## TECHNICAL SPECIFICATIONS
### FOR
### COMPRESSED AIR PIPING WORK

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1.0 **SCOPE OF WORK:**

The scope of work includes supply, installation, testing and successful commissioning and handing over of complete compressed air Pipeline Work.

**SCOPE:** This specification covers the general requirements for on site shop fabrication, erection, commissioning, testing and cleaning of compressed air pipelines. All pipe work shall be in conformity with the requirements of the applicable drawings and specifications. Where specific details of fabrication are not shown on the drawings or specified herein, fabrication shall be in accordance with BS 3351/ ASA B 31.3.

Piping shall also comply with applicable state, local or other Governmental laws and codes. All work shall be performed in accordance with the best modern practice for this type of work and shall be of highest quality workmanship.

Any deviations from these specifications, must have the approval of Consultant / Owner.

**LIST OF BUILDINGS:**

1. Building No. 1/1: Overhaul Hangar
2. Shop 201: Dismantling shop
3. Shop 202: Structure repair shop
4. Shop 203: Final assembly shop
5. Shop 208:
6. Shop 209: Section for removal of varnish and paint coating
7. Building 84a: Shop of washing and testing of fuel compartments
8. External low pressure and high pressure piping for Package-II & II Buildings from low pressure compressor house and turbo cool high pressure compressor house.
9. High pressure compressed air piping inside filling station for pressure ranges of 25-100barg, 100-150barg, 150-200barg and 200-250barg.

1.1 **DETAILED SCOPE OF WORK FOR PIPING WORK:**

(a) No changes without prior approval
(b) Site safety, security and cleanliness
(c) Project schedule
(d) Discrepancies / interferences resolved before installation.
(e) Supply of piping materials to work site/shop, fabrication and erection, testing and commissioning of all piping system in accordance with the specification.

(d) Fabrication and erection of pipe supports, brackets, as per pipe support standards and drawings and instructions of Engineer-in-Charge.

1. The contractor shall also bear the cost of repair, changes, replacement, etc. due to noncompliance with the standards, codes or due to disregard of instructions given by Engineer-in-Charge.

(i) It is the responsibility of the contractor to take care of all the material brought inside the HAL until the time of handing over to the Owners.

(i) Any other items as required in the drawings/specifications are to be fabricated and erected from the available materials.
All incidental jobs connected with Industrial piping work such as cutting chasing in concrete and brick work and making good cutting/drilling holes through walls, floors and grouting for fixing of supports etc. complete.

(a) The contractor for this work shall be required to work in Co-operation with other civil engineering, Electrical etc Contractors should give them all reasonable assistance and help for the execution of the work in an efficient manner as directed. Any work done without regard or consultation with other trades shall be removed by the Contractor without additional cost to the Owner, to permit the proper installation of all other works as desired by the Architects.

(i) Repair all damages done to the premises as a result of this installation and removal of all debris left by those engaged for this installation to the satisfaction of the Owner.

1.2 PIPE JOINTS:
In general joints shall be butt welded as specified in the applicable valve and piping specifications, with flanges and butt weld fittings used where required. Flange faces shall be in a plane perpendicular, true and square to the center line of the pipe to which they are welded. Bolts on flanged joints shall be drawn up to provide even and adequate pressure on gaskets.

WELDING
Fabricated piping system shall be erected as detailed on piping layout drawing and as advised by the consultant and / or owner. The contractor shall provide adequate field joints bearing in mind the fact that there may be variations in locations of equipments, equipment nozzles, inserts, structures, etc. but not limited to the aforesaid contingencies only. In certain cases site measurement may have to be taken before commencement of fabrication.

Flange joints shall be used at connections to equipments, valves, flanged fittings and wherever required for ease of erection and maintenance as indicated in the drawings.

1.3 MEASUREMENTS:
The measurements (for the payment purpose) shall be considered as per actual laid quantity. The mode of measurement shall be in running meters for the compressed air pipeline including fittings such as bends, elbows, tees, unions, nuts, bolts, washers, gaskets, nipples, expanders/reducers complete with adequate supports, and wrapping/ coating for the underground pipeline. Measurements (for the payment purpose) of the Flanges, Long Radius bends, Isolation (Ball) valves, Filters, Pressure gauges, Drip leg drains, Quick fix couplers with plug, Air compressor, Air dryer and Air receiver shall be considered as per the actual quantity used.

1.4 RESPONSIBILITY
(a) DRAWINGS:
The drawing enclosed herewith is the guidance to the contractor. The contractor shall submit shop floor drawings for the consultant approval. The contractor should execute the pipeline on the drawings enclosed. After the completion of the test and handing over the work, the contractor shall submit 3 sets of hard copies of as-built drawings. If required, draft copies of the same shall be approved by the consultant.

DRAWING/INFORMATION REQUIRED FROM SUCCESSFUL TENDERER WITHIN 15 DAYS AFTER AWARD OF WORK:
Bar chart showing engineering, manufacturing and dispatch of each equipment and erection services.
Drawing, literature and technical particulars of all bought out items.
Schedule for valves and piping material.
(i) **PAINTING:**
All piping, furnished under this work shall be properly painted with two coats of a synthetic enamel paint over a coat of primer after installation as per IS Code. Arrow marks for indicating flow direction and stenciling to be done as per Good Engineering Practice.
Colour Code of the piping shall be SKY BLUE

a) **SCAFFOLDING:**
All scaffolding and ladders required for the proper execution of the work shall be in the scope of the contractor.

b) **QUALITY OF MATERIALS AND GENERAL STANDARDS OF WORK**
The contractor under this contract commits himself to use the first class materials and assumes full responsibility for the quality of all material incorporated or brought for incorporation in the work. The work shall be executed in accordance with the best engineering practice and as per directions of the consultant.

c) **SAMPLES**
The samples of all the materials to be incorporated in the work shall be furnished to the consultant and got approved prior to bulk procurement. Necessary certificates / documents required for the bought out items are to be produced.

a) **GUARANTEE:**
The contractor shall guarantee the material and workmanship of the entire system for a period of 12 months from the date of commissioning or 18 months from the date of the supply of the items and hand over necessary documentations.
Guarantee / test certificates of equipment from suppliers / manufacturers / contractor shall be handed over to the Owner.
In case of any defective equipment / material / workmanship, the contractor shall rectify/modify/replace the defective item at free of cost. Any delay on the part of the contractor in doing so, gives the owner the right to get the defect rectified through other agency and the cost for the same shall then be borne by the contractor.

a. **INSTRUCTION MANUAL/COMPLETION DRAWINGS/TRAINING:**
The contractor shall furnish detailed instruction and operation manual in quadruplicate. The contractor shall also furnish detailed completion drawings as soft copy (in AutoCAD format) and hard copy on tracing sheet. The drawings shall be inclusive of control schematic, if any. The contractor shall train the Employer's personnel in the operation and maintenance of the system.

1. **TESTING:**
The Contractor shall arrange to test the entire system as per the procedure enumerated under particular specifications, after the erection is completed. The test reports shall be duly signed and sealed by foreman and subsequently submitted to the Owners and Architects in triplicate. If the results of the tests are not found to be satisfactory by the Owners and Architects, necessary rectification shall be done until the test results are found to be satisfactory. The installation shall be deemed to be completed only after successful completion of the tests.

(a) **TESTING PROCEDURE:**
All piping shall be hydraulically tested for 1.5 times of working pressure after completion of erection to check for leakages. The water shall be held for 6 hours and any leakages found are to be rectified, the water has to be drained out completely, flush out the entire pipe line with the compressed air continuously to remove all traces of the moisture / water traces if any left with in the pipeline.
The pipeline where hydraulic testing is not practically feasible there it shall be pneumatically tested at 1.5 times of working pressure after completion of erection to check for leakages.
d) **PRE-DESPATCH INSPECTION:**
Pre-dispatch inspection to be arranged for representatives of owner for the items like Air compressor, Air dryer and Air Receiver at the suppliers work. Where the performance of the equipments can be checked. The responsibility lies with the contractor for successful installation and commissioning of the equipments towards entire satisfaction to the owner at the site. Final acceptance shall be after entire satisfaction to owner.

**2. CUTTING AND WELDING PROCEDURE:**

### 2.1 CUTTING:
Pipe and plates shall be cut as per the standard engineering practice by suitable means. No Electric metal arc cutting shall be allowed.
All edges cut by oxy-acetylene shall be cleaned of impurities prior to welding joints.

### 2.2 CUTTING TOLERANCE SHALL BE AS FOLLOWS:

- a) For pipe or plates connected at both ends to - 1mm
- b) Elsewhere to - 3mm

### 2.3 EDGE PREPARATION OF PIPES FOR WELDING:
The edge preparation for welding of pipes more than ½" wall thickness shall be done by flame cutting and followed by grinding. Cut faces shall not have cracks or irregular. Edge preparation of pipe diameters below ½" wall thickness shall be done by Grinding Machine.

Sharp edges, rust of cut edges, notches, and irregularities fissures due to faulty cutting shall be chipped, grounded over the length.

Edge preparation for welding joints shall be carefully and accurately made so as to facilitate a perfect weld joints. Generally no special edge preparation shall be required for pipes under 1/6” wall thick.

Edge preparation beveling denotes cutting and grinding of the same so as to result in ‘V’ or ‘X’ shapes as per IS: 823.

The pipes to be assembled shall be clean and dry on the welding edges. Under no circumstances wet, greasy rust or dirt covered parts shall be welded.

### 2.4 WELDING PROCEDURE:
Welding shall be carried out only by fully qualified welders as tested and approved by the architects / consultants. Any test carried out in presence of either the architects / consultants or their representative or the inspectors shall constitute a right by them for such tests and the cost involved there on shall be borne by the contractor himself.

When welding is carried out in open air, steps shall be taken to protect the place of welding against wind, rain or moisture, the welding electrodes and parts being welded shall be dry.

Prior to the commencement of the welding, welder has to check the root gaps for all butt welds for single or double “V” as per IS: 823. The welding joints shall be allowed to cool slowly.

For multilayer welding, before welding the following layer, the formerly welded layer shall be cleaned to metal bright by light chipping and wire brushing. Packing strips shall not be allowed i.e., all slag shall be removed.

Only welding generator / rectifier shall be used for welding.

**Welder Qualification:**
2G welding position qualification test will be conducted in presence of Consultant / PMC / Client.

**Electrodes:** Welding electrodes with a suitable coating shall be in accordance with applicable IS and of a recognized quality of reputed manufacturers.

### INSTALLATION
Above Ground piping – All piping shall be erected as shown in the drawings and in accordance with the specifications so as to conform to the applicable codes and engineering design.

Arrangement drawings shall show general location and should indicate special dimensions, locations of valves, fittings etc wherever critical.

Slopes of piping specified on drawings shall be maintained.
INSIDE SHOP PIPELINE: The compressed air pipeline inside the shops should be laid along the walls with necessary brackets and supports. Adequate pipe supports, anchors and guides for piping shall be provided. The fabrication shall be as per the best engineering practice as laid down in the IS.

BRACKETS / SUPPORTS:
All brackets / supports shall be made out of suitable M.S. rolled steel sections, bar and strip with C.I. washers, helical springs, sling eyes, U bolts etc fixed on the walls or hung from the slabs/ roof truss by MS rods / angles including grouting / welding or fixed to special insert plates (already provided in the construction) or fixed to special inserts as the case may be including fasteners, bolts, anticorrosive and color painted etc complete as required and / or by suitable means as per best engineering practice and

2.5 WELDING INSPECTION:
All weld joints shall be DP tested after completion of the welding for blow holes, cracks etc.,

2.6 SOCKET WELD:
Allowable diameter range:
Threaded ≤ 2" NB
Welded > 2" NB

3. TECHNICAL SPECIFICATIONS:

3.1 PIPES:

i. Material : Mild Steel
Material of Construction : As per IS: 1239
Type : ERW
Class : Heavy

ii. Material : Stainless Steel
Material of Construction : As per ASTM A312 Gr.TP304
Type : Seamless
Class : Sch80s

3.2 FLANGES:

i. Material : Mild Steel
Material of Construction : As per IS: 1239 Part:II
Type : SORF
Standard : As per ANSI B16.5
Rating : 150 #

ii. Material : Stainless Steel
Material of Construction : As per ASTM A240 Gr. F304
Type : WNRF
Standard : As per ANSI B16.5
Rating : 2500 #

3.3 FITTINGS:

i. Material : Mild steel
Material of construction : As per IS:1239 Part-II
Standard : As per ANSI B 16.9
Class : Heavy
ii. Material : Stainless Steel  
Material of construction : As per ASTM A182 Gr.F304  
Standard : As per ANSI B 16.9  
Class : Heavy (as per BOQ)

3.4 GASKET:
Material : Neoprene  
Thickness : 3.0mm  
Standard : As per ANSI B16.21  
Sizes : To match RF 150# and 2500# rating flanges

3.5 BOLTS & NUTS:
Type : Hexagonal  
Material : Carbon steel / Stainless Steel  
Standard : As per IS:1364 & 1367

3.6 ISOLATION VALVE:
i. Type : Ball Valve  
Material of construction : Forged carbon steel from 15 to 40 mm NB  
Cast carbon steel from 50 to 150 mm NB  
Body : (<40NB) : ASTM A 105  
(>40NB) : ASTM A 216 Gr. WCB  
Ball : AISI 304  
Stem : AISI 304  
Seat & seal : PTFE  
Ends : Flanged to ANSI B16.5, 150#  
Lever : Carbon Steel with PVC Sleeve  
Hydro Test Pressure : Body : 30 Kg/cm²  
Seat : 21 Kg/cm²

ii. Type : Stop Valve  
Material of construction : Body: Brass / Bronze  
Spindle: Stainless steel  
Hand wheel: Aluminium alloy  
O-ring: Nitrile  
Backup ring: PTFE  
Ends : < 15NB, Socketwelded  
□ 15NB, Flanged to ANSI B16.5, 2500#  
Valve operating pressure : 250bar

3.7 PRESSURE GAUGE:
i. Type : Bourdon tube Pressure gauge  
Dial size : 100 MM  
Range : 0-10kg/cm²  
Mounting : Direct Mounting  
Housing : Weather proof housing  
Pointer : Micro type adjustable pointer  
Case : Stainless Steel  
Connection : ½” BSP Bottom connection
### Pressure Regulator:

**ii.** Type: Bourdon tube Pressure gauge  
Filling: Glycerin  
Dial size: 100 MM  
Range: 0-21kg/cm², 0-40kg/cm², 0-70kg/cm², 0-160kg/cm², 0-280kg/cm²  
Mounting: Direct Mounting  
Housing: Weather proof housing  
Pointer: Micro type adjustable pointer  
Case: Stainless Steel  
Connection: ½” BSP Bottom connection

**3.8 Pressure Regulator:**

**i.** Location: Filling station  
Type: Pilot operated  
Size: 15NB  
Inlet Pressure: 250barg  
Outlet Pressure range:  
- a. 25-100barg  
- b. 100-150barg  
- c. 150-200barg  
- d. 200-250barg  
Flow rate: 150nCu.m/hr (approximately)  
Material of construction:  
- Body & trim: AISI 304  
- Seal: Fluoroelastomers  
- Seat: PTFE

**ii.** Location: Shop 204A (Building 20/1)  
Type: Pilot operated  
Size: As per BOQ  
Inlet Pressure: 250barg  
Outlet Pressure range: 150-200barg  
Flow rate: 20nCu.m/hr  
Material of construction:  
- Body & trim: AISI 304  
- Seal: Fluoroelastomers  
- Seat: PTFE

**iii.** Location: Shop 204B (Building 21/1)  
Type: Pilot operated  
Size: As per BOQ  
Inlet Pressure: 250barg  
Outlet Pressure: 65barg  
Flow rate: 30nCu.m/hr  
Material of construction:  
- Body & trim: AISI 304  
- Seal: Fluoroelastomers  
- Seat: PTFE

**iv.** Location: Shop 204B (Building 21/1)  
Type: Pilot operated  
Size: As per BOQ  
Inlet Pressure: 250barg  
Outlet Pressure range: 10-18barg  
Flow rate: 100nCu.m/hr  
Material of construction:  
- Body & trim: AISI 304  
- Seal: Fluoroelastomers
v. **Location**: Shop 204A (Building 20/1)
   - **Type**: Pilot operated
   - **Size**: As per BOQ
   - **Inlet Pressure**: 250barg
   - **Outlet Pressure range**: 15-25barg
   - **Flow rate**: 170nCu.m/hr
   - **Material of construction**:
     - Body & trim: AISI 304
     - Seal: Fluoroelastomers
     - Seat: PTFE

3.9 **SAFETY RELIEF VALVE**:
   - **Location**: Filling Station
   - **Type**: Self-actuating, full lift, spring loaded
   - **Discharge**: Angle
   - **Bonnet**: Closed
   - **Set Pressure**: As given in BOQ
   - **Pressure Rating**: As given in BOQ
   - **Material of construction**:
     - Body & trim: Stainless steel 316
     - Seal: BUNA-N Elastomer
     - Seat: PTFE
   - **End Connection**: Flanged, as per ANSI B 16.5

3.10 **PRESSURE REGULATING STATION**:
   - a. PRS: 250barg to 150barg (Location: On branch line to Phase-II & III buildings)
   - b. PRS: 150barg to 42barg (Location: On branch line to Shop 204A; 20/1 building)
   - c. PRS: 150barg to 30barg (Location: On branch line to Shop 204B; 21/1 building)
   - d. PRS: 150barg to 18barg (Location: On branch line to Shop 203; 1/1 building)

Pressure regulating station consisting of
(a) Isolation valve
(b) Pressure regulator
(c) Pressure gauge
(d) Safety relief valve

**Isolation Valve**:
   - **Type**: Ball Valve
   - **Material of construction**:
     - Forged stainless steel from 15 to 40 mm NB
     - Cast stainless steel from 50 to 150 mm NB
     - (<40NB) : ASTM A 182 Gr.F304
     - (>40NB) : ASTM A 351 Gr.CF3
   - **Body**: AISI 304
   - **Stem**: AISI 304
   - **Seat & seal**: PTFE
   - **Ends**: Flanged to ANSI B16.5,
   - **Lever**: Carbon Steel with PVC Sleeve
   - **Valve operating pressure**: 250bar; 150bar; 42bar; 30bar, 18bar

**Pressure Regulator**:
   - **Type**: Pilot operated
   - **Inlet Pressure**:
     - a. 250barg
Outlet Pressure range:

- a. 150barg
- b. 42barg
- c. 30barg
- d. 18barg

Flow rate:

- a. 380nCu.m/hr
- b. 180nCu.m/hr
- c. 120nCu.m/hr
- d. 2nCu.m/hr

Material of construction:

- Body & trim: AISI 304
- Seal: Fluoroelastomers
- Seat: PTFE

Pressure gauge:

Type: Bourdon tube Pressure gauge
Filling: Glycerin
Dial size: 100 MM

Size:

- a. 0-160kg/cm², 0-280kg/cm²
- b. 0-70kg/cm², 0-160kg/cm²
- c. 0-40kg/cm², 0-160kg/cm²
- d. 0-21kg/cm², 0-160kg/cm²

Mounting: Direct Mounting
Housing: Weather proof housing
Pointer: Micro type adjustable pointer
Case: Stainless Steel
Connection: ½" BSP Bottom connection

Safety Relief Valve:

Type: Self–actuating, full lift, spring loaded
Discharge: Angle
Bonnet: Closed
Set Pressure:

- a. 151barg
- b. 43barg
- c. 31barg
- d. 19barg

Pressure Rating:

- a. 1500#
- b. 300#
- c. 300#
- d. 300#

Material of construction:

- Body & trim: Stainless steel 316
- Seal: BUNA-N Elastomer
- Seat: PTFE

End Connection: Flanged, as per ANSI B 16.5

3.11 Drip-Leg Drain:

Inlet Port: 1/2" BSP Female
Max. Pressure: 10 Kg/cm², 250 Kg/cm²
Body: Carbon Steel
Bowl : Transparent Polycarbonate bowl.
Draining : Automatic

3.12 **QUICK FIX COUPLING:**

i. Quick Release Coupling size : As per BOQ
   Construction : Poppet Type
   Mounting (Ends) : Threaded
   Material : Body : Brass with Nickel Plating
              Spring : Spring steel
              Ball : SS 304
              Seal : NBR
   Working pressure : 8 kg/cm²
   Check valves : Single check valve in socket., with heavy duty
   Sleeve with NBR Rubber Seal.
   End Connections  Socket : Threaded & Plug
                       Plug : Feasible for Rubber hose pipe connection.

ii. Quick Release Coupling size : As per BOQ
    Construction : Poppet Type
    Mounting (Ends) : Threaded
    Material : Body : Stainless Steel 304
               Spring : Spring steel
               Ball : SS 304
               Seal : Viton
    Working pressure : 250 kg/cm²
    Check valves : In socket as well as in plug, with heavy duty
                     Sleeve with Viton Seal.
    End Connections  Socket : Threaded & Plug
                       Plug : Feasible for Rubber hose pipe connection.

**Important Note :** One sample has to be approved from M/s HAL prior to bulk supply.
### LIST OF APPROVED MAKES:

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>DESCRIPTION</th>
<th>MAKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PIPES - MS</td>
<td>TATA / JINDAL</td>
</tr>
<tr>
<td>2</td>
<td>PIPE FITTINGS – MS</td>
<td>BHARAT FORGE / SANGHI IMPEX / METAL UDYOG</td>
</tr>
<tr>
<td>3</td>
<td>ISOLATION VALVE</td>
<td>AUDCO/ HALE HAMILTON / PARKER/SWAGELOK</td>
</tr>
<tr>
<td>4</td>
<td>PRESSURE GAUGE</td>
<td>H-GURU / WIKA</td>
</tr>
<tr>
<td>5</td>
<td>PRESSURE REGULATOR</td>
<td>HALE HAMILTON / PARKER / SWAGELOK</td>
</tr>
<tr>
<td>6</td>
<td>PRESSURE REGULATING STATION</td>
<td>HALE HAMILTON / PARKER</td>
</tr>
<tr>
<td>7</td>
<td>SAFETY RELIEF VALVE</td>
<td>HALE HAMILTON / PARKER / SWAGELOK</td>
</tr>
<tr>
<td>8</td>
<td>GASKET</td>
<td>CHAMPION</td>
</tr>
<tr>
<td>9</td>
<td>QUICK FIX COUPLINGS</td>
<td>PARKER / TECHNODRIVE (PNEUMAX) / PIONEER / SPIRAX / JANATICS or Equivalent</td>
</tr>
<tr>
<td>10</td>
<td>DRIP LEG DRAIN</td>
<td>PARKER / NORGREN / SPIRAX / JANATICS</td>
</tr>
<tr>
<td>11</td>
<td>BOLTS / NUTS</td>
<td>SKANDA / ZION / TVS / or equivalent.</td>
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