standards
 - 3.2.3 **I R** – Indian Railways
 - 3.2.4 **I SO** – International Organization for Standardization
 - 3.2.5 **BLW** –Benaras Locomotive Works Varanasi or their successors
 - 3.2.6 **FAD** – Free air delivery
 - 3.2.7 **M.R.**- Main Reservoir
- 3.3 Definitions of the different terms used in this specification are as under:

- 3.3.1 **Purchaser**–President of the Republic of India acting through General Manager BLW, DMW or Zonal Railways and Railway Board as the case may be.
- 3.3.2 **Inspecting Officer** – Person/persons nominated by the purchaser/IR for inspection and testing.
- 3.3.3 **Vendor** – The firms/group of individual who has been already involved in design, manufacturing and supply of air compressors for main line diesel, diesel–electric, electric locomotives and self propelled vehicles.

4.0 **Function**

- 4.1 The purpose of the air compressor is to compress the available air taken at atmospheric pressure to the pre-determined gauge pressure i.e 10.0 kg/cm² (approx. 140 PSI) and also to maintain the pressure of that compressed air between 8.0 & 10.0 kg/cm² in the main reservoirs of locomotive, to be used for train braking and auxiliary equipment.
- 4.2 Since the air compressor is to be driven by diesel engine of locomotive, it is not required to run continuously at constant speeds for pumping/delivering the compressed air to main reservoirs. Compressor is required to load the reservoirs from 8.0 to 10.0 kg/cm² (approx. 120 & 140 PSI) and unload from 10.0 & 8.0 kg/cm² irrespective of various notches of diesel engine.

5.0 **Description (Working principle)**

- 5.1 The air compressor shall be positive displacement, two stage, reciprocating type air cooled air compressor. The compressor shall have its own forced feed lubricating system having gear type or reciprocating type lube oil pump driven by crankshaft through gear train drive or plunger respectively.
- 5.2 The low- pressure cylinders are to be set at an angle (67°) to its vertical high-pressure cylinder. All the three pistons in respective cylinders are reciprocated through their individual connecting rods. The connecting rods are oscillated and reciprocating on a common crankshaft, which is directly driven by diesel engine of locomotive through a flexible coupling arrangement.
- 5.3 As compressor starts, air at atmospheric pressure is drawn through separate intake air filters, one for each LP cylinder through intake valves into low-pressure cylinders during downward stroke of the piston travel. OR The Compressor should have provision with a pre-filtered air supply from dry type pre filters. The suction air should / may be available through engine filtration system. As air is compressed on upward stroke due to pressure difference inside the cylinder and the atmosphere, inlet valve is closed and at the end of upward stroke, compressed air is forced through discharge valve into intercooler.
- 5.4 After passing through intercooler, compressed air is cooled and enters the high-pressure cylinder through intake valve and again compressed to predetermined level in high-pressure cylinder and comes out through discharge valve into after cooler. In the after cooler, compressed air is cooled so that the compressed air temperature should not exceed 28° C above ambient for storing the compressed air in the MR up to 10.0 kg/cm² (approx. 140 PSI).
- 5.5 When MR pressure reaches the pre- determined value of 10.0 kg/cm², the compressor magnet valve controls the suction air to unload the compressor cut out through

unloader assembly and holding intake valve open by further stopping the compression of atmospheric suction air.

- 5.6 When MR pressure falls below the predetermined value of 8.0 kg/cm² (approx. 120), the compressor magnet valve cuts out air from MR and closes the intake valve for normal loading of the compressor and storing of compressed air to MR between 8.0 (approx. 120) to 10.0 kg/cm² (approx. 140).
- 5.7 The inter cooler and after cooler contains fin tubes/plate type passages to remove heat from compressed air making the air more dense and improving its volumetric efficiency.

6.0 Design features

- 6.1 The air compressor shall be positive displacement, two stage, air cooled reciprocating W-type of compact and light weight design, yet it should be able to withstand the service conditions encountered in stationary and running condition of locomotives. The pressure ratio shall be approximately equal during first and second stage of compression of air.
- 6.2 The compressor shall be directly driven by the locomotive diesel engine and must be capable of being run satisfactorily over a speed range of 350 - 1250 rpm. The drive to compressor shall be given through fast coupling installed between the diesel engine and compressor crankshaft. Other end of crankshaft shall be accessible for connecting the driven shafts of other auxiliaries of locomotive through flexible coupling such as radiator fan drive, traction motor blower drive etc. The compressor shaft end shall be suitable to adopt the flexible coupling.
- 6.3 The design of the cylinders, cylinder heads, crankshaft, inter coolers and after coolers, piston and piston rings, valves, lubricating oil pump, bearings, connecting rod, filters, breather valves etc. shall be such as to ensure reliable and trouble free service between two complete overhauls.
- 6.4 Compressor inlet and delivery valve shall have liberal air flow passages to avoid airflow restrictions and to prevent excessive heating and choking of ports with carbon deposits due to thermal decomposition of lubricating oil. Each cylinder head will have 4 valves (two nos. of each suction and delivery).
- 6.5 Suitable crank case breather valve shall be provided to vent the extra air trapped in the compressor crankcase/ housing to vent the back pressure produced when piston is moved from top to bottom.
- 6.6 Protective hoods, safety guards and heat insulating laggings on hot pipe shall be provided to avoid human injuries during maintenance and operation of the compressor. Foundation bolts and cylinder head bolts shall not be used for securing the safety guards/protective hoods. The seamless pipes should be used instead of welded pipes for manifolds.
- 6.7 If aluminum alloy is used for threaded connections (in aluminum portion) for fastening of components, suitable helical steel inserts shall be used to avoid frequent wear and tear of thread.

- 6.8 Loose accessories like oil filler cap, dipstick etc. shall be attached to compressor crankcase through suitable chain. Crankcase cover should have a low level oil filling point from which no extra oil may be filled in crankcase above max. limit specified by the manufacture.
- 6.9 Intercooler and after cooler system and their circuitry shall have adequate thermal capacity with large heat dissipating area and shall be of robust design between the two pressure stages of compression. Inter cooler shall have built-in safety valve to prevent excessive pressure in the inter cooler, and drain plug to drain the condensate from time to time. The safety valve should lift at a static pressure of 3.5 kg/cm².
- 6.10 A proven compact design of cylinder, cylinder head and air pipe circuitry system shall be used to sustain the flow of adequate amount of cooling air at various speeds of locomotive engine. The cooling air received from fan shall cool the different components of the compressor (cylinders, heads, valves and valve plug, etc. where by compressed air passes).
- 6.11 A suitable and reliable in-built unloader shall be provided to load/unload the compressor as per cut-in / cutout pressure limits of 8.0 / 10.0 kg/cm² of main reservoir air pressure.
- 6.12 General arrangement of air compressor to be designed in such a way that it should remain in horizontal position and not in tilted position while lifting the whole assembly. Centre of gravity should pass through the center line of the crankshaft and HP cylinder head. Threaded lifting hole should also be provided at C.G of the compressor to ensure proper lifting.
- 6.13 Piston rings for both stages (LP and HP) cylinders of compressor should be 100% light tight, wear resistant with low oil carry over and long life features.
- 6.14 Air intake filter shall have fine filter element having corrosion resistant and shall avoid to suck disintegrated wire mesh particle in cylinder, and shall not require cleaning before 4 months of service.
- 6.15 The lubricating oil and lubrication system:
- 6.15.1 The crankcase shall have provision for easy cleaning/draining of lubricating oil. At least one drain plug in the bottom shall be provided to remove the ferrous particles from the lube oil.
- 6.15.2 Lubricating oil system- Forced feed lubrication system of reliable and proven design comprising of positive displacement type of lube oil pump shall be provided. The system shall have foolproof lube oil level (maximum, minimum & working) and pressure indicator & relief valve. The lubricating oil pressure should not be less than 2.2Kg/cm² at engine in idle (350rpm).
- 6.15.3 Oil level indicator shall have compact design so that lubricating oil level in the compressor sump is clearly and easily visible. There should be clear marking for minimum and maximum levels. The useable oil capacity of the sump should be minimum 10 litres. The compressor shall be so designed that lubricating oil consumption shall not exceed 2.5 ml/hour.
- 6.15.4 Lubricant must be premium quality of low detergent reciprocating compressor oil made from a well refined stable base oil to which oxidation and rust inhibitor and anti

additive is added. Recommended brand of lubricating oil is SAE-30 / IOC SERVO PRESS -150 RR or its equivalents.

- 6.16 A dynamically balanced, lightweight fan to provide large volume of cooling air at low velocity (to ensure minimum noise) to the inter cooler, cylinders, cylinders heads and after cooler. The direction of airflow shall be such that hot air from the diesel engine does not pass over the compressor.

7.0 Requirements

7.1 Common

- 7.1.1 The compressor must be capable of being driven by 16 cylinders, four- stroke diesel engine over a speed range of 350 – 1250 rpm and maximum service speed of 1050 rpm. It should also be suitable for 6 cylinder or 12 cylinder versions of ALCO design engine, with minimum modifications.

- 7.1.2 Duty cycle - The compressors are subjected to run for an average of 22 hours a day. The compressor must be able to give satisfactory performance at 100 % load of 10 kg/cm² (approx. 140 PSI).

- 7.1.3 Loading / unloading - The compressor will be loaded at 8.0±0.1 kg/cm² and will get unloaded at 10.0±0.1 kg/cm². The basic air compressor application provides a relief valve set at 10.5±0.1 Kg/cm² pressure in main reservoir of locomotive and compressor of loading system.

- 7.1.4 Operation in multiple locomotives

In multiple unit operation, when compressed air pressure reaches 10±0.1 kg/cm² in the reservoir, pressure switch is closed and current is passed through wire no. - 25 to magnet valve. Magnet valve is to be energised to unload the compressor. Current passing through wire no.-25 also energises magnet valve on trailing locomotive.

In multiple operation unit, when air pressure reach 8±0.1 kg/cm² pressure switch is opened and no current is passed through wire no. 25 to magnet valve. Magnet valve is de-energised to load the compressor. As no current in wire no.-25 de-energised the magnet valve of trailing loco to load the compressor of trailing locomotive.

- 7.1.5 Vibrations and shocks - The compressor shall be designed to withstand vibrations and shocks encountered in locomotive operation as per international specification IEC-61373, category- I class A or Equivalent Indian Standards.

- 7.1.6 Pouring point of lube oil should not be below the anticipated minimum crankcase temperature i.e. -5° C.

- 7.1.7 Maximum weight 865±10 Kg approx (including air suction filter)

- 7.1.8 Maximum space – The compressor (with filters) will be fit within a space as given in table-I.

TABLE-I

Space	Length along locomotive	Width across the locomotive	Height
Maximum envelop dimension for compressor arrangement	1207±0.5 mm (Shaft to shaft)	1420 ± 5 mm	1015 ± 5 mm

7.1.9 Overall dimension and mounting dimension should conform to RDSO drawing no. **SKDP-3872** placed at **annexure – I** of this specification.

7.2 **Environmental**

7.2.1 The compressor shall be capable of working satisfactorily under the service conditions indicated below.

Altitude - An altitude between 0 and 1000 meters above mean sea level.

Relative Humidity - Up to 100 % in rainy season.

Temperature (Ambient air) -5 to 80 deg C.

7.2.2 Ambient conditions - The compressor shall be capable of operating efficiently in spite of dust, dirt, mist, torrential rain, heavy sand or snow, storms, presence of oil vapours and radiant heat etc., to which rolling stock is normally exposed in service.

7.2.3 The ambient temperature around the compressor and inlet air temperature to the air filters can vary between -5° C and 70° C with a maximum of 80° C for approximately 9 minutes.

7.3 **Service**

7.3.1 Compressor crankcase should have adequate quality and quantity of lubricating oil and maintain its viscosity and spectrographic limits during running on adverse conditions. An oil level - indicating device should be provided to show low level of oil filling point clearly. Oil top up and refill period should be 180days (M6) and one year of operation respectively under duty cycle and environmental conditions as given in this specification.

7.3.2 **Oil filter** – An efficient oil filter / strainer is to be provided to assure the compressor life. Cleaning period of oil filter should be minimum one year of service.

7.3.3 Lubricating oil should conform to SAE-30 / IOC SERVO-150 RR approved as lubricant for this compressor.

7.3.4 Reconditioning of valves – The Compressor should be so designed with improved features that the cleaning of inlet and discharge valves of compressor shall be required only after 12 months. Valves shall not require changing before two years of service.

7.3.5 Overhauling period - Overhauling period of the complete compressor should be after three years of service. It means that the compressor should work satisfactorily in the field without failure/dismantling of any component except cleaning of compressor intake filters element, breather valve, valves & un-loader & oil change in 12 months.

7.3.6 Complete overhaul means removal of compressor from locomotive, disassembly of complete compressor, inspection and re-conditioning of wearing components and reassembly & testing of compressor on the test bed for orifice test.

7.3.7 Suction air filters – Cleaning of air suction filter should normally not be required before one year of service. It must be so designed that it can work with full efficiency minimum up to 06 months of service without cleaning or blow out.

7.4 Reliability Requirement:

- 7.4.1 Air compressor shall be designed for minimum two years reliability of 99.4 %. This assumes that constant failure rate of compressor may be allowed to 0.3 % per year within 24 months.
- 7.4.2 Above criteria shall imply for an understanding of minimum level of reliability of compressor. Therefore it is used to guide in choice of material, design of components and assembly of air compressor, quality control testing level, service life, endurance testing and maintainability.
- 7.4.3 A failure is defined as failed item/items for which it must be removed for its repair or replacement. This does not include item/items for normal servicing.
- 7.4.4 Failure Mode and effect analysis (FMEA) will be conducted for new design or major changes in existing design.
- 7.4.5 FMEA is to be identified for all possible failure modes of the components to determine the effect of those failure modes on locomotives and assign the possibilities of occurrence related to design and manufacturing based on past information in similar applications.
- 7.4.6 FMEA assures that the design is thoroughly analysed and failure modes are quantified before prototype production.

7.5 Maintenance Requirement

For healthy performance of compressor, major works will be carried out in different schedules as given in **Annexure – II**.

8.0 Performance Parameters:

Sr. No	Parameters	Performance values
1	Nominal displacement volume	8.694 litres per revolution
2	FAD at 10 kg/cm ² & Low idle speed 350 RPM Idle speed 400 RPM Rated full speed 1050 RPM	2130 LPM 2434 LPM 6390 LPM Tolerance admissible as per IS 5456: 2006
3	Power at 10 kg/cm ² & Low idle speed 350 RPM Idle speed 400 RPM Rated full speed 1050 RPM	23 HP 26 HP 69 HP Tolerance admissible as per IS 5456: 2006
4	Orifice test against 8.7 mm leak hole max Reservoir pressure (specified at MSL) Low idle speeds 350 RPM 400 RPM Rated full speed 1050 RPM	3.06 kg/cm ² Min. 3.5 kg/cm ² Min. 10.75 kg/cm ² Min.
5	Oil consumption, ml/hr	2.5 Max.
6	Oil carry over	3 PPM max. Note:- Quality of air should generally conform to class 4-3-4 of ISO 8573-1 2010(E) or Equivalent Indian Standards

9.0 Inspection and Testing

- 9.1 The objectives of these tests and inspection are to ascertain the reliability, performance potential and quality requirement of the complete compressor in respect to different category of tests.
- 9.2 Prototype testing shall also be in accordance with IS: 5456:2006 unless otherwise specified in this specification.
- 9.3 Whenever new design compressor is developed within mounting dimensions stated in RDSO Drg. No. **SK.DP-3872** as per **annexure-I**, one new unit shall be assembled/manufactured and subjected to series of prototype testing as reliability growth test (called prototype tests) to establish the 99.4 % reliability, performance and quality of the compressor.
- 9.4 Whenever a major change in same existing design of compressor is developed within mounting dimensions stated in RDSO Drg. No. **SK.DP-3872** as per **annexure -I**, one new unit shall be assembled/manufactured and subjected to series of prototype testing as reliability growth test (called prototype tests) to establish the 99.4 % reliability, performance and quality of the compressor.

10.0 Category of tests

- 10.1 **Preliminary Testing** -vendor shall carry out the following tests at locomotive operating conditions mentioned as given in this specification at his works under design development.
- 10.1.1 **Continuous Improvement** - The vendor should be engaged in a continuous test program designed to improve the reliability, performance, maintainability, and cost of this compressor and its wearing components/maintenance kit.
- 10.1.2 **Developmental testing** – The vendor shall develop test programs (subject to approval from RDSO) in order to meet the reliability goals of 99.4 % for the compressor. It is vendor's own responsibility to develop the test programs in consultation with RDSO and test the compressors at the locomotive conditions as given in this specification.
- 10.1.2.1 Minimum testing data to be collected by vendor and submitted to RDSO before the starting of proto-type testing of compressor by inspecting officer.
- 10.1.2.1.1 Displacement and FAD in LPM at both the speeds (350 and 1050 RPM).
- 10.1.2.1.2 Lube oil consumption, ml / hour.
- 10.1.2.1.3 Lube oil temperature in deg. C.
- 10.1.2.1.4 Inlet air temperatures at suction at LP & HP cylinders and intercooler and after cooler.
- 10.1.2.1.5 Outlet air temperatures at LP & HP cylinders and after cooler.
- 10.1.2.1.6 Power consumption at both the speeds for loaded and unloaded condition.
- 10.1.3 **Reliability Growth Testing (RGT)** – The purpose of RGT is to find out design flaws before a design reaches the purchaser. RGT should be carried out on compressor to stress their weak links in the operating conditions. Failures are expected in this test phase and corrections may be required in design to check the failures by supplier at their own end before starting the prototype test by inspecting officer.

- 10.1.3.1 For new compressor designs and major changes in existing same design:
 - 10.1.3.1.1 Minimum one compressor run for 400 hours.
 - 10.1.3.1.2 Vendor to develop a test sequence/programme in consultation with RDSO for operating the compressors at all relevant conditions given in this specification and test data has to be collected as in development testing and submitted to RDSO for approval of proto type testing.
 - 10.1.3.1.3 All the data obtained should be submitted to RDSO for their consent before starting prototype testing.
- 10.1.3.2 Failures (during RGT testing) - All the failures, which occur in tests must be fully documented and submitted to RDSO.
 - 10.1.3.2.1 Time to failure
 - 10.1.3.2.2 Cause of failure
 - 10.1.3.2.3 Corrective action taken
- 10.1.4 **Reliability Verification Testing (RVT)** -This test is to be carried out when failure are not occurred in RGT carried out at vendor’s own premises. RVT may not start until all failure modes found during RGT have been addressed and corrective actions taken.
- 10.1.4.1 **Field Trial / Testing**
 - 10.1.4.1.1 On satisfactory completion of prototype tests, one compressor shall be subjected to field trial. Quantity of compressor to be subjected to field trial and field trial period shall be as per RDSO document no- MP-M-8.1-1 (Latest version).Field performance feedback format is as under:

S. No.	Shed/ Rly.	Loco No.	Date of fitment	Date of failure, if any	Reason of failure	Remarks

The acceptance criteria of field trial shall be the satisfactory field performance of equipment.

During the field trial period following parameters will be monitored.

Lube oil consumption

Valve overhauling period

Maintaining of main reservoir pressure conforming to maintenance schedules of diesel electric locomotive.

Weight of carbon deposit

- 10.1.4.1.2 Any assembly / component including wearing/consumable items which fails during field trial shall be replaced free of cost by the vendor. Design improvement of failed items should be considered if found necessary.
- 10.1.4.3 All the compressors in this test shall be put on service in the field under supervision of inspecting officer and some compressors may be dis-assembled for inspection and dimensional measurements for wear of the components to conclude the particular design on the basis of field monitoring.

10.2 Prototype testing

- 10.2.1 The inspector will inspect and carryout prototype testing on 01 compressor to verify its performance, reliability and quality claimed by the vendor.
- 10.2.2 The inspecting officer will adapt any means or methods for inspection and testing of compressor to verify the performance, reliability, quality and fitment on locomotive. All the testing shall be carried out at the vendor's premises and government approved laboratory.
- 10.2.3 The prototype testing shall constitute the following test parameters and values obtained/measured in this testing should be conformed as per graphs, sketches and drawings and also the values mentioned in different clauses of this specification or otherwise.
- 10.2.3.1 Dimensional measurement of components and overall dimension of compressor.
- 10.2.3.2 Weight measurement of valves and valve plugs for determining the carbon deposit
- 10.2.3.3 Mechanical tests
- 10.2.3.4 Capacity (FAD) test at 350, 400 and 1050 rpm at 0.0, 8.0, and 10.0 kg/cm² gauge pressure (as per IS- 10431 on test rig RDSO drg. no. **SKDP-2852** placed at **annexure -IV**) as per clause 8 of this specification.
- 10.2.3.5 Power consumption at 350, 400 and 1050 rpm for compressor loaded and unloaded conditions i.e zero and 10.0 kg/cm² gauge pressure as per clause 8 of this specification.
- 10.2.3.6 Volumetric efficiency in % .
- 10.2.3.7 Lube oil consumption in ml/hour
- 10.2.3.8 Orifice tests at speed of 350, 400, 800 and 1050 rpm as per graph at **annexure –III** and 10.2.6 of this specification.
- 10.2.3.9 Testing of loading and unloading mechanism at speed of 350 and 1050 rpm (Cut-in and cut-out pressure of main reservoir) to fulfil the requirement as per clause 7.1.3 of this specification.
- 10.2.3.10 Charging time test at speed of 350, 400, 800 and 1050 rpm up to gauge pressure of 10.0 kg/cm² for main reservoir of stipulated capacity.
- 10.2.3.11 Endurance test/continuous running at 10 kg/cm² of 400 hours without stop as per clause 10.2.8 of this specification.
- 10.2.3.12 High Environmental/temperature test at (80° C) for 48 hours as per clause 10.2.9 of this specification.
- 10.2.3.13 Quality of compressed air as per clause 8 and 10.2.11 of this specification and ISO specifications no 8573-1 second edition 2001 class 4-3-4 or Equivalent Indian Standards.
- 10.2.3.14 Quality of lube oil as per clause 7.3.3 of this specification.
- 10.2.3.15 Weight measurement of complete unit as per clause 7.1.7 of this specification.
- 10.2.3.16 Wear measurement of wearing components to decide wear trend.
- 10.2.4 Mechanical tests are intended to ascertain the reliability of the machine and its accessories. Before starting proto type testing, performance of all the assemblies/sub-assemblies / parts of compressor and its accessories shall be checked for their adequacy. All the mechanical parts shall also be checked for proper functioning in their individual assembled condition and as a whole of compressor. The duration of various stages of mechanical tests is given in table-1 bellow.

TABLE-1

S. No.	Operation	Speed in rpm	Period in hrs
1.	Mechanical tests		
	a) Run the compressor as indicated below		
	i) Against the atmospheric pressure (check for undue heating, sound and crankcase leakages)	350	2
	ii) Slowly increase the pressure to 7.0 kg/cm²	350	2
	b) Increase speed to max. service speed 1050 rpm and adjust pressure to 0 kg/cm²	1050	2
	c) Increase speed to max and adjust pressure to 10.0 kg/cm² (approximately)	1050	2

10.2.5 FAD (capacity) testing/air flow measurement shall be carried out in accordance with I.S specification No.-10431-1994 and a test rig as per RDSO drawing No. **SKDP-2852** placed at **annexure –IV** of this specification. The readings will be recorded in given proforma (as per **Annexure – V**).

10.2.6 **Orifice Test** For the orifice testing, fit the plate of 1.5875 mm (1/16”) having an orifice dia. of 8.7 mm in the orifice holder. Close the globe valves on nozzle side. Run the compressor at four speed levels between 350 and 1050 rpm. When the pressure stabilises in the reservoir, observe and record the readings at speeds of 350, 400, 800 and 1050 rpm.

10.2.7 The compressor shall be subjected FAD, power consumption, and volumetric efficiency at the speeds of 350, 400 and 1050 rpm before and after endurance and high temperature test. Reading of the testing parameters will be recorded in given pro-forma as **annexure V**.

10.2.8 **Endurance Test-** After completing all the tests except high temperature test, drain & re-fill the 01 no of air compressor with calculated amount of lube oil. Run the compressor for 400 hours continuously at 10.0 kg/cm² without stop as per testing conditions given in table-2 (next page).

Table-2

Notch position	Compressor speed	% of 400 hours	Running hours	Time interval
Idle &1	350	10	40	0-40
2	450	10	40	40-80
3	550	10	40	80-120
4	650	10	40	120-160
5	750	10	40	160-200
6	850	10	40	200-240
7	950	10	40	240-280
8	1050	29	116	280-396
	1180	1	4	396-400

Readings of parameters such as temperatures, pressures etc. shall be recorded in pro-forma given at **annexure - VI** at interval of one hour for the first ten readings and next of the other 10 readings at interval of 2 hours and remaining at interval of 5 hours at every speed. After running of 400 hours, drain the compressors and calculate the lube oil consumption for compressor.

- 10.2.9 **High Temperature Test-** After completing all the tests including endurance test mentioned in clause 10.2.8, run the air compressor for 48 hours by putting it into an enclosure of high temperature about 80 deg. C at 10 kg/cm² pressure and maximum rated speed of 1050 rpm. The air compressor will be run for 8 hours and stopped for 30 minutes for cooling off at prevailing atmospheric conditions at 80 deg. C. Such six running cycles shall be performed. During this test, readings shall be recorded in pro-forma given at **annexure - VII**.
- 10.2.10 Samples of new and used lube oils, drawn from sump after completion of endurance and high environmental test, shall be subjected to following tests.
1. Physical – chemical characteristics.
 2. Elemental analysis for additives (new oil only)
 3. Spectrographic analysis (of used oil) for all elements including additives.
- 10.2.11 Sample of compressed air should be collected and tested its quality/purity for solid particle, humidity and total oil (aerosol, liquid and vapour) as per ISO specification Nos ISO 8573-4, 8573-3 and 8573-2 or Equivalent Indian Standards respectively. The quality of compressed air should be designated as A-B-C as per ISO: 8573-1 2010 (E) where A, B and C means quality class of solid, water and oil respectively. In accordance with ISO specification No.- 8573-1: 2010(E), quality of compressed air should be 4-3-4. For quality of compressed air, refer equivalent IS standards.
- 10.2.12 Orifice and charging time tests will be carried out before and after endurance test and high temperature test. Reading will be recorded in appropriate pro-forma.
- 10.2.13 Before and after the tests mentioned in this specification, weight of each valve assembly shall be recorded to determine the amount of carbon deposits on valve parts and valve plugs. Reading will be recorded in appropriate pro-forma.

10.3 Quality Acceptance / Routine tests:

- 10.3.1 Each and every compressor will be tested for following tests to ascertain its performance, quality and reliability before being accepted by the purchaser. The vendor shall also supply a copy of routine test report carried out with each and every compressor in approved proforma by inspecting officer to RDSO/MP.
- 10.3.2 Results of performance parameters should be submitted to purchaser along with dispatch of each and every compressor.
- 10.3.3 The quality acceptance testing shall constitute the following test parameters and results obtained/measured in this testing should conform to graphs, sketches and drawings and also the values mentioned in different clauses of this specification or otherwise.
- 10.3.3.1 Dimensional measurement of G.A. of compressor.
- 10.3.3.2 Capacity (FAD) test at 350, 400 and 1050 rpm at 0.0, 8.0, and 10.0 kg/cm² gauge pressure (as per IS- 10431 on test rig RDSO drg. no. **SKDP-2852** placed at **annexure -IV**) as per clause 8 of this specification.
- 10.3.3.3 Power consumption at 350, 400 and 1050 rpm for compressor loaded and unloaded conditions i.e zero and 10.0 kg/cm² gauge pressure as per clause 8 of this specification.
- 10.3.3.4 Volumetric efficiency in %.
- 10.3.3.5 Orifice tests at speeds of 350, 400, 800 and 1050 rpm as per graph at **annexure-III**.
- 10.3.3.6 Testing of loading and unloading mechanism at speed of 350 and 1050 rpm (Cut-in and cut-out pressure of main reservoir) to fulfil the requirement as per clause 7.1.3 of this specification.
- 10.3.3.7 Charging time test at speed of 350, 400, 800 and 1050 rpm up to gauge pressure of

10.0 kg/cm² for main reservoir of stipulated capacity.

- 10.3.3.8 Continuous running / endurance testing of 8 hours at 10.0 kg/cm² and 350 and 1050 rpm for 4 hours at each speed.

10.4 Capability Testing

10.4.1 In addition to the tests conducted in RGT, the vendor should also subject the compressor to the adverse or overload at speed of 1180 rpm and other conditions outlined in clause 6.2 and 8.0 of this specification.

10.4.2 Testing procedure and collection of data should be followed as directed in development testing as per clause 10.1.2.1 and submitted to RDSO/MP for analysis.

10.5 Quality Control Testing

10.5.1 One or 2 % of each and every supply, if quantity exists more than 100 nos. of the compressors chosen at random should be selected for the prototype testing.

10.5.2 Testing conditions and procedures should be followed as in prototype testing as clause 10.2.

10.5.3 The quality control testing shall constitute the following test parameters and values obtained/measured in this testing should conform to as per graphs, sketches and drawings and the also values mentioned in different clauses of this specification or otherwise measured during the prototype testing.

10.5.3.1 Dimensional measurement of various wearing components and overall compressor.

10.5.3.2 Weight measurement of valves and valve plugs for determining the carbon deposit

10.5.3.3 Mechanical tests

10.5.3.4 Capacity (FAD) test at 350, 400 & 1050 rpm and at 0.0, 8.0, 10.0 kg/cm² gauge pressure (as per IS-10431 on test rig as per RDSO drg no. **SKDP-2852** placed at **annexure - IV**).

10.5.3.5 Power consumption at 350, 400 and 1000 rpm for compressor loaded and unloaded conditions i.e zero and 10.0 kg/cm² gauge pressure.

10.5.3.6 Volumetric efficiency in %.

10.5.3.7 Lube oil consumption in ml/hour

10.5.3.8 Orifice tests at speed of 350, 400 and 1050 rpm as per graph at **annexure-III** and 10.2.7 of this specification.

10.5.3.9 Testing of loading and unloading mechanism at speed of 350 and 1050 rpm (Cut-in and cut-out pressure of main reservoir) to fulfil the requirement as per clause 7.1.3 of this specification.

10.5.3.10 Continuous running of 100 hours at 10.0 kg/cm² and speed of 1050 without stop with 10% over loading at 11.0 kg/cm² for one hour at interval of 10 hours.

10.5.3.11 Quality of compressed air as per clause 8 and 10.2.11 of this specification and ISO specifications no 8573-1 second edition 2010 (E) class 4-3-4 or Equivalent Indian Standards.

10.5.3.12 Lube oil should conform to clause 7.3.3 of this specification and report of this testing should be submitted to RDSO for assessment of vendor status

10.5.3.13 The duration of various stages of mechanical tests is given as per table-1 of this specification.

10.6 Prototype, Quality Assurance and Quality Control Condition

10.6.1 Maximum and minimum service speeds of 1050 and 350 rpm respectively.

- 10.6.1.1 Lubricating oil temperature of 60°C minimum
- 10.6.1.2 Lube oil pressure of 1.8 kg/cm² minimum at 350 rpm and 3.5 kg/cm² at maximum service speed of 1050 rpm at 10.0 kg/cm².
- 10.6.1.3 Air discharge pressures 0.0, 8.0, 10.0 kg/cm²
- 10.6.1.4 Air discharge temperature may be allowed up to 28 deg. C max. above ambient
- 10.6.1.5 Load cycle and time in endurance testing as per clause 10.2.8.
- 10.6.1.6 Load cycle and time in high temperature testing as per clause 10.2.9.
- 10.6.1.7 Auxiliary cooling fan should be provided with a fan capacity of 116 K lit/min.

10.7 Additional Testing

- 10.7.1 Vendor should indicate the test specification to inspecting officer at time of prototype testing for the following components and inspecting officer will ensure the proper testing of these sub assemblies.
 - 10.7.1.1 Lube oil pump
 - 10.7.1.2 Unloading device
 - 10.7.1.3 Oil pressure relief valve
 - 10.7.1.4 Intercooler
 - 10.7.1.5 After cooler
 - 10.7.1.6 Air suction filter
 - 10.7.1.7 Oil strainer/filter
 - 10.7.1.8 Safety valve
 - 10.7.1.9 Cylinders
 - 10.7.1.10 Crankcase
 - 10.7.1.11 Crankshaft
 - 10.7.1.12 Connecting rods
 - 10.7.1.13 Oil seal
 - 10.7.1.14 Oil pressure indicator
 - 10.7.1.15 Inlet valve
 - 10.7.1.16 Discharge valve
- 10.7.2 Testing being carried out for components mentioned in clause 10.7.1 should submitted before prototype testing to inspecting officer.

11.0 Approval

- 11.1 After completion of all the tests mentioned in RGT, prototype testing and field trial the compressor will be disassembled, cleaned for wearing components detailed below. These following components will be finally inspected visually for scratches on wearing surfaces to determine their conditions, wear trends and conclusion of the particular design or improvement in design.

- Lube oil pump
- Cylinders
- Crankshaft
- Connecting rods
- Oil seals
- Gasket joints
- “O” ring joints
- Valves for carbon deposit
- Pistons
- Piston rings
- Wrist pin bearings/bushes
- Crankshaft main bearings
- Cylinders

- 11.2 After completion of all the tests carried out in quality control testing, the compressor will be disassembled, cleaned for wearing components including the components detailed in clause 10.7.1 and inspected visually for scratches on wearing surfaces to determine their conditions to determine the further use, wear trends and conclusions of approval of the design.
- 11.3 Final approval of design of air compressor will be considered when field trial has been successfully completed and performance values found in three successive quality control testing are within limit.

12.0 Installation and Fitment

- 12.1 After all the tests mentioned in clause 10.2.3 in this specification testing and values found are conforming to this specification, the compressor will be cleared for fitment for locomotives by inspecting officer.
- 12.2 Installation and fitment of prototype tested air compressor on diesel electric on ALCO type locomotive (being manufactured by ~~DLW~~ BLW Varanasi) shall be the responsibility of vendor under supervision of inspecting officer and purchaser.
- 12.3 The vendor shall supply adequate no of instructions bulletin on installation procedure at least two months before the dispatch of the equipment to purchaser in consultation with inspecting officer.

13.0 Technical Documents and Drawings

- 13.1 The vendor shall apply for supply of air compressor along with the offer and two copies of drawing of complete compressor layout/arrangement, operating instructions, maintenance instructions, spare parts catalogue, troubleshooting instructions and testing instructions of the complete air compressor assembly. The vendor shall also submit drawings for individual assembly and sub assembly. The drawing of compressor arrangement should have following minimum information.
 - 13.1.1 Locating dimensions and type of mounting hole as per RDSO drawing no. SKDP-**3872 (annexure – 1)**
 - 13.1.2 Locating dimensions and type of mounting holes for external air filters and loading and unloading device.
 - 13.1.3 Locating dimensions, and type of mounting hole for external oil pressure gauge.
 - 13.1.4 Locating dimensions, and type of mounting hole for oil filters.
 - 13.1.5 Axis height and length of crank shaft and crankpin and key fitment details
 - 13.1.6 Crankcase height at which HP cylinder fitted
 - 13.1.7 Height of cylinder and heads
 - 13.1.8 Up to date drawings of whole compressors and serviceable parts.
- 13.2 The vendor shall provide up to date performance data and graphs to inspecting officer for all compressors including this compressor supplied to their customers. This data includes.
 - 13.2.1 Loaded horsepower Vs – RPM.
 - 13.2.2 Unloaded horsepower Vs – RPM.
 - 13.2.3 Displacement Vs – RPM
 - 13.2.4 Delivery Vs – RPM.
 - 13.2.5 Lube oil temperature Vs – RPM.
 - 13.2.6 Oil consumption in units of (ml/hour).
 - 13.2.7 Torque effect Vs – crank angle.

- 13.3 Offer should include the requirement of spares for a period of two years. The quotation for spares shall indicate the cost of individual components, assembly and sub-assemblies etc.
- 13.4 Technical data and detail of air compressor to purchaser and inspecting officer before submission of proposal for development in prescribed pro-forma of this specification at **annexure -VIII**.
- 13.5 The vendor shall indicate the maintenance schedule to of various parts /components to keep the compressor in proper working condition / service on locomotive.
- 13.6 The vendor shall indicate the periods after which the components of the air compressor must be made serviceable and completely overhauled. This information's should be certified by customers supported by certificates.
- 13.7 The vendor shall indicate details of marketing/manufacturing arrangements, if any, with other firms in India and abroad. The supplier shall also indicate the indigenous and the detailed programme for indigenous manufacture giving lists of specific items and their prices.
- 13.8 The vendor shall indicate particulars of maintenance facilities, which he recommends, for being set up in diesel sheds/POH shops.
- 13.9 The compressor vendor shall use IOC, SERVO PRESS-150 RR lube oil within its viscosity and spectrographic limits in the compressor.

14.0 Spares and Tool Kit

- 14.1 Along with the quotation for supply of the air compressor the vendor shall also furnish recommended list of spares for two years with quotations thereof. The tender shall also agree to hold the price of spares for a period of one year from date of the supply of the compressors.
- 14.2 For every 20 compressor units or part thereof, one complete set of tool kit shall be supplied as per the requirement.
- 14.3 The price for tool kit, when procured independent of the order, shall be indicated for information along with the quotations for the compressor.

15.0 Maintenance Manuals

- 15.1 The vendor shall arrange to supply a copy of maintenance manual covering the following vital details including fully illustrated pictures for all items, to the purchaser and RDSO at the time of submission of tender to purchaser in pro-forma at annexure - **VIII**.
- 15.1.1 Description, general arrangement and mounting dimensions.
- 15.1.2 Detailed dimensional drawings indicating mounting arrangement layout, sub-assemblies.
- 15.1.3 Technical data.
- 15.1.4 Manual shall contain information pertaining to working principle of operation of compressor.

- 15.1.5 Details of special tools if required, parts catalogue and testing procedure of the equipment being supplied.
- 15.1.6 Updated position of modifications will also be incorporated.
- 15.1.7 Periodical maintenance schedules and instructions.
- 15.1.8 Testing procedure for the equipment and auxiliaries already mentioned in the specification.
- 15.1.9 Wear limits and life of wearing components.
- 15.1.10 Clearance data for fitment and running of wearing component
- 15.1.11 Instructions for reclamation of worn out components.
- 15.1.12 List of instructions for use special tools.
- 15.1.13 Trouble shooting – symptoms, causes and remedies.
- 15.2 Two copies of the maintenance manual shall be supplied with the quotation.
One copy of the maintenance manual shall be supplied with every compressor.

16.0 Performance and Service warranty

- 16.1 The vendor should give in writing for warranty of two years minimum for the satisfactory service / working of air compressor without failure of any assembly / component.
- 16.2 However any assembly/component except consumable/wearing items which fails during warranty period shall be replaced free of cost by the vendor. The replaced components shall be under a further warranty for 2 years from the date of their commissioning.
- 16.3 If the replaced components also prove unsatisfactory performance in service, they shall be replaced by the modified and improved components by the vendor at their own cost.
- 16.4 The vendor should collect the failed components and study & investigate the failure mode occurred in service and whatever the results found in investigation should be furnished to RDSO.
- 16.5 Accordingly vendor may re-consider the process of their quality control, design and manufacturing of that component if some flaws have been found during failure mode investigation.

17.0 General conditions for Inspection and Tests

- 17.1 The tests shall be carried out at vendor premises and NABL accredited laboratories as directed by inspecting officer.
- 17.2 Labour and appliances required by the inspecting officer shall be provided by vendor for inspection and testing of the whole unit and its components, if required. The appliances include erection of suitable test stand and provision of a variable speed motor with multiple speed gearbox or suitable pulley ratios to drive the compressor. The speed range of the drive shall be 350 – 1250 rpm.
- 17.3 Stand by power supply shall be provided by the supplier to ensure the endurance test is not interrupted due to failure of electrical power supply. The circumstances and limits of permitted interruptions are indicated in **annexure – X**. An hour meter shall be connected between the drive motor and the supply to record the actual hours of run.
- 17.4 The inspecting officer shall have power to adopt any means he may consider necessary to satisfy himself that all the proper materials and parts specified are actually used during the manufacturing of the compressors.

- 17.5 The vendor shall have to make available the detailed drawings of components for inspection purposes, and also furnish the condemning limits for wearing components.
- 17.6 The inspecting officer shall have to access, at all reasonable items for stage inspection, to those portions of the vendor works in which the production of compressor or its components is being carried out and where the testing take place. This also applies to items procured from sub-vendors.
- 17.7 Should have any part of the compressor unit require alteration or any defect appears, during type, routine and other tests, the vendor shall without any extra charge, make such alteration or rectify the defects to the satisfaction of the inspecting officer. The unit after such modifications may be subjected to such tests as considered necessary by the inspecting officer.
- 17.8 If the performance results obtained during the tests are found unsatisfactory. The vendor may carryout minor modification to enable unit to satisfy the requirements, at his own cost, within a period mutually agreed between the inspecting officer and the vendor.
- 17.9 Any modifications or alterations to the components during regular supply of compressor shall be made only after the approval of RDSO/MP. The compressor after such modifications or alterations may be subjected to performance tests, if considered necessary.

18.0 Training

- 18.1 Training of purchaser's personnel for operation and maintenance of compressor shall be given by the vendor free- of-cost. Demonstration of the working of the device on locomotive shall be given by the vendor free-of-cost.

19.0 Technical Clarifications

- 19.1 Any other technical clarifications with regard to this specification may be obtained from Director General (Motive Power), RDSO, Manak Nagar, Lucknow -226 011

20.0 Quality Assurance Programme (QAP):

- 20.1 Supplier shall submit their internal quality assurance program in accordance with RDSO ISO procedures.
- 20.2 Supplier shall, on demand by RDSO/ Purchaser/ Inspecting authority nominated by RDSO/ Purchaser, make the records of checks carried out during internal quality assurance available for scrutiny.

21.0 Preference to Make in India:

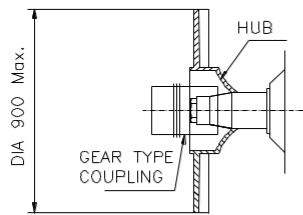
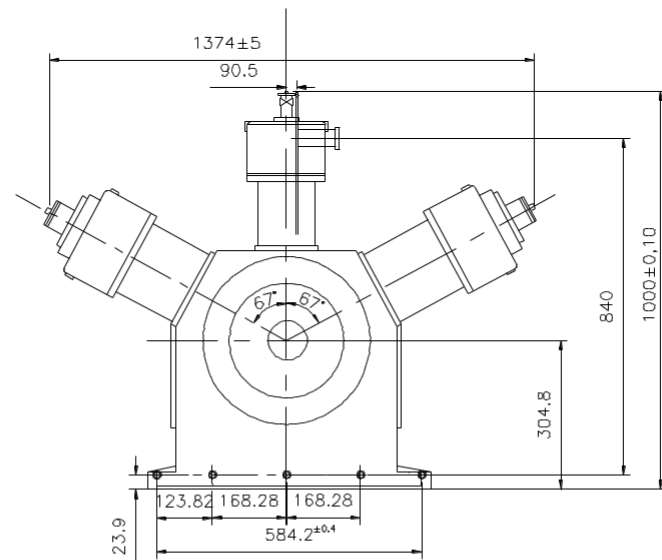
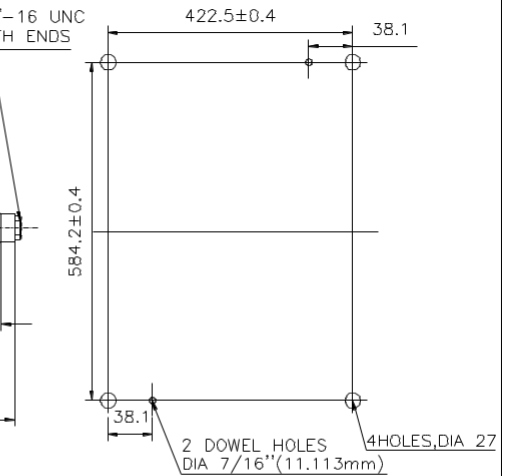
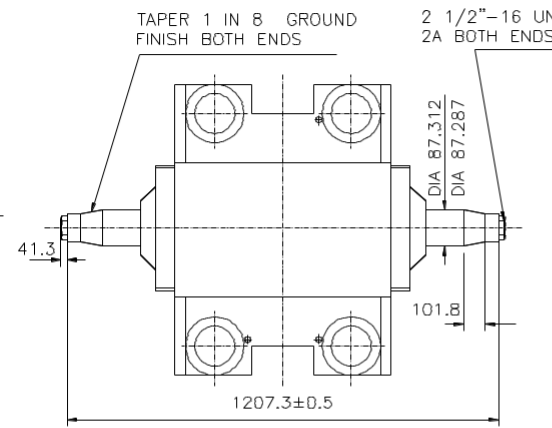
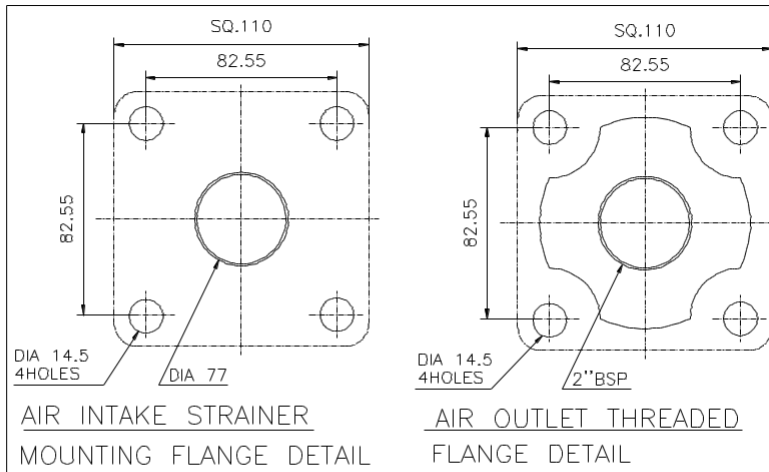
- 21.1 The Government of India policy on “make in India” shall apply.

22.0 Vendor Changes in Approved Status:

- 22.1 All the provisions contained RDSO's ISO procedures laid down in Document No. QO-D-8.1-11, dated 18.01.2021 (Titled “Vendor- changes in approved status”) and subsequent version/amendment thereof, shall be binding and applicable on the successful vendor/vendors in the contract floated by Railways to maintain of products supplied to Railways.

23. DATE OF ENFORCEMENT

The date of enforcement of the specification is with immediate effect i.e. 01.04.2021.



NOTE:

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL DIMENSIONS SHOWN ARE APPROXIMATE VENDOR SHOULD CONFORM PHYSICAL AVAILABILITY OF SPACE AND MOUNTING LOCATION OF AIR COMPRESSOR BEFORE SUPPLY.
3. FOR ANY OTHER DIMENSION CLARIFICATION DLW DRG NO. TPL-2375, ALT-C IS TO BE REFERED.
4. THIS DRG SHOULD BE REFERED ONLY FOR MOUNTING, BROAD OUTLINE DIMESIONS OF COMPRESSORS DURING FITMENT OF LOCO.

D	VED. PRAKASH
C	RAJENDRA SINGH
AD	O.P. CHAUBEY
APPD	ATULYA SINHA
Dr.	-10-2007

	50
	25
	6.3
	0.8
	0.1
SYMBOL	Raum (MAX)

*SURFACE ROUGHNESS TO IS:3073
WELDING SYMBOLS TO IS:813
TOLERANCES ON UNTOLERANCED DIMENSIONS TO IS: 2101 ()

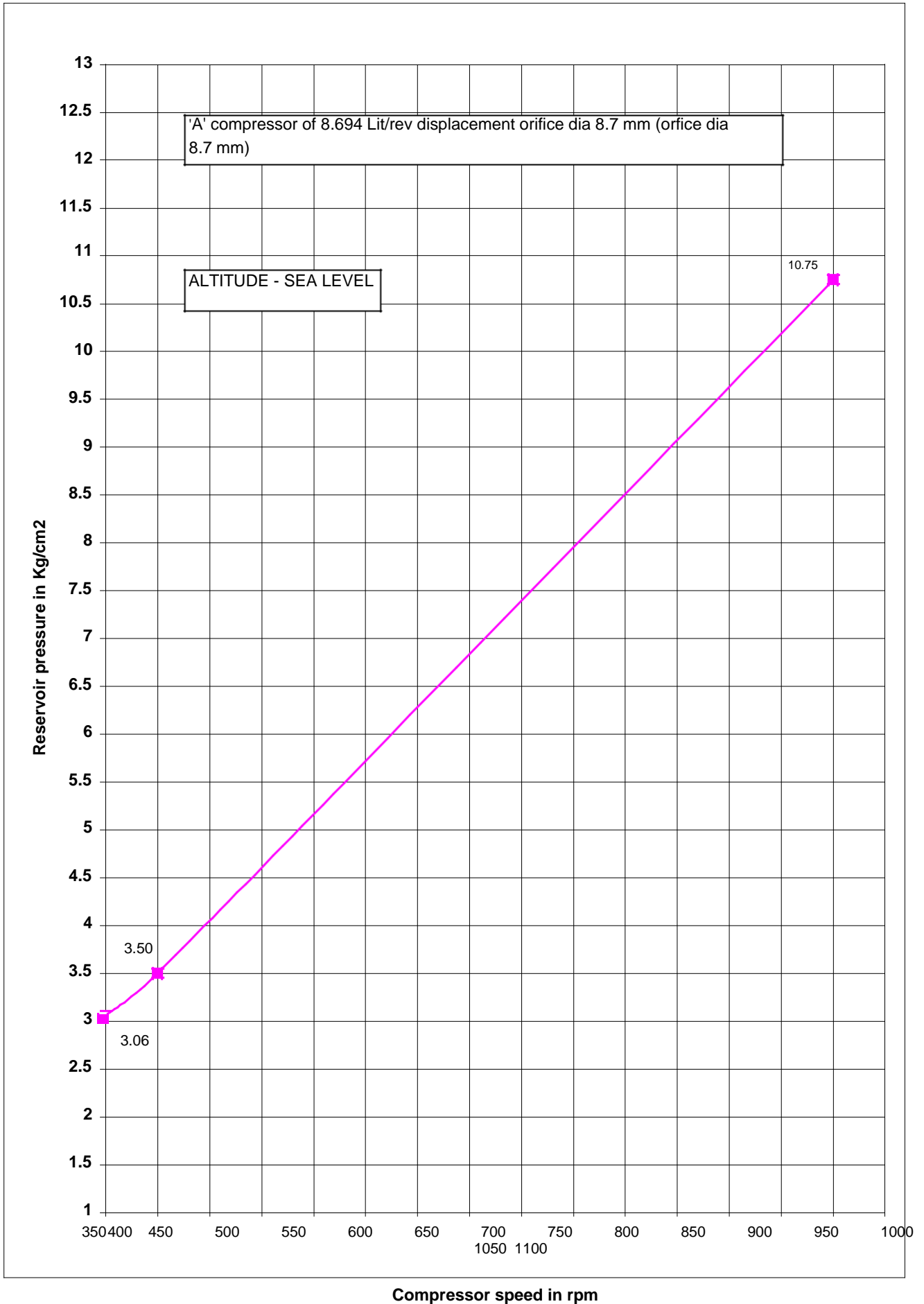
ALT	NO. OF PLACES	REF. NO.	DESCRIPTION	ALT. NOTE NO.	SIGN	DATE

REF NO	I R PART NO	DESCRIPTION	NO OFF	WT(kg) EACH	MATL	SPEC
APPLICABLE FOR ALCO TYPE DIESEL-ELECTRIC LOCOMOTIVES		MOUNTING ARRANGEMENT OF ALCO TYPE AIR COMPRESSOR				
SCALE	INDIAN RLYS RDSO (MP)		REF: DLW, DRG. NO. TPL-2375 ALT-C, & PT. NO. 11487501			
		DRG. NO. SKDP - 3872				

ANNEXURE-II

S.No	Parameter/assembly/sub assembly	Works to be conducted	Periodicity
1	Crank case - oil	(i) Check and record crank case vacuum	M2
		(ii) Measure crank case lube oil pressure and record.	M6
		iii) Check and add if necessary	M- 6
		iv) Change oil	M-12
		v) Clean interior of crankcase with natural sponge and mineral spirits in complete overhauling Oil quality IOC Servo Press –150 RR or SAE -30 or equivalent Indian Standards	M-12
2	Discharge valve	Clean and inspect the valves	M-12
3	Inlet valve	Clean and inspect the valves	M-12
4	Unloaders	Clean and inspect	M-12
5	Piston ring	Change all the piston rings	M-36
6	Cylinders	Change all the cylinders	M-36
7	Coolers	i) Clean exterior, drain	M –6
		ii) Over haul and hydraulic testing	M-36
8	Inter cooler & after cooler safety valve	Overhaul & testing	M-36
9	Air intake filter	i) Inspect, blow clean if necessary.	M-12
		ii) Clean & inspect filter media & remove if damage	M-12
10	Oil pump strainer	i) Clean strainer	M-12
		ii) Inspect, replace if damage	M-12
11	Oil pressure indicator assembly	(i) Oil pressure indicator must be fully extended(approx $\frac{3}{4}$ ' at 350 rpm)	M-12
		(ii) Overhaul	M-36
12	Lube oil pump assembly	Reciprocating type	
		i) Check oil pressure and record	M-12
		ii) Overhaul oil pump cartridge type	M-36
		Gear type pump	
		iii) Check mounting of gears	M-12
		iv) Over haul gear type pump	M-36
13	Crank case breather valve assembly	Inspect and clean breather valve.	M-12
14	Connecting rod	(i) Bush bearing or needle roller bearing: check & replace if necessary	M-36
		(ii) Big end bearing	M-36
15	Crank shaft	Overhaul	M-36
16	Complete overhauling	Overhaul	M-36

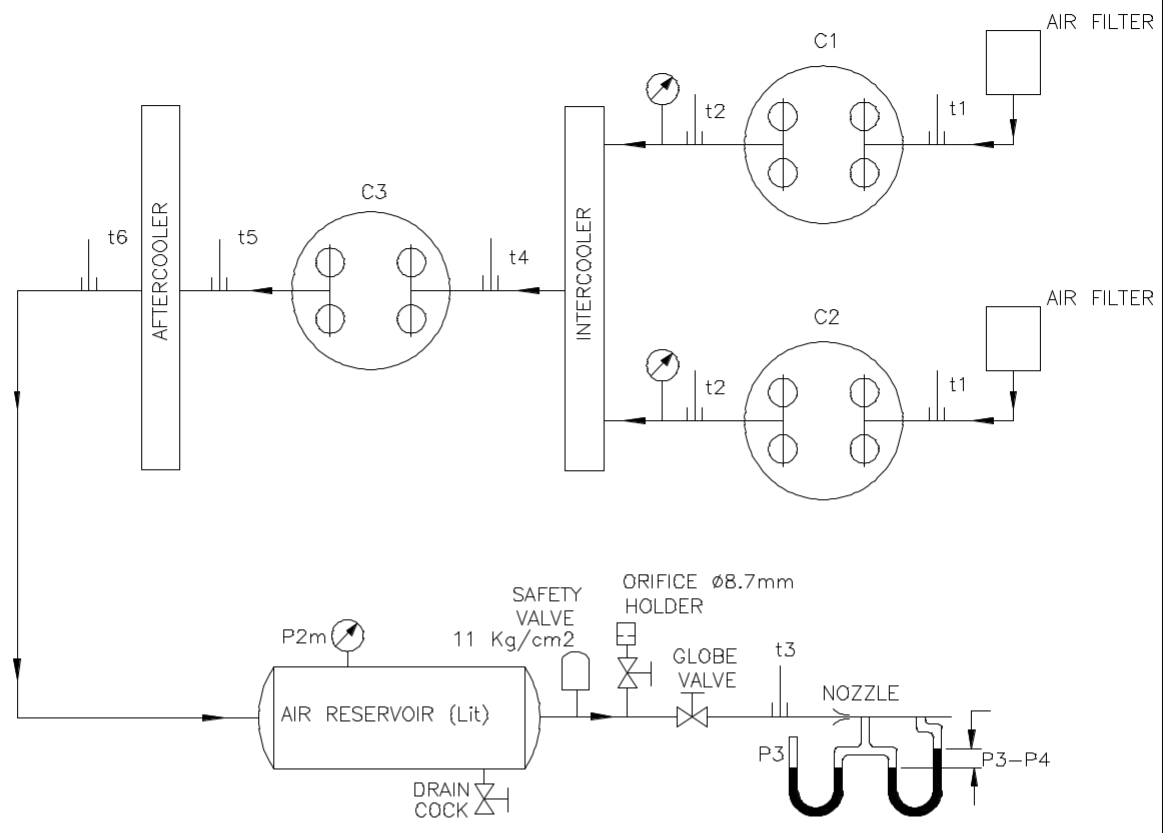
GRAPH OF ORIFICE TEST (SPEED Vs AIR PRESSURE) Annexure - III



GDP-728

Annexure-IV

INDIAN RLYS RDSO(MP)	APPLICABLE FOR DIESEL-ELECTRIC LOCOMOTIVES	TEST LAYOUT OF AIR COMPRESSORS (SCHEMATIC)
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LEGEND :

- C1, C2 & C3 – CYLINDER AND CYLINDER HEADS LP AND HP RESPECTIVELY
- t1 – AIR TEMPERATURE AT FILTER INLET ($^{\circ}$ C)
- t2 – AIR TEMPERATURE AT LP OUTLET ($^{\circ}$ C)
- t3 – AIR TEMPERATURE BEFORE NOZZLE ($^{\circ}$ C)
- t4 – AIR TEMPERATURE AT INTERCOOLER AT OUTLET / HP INLET ($^{\circ}$ C)
- t5 – AIR TEMPERATURE AT HP OUTLET ($^{\circ}$ C)
- t6 – AIR TEMPERATURE AT AFTER AFTERCOOLER ($^{\circ}$ C)
- P1 – OUTLET OF LP / INLET OF INTERCOOLER PRESSURE (Kg/cm²)
- P2m – ABSOLUTE AIR DISCHARGE PRESSURE (Kg/cm²)
- P3 – UPSTREAM NOZZLE PRESSURE (Kg/cm²)
- P3-P4 – DIFFERENTIAL PRESSURE AT THE NOZZLE (mm of H₂O)
- A R – AIR RESERVOIR (Lit)

D	VED PRAKASH							SCALE N.T.S.	REF:
C	BAJENDRA SINGH								DRG. NO. SKDP-2852
	APPED ATULYA SINHA							FIRST ISSUED	SUPERSEDES
Dt	-10-2007	ALT:	NO.OF PLACES	REF. NO.	DESCRIPTION	ALT. NOTE NO.	SIGN:	DATE	SUPERSEDED BY

Annexure -V

PRO-FORMA FOR (FAD) CAPACITY TESTING

Compressor model:

Altitude:

Compressor no:

Date:

Sheet no.:-

S. No.	Parameter	Measuring method	Units used	Date and time
1.	Barometric pressure	Barometer	mm of hg	
2.	Air outlet pressure P2	Gauge	psi	
3.	Dry bulb temp (LP1/LP2 inlet air temp)	Thermometer	° C	
4.	Wet bulb temp (LP1/LP2 inlet air temp)	Thermometer	° C	
5.	Compressor speed (rpm)	Digital tachometer	rpm	
6.	Nozzle inlet pressure (H2O) P3	Manometer	mm	
7.	Nozzle outlet pressure (H2O) P4	Manometer	mm	
8.	Nozzle air temp T3	Thermometer	° C	
9.	Actual free air delivery	Calculation	LPM	
10.	Free air delivery corrected to ----- RPM	Calculation	LPM	
11.	Volumetric efficiency	Calculation	%	
12.	Energy input to motor for 10 minutes	Energy meter	kwh	
13.	Power (motor input)	Calculation	HP	
14.	LP1 outlet temp (left side cylinder viewed from non drive end) / inter cooler inlet temp	Thermometer/CH	° C	
15.	LP2 outlet / inter cooler inlet temp	Thermometer/CH	° C	
16.	HP inlet / intercooler outlet temp	Thermometer/CH	° C	
17.	HP outlet air temp	Thermometer/CH	° C	
18.	Lube oil pressure	Gauge	Kg/cm ²	

Any remarks if any:-

Annexure -VI

PRO-FORMA FOR ENDURANCE TESTING

Compressor model:

Altitude:

Compressor no:

Date:

Sheet no.:-

S. No.	Parameter	Measuring method	Units used	Date and time
1.	Hour meter reading	Hour meter	hrs	
2.	Atmospheric pressure	Manometer	mm of Hg	
3.	Air outlet pressure	Gauge	kg/cm ²	
4.	Ambient temp (inside enclosure)	Thermometer	° C	
5.	Compressor speed (rpm)	Digital tachometer	rpm	
6.	Suction temp (LP1)	Thermometer	° C	
7.	Suction temp (LP2)	Thermometer	° C	
8.	LP1outlet temp (left side cylinder viewed from non drive end) / inter cooler inlet temp	Thermometer	° C	
9.	LP2 outlet / inter cooler inlet temp	Thermometer	° C	
10.	HP inlet / intercooler outlet temp	Thermometer	° C	
11.	HP outlet air temp	Thermometer	° C	
12.	LP1 cylinder	Thermometer	° C	
13.	Lube oil temp	Thermometer	° C	
14.	Lube oil pressure	Gauge	kg/cm ²	
15.	Inter cooler pressure	Gauge	kg/cm ²	
16.	LP1 cylinder head temp / Valve temp	Laser thermometer	° C	
17.	LP2 cylinder head temp / Valve temp	Laser thermometer	° C	
18.	HP cylinder head temp / Valve temp	Laser thermometer	° C	
19.	Power (for 10 minutes) once in day	Meter	Kwh	

Any remarks if any:-

Annexure -VII

PRO-FORMA FOR HIGH TEMPERATURE TESTING

Compressor model:
Compressor no:

Altitude:
Date:
Sheet no.:-

S. No.	Parameter	Measuring method	Units used	Date and time
1.	Hour meter reading	Hour meter	hrs	
2.	Atmospheric pressure	Manometer	mm of Hg	
3.	Air outlet pressure	Gauge	kg/cm ²	
4.	Ambient temp (inside enclosure)	Thermometer	° C	
5.	Compressor speed (rpm)	Digital tachometer	rpm	
6.	Suction temp (LP1)	Thermometer	° C	
7.	Suction temp (LP2)	Thermometer	° C	
8.	LP1 outlet temp (left side cylinder viewed from non drive end) / inter cooler inlet temp	Thermometer	° C	
9.	LP2 outlet / inter cooler inlet temp	Thermometer	° C	
10.	HP inlet / intercooler outlet temp	Thermometer	° C	
11.	HP outlet air temp	Thermometer	° C	
12.	LP1 cylinder water temp	Thermometer	° C	
13.	Lube oil temp	Thermometer	° C	
14.	Lube oil pressure	Gauge	kg/cm ²	
15.	Inter cooler pressure	Gauge	kg/cm ²	
16.	LP1 cylinder head temp / Valve temp	Laser thermometer	° C	
17.	LP2 cylinder head temp / Valve temp	Laser thermometer	° C	
18.	HP cylinder head temp / Valve temp	Laser thermometer	° C	
19.	Power (for 10 minutes) once in day	Meter	Kwh	

Any remarks if any:-

Annexure -VIII

General Technical data of air compressor

01	Type	Reciprocating ‘W’ type, forced feed lubrication
02	Normal working pressure	10.0 Kg/cm ² 140 PSI approximately
03	Free air delivery at 1050 rpm	6390 LPM
04	Displacement volume per revolution	8.694 litres
05	Direction of rotation	Anticlockwise viewed from drive end
06	Rated speed	1050 RPM
07	Speed range	350 to 1250 RPM
08	Compression stages	02 nos.
09	Low-pressure cylinders, nos. Bore dia Total height	02 nos. 196.875 – 196.850 mm 312.74 ±0.050/0.00 mm
10	High pressure cylinder, nos. Bore Dia Total Height	01 no. 139.00 - 139.725 mm 312.74±0.050 / 0.00 mm
11	Piston stroke length	142.875 mm
12	Type & nos. of piston rings (On both LP & HP)	01 No. -Taper compression ring 01 No. - Nose scraper ring 02 Nos. - Cross beveled oil control ring
13	Ring gap (For LP and HP)	0.20 - 0.45 mm (LP) 0.40 - 0.65 (HP) mm
14	Crank shaft, crank pin, dia Crank pin length Bearing seat dia	92.02 - 92.049 mm 133.6 -133.7 mm 190.005 – 189.976 mm
15	Low pressure piston, skirt dia Total height Hole for gudgeon pin dia	196.60 –196.64 mm 00±0.05 mm 44.45 – 44.46 mm
16	High pressure piston, skirt dia Total height Hole dia for gudgeon pin/wrist dia	145.80 -145.825 mm 00±0.25 mm 44.463 – 44.450 mm
17	Centre distance between big end to small end for connecting rod	349.25± 0 / 0.127 mm
18	Power consumption at rated speed of 1050 RPM	69 HP
19	Crankcase oil capacity	Minimum 14 litres Maximum 21 litres
20	Lube oil pressure at 350 rpm at 1050 rpm	2.2 Kg/cm ² minimum 3.5 kg/cm ² maximum
21	Envelope dimension (L X B X H)	1315±5 mm X 1374±5 mm X 1015±5 mm
22	Net Weight	Maximum 865±10 Kg

Annexure -IX

General conditions of endurance test

Endurance test is a continuous test and shall be carried out by running the compressor with compressor delivery pressure at 9.85 Kg/cm² running at load cycle maximum rated speed. The test shall be of 400 hours duration. Normally, the interruptions are not permitted during the testing except under following circumstances:-

1. Interruptions are permitted if any adjustment is required to be carried out during the course of testing, which warrants stopping of compressor or drive motor. Under these circumstances, the period of interruptions should not exceed 2 minutes. The aggregate total of such interruptions should be totalled at the end the period of endurance testing prolonged by this aggregate amount.
2. During endurance test, maximum of 4 interruptions shall be tolerated when they are required for attending defects in the equipments but in such case more than 20 minutes shall not be allowed to lapse between the interruptions and restart. In all such cases consent of RDSO or its representative should be obtained before recommencing the test. The aggregate total of such interruptions should be totaled at the end and the period of endurance testing prolonged by this aggregate amount. In case of more than 4 interruptions, the endurance testing should be done afresh.
3. If endurance testing is interrupted for reasons unconnected with compressor such as due to defect in drive motor and coupling, the test should be started within 24 hours, after the interruption will be allowed and in case the testing is interrupted by more than one interruption, RDSO or its representatives shall decide whether endurance test must be recommended from beginning or merely prolonged for the period equal to that of interruption. In case of such interruption should be entered in the column provided immediately after data prior to interruption.