

VOLUME-2
PART- I
Section-21
LP Compressed Air
System

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21. LP Compressed Air System

21.1 Scope of Work

The intent of these specifications is to define and cover the scope of work under this section which includes the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Purchaser's personnel, handing over to Purchaser and guarantee for trouble free operation of LP Compressed Air System for Keyi Hydro Electric Project, Arunachal Pradesh as per the specifications hereunder, each complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

It is not the intention to specify the minute details/smallest items to deliver a functional system or to define the standard manufacturing practice but to outline the performance, constructional, operational and guaranteed requirements. It is the responsibility of the contractor to ensure these requirements.

21.2 Scope of Supply

Scope of work under this section covers provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation & commissioning, performance testing, acceptance testing, handing over to purchaser, training to Employer's engineers and guarantee of performance of Compressed Air System as per the specifications furnished hereunder each complete with all accessories, spare parts and warranting a trouble free safe operation of the installation as detailed below.

The scope also covers all the equipment & accessories required for completion of the system to give the desired performance even though specifically not mentioned in these specifications

The Compressed Air System shall comprise of:

- Two (2) sets of LP compressors 250LPM each of 100% capacity rotary screw type with common dryer complete with associated accessories for equipment air supply, service air, turbine maintenance seal, and other permanent installations.
- One (1) no. of service air receiver of capacity 0.5m³ complete with manhole/ hand-hole and flanged/ screwed connections for inlet, outlet, safety, instrumentation and other purpose.
- LP compressed air headers and branch piping including all hangers/supports, clamps, fixtures, hardware etc.
- Valves of all types including safety and relief valves, snap-on couplings, moisture tap, drain connections, air filters, oil filters, required for the system.
- Service air hoses of length 30 m with necessary connectors etc. located in wall mounted service air including piping upto turbine for maintenance seal.
- The delivery pressure shall be not less than 7kg/cm² at remote end.
- Necessary Local Control Panel of the compressor.

- Other items not specified but required to complete the system in all respects.
- One set of spare parts.
- One set of special tools.

21.3 Codes and Standards

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / International Standards as given below except where modified and/or supplemented by these specifications.

ISO 9001	Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing.
ASME Code VIII + IX	Pressure Vessel Code
IS 6206	Guide for selection, installation and maintenance of air compressor plants with operating pressure up to 10 bars.
IS 7398	Specification for air receivers for compressed air installation
IS11780	Code for selection and testing of rotary screw air compressor (oil flooded)
IS 12258	Technical supply condition for air screw compressor (oil flooded) for general purpose and industrial application.
ISO 8573-1	Pressure vessel code

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted subject to approval of the Employer. In such case, copies of the English version of the standards adopted shall have to be submitted along with the bid.

21.4 Reference Drawings and Documents & Interfaces

- For the scheme of L.P. Compressed Air System refer tender drawing enclosed.
- For site-specific data such as, altitude, ambient temperature, humidity etc. and other technical requirement, refer General Technical Requirements/GTS.

21.5 Special Design and Layout Conditions

The L.P. compressed air system shall cater to the air requirement for general services and plant requirement as required on various floors of the powerhouse. The system shall consist of two L.P. Air Compressors, one L.P. Air Receivers for station service along with necessary auxiliaries. The compressors will have auto-starting panel. The working pressure of L.P. system shall be 8 Kg/cm².

The Station Service air will be distributed as follows:

- MIV Floor.
- Machine Hall.
- Service Bay.

21.5.1 Basic Dimensions and Ratings

Working and Designed Pressure-

The working and design pressure shall be 8kg/cm².

Capacity of compressors-

The rated capacity of each compressor shall be such that normally one compressor shall meet the total requirement of the system and second compressor shall be kept as standby. However, control philosophy shall be designed to run both the compressors in case of emergency.

Capacity of Receivers-

The capacity of each receiver shall be rated to provide 15 minutes compressor running time to raise receiver pressure from atmosphere system pressure.

21.6 Performance Criteria and Guarantee

The compressed air system along with accessories shall be capable of performing all the intended duties and it is the responsibility of the contractor to supply the equipment as per guaranteed particulars.

21.7 Design and Construction

Compressors-

Each low-pressure compressor of rating prescribed above shall be rotary screw type, heavy duty and electric driven complete with air filter, oil filter, after-cooler, instrumentation, moisture trap and other associated accessories. The motor of the compressors shall be continuous duty and shall capable of being started by means of direct on line starter. The insulation of motor winding shall be class-F and designed to operate at 415V $\pm 10\%$, 50Hz $+5\%$ & -5% . The rating of compressor shall be sufficient to meet the requirements of their respective systems. Adequate protection shall be provided against starting of the compressor in loaded condition. Suitable anti -vibration pads shall be provided in the compressor foundation.

The compressor unit shall rest on an anti-vibration mounting. It shall be designed so that sound level does not exceed ISO NR 85 over the octave band frequency range between 62.5 and 800 Hz measured at points 1 m from the compressor.

Valves, Pipings and Instrumentation-

All piping shall be of black seamless steel, heavy-duty class. Minimum pipe wall thickness shall be as per relevant standard for heavy-duty pipes. The valves in the airlines shall preferably be ball type and the material for the seat and ball shall be stainless steel. The valve shall be selected to have minimum leakage, reliable and ease of maintenance. Pressure gauges shall be provided at the service air outlet line for measuring pressure at the highest points. The total pressure drop inclusive of the pressure drop in valves and other fitting should not exceed 0.3 bar at remote location. Total leakage losses in the compressed air systems shall not exceed 3% of the total capacity of the respective compressor. The Contractor shall co-ordinate with the turbine, governor, generator and main inlet valve manufacturer (s) to decide about the layout of the piping system.

Air Receivers-

The pressure tank shall be constructed from plate steel in accordance with part UW of the ASME Code for Unfired Pressure Vessels, Section VIII. The tank shall be painted on the inside and on the outside as per approved painting system. Thickness of inside painting shall be such that these do not flake off during operation. Prior to shipping, all threaded openings shall be closed with standard pipe plugs. Flanged openings shall be protected with blind flanges with gaskets bolted in position. Each air receiver tank shall be equipped with pressure gauge, a safety relief valve, drain valve, isolating valve, check valves etc. A bleed-off valve should be provided between the isolating valve and the check valve to permit convenient testing of check valve tightness. The safety relief valve shall be set to open on 110 % of the working pressure of the tank. An automatic condensate drainage system shall be provided on the discharge separator to automatically drain condensate. It shall provide automatic drain of the system. Each air receiver shall be equipped with a manhole to allow visual inspection.

The air receivers shall be provided with pressure switches to switch the compressor ON and OFF, and to trigger an alarm in the control room following excessive losses of air pressure in the receiver.

Air Dryers-

Compressed air system shall be provided with common refrigerant type air dryers to dry the humid air and its heating element / fans shall be suitable for 240 V, 50 Hz ac supply. Normally one air dryer shall be used and shall have sufficient capacity to dry the air.

Control Panel-

The Control Panel shall accommodate the control equipment, motor starters, motor protection equipment, provisions for local and remote alarm, a set of terminals with 20% spare arranged on a terminal strip, electric heating, 240V, 50 Hz socket outlet and vapour-tight type lighting inside of the panel.

The control panel shall be mounted adjacent to the compressors.

The control equipment shall include the following components:

- Key operated selector switch, three positions, "Off", "Manual" and "Automatic".
- Push buttons "On" and "Off" for both compressors
- Indication lamps "On", "Off" and "Failure" for both compressors
- Operating hour counters for both compressors
- Manual selector switches for assigning the compressors as:
 - Main duty
 - Standby
- Emergency stop push button switch
- Collective alarm output.

Protection Equipment-

The motor for each compressor shall be provided with at least the following protection devices:

- Overload protection
- Under voltage protection
- Single phasing protection

21.8 Spare Parts

The spare parts mentioned here under are meant for use by the Employer during operation and maintenance stage and shall not be used as erection spares required during installation.

21.8.1 General Spare Parts

The Contractor shall supply the general spare parts as per “General Technical Specifications (GTS)”. The supply of these spare shall be as per the list of spares for each component/ equipment/ item approved during detailed engineering.

21.8.2 Specified Spare Parts

Mandatory spare parts shall be supplied in accordance with the list mutually agreed between the Owner and Contract, which is furnished by the Contractor in their final offers:

21.8.3 Recommended Spare Parts-

The Contractor shall furnish the list of recommended spare parts as per “General Technical Specifications (GTS)”.

21.8.4 Tools and Instruments-

The Contractor shall provide one set of all necessary special tools and maintenance equipment for repair and maintenance of the LP Compressed air system as recommended by the manufacturer.

A list of such tools shall be approved during detail engineering.

21.9 Drawings, Documents and Design Calculations

21.9.1 Design Memorandum

The Contractor shall prepare and submit to the Employer a “Designed Memorandum” of the proposed equipment/system fulfilling the contract specifications / requirements for approval prior to submission of drawing and documents. The memorandum shall include the design philosophy, methodology, system description, input parameters for design, standard and codes, design and selection criteria, equipment data, material specifications, measure technical features, basic arrangement / layout etc.

21.9.2 Drawings and Documents

The Contractor shall submit the all the drawings and documents in accordance with requirements stipulations in “General Technical Specifications (GTS)”.

In addition to the documents requested in General Technical Specifications the Contractor shall submit the following documents:

- Schematic diagram (P & ID) of the proposed low pressure compressed air system.
- Component lists.
- Sequence chart of control functions.
- Draft operation & maintenance manual at least three months before beginning of dry tests.

21.9.3 Design Calculations

The Contractor shall submit the design calculations covering at least the following, for review / acceptance:

- Calculations for selecting the compressor capacity and motor rating.
- Size and thickness selection of air receivers for compressed air systems.
- Size of piping including main and distribution header.

The Contractor shall also provide other calculations as required by the Engineer for his approval of the Contractor's design.

21.10 Quality Control and Quality Assurance

The contractor shall furnish detail document of Quality Assurance Plan for Purchaser's review & approval.

21.11 Tests

21.11.1 Shop Tests

The motors, compressors, air receivers, valves and pipes etc shall be routine tested as per relevant IEC/IS and international code for pressure vessels. The contractor is required to submit routine test certificates of the equipment. Copies of the type test certificates in respect of the similar equipment supplied in the past for hydro projects would also need to be supplied.

21.11.2 Field Tests

After installation, both compressed air systems shall be field tested for operational tests as per the intended requirements and leakage tested. Total compressed air system shall be pressure tested at 1.5 times of the design pressure. If the system shall be tested in sections, the same applies for each section.

All necessary materials and labour for performing the entire required test shall be provided by the contractor.

The contractor shall prepare and hand over to the Employer details of all test results in a report in a mutually agreed format.

21.12 Installation and Commissioning

The contractor shall furnish all labour, supervision, tools, supplies, bracing, spiders, shims and supports and all other provisions or materials necessary to assemble, erect, install, test and commission the equipment in a thorough workman like manner following the best modern practices. The equipment and all its components shall be placed with great care and accuracy and shall be aligned correctly to provide an installation consistent with the close tolerances used in the erection of modern equipment.

The proper elevations and centrelines to which equipment is to be set shall be established by the contractor.

All installation of compressors, air receivers and piping etc. of LP compressed air system shall be done by skilled workers in a workmanlike manner. Pipe fixtures shall be spaced according to accepted standards and provision made for thermal expansion and contraction of piping. Before installation all system components shall be checked for cleanliness.