

DO 22027 PH**Technical Specification for Pumps****1. Introduction**

This specification describes the requirements for the supply of clean gas compressors, which shall be used in gas systems of the four LHC experiments: ALICE, ATLAS, CMS and LHCb. They shall be used for two distinct applications:

- 1) As circulator pump assemblies (see figure 1) for the large detectors gas circuits. The pumps are installed in return lines to compress the gas for purification and re-circulation. The inlet pressure shall be regulated via a by-pass control valve to the pump. For the systems with large flow the bidder may propose to use several (smaller) pumps in parallel.
- 2) As vacuum pumps used, for example on membrane gas separators. For such applications, the pumps have to evacuate the inlet side to < 0.1 bara and to recompressed the outlet side to several bars.

The compressors will be installed in a standard gas rack of 19" They must be easily accessible for maintenance, repair or removal. To avoid the propagation of vibration, the compressors will be isolated from the rack using "silenblock" elements, the inlet and outlet pump gas connections will be connected to fixed pipes, through flexible connections. Figure 2.

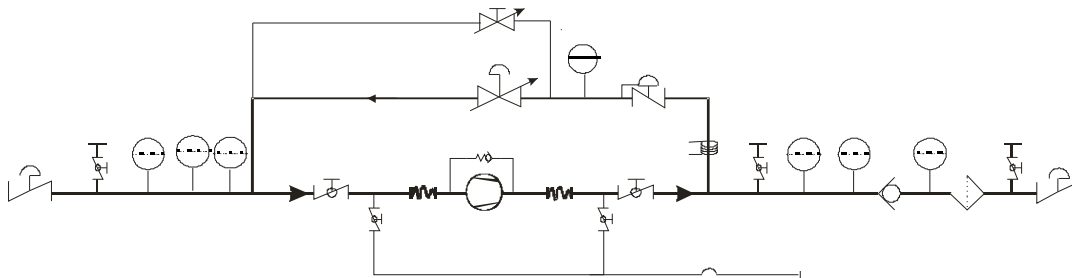


Figure 1. Typical pump installation with a bypass pressure regulation

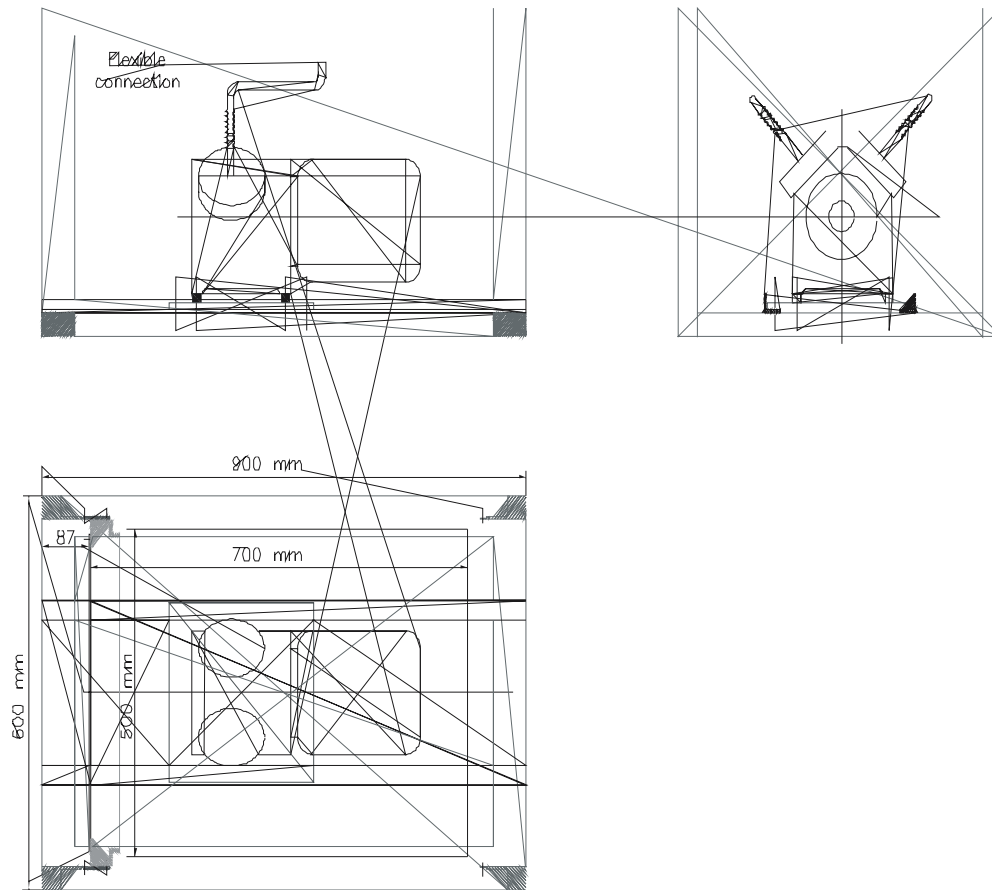


Figure 2. Mechanical drawing for pumps establishment in a standard gas racks

2. Scope and Schedule of the Contract

The purpose of this tender is the procurement of pumps for the LHC detector gas systems. This concerns 11 circulator pump assemblies and 8 vacuum pumps (Table 1, 2), which are the compulsory part of the contract. CERN would expect that a potential supplier could propose 3 or maximum 5 different pumps to cover the needs for the 11 circulation systems. Some of the large systems may require more than one pump installed in parallel or in series.

As purchase options the contract shall include a price list for additional pumps and spare parts, which CERN may order until the “31 of December 2005”

| Experiments | Total Number of Circulators Pumps |
|-------------|-----------------------------------|
| ATLAS | 3 |
| CMS | 3 |
| ALICE | 1 |
| LHCb | 4 |
| Total | 11 |

Table 1. Circulators Pumps

| Experiments | Total Number of Vacuum Pumps |
|-------------|------------------------------|
| ATLAS | 2 |
| ALICE | 2 |
| Other | 4 |
| Total | 8 |

Table 2. Vacuum Pumps

CERN would expect a potential supplier to deliver approximately 20% of the order within six weeks (from date of order) and the remainder within 12 weeks (from date of order).

3. Operating Conditions

The circulators will have an operation cycle of 8 months per year without interruption (24 h a day and 7 days a week), for a total lifetime of 15 years. The operating gases are mixtures of two or three components of the following gases: Ar, CF₄, C₂H₂F₄, CH₄, C₅H₁₂, CO₂, N₂, Ne, SF₆ or Xe (list not exhaustive). The ambient conditions are stabilised: Temperature = 22°C, relative humidity 40-60%.

The operating parameters of the pumps are listed in Table 3 and 4

| ID. Nb. | Experiments | Detectors | Gas Mixtures | Pump Flow [Nm ³ /h] | p 1 | Δp [bar] | Flammable Zone |
|---------|-------------|-----------|--|--------------------------------|---------------|----------|----------------|
| C1 | ATLAS | RPC | C ₂ H ₂ F ₄ , iC ₄ H ₁₀ , SF ₆ | 20 | Atm. pressure | 1 - 2 | No |
| C2 | | TRT | Xe, CO ₂ , O ₂ | 4 - 5 | Atm. pressure | 1 - 2 | No |
| C3 | | TGC | CO ₂ , n-Pentane | 3.5 | Atm. pressure | 0.2 - 1 | Zone 2 |
| C4 | CMS | DT | Ar, CO ₂ | 30 | Atm. pressure | 0.5 - 2 | No |
| C5 | | CSC | CO ₂ , Ar, CF ₄ | 20 | Atm. pressure | 1 - 2 | No |
| C6 | | RPC | C ₂ H ₂ F ₄ , iC ₄ H ₁₀ , SF ₆ | 10 | Atm. pressure | 1 - 2 | No |
| C7 | ALICE | TOF | C ₂ H ₂ F ₄ , iC ₄ H ₁₀ , SF ₆ | 3 | Atm. pressure | 1 - 2 | No |
| C8 | LHCb | Muon | Ar, CO ₂ , CF ₄ | 5 - 10 | Atm. pressure | 1 - 2 | No |
| C9 | | OT | Ar, CO ₂ , CF ₄ | 5 - 10 | Atm. pressure | 1 - 2 | No |
| C10 | | Rich 1 | C ₄ F ₁₀ | 2 - 3 | Atm. pressure | 1 - 2 | No |
| C11 | | Rich 2 | CF ₄ | 15 - 20 | Atm. pressure | 2 - 5 | No |

Table 3. List of circulators pumps

| ID. Nb. | Experiments | Detectors | Gas Mixtures | Pump Flow [Nm ³ /h] | p 1 [mbara] | Δp [bar] | Flammable Zone |
|---------|--------------------|-----------|--------------------------------------|--------------------------------|-------------|------------------|----------------|
| P1 | ATLAS | TRT | Xe, CO ₂ , O ₂ | 1.2 | < 100 | 4 | No |
| P2 | ALICE | TRD | Xe, CO ₂ | 1.2 | < 100 | 4 | No |
| P3 | Other vacuum pumps | | | 1.2 | < 10 | 1 | Zone 2 |

Table 4. List of vacuum pumps.

The bidder may propose to install two or more pumps (in series or in parallel) for the same system; in such a case the layout and the performance of such an assembly shall be clearly described in the offer.

4. Technical Requirements:

Although bidders are free to propose any pump type, CERN believes that membranes pumps will be most adequate for these applications.

4.1. General Requirement

- All materials in contact with the gas must be specified in the offer. The preferred materials are metals (stainless steel or Aluminium) Viton, PTFE or similar.
- The pumps must be fully lubricant free.
- The process gas should be at all circumstances kept separated from the drive unit or from the motor, as these parts would normally not be considered sufficiently clean.
- Some pumps (see table 3, 4) operate in a zone with a flammable gas atmosphere (Zone 2). In this case all electrical equipment inside or around the pump must be protected following the IEC-79-10 standard for zone 2.
- Some operating gases are nearly saturated vapours (n-Pentane, iC₄H₁₀), which could in certain circumstances produce some condensate. The pumps should be able to convey small amounts of condensate.
- Additional pump features, e.g. an internal bypass for overpressure protection, must be specified in the offer, and can only be accepted if all parts are lubricant free and mentioned in the offer.
- The pumps shall have an electromagnetic compatibility complying with the following standards:
 - EN 50081-1, EN 50081-2 and EN 55011.
 - Inlet and outlet gas connections fittings BSPP

- Identification plates for each pump (containing CERN specification pump identification reference number)

4.2. Cleanliness Requirements

All parts of the pump in contact with the gas should be cleaned and degreased before assembly, following a protocol comparable to the one given in the example bellow. The mounting of the pumps shall be made in clean conditions to avoid any contamination of the cleaned pieces. Tests of the pumps shall be made with a clean gas, e.g. Nitrogen. Air or water shall not be used.

All hardware parts of pumps in contact with the gas should be at no stage of fabrication, assembly, packing or transport in contact with Si containing lubricant.

Every bidder shall provide (together with the offer) test samples of all critical materials that are in contact with the gas. These test samples shall be cleaned according to the protocol given in the offer.

CERN reserves the right to refuse offers with inadequate or incomplete cleaning procedures.

Cleaning protocol (*Example for stainless steel components.*)

1) **Degreasing**

- Immerse every piece in an ultra-sonic bath containing the detergent NGL 17.40 ALU manufactured by ‘Cleaning Technology’, at a concentration 10 g/l in demineralised water at a temperature of 45 - 50° C for a duration of 30 min.
- Rinse every piece under ultra sound in town water for 10 min.

2) **Acid bath**

- Immerse every piece in an ultra-sonic bath containing de-ionised water with a concentration of 400 ml/l nitric acid (concentration 70%)¹ and 8.5ml/l hydrogen fluoride² at room temperature for a duration of 5 min.
- Rinse every piece under ultra sound in town water for 10 min.
- Rinse every piece under ultra sound in de-ionised water for 10 min, with a water conductivity of less than 0.5 µS/cm.

¹

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Concentrated Nitric Acid (70%), MSDS at: <http://www.inchem.org/documents/icsc/icsc/eics0183.htm>

5.

6. Quality Assurance Provisions

The Contractor's quality control plan shall comply with ISO 9002 or national equivalent in all respects. He shall plan, establish, implement and adhere to a documented quality assurance program that fulfils all the requirements described in this Technical Specification.

7. Packaging and Transport

The contractor is responsible for the packing, insurance and where included the transport to CERN. He shall ensure that the equipment is delivered to CERN without damage and any possible deterioration in performance due to transport conditions. It is recommended that the inlet and outlet pumps are individually wrapped in aluminium foils and then sealed polyethylene bags. The sealed pieces shall be packed in wooden crates for shipment.

8. Technical contact persons

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|----------------|----------------|-----|--------------|
| Albin Wasem | Dep. PH/TA1/GS | Tel | +41 22 75851 |
| | | Fax | +41 22 79760 |
| Ferdinand Hahn | Dep. PH/TA1/GS | Tel | +41 22 75865 |
| | | Fax | +41 22 79760 |