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भारतीय मानक मसौदा

**सामान्य प्रयोजन एवं औद्योगिक अनुप्रयोगों हेतु प्रत्यागामी
वायु संपीडकों के लिए तकनीकी आपूर्ति की स्थिति**

(आई एस 17093 का पहला पुनरीक्षण)

Draft Indian Standard

**TECHNICAL SUPPLY CONDITIONS FOR RECIPROCATING AIR COMPRESSORS
FOR GENERAL PURPOSE AND INDUSTRIAL APPLICATIONS**

(First Revision of IS 17093)

ICS 23.140

Turbo Machinery
Sectional Committee, MED 22

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FOREWORD

(Formal clause to be added later)

This standard was first published in 2019. The present revision has been taken up with a view to incorporate the following changes:

- a) General Requirements, provisions for Piston rings and valves have been modified.
- b) Provisions for forced feed lubrication has also been modified.
- c) Provision for air and water pipes for hydro test has been included.
- d) Provisions for instrumentation in clause 19.2 has been added.
- e) Annex B, Annex C and Annex D has also been modified.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded-off value should be the same as that of the specified value in this standard.

Draft Indian Standard

**TECHNICAL SUPPLY CONDITIONS FOR RECIPROCATING AIR COMPRESSORS
FOR GENERAL PURPOSE AND INDUSTRIAL APPLICATIONS**

(First Revision of IS 17093)

1 SCOPE

This standard specifies general requirement of intermittent or continuous duty reciprocating air compressors for stationary application.

2 REFERENCES

The standards listed in Annex A contain provisions, which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard definitions given in IS/ISO 3857-1 and IS/ISO 3857-2 shall apply.

4 MATERIALS OF CONSTRUCTION

4.1 Materials used for manufacturing of compressor components and parts shall conform to standards listed in Annex B.

4.2 Pressure casted cast iron is accepted for pressure components subject to passing of following tests:

- a) Hydraulic test at 1.5 times the maximum operating pressure, or
- b) Pneumatic test at maximum operating pressure.

4.3 All castings shall be sound, free of shrink, blow holes, cracks, scale blisters or other similar injurious casting defects. Surfaces of castings shall be cleaned by sand blasting, shot blasting, pickling or any other equivalent process.

5 ENQUIRY AND PROPOSAL

5.1 Enquiry

The purchaser shall complete the data as given in Annex C to the extent possible and applicable and also specify any known abnormal working conditions. In addition, purchaser may also specify additional requirements, if any.

5.2 Proposal

5.2.1 In reply to the enquiry by the purchaser, the supplier shall supply a list of all the components along with any other details required by the purchaser.

5.2.2 The proposal shall include either a specific statement that all equipment are in strict compliance with this standard and purchaser's specifications or where supplier is unable to comply to all requirements a specific list of deviation(s) shall be furnished.

5.2.3 The supplier shall also submit a list of spare parts which are recommended for normal maintenance of the machine for a period of 2 years or 4 000 operating hours or one overhaul whichever is earlier.

5.2.4 If required by the purchaser, the charges for deputing suppliers' representative for supervision of erection shall be furnished.

5.2.5 The condition for erection and commissioning of compressor shall be as specified in the contract or order.

5.2.6 The supplier shall quote for any special tools required for installation and maintenance work.

5.2.7 *Conflicting Requirements*

In case of conflict between this standard and the enquiry or order, the agreement reached between the purchaser and the supplier shall form a part of the order & that shall govern the supply.

5.2.8 The supplier shall assume full responsibility of design, manufacture, testing, delivery, installation, startup and trial run of the machines as per scope agreed with purchaser. Supplier also shall assure performance guarantee of the complete system supplied by the supplier.

6 GENERAL REQUIREMENTS

6.1 Compressor, prime mover and auxiliary equipment shall be designed for the required duty at the specified operating conditions and for rapid and easy maintenance, particularly regarding packing and valves.

6.2 Parts subjected to air pressure shall have sufficient strength.

6.3 Where special area classification for electrical and instrument is specified, these shall be followed for the design and construction of those items to meet the relevant safety requirements.

6.4 Design shall be such that no part of the compressor shall easily cause mechanical or electrical failure.

6.5 Compressor shall be free from excessive vibrations and ready for normal operation as per ISO 20816 (Part 8).

6.6 If electrical prime-mover is used, proper earthing shall be ensured.

6.7 Every part shall have the interchangeability and shall be so constructed as not to cause any change in the performance by changing a part.

6.8 Parts shall be manufactured to 'fits and tolerances' as per IS 919 (Part 1).

7 CYLINDER AND CYLINDER HEAD

7.1 Maximum allowable working pressure shall exceed rated discharge pressure by at least 10 percent or 1 bar whichever is greater but must not be lower than safety valve set pressure.

7.2 Cylinders without liners and having bore of 150 mm and above shall have wall of sufficient thickness to provide for a total of 1.5 mm in diameter for re-boring without affecting the maximum allowable working pressure and maximum allowable rod loading.

7.3 Cylinders shall be spaced and arranged to permit access to all openings, valves, packings and controls without removing the cylinder, cylinder head or major piping.

7.4 Cylinder shall have cooling provision as required by service conditions.

7.5 The design pressure of water jacket in case of watercooled compressor shall not be less than 5 bar.

7.6 Cylinder wall and cylinder head which are directly subjected to the pressure shall have adequate wall thickness and uniformity which is generally acceptable per practice.

7.7 Cylinder head shall bear the hydrostatic test of the same pressure with that of the cylinder. When gaskets are inserted between the cylinder and the cylinder head, a gasket of uniform thickness, heat resistant, oil proof and pressure resistant shall be used. This shall be as per ISO 7483.

8 PISTON, PISTON RINGS AND PISTON ROD

8.1 Piston shall be carried by connecting rod with piston pin or piston rod with piston nut of adequate design.

8.2 Piston shall have suitable material to withstand design pressure taking into account the optimum case of operation.

8.3 Piston shall have sufficient number of piston rings and grooves and piston rings shall be accurately finished.

8.4 Piston pin shall have adequate hardness and surface finish depending upon the compressor design (whether lubricated or oil-less type).

8.5 The manufacturer shall make available readily oversize pistons and rings to conform to standard oversize cylinder bores as per **7.2**.

8.6 Connecting rod shall have suitable material with adequate strength for design operating condition.

8.7 Small end and big end bearings shall be in accordance with the connecting rod material selected. Depending upon the connecting rod material and whether lubricated or oil-less type compressor, the bearing type shall be selected.

8.9 In case piston rod is used, the attachment shall be positively locked.

8.9 Piston rods shall be furnished with fine threads. Piston rod material shall be alloy steel of suitable schedule. Wrought steel rods shall be surface hardened in the packing area to a hardness of 50 HRC (*Min*), and shall be inspected for cracking. Piston rods for use in corrosive environments shall be suitable for the service.

8.10 The actual rod loading, calculated on the basis of maximum allowable working pressure, oversized pistons, if applicable and considering part load operation, shall not exceed the manufacturer's maximum allowable rod-load for the compressor. Calculations supporting the same shall be made available to purchaser on demand.

9 VALVES

9.1 The valve, retainer and associated fitting design shall be such that valve assemblies cannot be inadvertently reversed nor a suction valve assembly be fitted into a discharge part.

9.2 If gaskets are used between valve seat and cylinder they shall be metallic, metal shrouded or of any other suitable material which can withstand operating pressure, temperature and oil.

9.3 Spring design shall be such as not to damage the valve plate.

9.4 Valve shall be held down by suitable means such that it seats properly in valve seat.

9.5 Suction and delivery valves shall be designed such that they operate smoothly, prevent counter flows of the air, failures and resting.

9.6 Valve disc and spring shall be such as to withstand the corrosion in the designed operating conditions.

9.7 The valve and cylinder design shall be such that neither the valve guard nor the assembly bolting can fall into the cylinder even if the valve assembly bolting breaks or unfastens.

10 CRANKSHAFT, CONNECTING ROD AND BEARINGS

10.1 Crankshaft shall be suitably designed and shall have suitable material with adequate strength for the design operating conditions.

10.2 Crankshaft shall be in one piece (but may have provision for removable counter weights) and shall be suitably heat treated, ground and lapped.

10.3 Crankshaft shall be adequately supported by bearings suitably selected to meet the design operating condition.

10.4 The crankshafts which are not forged and not symmetrically machined shall be balanced dynamically if the operating speeds exceed 800 rev/min (applicable for > 25 kW).

10.5 Any holes required for lubrication in crankshafts or connecting rod shall be drilled and not cored.

10.6 Bearing shall be precision plain, ball or roller type and shall be replaceable and capable to withstand the shaft load for prolonged usage.

10.7 Cross-head on horizontal compressors with more than 125 kW shall be of forged or cast steel or spheroidal cast iron of suitable grade or any other suitable material with adequate strength for maximum allowable operating conditions.

10 SOLEPLATES AND RAILS

11.2 When soleplates or rails are required for items supplied, they shall be provided by the supplier.

11.2 Soleplates, rails or compressor parts to be grouted (such as a crankcase or a cross-head frame) shall be drilled and tapped for levelling screws. Screws for levelling and bolts for attaching the frame to the soleplate or rail shall be provided by the supplier.

11.3 Compressor for installation in dusty environments shall have distance pieces equipped with covers. Compressors for outdoor installation shall have distance piece equipped with suitable covers to prevent ingress of moisture and dust.

11.3.1 Special Requirements for Non-Lubricated Construction

The compressor shall be provided with an extra-long distance piece of sufficient length to prevent oil carry over. The piston rod shall be equipped with oil slinger and crank end of housing shall be equipped with oil wiper rings (for > 25 kW).

12 FRAME AND CYLINDER LUBRICATION

12.1 Lubrication System shall be provided such that it satisfies the need for compressors'

maximum design conditions and lubricates crankshaft, journals, bearings, cylinder walls, etc adequately. The method of lubrication may be splash type or positive pressure type.

12.2 Bottoms of crank chambers are formed as oil reservoirs (except oil-less) and they shall prevent oil leakages and dust intrusions from open air.

12.3 Lubricating oils or greases shall be selected depending upon the compressor design needs, which, as far as possible, shall be readily available.

12.4 In case of pressure lubrication cylinders and packing, a forced feed mechanical lubricators complete with piping and sight flow indicator to each lubrication point shall be provided. The lubricator shall be capable of adjustments for full rate. A check valve shall be provided at each lubrication connection. The forced feed lubrication system shall draw from a reservoir having a capacity for minimum 24 h working. The cylinder lubrication shall have provision for hand cranking prior to compressor start-up.

12.5 In case of pressure lubrication, the oil pump shall be driven by a separate motor or directly through the shaft. This pump shall be positive displacement type and protected by a relief valve.

12.6 A full flow oil filter suitable for operation at pressure not less than relief valve set pressure shall be provided.

12.7 If required, a suitably designed oil cooler shall be provided to maintain oil temperature within limits.

13 PISTON RINGS AND OIL WIPER RINGS (FOR LUBRICATED CYLINDER COMPRESSORS)

Piston rings of adequate size and design shall be provided so that they compress the air effectively. It shall offer minimum of rubbing resistance and minimize air leakage from high pressure side.

13.1 Oil Wiper Rings

Shall be provided such that they adequately wipe oil from cylinder walls and allow minimal of oil carryover with the discharge air.

13.2 Piston Rings and Wear Bands (For Oil-less Cylinder Compressors)

For an oil-less application, piston ring material shall be suitably selected to meet this special requirement. The filler material for piston rings shall be suitably selected to give longer compressor running period and better heat dissipation.

13.3 Wear Bands

13.3.1 Wear bands of adequate size and design shall be provided on piston to ensure its proper running within cylinder and avoid metal-to-metal contact. Its material shall be suitably selected

to meet the special need for air to be oil-less and along with this the filler material shall also be suitably selected to give better life and heat dissipation.

14 PRIME MOVER AND DRIVE EQUIPMENT

14.1 General

The purchaser shall specify in the enquiry the type of prime mover required, namely electric motor, diesel engine, spark ignited engines, etc.

14.2 The drive may be through gear box, belt or directly connected as appropriate.

14.3 In case, the prime mover is required to be supplied along with the compressor the purchaser shall specify in the enquiry the technical data of the prime mover design (type of motor, electrical supply characteristics, type of engine, etc.) and also the relevant Indian or international standard or code to which the same shall conform.

14.4 The rated power of the prime mover shall be higher by minimum 5 percent from the maximum power required under any operating conditions (maximum power includes shaft power or brake power plus all transmission losses).

NOTE — The above margin includes any required tolerances on capacity and power consumption according to IS 5456.

14.5 The prime mover shall have sufficient starting torque and capable of starting the compressor from a stopped condition and running it up to full speed taking into account that the compressor commences discharging against the rated discharge pressure from start up.

14.6 When the prime mover is to be procured by the purchaser the supplier shall furnish the following data:

- a) Compressors and transmission starting torque characteristics;
- b) Inertia value (GD^2);
- c) Mounting or coupling details or both;
- d) Maximum power required under worst operating condition; and
- e) Maximum power at relief valve set pressure.

14.7 In case of turbine driven compressors, they shall be provided with an over-speed shutdown device capable of being manually tripped and re-set. The over-speed trip shall be such as to prevent running at a speed greater than the maximum allowable speed.

15 AUXILIARY EQUIPMENT

15.1 Coupling

15.1.1 Where a coupling is provided, it shall be suitable for the maximum shaft power of compressor. The coupling shall conform to IS 2693. Any coupling other than that covered by IS

2693 shall also be acceptable, if mutually agreed by the supplier and the purchaser.

15.1.2 The coupling design shall be such that it or its wearing parts can be replaced without dismantling the internal parts of the compressor or the prime mover. This does not prohibit shifting of prime mover from its location.

15.2.3 Coupling shall be suitable for expansion and any other movement of the shaft.

15.2 Reduction Gears

15.2.1 Gears shall be of suitable design and make. Accuracy requirements shall be as per IS 3681 or any other international standards.

15.2.2 Reduction gear shall be suitable for power transmission on continuous operation basis for maximum shaft power of the compressor.

15.3 Belts

15.3.1 In case of belt drives, the 'V' belts shall be according to IS 2494 (Part 1) and flat belt shall conform to IS 1370.

15.3.2 If more than one 'V' belt is required a matched set shall be supplied. A banded V-belt can also be considered.

15.3.3 Auto belt tensioner or any other positive belt tensioning device/arrangement shall be provided for all belt drives.

15.3.4 When belt driven compressor is considered, belts shall be selected to transmit maximum shaft power of the compressor and shall be provided with the properly designed safety guard. The slide rails, if used under motor for taking up belt slackness, shall be selected such that it provides sufficient room for tightening.

15.4 Filters

15.4.1 The purchaser may specify any special requirement regarding filtering particle size in microns and required efficiency, otherwise manufacturer may furnish the standard filter and state the normal cleaning interval.

15.4.2 The purchaser shall specify if there is any particular atmospheric pollution adjacent to the compressor so as to enable the manufacturer to select a proper filter.

15.4.3 Suction filters shall be selected such that they offer minimum resistance to suction and shall be effective for dust removal.

15.4.4 The position of filter shall be such as to permit easy cleaning and replacement. Filter shall be placed as close to compressor as possible and suck air as near to the atmospheric temperature as possible.

15.4.5 For non-lubricated compressors, dry filters shall be furnished.

15.5 Coolers

Intercoolers and after coolers shall be designed on the air side to the design pressure not less than the safety valve set pressure. The design pressure for the water side shall be 5 bar as or specified by purchaser, whichever is higher.

15.5.1 Intercoolers

In case shell and tube type of coolers are used, the design and construction of the same shall be in accordance with IS 4503 or any other international standards.

15.5.2 Intercoolers

Double or multi-stage compressors shall be so constructed that heat generated in the first stage cylinder shall be discharged and the compressed air temperature shall be reduced, by installing an intercooler between successive stages.

15.5.3 The water side shall be designed for a maximum pressure drop of 1 bar.

15.5.4 The fouling factor to be used on water side shall be agreed between purchaser and supplier but shall not be less than $0.0004 \text{ m}^2\text{h}^\circ\text{C} / \text{kcal}$.

15.5.5 For oil coolers, if the water is on shell side, the tube bundle shall be removable. It is expected that the intercoolers and after coolers shall have normally water on tube side. However, water on shell side shall also be acceptable if agreed between purchaser and supplier.

15.5.6 The cooled air shall be brought to within 10°C of cooling water supply temperature. Higher cold temperature difference (CTD), if agreed by purchaser, shall be designed with due considerations on the overall performance and reliability.

15.5.7 Other type of coolers such as brazed plate heat exchangers, if approved by purchaser, shall be designed for reliability, performance and ease of maintenance and shall meet performance requirements of the compressors.

15.6 Air Receivers

15.6.1 Maximum working pressure of the air receiver shall be higher than the rated pressure of the compressor according to IS 7938.

15.6.2 Air receiver shall be of circular shape and the end plates shall be of dished or semi-spherical shape and shall have sufficient strength. Air receivers shall conform to IS 7938.

15.6.3 Air receivers upon which equipment such as compressors are mounted shall be capable to

withstand the stresses due to weight and starting and stopping forces of the machine.

15.6.4 The design pressure of separators and air receivers shall be equal or greater than the pressure rating of the preceding cooler.

15.6.5 The air receiver provided after final discharge shall be according to IS 7938 or any other international standard.

15.7 Moisture Separators and Traps

15.7.1 Proper arrangements shall be made to remove oil and condensate after each stage coolers and receivers.

15.7.2 If separators are provided for the purpose, they shall be highly reliable and offer least resistance to compressed air flow.

15.7.3 The design pressure of separators and air receivers shall be the same as that of the preceding cooler.

15.7.4 Where automatic drain traps are used, these shall be provided with isolating valves with bypass arrangement to allow trap maintenance with the compressor running to remove condensate. Automatic drains shall be of reliable design and shall not cause any loss of compressed air during operation.

15.8 Base Plate

Base plate shall be of suitable construction to withstand the weight of the compressor unit and the driving prime mover along with the associated vibration developed.

15.9 Frame

Frame shall be designed such that it offers maximum sturdiness, hence low level of vibration. In the case of lubricated frame, the frame shall have adequate size of oil sump capacity to meet the need of maximum design condition, which also offers good surface area for cooling of sump oil, in the case of totally oil-less compressor the crankcase need not have the oil sump in frame but shall be sturdy enough for keeping compressor vibration level to minimum and offer better air cooling.

16 SAFETY DEVICES

16.1 Guards

16.1.1 Removable guards shall be provided on all movable parts which are likely to be hazardous to operating personnel.

16.1.2 If guards are not easily removable type, opening, if necessary with covers or suitable

mechanism shall be provided to have access for any part requiring attention or for rotating parts manually. As a safety precaution, fixtures are preferred while rotating parts manually. Guards shall be designed as per IS 9474/ IS 16811.

16.2 Safety Valves

16.2.1 Each stage shall be protected by a safety valve. This safety valve shall be dimensioned for full compressor capacity with set pressure not more than maximum allowable working pressure for that stage.

16.2.2 Safety valve shall be provided on inter-stage manifold or inter-stage piping for multistage compressor. In case when more than two stages, each inter-stage shall have suitable safety valve. When the air receiver is provided it shall be fitted with a suitable safety valve.

16.2.3 The safety valves shall be designed and mounted in such a manner that the setting is not disturbed by the vibration.

16.2.4 No additional safety valve after the final stage is required if a safety valve of proper size is provided on the air receiver and there is no isolation valve between discharge of the final stage and the air receiver.

16.2.5 Multistage compressors shall be provided with a safety valve at each of the suction side from second stage onwards to prevent abnormal pressure rising and to ensure the safety of the unit (optional for < 60 kW).

16.2.6 Safety valve shall be free from rusting and disorder even when they are not in use for a long period.

16.3 Other Safety Devices

16.3.1 Compressor shall have mechanical unloaders (for example, centrifugal unloaders) or any other suitably designed device so that at starting of the compressor it starts on no-load condition. When the motor picks up full speed only then the compressor begins to develop set pressure (optional for < 25 kW, but shall specify effective method for safe operation).

16.3.2 Automatic control system for unloaders shall be fitted as to be operated against the static pressure of the air receiver and accurately operated when reached to the operating pressure. Also the pressure in the air receiver shall not rise when the air inlet valve is unloaded. Their operations shall be accurately restored when reached to the recharging pressure. Generally, this is given when constant speed control is required.

16.3.3 Pressure switches/transmitter shall be so fitted as to be operated against the static pressure of the air receiver. The operations shall be accurate and repeatable and their contact points shall be durable.

16.3.4 For compressor crankcase oil level, a low oil level switch shall be provided (optional for < 60 kW). When pressure feed lubrication is supplied, low lube oil pressure protection

(switch/transmitter) shall be provided.

17 PIPING

17.1 When given as a package with receiver or base plate all pipe work required for the functioning of the compressor to be provided.

17.2 The scope of supply of pipe work by the supplier shall be properly defined with terminal points clearly fixed and identified.

17.3 The supplier shall supply all pipe work to inter-connected items of his supply reducing the number of terminal points for the purchaser's connection, to a minimum when the scope of supply shall be as mutually agreed upon.

17.4 Auxiliary pipe work required for lubricating oil, cooling water, drain and vent and instrument air shall be machine mounted in fully erected and fabricated condition unless otherwise specified.

17.5 Unless otherwise specified the supplier shall supply the pipe work to the standard of his own choice but shall be as indicated in the offer.

17.6 The pipe work shall be free of rust, slag, welding beads and other foreign matter. Pipe shall be coated with suitable rust preventive coating.

17.7 The water pipe-work shall be fitted with high point vent and low point pipe drain connection such that the entire system can be vented and drained.

17.8 Each parallel water circuit for the jacket shall incorporate a sight glass (> 60 kW).

17.9 For auxiliary lubricating oil pipe-work, the pipe down stream of oil filter and if made of Carbon steel shall be duly pickled after fabrication.

17.10 All air and water passages shall be hydro tested before installation.

18 VIBRATION AND CRITICAL SPEEDS

18.1 In case the entire system is supplied by the compressor manufacturer supplier shall assume full responsibility for the performance of the system, necessary torsional studies and elimination of any lateral or torsional vibrations that may hinder the operation of the complete unit within the specified operating range in any specified loading step. Pulsation study to be considered as per IS 11421 or ISO 13707.

18.2 The manufacturer shall state the speeds (from dead stop up to or down from trip speed or synchronous speed) at which all critical speeds occur. If a gear reducer is provided, the design of the compressor driver train shall prevent any torsion from exceeding the limits allowed by any major component (compressor, prime mover, gear coupling, or the like) of the train.

18.3 Torsional natural frequencies of the prime mover/Drive train of compressor system (including couplings and any gear unit) shall be avoided within 5 % of any multiple of operating shaft speed in the rotating system up to and including the tenth multiple.

NOTE — Torsional analysis is optional for belt driven compressors.

If specified, vibration measurement and acceptance criteria shall be as per ISO 20816 (Part 8).

19 CONTROLS AND INSTRUMENTATION

19.1 Capacity Control

The manufacturer shall provide suitable capacity control to meet the requirement of the purchaser as given in the data sheet:

- a) Automatic start/stop mode of operations: Makes or breaks electric contact to the motor at pre-determined pressures. This type of regulation is used when the demand of air is small or intermittent, but where pressure shall be continuously maintained.
- b) Constant speed mode of operations: Unloads the compressor at a pre-determined pressure while the motor continues to operate. Manufacturer shall specify maximum allowable continuous unload running time and provide interlocks to safeguard the machine from damage due to continuous unload condition. This type of regulation is used when the demand for air shall be practically constant at the capacity of the compressor.
- c) Dual control permits a manual selection between constant speed control and automatic start and stop control, depending upon the air requirements.

19.2 Instrumentation

The following instruments shall be included in supply which is considered as normal requirement. Extra instruments as specified by the purchaser shall also be included.

- a) Air side
 - 1) Air outlet pressure gauge / transmitter;
 - 2) Interstate pressure gauge / transmitter (optional for < 60 kW);
 - 3) Outlet temperature gauge / switch / transmitter for each stage (>150 kW essential and < 150 kW optional);
 - 4) Inter stage temperature gauge before and after inter cooler (optional);
 - 5) Air filter pressure drop indicator;
 - 6) High discharge air temperature; and
 - 7) High discharge air pressure switch/transmitter.
- b) Lube oil side
 - 1) Oil sump level indicator;

- 2) Pressure gauge or DPT (for pressurized systems only) > 60 kW (essential), < 60 kW (Optional);
 - 3) Cylinder lube oil tank level (for lubricated compressors only);
 - 4) Differential pressure indicators on filter (optional < 60 kW);
 - 5) Temperature gauge/transmitter (optional);
 - 6) Low pressure alarm (< 60 kW optional); and
 - 7) Low pressure trip.
- c) Cooling water side
- 1) Cylinder jacket flow indication for each parallel circuit (optional for < 150 kW);
 - 2) Temperature gauge/transmitter cooling water (optional);
 - 3) Flowmeter for cooling water (optional); and
 - 4) Trip for cooling water flow / Pressure failure.
 - 5) Cooling water pressure gauge

20 MARKING

20.1 The following particulars shall be marked in the name plate and mounted at a visible location on the compressor:

- a) Description and model;
- b) Rated pressure of compressor;
- c) Rotational speed;
- d) FAD at the rated pressure of compressor;
- e) Registered trade mark or name of the manufacturer;
- f) Serial No. and year; and
- g) Maximum allowable discharge pressure.

20.1.1 Name Plate shall be securely attached at an easily accessible point on the compressor and any other major auxiliary equipment. Name plate shall be made of metallic plate with all details embossed or printed with permanent ink suitable for industrial environment.

20.1.2 Rotation arrows shall be cast in or attached appropriately to indicate the direction of rotation.

20.2 BIS Certification Marking

The reciprocating air compressor may also be marked with the Standard Mark.

20.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations made thereunder. The details of the conditions under which the license for use of the Standard Mark may be granted to the manufacturers or the producers may be obtained from the Bureau of Indian Standards.

21 INSPECTION AND TESTS

21.1 The purchaser shall specify if shop inspection by purchaser is required and the tests which are required to be witnessed.

21.2 Where shop inspection is specified:

- a) Inspector representing the purchaser shall have free access at all reasonable times to manufacturer's plant while work on or testing of equipment is being performed;
- b) The purchaser shall receive prior notice of at least a week about mechanical/performance test where this has to be witnessed;
- c) No pressure parts shall be painted unless inspection is completed;
- d) The manufacturer shall furnish the inspector with all necessary certificate on materials, shop data on pressure vessels etc, to verify whether the specifications as per the order are met;
- e) Inspection by purchaser's Inspector shall not relieve compressor manufacturer of his responsibility in any way; and
- f) If agreed between purchaser and manufacturer, material certificates can be provided for critical components.

21.3 Cleanliness

The compressor including all cast-in passages and piping and vessels furnished by compressor supplier shall be fully cleaned to remove all dirt, rust, mill scale, welding beads or slags or other foreign matter.

21.4 Tests on Compressors

The tests other than hydrostatic and pressure tests shall be in accordance with IS 5456 unless and otherwise specified. If mutually agreed by the purchaser and supplier tests performed as per international standard is also acceptable.

21.5 Recommended tests are enlisted hereunder. Compressors may be tested using a suitable motor, when compressors which are shipped without equipping a prime mover are to be tested:

- a) Volumetric and overall efficiency (type test), (optional);
- b) Lubricating oil consumption (type test) (optional);
- c) Capacity (routine test);
- d) Specific power consumption from no load to full load (routine test);
- e) Speed (routine test);
- f) Testing of unloader (routine test); and
- g) Safety valve test (routine test).

NOTE — The details of the above tests shall be as per IS 5456 or any other code or standard mutually agreed between purchaser and manufacturer.

21.6 The piping, pressure vessels, filters, coolers and the like shall be subjected to the hydrostatic test pressure of 1.5 times the maximum allowable working pressure but not less than 0.7 MPa, in accordance with the specified code or as specified by the purchaser. The air receiver shall be tested according to IS 7938 and coolers according to IS 4503.

21.7 Safety valves shall be tested for smooth functioning and pressure for which it is installed.

22 PREPARATION FOR DISPATCH

22.1 After test and inspection are completed all exposed machined surfaces shall be coated with suitable rust preventive material. Cylinder, pistons, coolers, process piping etc. shall be cleaned and suitably protected to prevent corrosion.

22.2 Unmachined external surfaces shall be cleaned thoroughly and painted with suitable paint.

22.3 All openings shall be provided with suitable closure to prevent entry of duct and foreign materials.

22.4 Each unit shall be suitably packed for at least three months storage. Purchaser may specify for packing suitable for outdoor storage or long term storage as an option.

23 Guarantees

23.1 *Performance Guarantee*

The compressors shall be guaranteed for satisfactory performance at the specified operating conditions. These include a guarantee for capacity and powers at the time of performance test. Tolerances to be allowed on the capacity and power consumption shall be in accordance with IS/ISO 1217 or any other international standard.

23.2 *Workmanship Guarantee*

All equipment, components and spare parts other than bought out items shall be guaranteed by the supplier against defects which despite proper use and maintenance appear therein and arise from defective or improper materials or poor or faulty design or workmanship. This guarantee shall be applicable for a period of 18 months from dispatch or 12 months from the date of installation whichever is earlier. If any defects or mal-performance is established during the guarantee period, the supplier shall make all necessary or desirable alterations, repairs and replacements free of charge.

23.3 Special warranty terms, if any, may agree between purchaser and supplier at the time of placement of order.

23.4 Supplier shall negotiate guarantee terms of bought out item and pass on the same to purchaser.

24 Documentation

24.1 The following data and drawings shall be furnished by the supplier, in addition, any other documentation mutually agreed between the purchaser and the supplier before placement of the order shall be furnished.

24.2 Manufacturer shall provide data as required by data sheet given in Annex D along with deviations and exception etc. if agreed at the time of placing order.

24.3 Provide overall arrangement drawing of the compressor, prime mover and other accessories. This drawing shall also show the following:

- a) All principal dimensions, including those required for purchaser's foundation and maintenance and withdrawal space;
- b) Direction of rotation of drive shaft;
- c) Position of foundation bolts; and
- d) Overall weight, erection weight and purchaser's connection.

24.4 If the prime mover is not included in the supply, the relevant requirement data for the prime mover shall be supplied.

24.5 Supply schematic drawing of control system when required and not covered in the maintenance and operating instruction book, cooling system and outline dimensional drawing for accessories such as after coolers, instrument panel, etc. Make, type, size, etc, shall be indicated for all these accessories.

24.6 Maintenance and Operating Instructions

These instructions shall be such that they include assembly type drawings, showing all customer serviceable parts, torques for tightening fasteners, lubricating oil data and other instructions and guidance given for satisfactory operation of the compressor, accessories, etc.

24.7 Certificates of pressure vessels as per relevant code to which these are designed and manufactured shall be provided.

24.8 Materials certificate for material used in manufacture of compressor and all test reports for mechanical, performance tests and any other tests shall be provided if agreed at the time of placing order.

24.9 Required data for ordering spare parts shall be provided.

24.10 The supplier and buyer shall mutually agree on the quantity of hard copies or soft copies of the drawings and documentation.

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>
IS 919 (Part 1) : 2014/ ISO 286-1 : 2010	Geometrical product specifications (GPS) system for tolerances on linear sizes: Part 1 Basis of tolerance, deviation and fits (third revision)
IS 5456 : 2024	Positive Displacement Type Air Compressors and Exhausters – Testing and Acceptance (Third Revision)
IS 2693 :1989	Power transmission — Bush type flexible coupling (second revision)
IS 3681 :1995	Gears — Cylindrical gears — Accuracies (first revision)
IS 2494 (Part 1) : 1994	V-belts — Endless V-belts for industrial purposes: Part 1 General purpose (second revision)
IS 1370 : 1993	Transmission belting — Friction surface rubber belting — Specification (third revision)
IS 4503 : 1967	Shell and tube type heat exchangers
IS 7938 : 2023	Air Receivers for Compressed Air Installation — Specification (<i>first revision</i>)
IS 11421 ; 1985	Techniques of pulsation for suppression for reciprocating compressor
ISO 13707 : 2022	Petroleum and natural gas industries reciprocating compressors
ISO 20816-8	Mechanical vibration — Measurement and evaluation of machine vibration Part 8: Reciprocating compressor systems
IS/ISO 1217 : 2009	Displacement Compressors - Acceptance Test
IS/ISO 3857-1 : 1977	Compressors, pneumatic tools and machines — Vocabulary: Part 1 General
IS/ISO 3857-2 : 1977	Compressors, pneumatic tools and machines — Vocabulary: Part 2 Compressors

ANNEX B

(Clause 4.1)

RECOMMENDED MATERIALS OF CONSTRUCTION

Name of Part	Relevant Indian Standard
Crank chamber	IS 210, IS 1865 and IS 617
Cylinder or cylinder liner	IS 210 and IS 1865
Cylinder head	IS 210, IS 1865 and IS 617
Fly-wheel pulley	IS 210 and IS 1865
Crank shaft	Grade 2 of IS 2004 and IS 2062
Connecting rod	Grade 2 of IS 2004, IS 617, IS 2062
Piston	IS 210, IS 1865 and IS 617
Piston pin	IS 2062 and IS 1170
Bearing bush	IS 318 and IS 305
Crank pin bush	IS 318 and IS 305
Piston pin bush	IS 318, IS 305 and IS 28
Air reservoir	IS 7938 and IS 2825
Base plate	IS 210, IS 1865, IS 2062 and IS 1030
Disc of suction and delivery valve	IS 1170
	IS 4409
Spring of suction and delivery valve	IS 7906 (Part 1 and Part 2)
Disc and seat of safety valve	IS 6603, IS 12992-1 (1993), IS 318 and IS 305
Spring of safety valve	IS 7906 (Part 1) and IS 7906 (Part 2)
Piston rings	IS 8422 (Part 1 to 8)
Roller bearings, ball bearings	IS 6454, IS 6455, IS 6456, IS 6457, IS 6458 and IS 14803 (Part 1)
Bolts and nuts	IS 1364 (Part 1 to 6), IS 1365 and IS 1366

ANNEX C

(Clause 5.1)

DATA SHEET CONTAINING PURCHASER'S SPECIFICATIONS

C-1 GENERAL

- a) Number of units : Running Standby
- b) Site
- c) Service: Continuous Intermittent
- d) Installation Indoor out-door with roof Out-door without roof
- Dusty environment Clean environment
- e) Type of driver : Electric motor Diesel engine
- Petrol engine Other
- f) Prime mover furnished by : Purchaser Supplier

C-2 REQUIRED OPERATING CONDITIONS

C-2.1 Site Data

- a) Site location:
- b) Barometric pressure: _____ bara
- c) Relative humidity: *Max* _____ *Percent Rh*, *Min* _____ *Percent Rh*, Design _____ *Percent Rh*
- d) Ambient temp: *Max* _____ °C, *Min* _____ °C, Design _____ °C
- e) Environmental conditions where machine will be installed
- Clean • Sandy • Dusty • Corrosive atmosphere
- (Provide details _____)
- f) Any special electrical equipment hazard
- Class _____ Grade _____ Division _____
- a) Cooling water supply for compressor cylinder, oil coolers, intercooler and aftercooler
- Soft water Hard water (Details _____)
- Pressure: Supply _____ barg, Return _____ barg
- Temperature: Supply _____ °C, Return _____ °C
- b) Instrument air supply available: Yes No

C-2.2 Electrical Supply Characteristics (Required if Prime Mover is a Motor)

- Phases : 3 Phase Single Phase
- Voltage : 230 V ± 10 Percent 415 V ± 10 Percent

Others (Specify _____)

Frequency 50 + 5 Percent Others (Specify _____)

C-2.3 Capacity Required (Each Machine)

Inlet capacity: _____ SCFM

(Alternatively capacity in _____ standard air or Nm³/h).

C-2.4 Discharge Pressure: _____ barg

C-2.5 Discharge Temperature Required _____ °C

(specify only if after-cooler is required)

C-3 CAPACITY CONTROL

C-3.1 For Maintaining Receiver Pressure at _____ barg

- Suction valve unloaders
- Start-Stop
- Inlet throttling (specify only if particular preference exists)
- Variable Frequency Drive

C-3.2 Any Other Requirements _____

C-4 SPECIAL REQUIREMENT

C-4.1 Non-lubricated Construction: Yes No

C-4.2 Any Special Preferences Air cooled
 Water cooled.

C-4.3 Maximum Allowable Rotational Speed: _____ rpm

C-4.4 Maximum Allowable Cylinder Discharge Air Temperature: _____ °C

C-4.5 Special Materials: _____

C-4.6 Type of Filter: _____

C-4.7 Design code for pressure vessels and exchangers: _____

C-4.8 Fouling Factor Exchanger Design (If Different from Standard):

C-4.9 Standard to which Prime Mover should Conform: _____

C-4.10 Transmission

- V-Belt
- Banded V-Belt
- Flat belt
- Gear box
- Direct connection

C-4.11 Any Special type Couplings: Yes No

If yes, specify: _____

C-4.12 Noise Control Enclosure Required?: Yes No,

If Yes, allowable noise level _____ dbA (as per IS 11461)

C-4.13 Rain Shield Required for Exposed Unloader Parts?: Yes No

C-5 SCOPE OF SUPPLY

C-5.1 Driver Yes No

C-5.2 Additional Instrumentation Yes No (If yes, specify: _____)

C-5.3 Additional Safety Device Yes No (If yes, specify: _____)

C-5.4 Inter-Cooler Yes No

C-5.5 After-Cooler Yes No

C-5.6 Air Receiver Yes No

C-5.7 Inter-stage Piping and Safety Valve Yes No

C-5.8 Filter Yes No

C-5.9 Silencer Yes No

C-5.10 Cylinder Cooling Water Piping Yes No

C-5.11 Cooling Water Piping for Coolers and Intercoolers Single Inlet and Outlet Yes No

C-5.12 Instrument Panel Yes No

C-5.13 Special Tools Yes No

C-5.14 Spare Parts Yes No

C-5.15 Foundation Design Yes No

C-5.16 Piston Rod Drop Indicator Yes No

C-6 INSPECTION AND TESTS

Doc: MED 22 (27735)WC

March 2025

C-6.1 Shop Inspection Required Yes No

C-6.2 Test to be Witnessed Yes No

C-6.3 Cylinder Hydro-test Yes No

C-6.4 Mechanical Run Test Yes No

C-6.5 Performance test Yes No

C-6.6 Dismantling Test Yes No

C-6.7 Run Test of the Prime Mover (At Suppliers' Factory) Yes No

ANNEX D

(Clause 24.2)

DATA SHEET OF SUPPLIER'S OFFERING / SELECTION

D-1 CYLINDER DATA

- a) Number of stages : _____
- b) Number of cylinders per stage : _____
- c) Type of cylinder cooling: Air cooled Water cooled
- d) Type of cylinder arrangement : _____
- e) Single/Double acting: Single acting Double acting
- f) Cylinder liner Yes No
- g) Cylinder liner type Wet Dry
- h) Number of inlet/discharge valves/cylinder : _____
- j) Type of valves : _____

(Optional information at enquiry stage, but to be provided in final documentation)

- k) Outside diameter of liner : _____ mm
- m) Bore : _____ mm
- n) Stroke : _____ mm
- p) Piston displacement : _____ cm³
- q) Percentage clearance : _____ percent
- r) Volumetric efficiency, percent : _____ percent
- s) Valve gas velocity : _____ m/s
- t) Inlet/discharge valve lift : _____ mm
- u) Maximum allowable crank speed : _____ RPM
- v) Normal piston speed : _____ m/s
- w) Rod diameter : _____ mm
- x) Maximum allowable rod loading : _____ KN
- y) Maximum allowable cylinder working pressure : _____ MPa
- z) Maximum allowable cylinder temperature : _____ °C

D-2 SUPPLIER – CUSTOMER INTERFACE INFORMATION:

D-2.1 Suction Flange Size, Facing and Rating : _____ (if applicable)

D-2.2 Discharge Flange Size, Facing and Rating : _____

D-2.3 Cooling Water Inlet connection:

D-2.4 Cooling Water Outlet Connection

D-2.5 Drain header:

D-2.6 Instrument air for suction valve unloaders:

D-3 MATERIAL OF CONSTRUCTION

a) Cylinders :

b) Pistons :

c) Piston rod :

d) Valve seats :

e) Bearing :

(Optional information at enquiry stage, but to be provided in final documentation)

f) Cylinder liners:

g) Piston ring :

h) Rider rings :

j) Piston rod, hardness, HRC :

k) Valve stops :

m) Valve plates :

n) Valve springs :

p) Rod packing :

q) Crankshaft :

r) Connecting Rod:

s) Cross-head :

D-4 UTILITY CONSUMPTION

Cooling water	Cylinder	Lube oil Cooler	Intercoolers	Aftercooler	Packing Case
a) Quantity m ³ /min,					
b) Inlet temp, °C					
c) Outlet temp, °C					
d) Inlet pressure, MPa					
e) Outlet pressure, MPa					
f) Maximum pressure, MPa					

<i>Electric loads</i>	<i>Power Rating (in kW)</i>	<i>Starting Motor (in Amps)</i>	<i>Full Load Current (in Amps)</i>
a) Main prime mover			
b) Main lube oil pump (if driven by a separate motor)			
c) Auxiliary lube oil pump (if driven by a separate motor)			
d) Packing coolant oil pump (if driven by a separate motor)			
e) Frame oil heater Watts Volts Hz
f) Lubricator heater Watts Volts Hz
g) Space heater Watts Volts Hz

D-5 CAPACITY CONTROL

a) Type of control : _____

b) Cut-off pressure : _____ barg

c) Cut-in pressure : _____ barg

D-6 WEIGHTS AND DIMENSIONS

a) Maximum erection mass : _____ kg

- b) Maximum maintenance mass : _____ kg
- c) Total mass less driver and gears : _____ kg
- d) Approximate floor space
Length _____ mm, Width _____ mm, Height _____ mm
- e) Rod removal distance : _____ mm

D-7 RATED OPERATING CONDITIONS (EACH COMPRESSOR)

<i>Parameter</i>	<i>Unit</i>	<i>Comp#</i>
a) Relative humidity:	percent	
b) Inlet temp:	°C	
c) Inlet pressure:	MPa	
d) Pressure drop between stages:	MPa	
e) Discharge temp:	°C	
f) Discharge pressure:	MPa	
g) Compressor Shaft Power:	kW	
h) Transmission losses:	kW	