

Government of India
(BHARAT SARKAR)

SPECIFICATION FOR MOTOR DRIVEN
HIGH VACUUM EXHAUSTERS FOR
ELECTRIC LOCOMOTIVES
(With Annexure-3)

SPECIFICATION NO. MP:0.0700-07

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Ministry of Railways
Research, Designs And Standards Organisation
Manaknagar, Lucknow-226011.

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SPECIFICATION FOR MOTOR DRIVEN
HIGH VACUUM EXHAUSTERS FOR
ELECTRIC LOCOMOTIVES

0. FOREWARD

0.1 This is a technical specification for motor driven high vacuum exhausters for electric locomotives application.

0.2 In preparing this specification, assistance has been drawn from the following Indian Standards:

IS:5456-1969 Code of Practice for Testing of Positive Displacement Type Air Compressors and Exhausters.

IS:5538-1969 Measurement of air flow of Compressors and Exhausters - Part I - "Nozzles".
(Part I)

IS:5727-1970 Glossary of Terms Relating to Compressors and Exhausters.

0.3 This specification covers clauses which call for agreement between the purchaser and the supplier and supply of certain technical information by the manufacturer/supplier at the time of submitting tenders for the equipment.

1. SCOPE

This specification covers exhausters for use on Electric Locomotives fitted with Air/Vacuum brake system. This is a technical specification and does not cover all the necessary provisions of a contract.

2. TERMINOLOGY

2.1 For the purpose of this standard, the following definitions in addition to those given in "Indian Standard Glossary of Terms Relating to Compressors and Exhausters" - IS:5727;1970, shall apply.

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- 2.2 Manufacturer - The party manufacturing the machine. The manufacturer may or may not be the supplier.
- 2.3 Engineers - The term 'Engineers' shall apply to the Director General (Motive Power), Research Designs and Standards Organisation, Ministry of Railways, Lucknow-226011, and person or persons authorised by him.
- 2.4 Sub-Contractors - Sub-contractor means person or persons from whom the manufacturer buys parts/assemblies for fitment to the equipment to be supplied.
- 3.0 DESIGN FEATURES AND SERVICE CONDITIONS
- 3.1 Basic Design - Exhauster shall be of positive displacement type suitable of being driven by a two-speed electric motor.
- 3.2 Capacity -
- 3.2.1 The capacity of motor driven exhauster shall be around 4500 l/min. at slow speed and about 7000 l/min. at high speed of the drive motor at zero vacuum.
- 3.2.2 The exhauster shall be able to maintain 75% vacuum against parallel leak hole of 5/16" dia in 1/8" thick plate while working at slow speed and against a parallel leak hole of 1/2" dia while working at high speed. A reservoir of 85 litre capacity shall be fitted at the inlet of the exhauster and the leak hole shall be provided at a distance of 1 m from the reservoir.
- 3.3 Normal Duty - The exhauster shall be suitable for working continuously at vacuum level of 80% without resulting in overheating or abnormal wear of components.
- 3.4 Drive
- 3.4.1 The exhauster shall be driven by a two speed motor.
- 3.4.2 Drive to the exhauster shall be through a flexible coupling of proven design. It shall be selected to suit the arduous duty encountered in normal service without the

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necessity of renewing any wearing part within 3 years of its operation. The coupling shall be of simple design and shall require minimum attention during operation.

3.4.3 The limits of angular, and axial misalignments which the coupling is capable of withstanding shall be intimated to "Engineers" or "Purchaser" and their approval be obtained.

3.4.4 The coupling shall be required to withstand shocks due to frequent starting and stopping and variation of load on exhaustor-motor set due to operation of vacuum relief valve.

3.4.5 The drive arrangement of the exhaustor shall be subject to the approval of the purchaser/Engineers. Manufacturer shall advise breakaway torque of the coupling.

3.5 Mounting and Lifting Arrangement

3.5.1 The exhaustor and drive motor shall be mounted on a common bed plate.

3.5.2 The bed of the exhaustor/exhaustor-motor set shall be robust in design and shall be able to withstand shocks and stresses normally encountered in locomotive operation.

3.5.3 Exhaustor/Exhaustor-motor set when mounted on the locomotive shall be free from excessive vibrations and shall be able to withstand vibration and shocks causing an acceleration of "3g" (g = acceleration due to gravitational force at sea level) in the longitudinal direction, and 1 g in vertical and transverse directions. Any special anti-vibration mounting, if required, shall be specifically indicated and supplied as a part of the unit.

3.5.4 Suitable lifting arrangements shall be provided separately for motor and exhaustor and also for the complete unit.

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3.6 Lubrication

- 3.6.1 The exhauster shall have a positive lubricating system of proven design. The lubrication arrangement shall be reliable and capable of withstanding continuous operation at the temperature prevalent inside the locomotive, without undue carbonisation of the moving parts and discharge ports/valves. The lubricating system shall be such that its working can be observed during operation and parts are easily accessible for attention during maintenance.
- 3.6.2 The oil consumption shall be low and shall be specified. The capacity of oil tank shall also be specified.
- 3.6.3 Metallic dipstick arrangement shall be provided for checking oil level.
- 3.6.4 The lubricating system shall have a filter of adequate capacity to ensure reliability of the lube oil system under the actual service conditions. The filter shall be easily removable for maintenance.
- 3.6.5 The oil reservoir/sump shall be designed to permit easy drainage/cleaning.
- 3.6.6. Inter-connecting pipes of the lubricating system shall be so designed so that there is no possibility of damage during transit, service, storage and handling.
- 3.6.7 The drop oil counter, if provided, should be of adjustable type so that sight glasses are visible from any convenient position and shall not become loose and develop leakage during service. The oil flow shall not be affected by locomotive vibration. The rate of oil flow shall be specified for each drop oil counter for different points of lubrication.

3.7 Cooling

- 3.7.1 The exhauster shall be air cooled. A cooling fan of a simple and rugged design shall be provided. The fan shall be mounted on the shaft and shall be dynamically balanced.

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3.7.2 The design of cooling arrangement shall ensure that hot air from motor does not flow over the exhauster.

3.7.3 The temperature at the bearing cover of the exhauster should not exceed 120°C.

3.8. Miscellaneous

3.8.1 For securing protective hoods, pipe brackets etc. foundation bolts shall not be utilised.

3.8.2 Whenever bearings are grease lubricated, easily accessible grease nipples to IS: 4974 shall be provided. Suitable vent for overflow of excess grease shall also be provided. Type of indigenously available grease to be used, shall be specified.

3.8.3 Direction plate with 50 mm arrow shall be fitted on the exhauster and motor, separately to indicate the normal direction of rotation.

3.8.4 Parts like oil filler caps etc. shall be secured to the exhauster body by means of a chain.

3.9 Ambient conditions

An exhauster shall be capable of working satisfactorily under the following conditions:-

- .1 Ambient temperature - 5° to 55°C
- .2 Maximum temperature of air at inlet port - 60°C
- .3 Relative humidity - upto 100%
- .4 Altitude - Sea level to 1000 m.
- .5 The equipment shall be capable of operating satisfactorily in spite of dust, dirt, mist, rain and heavy dust storm to which rolling stock is normally exposed in service. The equipment shall also be capable of withstanding continuous contact

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or prolonged exposure to petroleum products without any effect on its efficiency.

4. ACCESSORIES

The exhauster shall be supplied with the following accessories:-

4.1 Intake Filter - A suction filter of approved design shall be provided at the air inlet to the exhauster. The filter shall be of compact construction and shall be able to withstand the conditions prevailing in the locomotive.

4.2 Silencer and oil separator - The exhauster shall be provided with a silencer and an oil separator unit of adequate capacity. Combined silencer-cum-oil separator unit is also acceptable. The arrangement should be leak proof and easy in dismantling and cleaning.

5. Testing and Inspection

5.1 The testing of exhausters shall generally conform to IS:5456-1969.

5.2 Type Test

5.2.1 Whenever a new series of exhauster is manufactured two numbers of prototype exhauster shall be subjected to a series of test to establish the reliability and performance of the unit.

5.2.2 If the supply order exceeds 100 nos., the type tests shall also be conducted at the rate of two exhausters for every subsequent 100 exhausters or part thereof.

5.2.3 The type test shall constitute the following tests and measurements in accordance with IS: 5456-1969 or relevant BS specification.

5.2.3.1 Initial test check

Run the exhauster at the following vacuum levels and speeds for the duration indicated against each:-

- i) At 0% vacuum and slow speed ... 1 hr (Min)
- ii) At 20% -do- ... 3 hrs
- iii) At 60% vacuum and max. rated speed 5 hrs
- iv) At 80% -do- 10 hrs.

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During these tests check shall be made for undue heating, leakages and proper functioning of all parts and accessories. Adjustments, if called for, shall be made during these tests.

5.2.3.2 Vacuum Maintainability Test -

Maximum vacuum levels attained at slow and high speed shall be determined against parallel leakholes of 5/16" (7.9 mm) and 1/2" (12 mm) respectively with the arrangement indicated in para 3.2.2. Following observations shall be recorded:-

1. Test speed
2. Leak hold size
3. Ambient temperature
4. Barometric Pressure
5. Stabilised vacuum level
6. Time to reach stabilised vacuum level.
7. Starting current of the motor and voltage and current values in the steady state conditions.

5.2.3.3 Determine the exhauster capacity in terms of FAD (Free Air Delivery) in litres per minute at 0, 570, 600 and the maximum obtainable vacuum level both at slow and high speeds.

5.2.3.4 Endurance Test *

5.2.3.4. The exhauster shall be run at a vacuum level of 80% (600 mm) at the maximum rated speed for a period of 400 hrs. Following measurements shall be made during these tests at intervals of 1 hr. for the first 10 readings, 2 hrs., for the next 10 readings, 5 hrs., for the next 10 readings and the remaining at the intervals of 8 hours.

1. Date
2. Time
3. Speed (rpm)
4. Barometric pressure
5. Vacuum level (mm of Hg)
6. Ambient temperature

* See Annexure - 3

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7. Temperature of air at inlet port
8. Temperature of air at exhaust port
9. Temperature of the exhauster motor set at -
 - (a) Bearing cap.
 - (b) Exhauster body
 - (c) Motor body
 - (d) Motor Bearing cap.
 - (e) End covers both drive and non-driving ends.

10. Crank case vacuum (In case of reciprocating machine)

11. Motor voltage, current during run.

~~12. Starting current of the motor.~~

12. During the test observe for any abnormal sound, leaks through joints, commutation conditions of the motor.

5.2.3.4.2

Following checks/measurements shall be made before and after completion of tests:-

1. Dimensions of wearing components according to chart supplied by Engineers at the time of test.
2. Important clearances which effect performance of the exhauster

5.2.3.4.3

After completion of test the exhauster shall be completely dismantled, all components cleaned throughly and examination shall be made for -

- (a) Any abnormal wear/sign of damage to bearings, gears, rotors, oil seals, rotor casing, couplings, and crank shaft, pistons, connecting rod, piston rings, etc. in case of reciprocating machines.
- (b) Looseness of rotors, gears, couplings, and covers, bearings etc.
- (c) Condition of air and oil filter.
- (d) Total consumption of lube oil during the trials.
- (e) Oil/sludge deposits if noticed in exhausters.

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5.2.3.5 Test with elevated inlet temperature

The exhauster shall be worked for 8 hours at the rated maximum speed and 80% vacuum with inlet air temperature of 60°C and then stopped for half an hour for cooling under prevailing atmospheric conditions. Three such cycles of test shall be performed and measurements/observations as made during the endurance tests shall be recorded.

5.2.3.6 Run in tilted position -

With the oil filled upto the minimum dipstick level, the exhauster-motor set shall be mounted on a platform of 1 in 20 inclination with the exhauster raised. The platform shall also have a side tilt of 1 in 10. The exhauster shall be worked in this position at the rated maximum speed and vacuum level of 80% for 12 hours. At the end of the test, the parts shall be examined for any starvation of oil etc.

5.3 ROUTINE TESTS

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

5.3.1 Run the exhauster at maximum rated speed and 80% vacuum till the temperature of the bearing cover stabilizes. Record the temperature and check for any leakage from joints etc.

5.3.2 Leak hole tests with 5/16" and 3/8" dia. parallel leak holes on 1/8" thick plate at slow and high speed respectively. The results shall be compared with those obtained during type tests (para 5.2.3.2)

5.3.3 Maximum level of vacuum attained against dummy, both at slow and high speed. Time to achieve the maximum vacuum shall also be recorded.

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6. GENERAL CONDITIONS FOR INSPECTION AND TESTS

- 6.1 All tests shall be conducted at manufacturers premises. Any shortcoming or defect noticed during the type test shall be pointed out to the manufacturer by the purchaser, or his representative to enable him to incorporate the necessary improvements before bulk manufacture is commenced without effecting the guaranteed deliveries or guaranteed performance characteristics.
- 6.2 Any additional tests/trials, if considered necessary by the Engineer, shall also be arranged by the supplier free of cost.
- 6.3 The purchaser/Engineers, or their representative shall have access at all reasonable times, 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.
- 6.4 The inspecting officer shall have the power to adopt any means he may consider necessary to satisfy himself that proper materials and parts specified, are actually used during the manufacture of the unit.
- 6.5 The supplier/manufacturer shall provide labour or appliances required by the inspecting officer free of charge for inspection and testing of the whole unit and its components, if required.
- 6.6 Should any part of the exhaustor unit require alteration or any defect appear 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/Engineers or his representative.

7. SPARES

Along with the quotations for supply of the exhaustor, the tenderer shall also furnish a recommended list of spares for two years and quotations thereof, The tenderer shall also agree to hold the price of spares for a period of one year from the date of the supply of exhaustors.

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8. INFORMATION/DATA TO BE FURNISHED BY THE TENDERER

8.1 Data as per Annexure I shall be furnished by the tenderer alongwith the quotations in triplicate. tenderers shall also furnish the following information alongwith the quotation.

- .1 Location of the factory
- .2 Name and address of authorised stockists for spares.
- .3 Whether the type of exhauster proposed to be supplied has already been in service in rail application, and the name of the country/railway where it has been used.

8.2 Detailed information as per Annexure II shall be furnished by the tenderer if an order is placed.

9. TOOL KIT

9.1 For every exhauster units, or part thereof, a complete tool kit shall be supplied, free of cost.

9.2 The price for tool kit, when procured independent of the order, shall be indicated for information alongwith the quotation of the exhauster.

10. MAINTENANCE MANUALS

10.1 The tenderer shall supply 3 copies of exhaustive; fully illustrated manuals covering among other items, the following vital details, to the "Purchasers" and "Engineers" at the time of submission of the tender.

- .1 Description and arrangement
- .2 Technical data
- .3 Commissioning instructions
- .4 Dismantling and assembly instructions.
- .5 Particulars of indigenously available recommended lubricants.

- .6 Periodical inspection and maintenance schedule.
- .7 Maintenance instructions along with trouble shooting instructions.
- .8 Testing procedure for the equipment and other auxiliaries.
- .9 Wear limits for vital components.
- 10 Detailed parts catalogue with description of items. The parts shall be detailed by sketches to facilitate ordering.
- .11 Instructions for reclamation of worn out components.
- .12 List of special tools with instructions for use.
- .13 Detailed packing and storing instructions.

9.2 Two copies of maintenance manuals shall be supplied with the first machine one each to the Engineer and the purchaser.

9.3 One copy of maintenance manual shall be supplied with every 10 exhaustor sets and part thereof.

10. TRAINING

The supplier shall provide facilities for free training of the railway maintenance staff at their works on aspects of maintenance; overhaul and testing of equipment.

11. GUARANTEE

11.1 Any component found to be defective either due to bad workmanship, design or faulty material within a period of 18 months, from the date of commissioning and 20 months from the date of receipt of the exhaustor in the consignee premises (which ever is earlier) shall be replaced by the purchaser free of cost. The free replacement items shall be supplied expeditiously to the user of the

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locomotive employing the subject exhausters. The replaced components if proved unsatisfactory in service, shall be replaced by the modified and improved components by the supplier at his own cost.

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ANNEXURE 1

BROAD TECHNICAL FEATURES OF THE EXHAUSTER

1. Type, make and model.
2. Displacement/swept volumes at minimum and maximum speeds (also indicating the minimum and maximum speeds).
3. Graph showing free air delivery against vacuum levels of 0 to 85% at minimum and maximum rated speed.
4. Leakhole Vs vacuum graph with varying leakholes and without leak holes (leakholes to be provided in a chamber of 35 litres volume) at slow and high speed.
5. Maximum permissible temperature at inlet and exhaust ports.
6. Horse power consumption at different vacuum levels and speeds as indicated in para 3 above.
7. Weight of the unit complete with accessories.
8. Details of drive arrangements.
9. Details of couplings (if used) including alignment data and method of checking alignment.
10. Details of mounting arrangement with overall dimensions.
11. Overall space requirements inclusive of all accessories (layout drawings should be supplied).

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1. Type, make and model.
2. Details of technical collaboration(if any).
3. Basic design data
 - 3.1 If reciprocating type,
 - .1 Cylinder arrangement.
 - .2 No. of cylinders.
 - .3 Cylinder dia. and stroke.
 - .4 Details and expected life and vital components like suction and delivery valves, piston, rings, small and big end bearings, etc.
 - .5 **Dimensions**, material specification, heat treatment and method of manufacture of:-
 - Piston
 - Piston rings
 - Cylinder heads
 - Valves
 - Crankshaft
 - Connecting rod.
 - Crankcase.
 - 6 No. and type of main bearings.
 - 7 Lubricating system, if by pump, details of the pump including working principles, drawings and life of wearing parts.
- 3.2 If rotary (Vane/lobe) type
 - .1 Barrel dimensions.
 - .2 Rotor dimensions.
 - .3 Lobe profile (if lobe type)

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- .4 No. and material of blades.
 - .5 Floating ring/drum dimensions and material
 - .6 Side clearance between the rotor and end covers.
 - .7 No. and type of main bearings.
 - .8 Lubricating system - if by a pump details of the pump including working principles, drawings and life of wearing parts.
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4. Technical specification of coupling (if used) including dimensions and material specification for the key and assembly drawings of the coupling on shaft calculations indicating life of coupling with regard to maximum and continuous torque of the motor also be submitted.
 5. Direction of rotation
 6. Type and details of air filters used in the exhauster i.e. suction inlet and lube oil suction filter etc.
 7. Lube oil consumption at different speeds.
 8. Sump capacity
 - i) Maximum dipstick level.
 - ii) Minimum dipstick level.
 9. Recommended brands of lubricating oil
 10. Materials used for gaskets and seals. Submit specification and drawings of oil seals.
 11. Location of rubber or synthetic sealing media, if used.
 12. Details of cooling fan including mounting drawings.

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AMENDMENT TO SPECIFICATIONS FOR COMPRESSOR,
EXHAUSTER AND EXPRESSOR UNITS.

5.2.3-4-1

Endurance Test:

Endurance test is a continuous test and shall be carried out by running the expressor/compressor/exhauster with compressor delivery pressure at 10 kg/cm² and with the exhauster at 80% vacuum, with compressor, exhauster or expressor running at maximum rated speed. The test shall be of 400 hours duration. Normally, interruptions are not permitted during the testing except under following circumstances:-

- (i) Interruptions are permitted if any adjustment is required to be carried out during the course of testing which warrants stopping of compressor/exhauster or driving 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 and the period of endurance testing prolonged by this aggregate amount.
- (ii) During endurance test, a maximum of 4 interruptions shall be tolerated when they are required for attending defects in the equipment but in such case more than 20 minutes shall not be allowed to lapse between the interruption 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 totalled 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.
- (iii) If endurance testing is interrupted for reasons unconnected with compressor/exhauster such as due to defect in drive motor and coupling, the test should be started within 24 hours, after the interruption. Only one such interruption will be allowed and in case the testing is interrupted by more than one interruption, RDSO or its representative shall decide whether the endurance tests must be recommenced from the beginning or merely prolonged for the period equal to that of interruption. In case of such interruption, the reasons of interruption as well as time of beginning and end of the interruption should be entered in the column provided immediately after data prior to interruption.