

GENERAL SPECIFICATION

ROTATING MACHINERY

GS EP MEC 214

Fuel Treatment Units

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1. Scope

This specification indicates the minimum requirements for design and construction of fuel treatment units for gas turbines (equipped with both single and dual fuel engines), gas engines and diesel engines.

The analysis and physical properties of the fuel gas and diesel oil before treatment are given in project specifications.

The purpose of this general specification is to define the characteristics of fuel treatment units. These characteristics must be considered as technical minima, and any requirements of project specifications must be met. The control system of fuel treatment units shall be hooked up directly to the plant DCS.

The fuel treatment unit shall be supplied by the EPC Contractor.

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
ISO 16889	Hydraulic Fluid Power - Filters - Multi-Pass Method for Evaluating Filtration Performance of a Filter Element

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
Not applicable	

3. Source(s) of fuel gas

3.1 Source of gas available with pressure compatible with gas turbines requirements

If a permanent source of fuel gas, which maybe the HP separation gas, is available with associated pressure such that it can be utilized to feed the gas turbines and/or the gas engines, then this source may be considered as the main fuel gas supply and treated as described in this specification. In this case, one source of fuel gas only is sufficient to operate the gas turbines.

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The black start-up procedure shall then be as follows:

- Start-up of the Emergency Diesel generator to feed the turbo generators auxiliaries
- Start-up of one turbo generator on liquid fuel
- When production gas is available, fuel gas must be produced and treated as described in this specification
- Switch over the turbo generator fuel source from liquid fuel to gas fuel
- Achieve plant start-up, including the gas compressors, either gas turbine or electrical motor driven.

3.2 Source of gas available with pressure not compatible with gas turbines requirements

If the permanent source of gas, which maybe the HP separation gas, has a pressure that is not high enough to feed the gas turbines and/or the gas engines, one "utility" source must be provided in addition to other "process" sources, as follows:

- One "utility" source coming from the HP separator, compressed and treated as described in this specification
- One or more "process" source(s), taken off downstream the process compression network or from an interconnected adjacent plant.

The black start-up procedure shall then be as follows:

- Start-up of the Emergency Diesel generator to feed the turbo generators auxiliaries
- Start-up of one turbo generator on liquid fuel
- When production gas is available, fuel gas must be produced, compressed by dedicated fuel gas compressors and treated as described in this specification. The fuel gas compressor shall have a capacity sufficient to start-up the plant so that one process gas compressor at least can produce the process fuel gas source
- Switch over the turbo generator fuel source from liquid fuel to gas fuel
- Achieve plant start-up, including the gas compressors, either gas turbine or electrical motor driven
- Then, if required, the fuel gas source may be switched over to the "process" source taken off one of the compression stages.

Note: In case of electrical driven gas compressors only, the turbo generators may remain fed with liquid fuel and provide power to start-up the main process compressors which, in turn, may generate the "process" source of fuel gas allowing the turbo generators switch over from liquid to gas.

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4. Characteristics of the gas after treatment

4.1 Composition

The composition given in the project specification for the fuel gas upstream of the fuel gas treatment unit shall detail all the components up to C14.

Based on fuel gas composition upstream the fuel gas treatment skid, the EPC Contractor will perform all necessary engineering studies to reduce the contaminants down to the specified gas turbine or gas engine criteria.

When sulphur is present, the amount of H₂S after fuel gas treatment shall not exceed 10 ppmv.

The engineering study results will be presented to Company for review and comments.

Gas fuel analysis sampling device shall be installed downstream the fuel gas treatment skid and shall allow sampling without any disturbance of gas turbine or gas engine operation.

4.2 Pressure

The delivery pressure of the gas treatment unit shall be sufficient to feed the gas turbine and the gas engine at 120% of their maximum required fuel flow.

The nominal pressure requirement at the gas turbines and gas engine skid edge is stated in the equipment data sheet.

- The pressure control valve(s) and associated controller shall be such that the pressure variations in steady conditions do not exceed $\pm 1\%$ of the nominal value requested at the fuel gas treatment unit outlet.
- During transient operating conditions such as starting up, acceleration, and deceleration of the gas turbine, the pressure variations shall not exceed $\pm 5\%$ of the nominal value.

4.3 Heating value

The fuel gas Lower Heating Value (LHV) and the Wobbe Index shall be calculated on the basis of the fuel gas composition downstream of the fuel gas treatment unit.

The fuel gas treatment unit shall have provision to accommodate possible variations of raw gas compositions resulting in a low heating value variation of $\pm 10\%$.

4.4 Temperature

The temperature of the fuel gas at gas turbine skid edge before the last chance scrubber supplied by the gas turbine Manufacturer or at the skid edge of the gas engine (refer to Appendix 1) shall meet all of the following requirements:

- Temperature such that no hydrate forms during the successive expansions in the circuits of the driving machine.
- Temperature 30°C (or higher value if required by the gas turbine or gas engine Manufacturer) higher than the dew points of water and hydrocarbons at any operating conditions between start up and maximum load.

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5. Stages of treatment of fuel gas

Refer to schematic attached Appendix 1. The fuel gas treatment skid shall be manifolded to allow operation on either of two 100% components described hereafter.

The fuel gas treatment shall consist of:

5.1 Isolating ESDVs

5.2 Pressure Control with two 100% PCVs in parallel

The pressure shall in all cases be adjusted by expansion. At least two expansion lines in parallel shall be supplied, each sized for the maximum flow rate + 20%, to allow for maintenance on one of the pressure control valve without interfering with the operation of the gas turbine or gas engine package.

5.3 One fuel gas receiver

5.4 Two 100% coalescing filters in parallel

The filters shall be designed to remove 100% of 10 microns droplets. Each filter shall be designed for the maximum fuel gas flow rate + 20%.

5.5 Two 100% electrical heaters in parallel

- With continuous temperature control by means of thyristors and designed to minimise perturbation on electrical grid. Heaters shall be designed for increasing the gas temperature by at least 30°C between the fuel gas receiver exit and the gas turbine or gas engine skid edge (or higher if required) at maximum gas fuel flow with 20% margin. They shall switch OFF in no flow conditions and automatically switch ON when fuel gas flow is detected.
- When the ΔT between the fuel gas receiver exit and the gas turbine skid edge is lower than 15°C, a signal from the fuel gas treatment skid shall be sent to the turbine control panel for alarm and initiation of a gas turbine normal stop sequence.
- The gas turbine or the gas engine will be prevented to start until the temperature across the heater has reached the specified value.
- The gas fuel warm up will be part of the automatic gas turbine start sequence. The fuel gas automatic warm up system shall include an automatic vent valve connected to the flare system which shall be in the scope of Gas Turbine Manufacturer.
- For commissioning and start up after a long stop period, a manual fuel gas vent valve shall be provided. This valve (globe type) shall be connected to the flare system and a local temperature indicator shall be provided (refer to Appendix 2).

5.6 Two 100% fine filters in parallel

- Each filter will be designed for the maximum flow + 20% and no maintenance required before 4,000 (four thousands) hours of operation and it shall be possible to replace the filter elements without interfering with operation. If interlock transfer valves are used, they shall be tight shut off type.

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- The filtration will be coalescing type with the following characteristics:
 - 100% efficiency for solids removal for 3 micron size and above
 - 100% efficiency for liquid droplets removal for 10 micron size and above
 - 99% efficiency for liquid droplets removal for 5 micron to 10 micron size.

5.7 Adjustment of pressure level

If required, adjustment of pressure level shall be done by means of a booster compressors located upstream the PCVs.

If one or more “process” sources, as defined in paragraph 3.2, are available, the fuel gas booster compressor configuration shall be 1 x 100%.

The respective compressor API standard shall apply in this case. If required, such equipment and installation shall be detailed in separate project specifications or in the dedicated Rotating Machine Package Specification.

If required, gas coming from the booster compressor shall be cooled by means of two 100% coolers located between the PCVs and the fuel gas receiver.

6. Construction of fuel gas treatment units

6.1 General rules

If feasible, the gas treatment unit shall be built in the form of a single skid assembly which can be handled by single lift. The gas treatment unit shall be designed for continuous operation and for at least:

- 40,000 hours for scrubber internals
- 10,000 hours between maintenance inspections
- 4,000 hours between filter cartridge replacements.

Piping and equipment downstream the fine filters (included) shall be made of 316L stainless steel.

Insulation and heat tracing is required and will be part of scope of supply for the fuel gas treatment unit. Insulation and heat tracing of the line from the fuel gas treatment unit up to the gas turbine skid edge will be supplied by the EPC Contractor.

The number of fluid and electrical connections shall be held to a minimum, typically:

- One gas inlet
- One treated-gas outlet
- One compressed-air inlet
- One liquid drain outlet
- One gas outlet to flare
- One electric power connection

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- One junction box for measurements
- One junction box for alarm and shutdown signals
- One junction box for thermocouples (if used).

6.2 Instrumentation and safety devices

The locations and types of the measurement and control functions to be provided are listed in Appendix 1.

6.3 Inspections and tests

Shop inspections shall be carried out in accordance with the quality and inspection plan developed for the project. It shall cover all main components like separator, filters, heaters, coolers, control valves, instruments, piping, skid and compressors (if used).

As a minimum, on these main components, two inspections, the first one before tests and the second one before shipment, shall be conducted in presence of a Company representative.

The tests of the treatment unit shall include:

- Mechanical tests and performance tests of the gas compressors (if used)
- Operational tests of heaters
- Operational tests of all instruments and valves (PCVs, ESDVs, BDVs).

7. Diesel oil treatment

This chapter defines the minimum requirements for diesel oil treatment for gas turbines and diesel engines.

The diesel oil treatment basically consists of two different stages of sequential filtration (from large to fine particles), a water removal system and a third stage of fine filtration.

All the filtration levels mentioned in this specification are expressed in terms of absolute micron rating. This rating can be determined by means of a multi-pass test as indicated in [ISO 16889](#) and is then expressed in terms of Beta ratio (β) as explained in the following example:

$$\beta_{10(c)} = 200$$

Above indication contains the following information: The filter media has a Beta ratio of 200 with regard to 10 micron size particles. The Beta ratio of 200 means that the ratio between the number of particles of given size contained in a fluid sample taken upstream the filter media and the number of particles contained in a sample taken downstream the filter media is 200.

The conversion from the Beta ratio into meaningful information can be done in the following way:

$\beta_{10(c)} = 200$, then $(200-1)/200 = 0.995$ which means that the media efficiency is 99.5% in removing particles of the given size, 10 microns in this case.

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Some values of Beta ratio and corresponding efficiencies are given in the following table:

Beta Ratio	Filter Media Efficiency
2	50%
10	90%
20	95%
75	98.7%
100	99%
200	99.5%
1000	99.9%
5000	99.98%

The diesel oil treatment and supply network shall be based as a minimum on the following requirements according to the typical schematic attached in Appendix 3.

All diesel oil tanks shall have internal epoxy coating, or equivalent, in order to avoid corrosion due to possible water presence. The coating shall not contain zinc.

1. Raw diesel loading filter

The purpose of this filter is to provide a first rough filtration of diesel oil being loaded in the diesel oil network; 1 x 100% filter, $\beta_{500(c)} = 10$, is required.

2. Raw diesel storage tank

The capacity of this tank is defined in project specification depending on actual project needs.

3. Raw diesel transfer pumps filter

This filter, normally Y type, is required to protect the pumps against foreign objects and is not intended to treat the diesel oil; 1 x 100% filter, $\beta_{500(c)} = 10$, is required.

4. Raw diesel transfer pumps

2 x 100% pumps are required

5. Raw diesel filters

These filters shall have a large surface such that a minimum service life of two days is achieved.

This will allow removing or stopping sludge, gums, gels etc. at the earliest achievable stage and keeping the centrifuge as efficient as possible and piping clean from this stage.

Three alternatives are acceptable for these filters:

- Alternative A: 2 x 100% Back Wash filters, $\beta_{70(c)} = 200$
- Alternative B: 2 x 100% Static glass fibre (non sensitive to hydrocarbons) replaceable filters, $\beta_{70(c)} = 200$
- Alternative C: 2 x 100% metallic mesh filters, $\beta_{70(c)} = 200$

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The surface area of raw diesel filters shall be determined on the basis of the flow of raw diesel transfer pump according to the following rule: 1 m³/h flow requires 0.5 m² of filtration surface.

6. Diesel settling tank

The capacity of this tank is defined in project specification depending on actual project needs.

7. Diesel treatment package including the following items:

7.1 Pumps filter

This filter, normally Y type, is required to protect the pumps against foreign objects and is not intended to treat the diesel oil; 1 x 100% filter, $\beta_{500(c)} = 10$, is required.

7.2 Pumps

2 x 100% pumps are required.

7.3 Centrifuge

The centrifuge is required mainly to remove water as well as sludge and solids from the diesel oil and it has to be tuned according to the specific gravity of the diesel oil; 2 x 100% centrifuges are required, as a minimum (other arrangement should be project specific).

A static filter followed by a coalescing filter can be considered as an alternative to the centrifuge; 2 x 100% filters, $\beta_{10(c)} = 1000$, are required if the case.

8. Treated diesel service tank

The capacity of this tank is defined in project specification depending on actual project needs.

9. Treated diesel transfer pumps filter

This filter, normally Y type, is required to protect the pumps against foreign objects and is not intended to treat the diesel oil; 1 x 100% filter, $\beta_{500(c)} = 10$, is required.

10. Treated diesel transfer pumps

2 x 100% pumps are required.

11. Diesel fuel skid

The purpose of this fuel skid is to deliver the diesel oil at the pressure level required by the gas turbine.

One diesel fuel skid shall be provided for each gas turbine by the gas turbine Manufacturer. This skid shall be installed off-base plate of the gas turbine and shall include the following items:

11.1 Diesel fine filters

The purpose of this filter is to obtain the final filtration quality of the diesel oil; 2 x 100% static glass fiber (non sensitive to hydrocarbons) replaceable filters, $\beta_{10(c)} = 200$ or $\beta_{20(c)} = 5000$, are required.

11.2 Diesel high pressure pump

1 x 100% pump is required.

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11.3 Last chance filter

The purpose of this filter is to protect the gas turbine engine filters against foreign particles that may come from the high pressure pump in case of failure; 1 x 100% filter, $\beta_{10(c)} = 10$ or $\beta_{25(c)} = 10$, is required.

The surface of Diesel fine filters shall be determined on the basis of the flow of high pressure pump according the following rule: 1 m³/h flow requires 4 m² of filtration surface.

All duplex filters shall be able to achieve changeover in operating conditions without interruption of fuel supply and shall be provided with differential pressure measurement indicating the need for cleaning.

The diesel oil network shall be provided with recirculation loops for system flushing as indicated in Appendix 3.

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ASTM D 1072-06 - Standard Test Method for Total Sulphur in Fuel Gases by Combustion and Barium Chloride Titration

ASTM D 1142-95 - Standard Test Method for Water Vapour Content of Gaseous Fuels by Measurement of Dew-Point Temperature

ASTM D 1826-94 - Standard Test Method for Calorific (Heating) Value of Gases in Natural Gas Range by Continuous Recording Calorimeter

ASTM D 1945-03 - Standard Test Method for Analysis of Natural Gas by Gas Chromatography

ASTM D 4418-00 - Standard Practice for Receipt, Storage and Handling of Fuels for Gas Turbines

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Appendix 1

Appendix 1 Typical measurements and control functions

Typical pressure and differential pressure measurement and control functions

Measurement point	Local reading	Control-room reading	Recording	Control-room alarm
Gas inlet pressure	x	x		x
Separator pressure	x			
Pressure downstream of separator	x	x		
No. 1 filter differential pressure	x			x
Pressure at no. 2 filter	x			
No. 2 filter differential pressure	x			x
Unit output pressure	x	x	x	x

Typical level measurement and control functions

Measurement point	Local reading	Control-room reading	Control-room alarm
Inlet separator	x	x (A)	x (C)

(A) If the control loop is not local only

(C) Two levels, alarm and shutdown of machines

Typical temperature measurement and control functions

Measurement point	Local reading	Control-room reading	Recording	Control-room alarm
Gas inlet	x	x		x
Downstream of pressure control valve	x			
Upstream of heater	x	x		
Downstream of heater	x (B)	x (B)		x

(B) A single point if the heater is the last element of the treatment unit

Typical flow measurement and control functions

Measurement point	Local reading	Control-room reading	Control-room alarm
Outlet of unit (downstream of filter)	x	x	x

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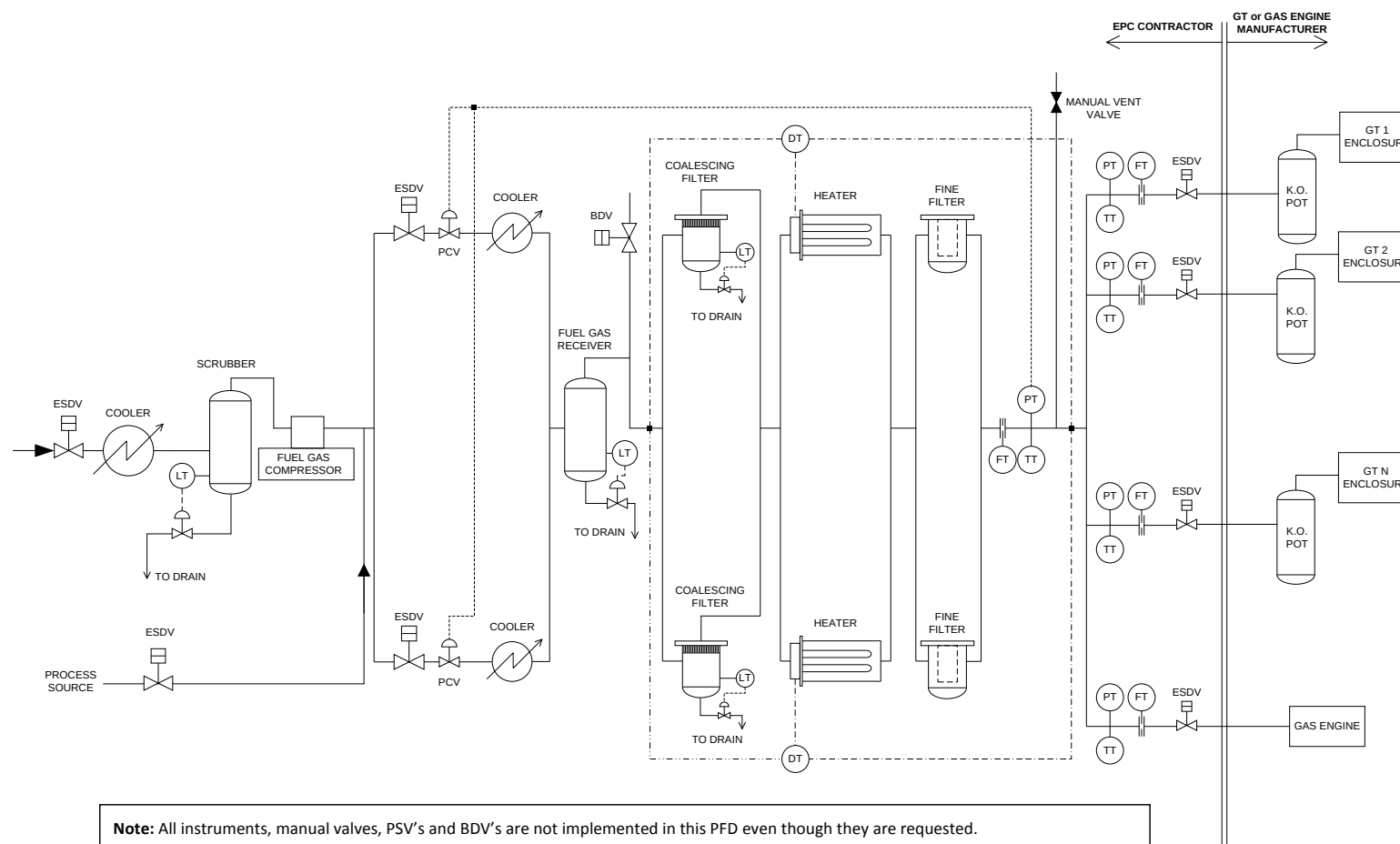
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Appendix 2

Appendix 2 Typical PFD of gas fuel treatment unit



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Appendix 3

Appendix 3 Typical Diesel Oil Network

