

GENERAL SPECIFICATION

ROTATING MACHINERY

GS EP MEC 292

Rotating Machines Packages Installation Requirements

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1. Scope

This specification defines the minimum requirements for integration of machinery packages within a Plant for the safe, reliable and easy operation and maintenance of such machineries.

These requirements have to be studied and developed on a project basis and included in the scope of supply of the Contractor.

The specification is applicable to any package involving rotating equipment to be installed within the Plant by the Contractor, whatsoever is the Purchaser of the package.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
ANSI B31.3	Process Piping
ASME B16-9	Factory-made wrought butt welding fittings
ISO 5167-1	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP INS 110	Instrumentation for package units
GS EP MEC 214	Fuel Treatment Units
GS EP MEC 251	Supply of Axial and Centrifugal Compressors and Expander-compressors for Petroleum, Chemical and Gas Industry Services according to API Standard 617
GS EP MEC 253	Anti Surge System for Centrifugal and Axial Compressors
GS EP PVV 175	Cleaning of piping and vessels

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3. Definitions and abbreviations

Company	Total E&P or any Total E&P subsidiary.
Contractor	Any company Total E&P has signed a Contract with for the Engineering, Procurement, Construction and Installation of a part of a Project.
Supplier or Vendor	The package Supplier or Vendor.
Package	Prefabricated process or utility self-contained unit, generally able to operate on its own, supplied fully tested and ready for immediate installation.
ICSS	Integrated Control and Safety System

4. Piping and Piping accessories

4.1 Interconnecting piping

Contractor shall design, procure, fabricate, test, paint, install, passivate and clean all the interconnecting piping between package main base plates and off main base plates package auxiliaries of the following systems, where applicable, in accordance with the Project piping specifications.

Contractor piping design shall comply with Supplier requirements.

4.1.1 Lube oil systems

Interconnecting piping covered by this paragraph is piping between:

- Off main base plate package lube oil coolers (water or air cooled) flanges and main base plate package flanges of the following oil systems: mineral, synthetic, hydraulic or control oil systems, where applicable:
 - Oil in
 - Oil out
 - Oil permanent vent
 - Oil drain.

All this piping shall be made of AISI 316L stainless steel.

In cold climate or as specified by the Project, Contractor shall also insulate and heat trace the piping, in accordance with Project specifications:

- Any loose delivered run down tank or over head tank flanges and the package main base plate flanges and associated interconnecting piping.
- Oil demisters flanges and the package main base plate flanges, made of AISI 316L stainless steel.
- The interconnecting piping between oil demisters flange and flame arrestors flange.
- The interconnecting piping between flame arrestors flange and vent terminal point.

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4.1.2 Fuel gas K.O pot skid (provided by Supplier)

For package involving gas turbine or gas engine, interconnecting piping covered by this paragraph is the fuel gas piping between the package main base plate fuel gas knock out pot skid out flange and main package flange.

In addition, these lines shall be made of AISI 316L stainless steel, heat traced and insulated by Contractor in accordance with the Project piping specifications.

This skid shall be located at 2 meters maximum to the main base plate package inlet flange and the generated hazardous area shall not interfere with any air inlets.

4.1.3 Cleaning and final cleanliness

The Contractor shall clean the interconnecting piping in accordance with the **GS EP PVV 175** or the Project specification (if any) or Supplier specification if more stringent.

This cleaning shall occur after the hydrotest.

Supplier shall specify the piping cleanliness level required with the corresponding standard. The oil piping shall be designed and routed in such way that all piping can be dismantled or broken on site, to be cleaned separately or by group of assembled sections. The cleaning method shall be passivation followed by neutralization, drying and preservation, handled by specialized qualified Sub-vendor.

Supplier shall provide the dedicated study and detailed drawings covering the piping design, the cleaning and the final flushing procedures to be approved by Company.

Contractor shall be responsible to provide chemicals and flushing unit as required to perform the piping cleaning.

Cleanliness shall be witnessed by Company.

4.2 Gaseous and oil mist vents and flame arrestors

Contractor shall design, procure, fabricate, test, paint, install, passivate and clean these vent lines.

These interconnecting piping shall be made of AISI 316L stainless steel.

Any gaseous vent: permanent or intermittent hydrocarbon mixture release, intermittent nitrogen and hydrocarbon mixture release shall be provided with flame arrestor.

Contractor shall be in charge to install on the vent lines flame arrestors supplied loose by Supplier. These flame arrestors shall be installed in end line position.

Gaseous vents shall be routed to safe area, preferably in the draft of the process gas coolers, when applicable, for better dilution and dispersion.

Oil mist vents shall be routed to safe area, away from hot surfaces zones, in particular away from machinery exhausts.

4.3 Centrifugal compressor seal gas systems

Contractor shall design, procure, fabricate, test, paint, install, clean, heat trace and insulate (when specified) all here after lines made of AISI 316L stainless steel of the following systems, where applicable, in accordance with the Project piping specifications.

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Piping cleaning shall be performed according to [GS EP PVV 175](#) requirements. This cleaning shall occur after the hydrotest.

4.3.1 Seal gas external source

When a seal gas external source is used during standstill pressurized operation and/or normal operation, the location of the tie-in of this external source, as well as the logic of any ESDV valve located on the line, shall be compatible with a continuous feeding of the compressor seals.

These lines shall be heat traced, insulated and made of AISI 316L stainless steel.

4.3.2 Primary dry gas seal leaks

These leaks shall be routed from the package main base plate flanges to the Plant Low Pressure flare network, connecting point being located on the top of the flare header.

These lines shall be heat traced and insulated.

Depending on the Supplier requirement, these leaks shall be individually routed or manifolded to the LP flare header.

When individually routed, each leak line shall be provided with a low pressure drop non return valve (less than one kPa) a manual full bore block valve locked open.

Otherwise, common leak line shall be provided with a low pressure drop non return valve (less than one kPa) and a manual full bore block valve locked open.

4.3.3 Secondary dry gas seal leaks

These leaks shall be routed from the package main base plate flanges to a safe area as defined by the Project specification and terminate with a flame arrestor, supplied loose by Supplier.

Recommendation is to send these lines in the draft of any nearby air coolers, when applicable.

4.4 Compressor and pump temporary suction strainers

The suction pipe of any compression or pumping section shall be provided with a temporary suction strainer located as close as possible to the compressor or pump suction flange. The spool piece is equipped with a differential pressure transmitter (both spool piece and transmitter provided by Supplier for compressors and by Contractor for pumps) to be mounted by Contractor.

Contractor shall chemically clean these suction strainers as well as the process piping between the suction ESDV and the compressor or pump inlet flange.

These suction strainers shall be considered as a piping special item and be in accordance with the Project piping specifications and [ANSI B31.3](#).

These suction strainers shall be removed after the site acceptance tests and not later than 1000 running hours.

4.4.1 Reciprocating compressor

The suction strainer shall be designed, provided by Supplier and installed in a flanged spool piece also provided by Supplier.

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4.4.2 Centrifugal or axial compressor

The compressor suction strainers shall be designed and provided with associated spool piece by the compressor vendor and installed by EPC Contractor.

The suction strainer shall be designed according to [GS EP MEC 251](#) chapter 1 paragraph 3.5.4.

These temporary strainers shall be located as close as possible to the compressor suction nozzle but upstream the PT and TT anti-surge instrumentation.

4.4.3 Pump

The suction strainer shall be designed, provided by Contractor and installed in a flanged spool piece also provided by Contractor.

5. Compressor anti surge and hot gas bypass systems

Contractor shall install and connect the required field anti-surge instruments, as defined in [GS EP MEC 253](#).

The anti surge loop including the control valve shall be installed with the following mandatory requirements:

- Installed in such a way to minimize the volume of gas at the compressor discharge.
- Installed at highest point of a loop.
- The anti surge valve upstream and downstream straight piping lengths shall not be less than 5 times nominal diameter of downstream pipe.
- The inlet and outlet piping concentric and/or eccentric reducers shall comply with [ASME B16-9](#), and in all cases two subsequent reductions are strictly prohibited.
- The anti-surge valve shall be adequately supported. The compressor vendor shall review and approve the supporting system.
- Anti surge loop tie in point shall be located on the top of the compressor discharge line.
- The compressor anti surge protection loop(s) shall be free of any isolation or check valves.
- Discharge pressure transmitter shall be located upstream compressor discharge check valve.

Furthermore, Contractor shall provide and install check valves of anti slam type at the following locations:

- Downstream each anti surge protection loop high pressure side tie in point such that the compressor discharge volume is minimized. Between each compressor section provided with a dedicated anti surge protection loop for loop isolating purpose.
- At compressor discharge, as close as possible to the compressor discharge flange, to minimize the compressor discharge volume in case of hot bypass recycle valve.

Contractor shall provide Supplier in due time with isometrics drawings of process compressor lines in order to allow Supplier to perform the dynamic study necessary to determine whether a hot bypass line is required.

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The hot gas return line tie-in connection point shall be taken as close as possible from the compressor discharge flange directly back to the compressor suction, as close as possible to the compressor suction flange and in any case downstream the compressor suction scrubber outlet flange using as short piping as possible.

Refer to Appendix 1 for details.

6. Fuel gas treatment package

Contractor shall design, procure, fabricate, test, paint, install, clean, heat trace and insulate the fuel gas treatment package of the gas turbine or gas engine driven package in accordance with [GS EP MEC 214](#) and Project specifications.

Design and operating conditions: pressure, temperature, overheating, flow, degree of filtrations shall meet the requirements of the gas turbine or gas engine Supplier based on the fuel gas compositions provided by Company.

Fuel gas heater upstream temperature signal shall be sent to the control system of each package.

Fuel gas piping between the fuel gas treatment package, the Supplier fuel gas knock out pot skid flange (when knock out pot off main base plate) and the Supplier package main base plate flange shall be made of AISI 316L stainless steel, heat traced and insulated in accordance with the Project specifications.

Contractor shall provide a dedicated fuel gas flow measurement according to [ISO 5167-1](#) and liquid fuel flow measurement to each gas turbine. Supplier will treat make available and display the fuel flows on the turbine PLC.

7. Structural

7.1 Supports and maintenance platforms

Contractor shall design, procure, fabricate, test, paint and install the following components or systems, in accordance with the Project specifications (Note: this may not apply if the below components are "on-skid supported", in which case the supports and maintenance platforms are usually designed, procured, fabricated, painted and installed by the Supplier. Details for the scope of supply breakdowns are given in the Project specification):

7.1.1 Combustion air inlet housings and ducting of gas turbine or gas engine driven packages

- The supporting structure
- The maintenance platform all around the combustion air inlet filter housings at access door and in front levels, with appropriate access ladders and handrails
- Shimming shall be anticipated to allow expansion joint adjustment.

7.1.2 Ventilation air inlet and outlet systems of gas turbine or gas engine driven packages

- The supporting structure

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- The maintenance platform all around ventilation fans and motors with appropriate access ladders and handrails
- Shimming shall be anticipated to allow expansion joint adjustment.

7.1.3 Exhaust stack of gas turbine, including WHRU if applicable, or gas engine driven packages

- The supporting structure
- The maintenance platform at all sample points level for manual sampling, with appropriate access ladders and handrails
- Shimming shall be anticipated to allow expansion joint adjustment
- The maintenance platform for WHRU bundle removal.

7.1.4 Enclosure fire dampers of gas turbine or gas engine or diesel engine driven packages

- Maintenance platforms with appropriate access ladders for any fire damper.

7.1.5 Package common base plate

- Operation and maintenance platforms all around the package common base plate at operating or top of the package common base plate levels, with appropriate access ladders and handrails.

In case of several units installed in parallel, operation and maintenance continuous platforms shall be provided in between and designed to support the heaviest maintenance weight of the packages.

7.1.6 Flame arrestors

- Maintenance platform for routine inspection and removal at any flame arrestor, with appropriate access ladders and handrails.

7.1.7 Lube oil air coolers

- The supporting structure
- Maintenance platform at each air cooler end with appropriate ladders and handrails.

7.1.8 Auxiliary low voltage motors

- Maintenance platform at each auxiliary low voltage motor with appropriate ladders and handrails.

7.1.9 Compressor or pump suction strainers

- Maintenance platform with appropriate access ladders and handrails, if required.

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7.1.10 Centrifugal compressor anti surge systems

- Maintenance platforms at each anti surge valve (and at each hot gas bypass, if any) and at each associated field instrument supplied by the Supplier of the compressor, with appropriate access ladders and handrails.

For all the above items, a maintenance review shall be conducted between Company and Contractor on the basis of CAD 3D models during the engineering phase.

7.2 Foundations

7.2.1 Anchor bolts, shims, soleplates

7.2.1.1 Concrete foundations

Contractor shall install all anchor bolts, shim packs and sole plates of all the packages in accordance with the Project specifications and Supplier requirements (number, size, location, material, strength and tightening torque).

Refer to Appendix 1 for scope of supply breakdown details.

7.2.1.2 Steel foundations

Contractor shall weld sole plates of all the packages and install all anchor bolts in accordance with the Project specifications and Supplier requirements (number, size, location, material, strength and tightening torque).

The supporting structure shall be machined prior to welding the soleplates.

Refer to Appendix 1 for scope of supply breakdown details.

8. Electrical

8.1 Cables, cable glands and junction boxes

Contractor shall design, procure, test and install all power cables and power control cables with appropriate cable glands at termination ends in accordance with the Project specifications.

Contractor shall design, procure, paint, test and install any required intermediate junction boxes to cope with the interconnecting cable sizing due to the voltage drop calculations and the package electrical consumer junction box size ports.

8.2 Motor starters and LV feeders switchboards

Contractor shall design, procure, test and install all package motor starters/feeders switchboards (MCC's) in accordance with Supplier requirements and the Project specifications.

When required by Supplier, some specific MCC's (gas turbine enclosure standby ventilation, for example) shall be designed for hazardous area Zone 1 and fed from the emergency or essential bus bar.

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8.3 Gas turbine driven Package DC voltage systems supply and distributions

Except when provided by Supplier, gas turbine driven package DC voltage system shall be part of the plant DC Uninterruptible Power System (UPS) provided by Contractor.

Contractor shall strictly conform to Supplier requirements in term of Voltage, Power rating and cable sizing and design.

The DC voltage systems shall feed all required consumers to ensure a safe coast down and post lube sequence in case of electrical isolation due to a complete PLANT AC power shutdown.

As a consequence, these DC voltage emergency systems shall be designed for a hazardous area Zone 1 from the battery down to the consumer and left energized.

9. Installation and remote monitoring requirements

9.1 Remote monitoring definition

The remote monitoring consists in receiving and analyzing raw signals in real time and/or post-treatment at distance from rotating machinery packages. This implies that raw dynamic signals are made available at distance from the package, i.e. beyond package programmable logic controller.

The way the analysis of these raw signals must be performed is not part of this specification.

9.2 Evaluation of need for remote monitoring

9.2.1 Local affiliate offices vibration monitoring system

Contractor shall procure and install a vibrations analysis system (on or off line, ADRE® or OROS® type), on top of the package vibrations control system, to continuously monitor and diagnostic the vibrations of the machineries involved with the packages. A particular Project specification will be issued during Basic Engineering/Feed to define this system. As a minimum, it shall perform the following:

- Driving and driven machineries vibration and displacement frequency spectrum analysis
- Bode and polar diagrams
- Orbits filtered and unfiltered
- Trends
- Displays.

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The system shall be defined within the Project SOR (Statement of Requirements) and shall be implemented as a minimum for the equipment as listed below:

Machinery
Gas turbines
Centrifugal compressors
Reciprocating compressors
Screw compressors (process gas)
Pumps (API610 greater than 500 kW)
Gearboxes
Electric motors
AC generators

This monitoring shall be implemented locally on site. The Project specification will define whether it shall be implemented in onshore affiliate offices too.

Note: The latter can be implemented only if the communication link between site and onshore affiliate offices allows for fast data transmission (e.g. fiber link), in which case the architecture interface shall comply with **GS EP INS 110**.

9.2.2 Headquarters remote monitoring

Contractor shall ensure that every raw signals coming from the machinery or auxiliaries involved within the package as well as process signals surrounding the latter will be made available for remote transmission to TOTAL E&P headquarters' offices. The raw signals concerned will be of slow dynamic type (e.g. pressure, temperature, liquid levels). All data shall be routed through the supervision system PI[®]. The storage of these signals will be performed within PI[®] server. The post-treatment and analysis of the signals are outside Contractor's scope.

Note: It is understood that the fast dynamic type signals (e.g. shaft vibration sensors signals) cannot be made available as required above. Hence, they will be systematically collected on the machinery as detailed below and post treated as detailed in paragraph 9.2.1.

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The above is applicable for the following equipment:

Machinery	Auxiliaries
Gas turbines	Gas turbines air filters
Centrifugal compressors	Gas turbine ventilation system
Reciprocating compressors	Lube oil systems (mineral and synthetic)
Screw compressors (process gas)	Lube oil coolers
Pumps (API610 greater than 500 kW)	Electric motors coolers
Gearboxes	AC generator coolers
Electric motors	Sealing systems
AC generators	Process valves (e.g. anti-surge valve, throttling valve)
Hydraulic power units	

This is not applicable for:

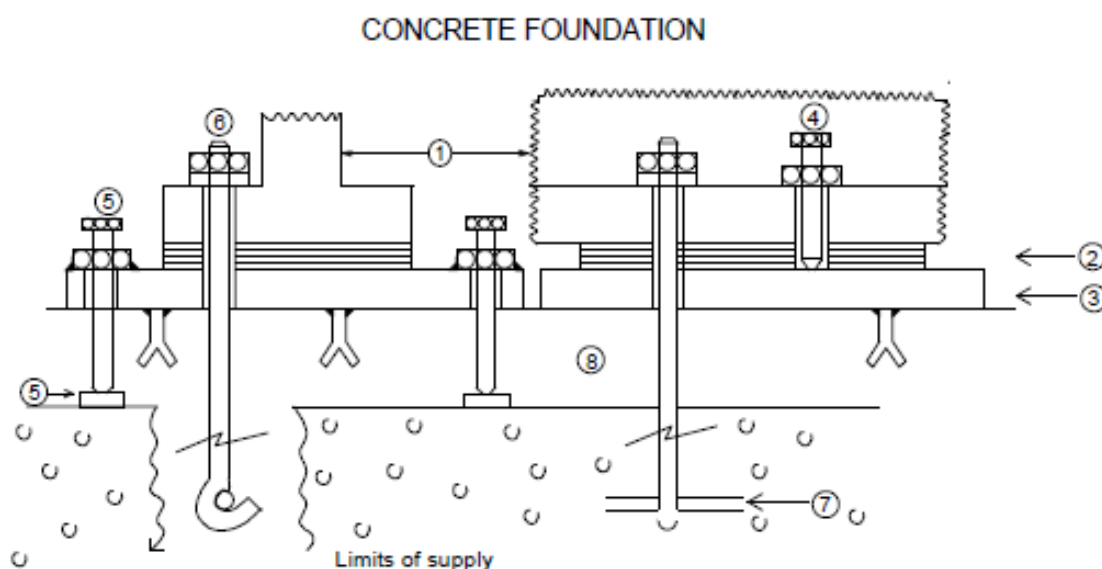
- Diesel and gas engines in general
- Emergency and essential generators driven by diesel or gas engines
- Fire fighting pumps.

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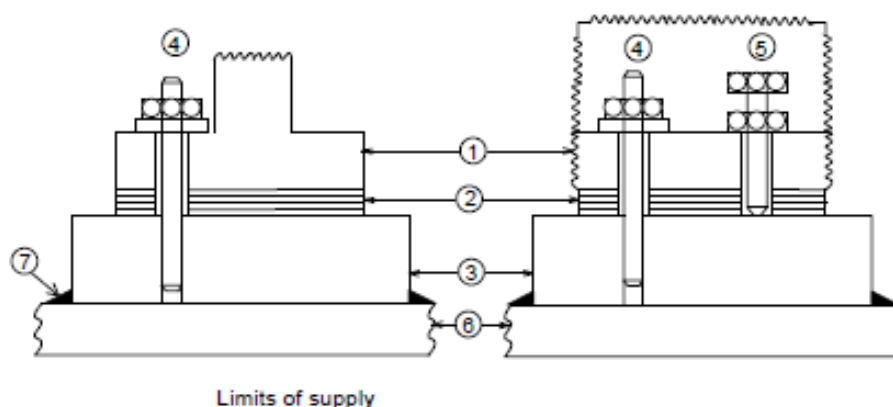
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Appendix 1
Appendix 1 Base plate Installation

SUPPLIER

- ① Base plate
- ② Shims (20 mm min)
- ③ Sole plate (30 mm min)
- ④ Base plate levelling screws
- ⑤ Soleplate levelling screws
- ⑥ Anchor bolts
- ⑦ Anchor bars

CONTRACTOR

- ⑧ Non shrinking epoxy grout

STEEL STRUCTURE FOUNDATION

SUPPLIER

- ① Baseplate or Gimbals or AVM
- ② Shims (20 mm min)
- ③ Soleplate (50 mm min)
- ④ Anchor bolts
- ⑤ Levelling screws

CONTRACTOR

- ⑥ Deck
- ⑦ Welding

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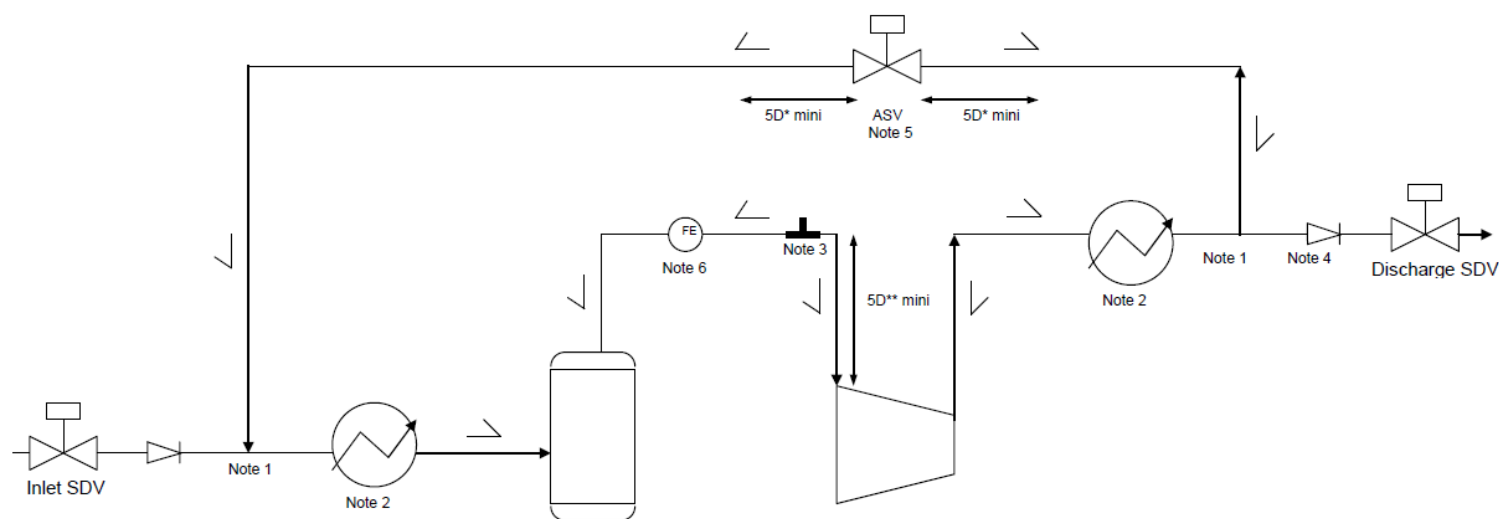
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Appendix 2

Appendix 2 Minimum requirements for compression loop design

Minimum requirements for compression loop design



NOTES:

Note 1: Anti-surge line branch located on the top of the pipe and preferably sloped at 45° in direction of the flow to avoid turbulences. If a throttling valve is present on the suction line, the branch shall be located downstream this valve.

Note 2: Pre or after coolers. Pre cooler is preferred.

Note 3: Temporary suction strainer (as per [GS EP MEC 251](#)). This element must be located as close as possible to the compressor suction (no more than 10 to 15 linear meters). The fine mesh must be removed after the clean run and the complete strainer must be removed after the site acceptance tests and not later than 1000 running hours.

Note 4: The check valve shall be located as close as possible to the anti surge valve line branch.

Note 5: The anti surge valve must be located at high point.

Note 6: Flow element for anti-surge flow monitoring.

* Downstream pipe diameter

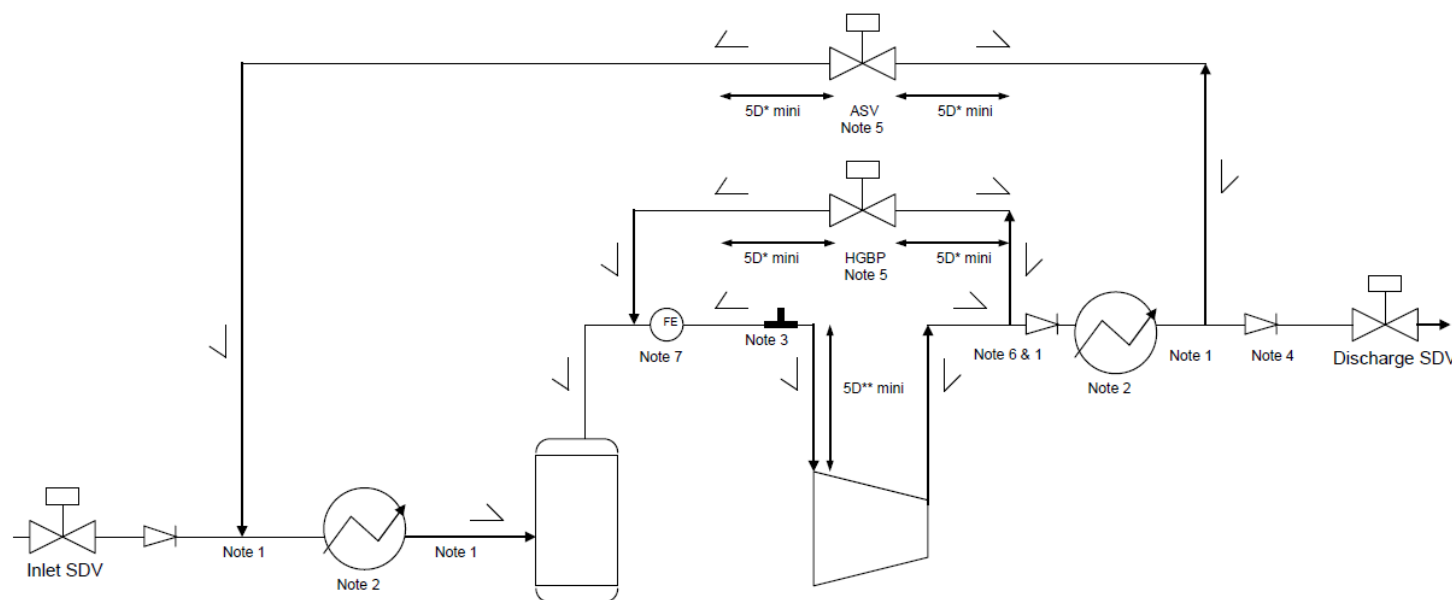
** Compressor flange diameter

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Appendix 2
Minimum requirements for compression loop design (with Hot Gas ByPass)

NOTES:

Note 1: Anti-surge and hot gas bypass line branch located on the top of the pipe and preferably sloped at 45° in direction of the flow to avoid turbulences. If a throttling valve is present on the suction line, the branch shall be located downstream this valve.

Note 2: Pre or after coolers. Pre cooler is preferred.

Note 3: Temporary suction strainer (as per **GS EP MEC 251**). This element must be located as close as possible to the compressor suction (no more than 10 to 15 linear meters). The fine mesh must be removed after the clean run and the complete strainer must be removed after the site acceptance tests and not later than 1000 running hours.

Note 4: The check valve shall be located as close as possible to the anti surge valve line branch.

Note 5: The anti surge valve and hot gas bypass must be located at high point.

Note 6: The check valve shall be located as close as possible to the hot gas bypass line branch.

Note 7: Flow element for anti-surge flow monitoring.

* Downstream pipe diameter

** Compressor flange diameter