

GENERAL SPECIFICATION

ROTATING MACHINERY

GS EP MEC 101

Driver Power Sizing

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1. Scope

1.1 Purpose of the specification

To define the minimum required power to be delivered by the drivers (output shaft power) with regard to the power absorbed by the driven machines.

1.2 Limits of application

This specification applies to the following driven machines, whether or not covered by a professional document or a standard:

- Centrifugal compressors as per [API Std 617](#)
- Axial compressors as per [API Std 617](#)
- Volumetric compressors as per [API Std 618](#), [API Std 619](#) and or [ISO 13631](#)
- Centrifugal as per [API Std 610](#) or [ISO 5199](#), or axial or helico-axial pumps
- Volumetric pumps as per [API Std 674](#)
- Electric generators as per [IEC 60034-1](#).

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
API Std 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
API Std 617	Axial and Centrifugal Compressors and Expander-compressor for Petroleum, Chemical and Gas Industry Services
API Std 618	Reciprocating Compressors for Petroleum, Petrochemical and Natural Gas Industries
API Std 619	Rotary-type Positive Displacement Compressors for Petroleum, Petrochemical and Natural Gas Industries
API Std 674	Positive Displacement Pumps - Reciprocating
IEC 60034-1	Rotating electrical machines - Part 1: Rating and performance
ISO 5199	Technical specifications for centrifugal pumps - Class II
ISO 13631	Packaged reciprocating gas compressors

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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 ELE 001	Electrical design criteria
GS EP ELE 111	Induction motors

3. Definitions

- **Absorbed Power (P_{Absorbed}):** Power absorbed by the driven machine at any of the specified operating points provided by Company including all losses and all applicable standard tolerances of the driven machine.
- **Company:** Total E&P or any Total E&P subsidiary
- **Driven Machine Degradation ($K_{\text{Driven Machine Degradation}}$):** Percentage of the power corresponding to the fouling and the wearing of the driven machine.
- **Driven Machine Mechanical Losses ($P_{\text{Driven Machine Mechanical Losses}}$):** Mechanical losses generated by the driven machine in order to produce the required hydraulic or thermodynamic power P_{Fluid} .
- **Driven Machine Tolerance according to API or ISO standard ($K_{\text{Tolerance API/ISO}}$):** Tolerance in power of the driven machine allowed by the API, ISO or IEC standard.
- **Driver Machine Degradation ($K_{\text{Driver Degradation}}$):** Percentage of driver output power loss due to the driver ageing and fouling.
- **Driver Power (P_{Driver}):** Required power to be delivered at the driver shaft output.
- **Driver Speed Correction ($K_{\text{Speed Correction}}$):** Percentage of driver power correcting the driver site power at optimum running speed in order to obtain the driver site power at the actual running speed.
- **Fluid Power (P_{Fluid}):** Maximum required hydraulic or thermodynamic power from any of the Specified Operating Points.
- **Required Percentage of Power according to API or ISO standard ($K_{\text{Standards Required Power}}$):** percentage of power required by API or ISO in order to define the minimum Driver Power. Since API or ISO do not cover all driver types, the percentages of power required by API or ISO have been extended to those drivers on which standards are silent.
- **Site conditions:**
 - **Best Site Conditions:** Site Conditions at which driver delivers its highest shaft output power (e.g. minimum site temperature)
 - **Worst Site Conditions:** Site Conditions at which driver delivers its lowest shaft output power (e.g. maximum site temperature)

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- **Design Site Conditions:** Site Conditions at which driver shall be sized. If Design Site Conditions are not defined by Company, the Worst Site Conditions shall apply.

Note: In principle, the Design Site Conditions shall be as close as possible to the Worst Site Conditions and thus shall be carefully selected to account for production or process requirements, as having a direct impact on the performance of the driver.

- **Specified Operating Point:** Any operating point indicated in the Project Data Sheets.
- **Transmissions and Shaft Driven Accessories Losses ($P_{\text{Transmission Losses}}$):** All mechanical losses induced by transmissions, couplings, gears and shaft driven accessories.
- **Vendor:** The package Supplier

4. Calculation of Driven Machines Absorbed Power

4.1 Electric Generators

The electric generator absorbed power results from the overall power balance provided by others. In all cases, the mechanical power absorbed by the generator from the driver shall include:

- All driven machine losses, and transmission, coupling, gears and associated shaft driven accessories losses
- Power tolerance of the generator, which is 10% of the generator losses according to IEC 60034.

Refer to **GS EP ELE 001** for the sizing of the electric generator and to an example in Appendix 3 for further details.

4.2 Other Driven Machines

In all cases, the power absorbed by the driven machine shall include the following:

- All driven machine losses ($P_{\text{Driven Machine Mechanical Losses}}$), and transmission losses (coupling, gears and shaft driven accessories losses ($P_{\text{Transmission Losses}}$))
- Fouling and wearing ($K_{\text{Driven Machine Degradation}}$)
- Power tolerance of the driven machine according to related API or ISO standard ($K_{\text{Tolerance API/ISO}}$).

The absorbed power is computed as follows:

$$P_{\text{Absorbed}} = (P_{\text{Fluid}} + P_{\text{Driven Machine Mechanical Losses}}) \times (1 + K_{\text{Tolerance API/ISO}}) \times (1 + K_{\text{Driven Machine Degradation}}) + P_{\text{Transmission Losses}}$$

The K coefficients in the above formula are indicated in tables attached in Appendix 1.

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Examples:

For centrifugal compression applications, $K_{\text{Driven Machine Degradation}}$ is defined as follows:

- 2% for commercial gas and refrigeration, Boil Off Gas and End Flash Gas applications
- 6% for any other type of application.

For centrifugal pumping applications, $K_{\text{Driven Machine Degradation}}$ is defined as follows:

- 6% for all applications.

5. Calculation of the Driver Power Sizing

5.1 General Rules

$P_{\text{Driver}} \geq P_{\text{Absorbed}} / (1 - K_{\text{Driver Degradation}})$ or, $P_{\text{Driver}} \geq [(P_{\text{Fluid}} + P_{\text{Driven Machine Mechanical Losses}}) + P_{\text{Transmission Losses}}] \times (1 + K_{\text{Standards Required Power}}) / (1 - K_{\text{Driver Degradation}})$ whichever is the highest.
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The K coefficients in the above formula are indicated in tables attached in Appendix 1, depending on application listed here below:

- Diesel engine driver: Refer to Table 1 in Appendix 1
- Gas engine driver: Refer to Table 2 in Appendix 1
- Gas turbine driver: Refer to Table 3 in Appendix 1. In addition, refer to example of a turbo-compressor application in Appendix 2 and example of a turbo-generator application in Appendix 3
- Motor driver: Refer to Table 4 in Appendix 1
- Steam turbine: Refer to Table 5 in Appendix 1.

At any of the Site Conditions as defined above, drivers shall be sized for continuous duty.

Degradation factor is not applicable to Diesel engine, electric motor, gas engine and is therefore considered as 0% for applications using such drivers.

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5.2 Special rules

Furthermore, the following special rules shall apply:

5.2.1 Start-up conditions

- Start-up of a rotating machines train shall be possible at the Settle Out Pressure (SOP) without any depressurization.
- For electric motors, the starting time shall conform to **GS EP ELE 111** paragraph 5.8.4. Gas turbine.

In all cases, Vendor shall guarantee that the maximum gas turbine firing temperature corresponding to base load operation is never exceeded at any operating point in steady state.

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Appendix 1

Appendix 1 Driven Machines Absorbed Power Table and Driver Power Sizing Tables

Table 1 - Detailed Diesel Engine Power K coefficients

Shaft line	DRIVER	DRIVEN MACHINE		
	K _{Driver degradation}	K _{Standards Required Power}	K _{Tolerance API/ISO}	K _{Driven Machine Degradation}
1.1 Diesel engine + centrifugal pump				
Diesel engine + centrifugal pump	Not applicable	10% (3)	4% (1)	6%
1.2 Diesel engine + positive displacement pump				
Diesel engine + positive displacement pump	Not applicable	10% (3)	4% (1)	Not applicable
1.3 Diesel engine + rotary compressor				
Diesel engine + rotary compressor	Not applicable	10% (3)	4% (1)	2% or 6% (4)
1.4 Diesel engine + reciprocating compressor				
Diesel engine + reciprocating compressor	Not applicable	10% (3)	3% (1)	Not applicable
1.5 Diesel engine + centrifugal compressor				
Diesel engine + fixed speed centrifugal compressor	Not applicable	10% (3)	7% (1)	2% or 6% (4)
1.6 Diesel engine + generator				
Diesel engine + generator	Not applicable	10% (3)	(5)	Not applicable

(1) Issued from driven machine standard.

(2) Required power margin for the driver sizing issued from driven machine standard.

(3) Required power margin for the driver sizing extended from driven machine standard.

(4) For the value selection, refer to paragraph 4.2 "Other Driven Machines".

(5) 10% of generator losses according IEC 60034.

Table 2 - Detailed Gas Engine Power K coefficients

Shaft line	DRIVER	DRIVEN MACHINE		
	K _{Driver degradation}	K _{Standards Required Power}	K _{Tolerance API/ISO}	K _{Driven Machine Degradation}
2.1 Gas engine + centrifugal pump				
Gas engine + centrifugal pump	Not applicable	10% (3)	4% (1)	6%
2.2 Gas engine + positive displacement pump				
Gas engine + positive displacement pump	Not applicable	10% (3)	4% (1)	Not applicable
2.3 Gas engine + rotary compressor				
Gas engine + rotary compressor	Not applicable	10% (3)	4% (1)	2% or 6% (4)
2.4 Gas engine + reciprocating compressor				
Gas engine + reciprocating compressor	Not applicable	10% (2)	3% (1)	Not applicable
2.5 Gas engine + centrifugal compressor				
Gas engine + fixed speed centrifugal compressor	Not applicable	10% (3)	7% (1)	2% or 6% (4)
Gas engine + variable speed centrifugal compressor	Not applicable	10% (3)	4% (1)	2% or 6% (4)
2.6 Gas engine + generator				
Gas engine + generator	Not applicable	10% (3)	(5)	Not applicable

(1) Issued from driven machine standard.

(2) Required power margin for the driver sizing issued from driven machine standard.

(3) Required power margin for the driver sizing extended from driven machine standard.

(4) For the value selection, refer to paragraph 4.2 "Other Driven Machines".

(5) 10% of generator losses according IEC 60034.

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Appendix 1
Table 3 - Detailed Gas Turbine Power K coefficients

Shaft line	DRIVER	DRIVEN MACHINE		
	K _{Driver degradation}	K _{Standards Required Power}	K _{Tolerance API/ISO}	K _{Driven Machine Degradation}
3.1 Gas turbine + centrifugal pump				
Gas turbine + centrifugal pump	8%	10% (3)	4% (1)	6%
3.2 Gas turbine + positive displacement pump				
Gas turbine + positive displacement pump	8%	10% (3)	4% (1)	Not applicable
3.3 Gas turbine + rotary compressor				
Gas turbine + rotary compressor	8%	10% (3)	4% (1)	2% or 6% (4)
3.4 Gas turbine + reciprocating compressor				
Gas turbine + reciprocating compressor	8%	10% (3)	3% (1)	Not applicable
3.5 Gas turbine + centrifugal compressor				
Gas turbine + fixed speed centrifugal compressor	8%	10% (3)	7% (1)	2% or 6% (4)
Gas turbine + variable speed centrifugal compressor	8%	10% (3)	4% (1)	2% or 6% (4)
3.6 Gas turbine + generator				
Gas turbine + generator	8%	0%	(5)	Not applicable

(1) Issued from driven machine standard.

(2) Required power margin for the driver sizing issued from driven machine standard.

(3) Required power margin for the driver sizing extended from driven machine standard.

(4) For the value selection, refer to paragraph 4.2 "Other Driven Machines".

(5) 10% of generator losses according IEC 60034.

Table 4 - Detailed Electrical Motor Power K coefficients

Shaft line	DRIVER	DRIVEN MACHINE		
	K _{Driver degradation}	K _{Standards Required Power}	K _{Tolerance API/ISO}	K _{Driven Machine Degradation}
4.1 Motor + centrifugal pump				
Motor < 22 kW + centrifugal pump	Not applicable	10% (2)	4% (1)	6%
22 kW ≤ Motor ≤ 55 kW + centrifugal pump	Not applicable	10% (2)	4% (1)	6%
Motor > 55 kW+ centrifugal pump	Not applicable	10% (2)	4% (1)	6%
4.2 Motor + positive displacement pump				
Motor + positive displacement pump	Not applicable	10% (2)	4% (1)	Not applicable
4.3 Motor + rotary compressor				
Motor + rotary compressor	Not applicable	10% (2)	4% (1)	2% or 6% (4)
4.4 Motor + reciprocating compressor				
Motor + reciprocating compressor	Not applicable	10% (2)	3% (1)	Not applicable
4.5 Motor + centrifugal compressor				
Motor + fixed speed centrifugal compressor	Not applicable	10% (2)	7% (1)	2% or 6% (4)
Motor + variable speed centrifugal compressor	Not applicable	10% (2)	4% (1)	2% or 6% (4)

(1) Issued from driven machine standard.

(2) Required power margin for the driver sizing issued from driven machine standard.

(3) Required power margin for the driver sizing extended from driven machine standard.

(4) For the value selection, refer to paragraph 4.2 "Other Driven Machines".

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Appendix 1
Table 5 - Detailed Steam Turbine Power K coefficients at normal steam condition

Shaft line	DRIVER	DRIVEN MACHINE		
	K _{Driver degradation}	K _{Standards Required Power}	K _{Tolerance API/ISO}	K _{Driven Machine Degradation}
5.1 Steam turbine + centrifugal pump				
Steam turbine + centrifugal pump	4%	10% (2)	4% (1)	6%
5.2 Steam turbine + positive displacement pump				
Steam turbine + positive displacement pump	4%	10% (2)	4% (1)	Not applicable
5.3 Steam turbine + rotary compressor				
Steam turbine + rotary compressor	4%	10% (2)	4% (1)	2% or 6% (4)
5.4 Steam turbine + reciprocating compressor				
Steam turbine + reciprocating compressor	4%	20% (2)	3% (1)	Not applicable
5.5 Steam turbine + centrifugal compressor				
Steam turbine + fixed speed centrifugal compressor	4%	10% (2)	7% (1)	2% or 6% (4)
Steam turbine + variable speed centrifugal compressor	4%	10% (2)	4% (1)	2% or 6% (4)
5.6 Steam turbine + generator				
Steam turbine + generator	4%	0%	(5)	Not applicable

(1) Issued from driven machine standard.

(2) Required power margin for the driver sizing issued from driven machine standard.

(3) Required power margin for the driver sizing extended from driven machine standard.

(4) For the value selection, refer to paragraph 4.2 "Other Driven Machines".

(5) 10% of generator losses according [IEC 60034](#).

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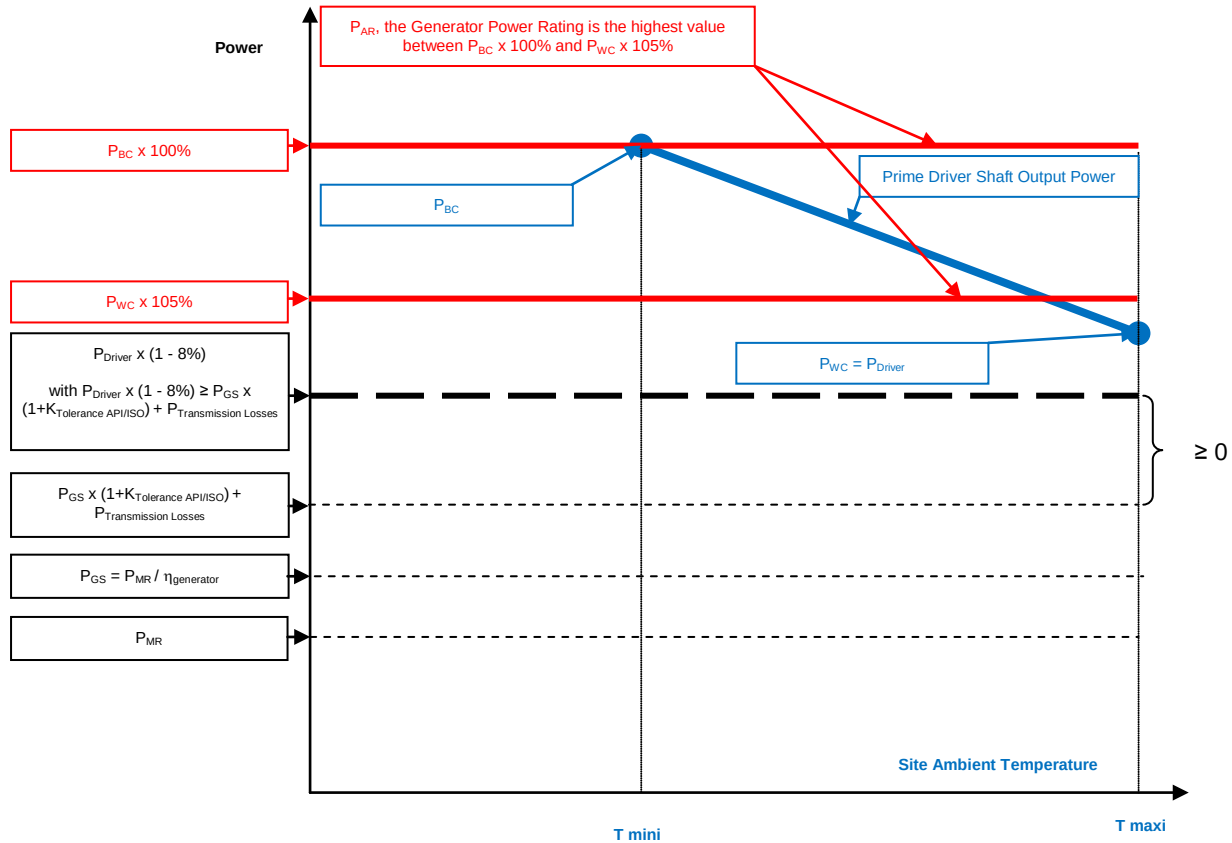
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Appendix 2

Appendix 2 Power Calculations Applicable to Centrifugal Compressor Driven by Gas Turbine

TURBINE	Turbine power in kW (ISO base rating) at optimum turbine speed.	ISO power
	Site expected power in kW at Design Site Conditions. Note: The calculation shall be based on the Vendor gas turbine expected performance.	Site power
	Site inlet and exhaust losses in kW.	Site inlet and exhaust power losses
	Optimum turbine speed correction factor.	$K_{\text{Speed Correction}}$
	Power available at power turbine output shaft in kW (P_{Driver}), considering new and clean gas turbine.	$P_{\text{Driver}} = (\text{Site power} - \text{Site inlet and exhaust power losses}) \times K_{\text{Speed Correction}}$
	Power available at power turbine output shaft in kW where $K_{\text{Driver degradation}} = 8\%$, considering used and fouled gas turbine.	$P_{\text{Driver}} \times (1 - K_{\text{Driver Degradation}})$
As stated in paragraph 5.1 "General Rules" the power available on turbine output shaft in worst conditions (P_{Driver}) shall exceed the absorbed power of driven equipment ($P_{\text{Absorbed Power}}$) where $K_{\text{Standards Required Power}} = 10\%$.		$P_{\text{Driver}} \geq [(P_{\text{Fluid}} + P_{\text{Driven Machine Mechanical Losses}}) \times (104\%) \times (106\%) + P_{\text{Transmission Losses}}] / [1 - K_{\text{Driver Degradation}}]$ or $[(P_{\text{Fluid}} + P_{\text{Driven Machine Mechanical Losses}}) + P_{\text{Transmission Losses}}] \times (1 + K_{\text{Standards Required Power}}) / (1 - K_{\text{Driver Degradation}})$ whichever is the highest.
COMPRESSOR	Absorbed power ($P_{\text{Absorbed Power}}$).	$(P_{\text{Fluid}} + P_{\text{Driven Machine Mechanical Losses}}) \times (104\%) \times (106\%) + P_{\text{Transmission Losses}}$
	Transmission, couplings, gear losses and shaft driven accessory losses, if applicable.	$P_{\text{Transmission Losses}}$
	Total absorbed power of the driven compressor at compressor shaft end where $K_{\text{Tolerance API/ISO}} = 4\%$ and $K_{\text{Driven Machine Degradation}} = 6\%$ for "process gas" compressor application.	$(P_{\text{Fluid}} + P_{\text{Driven Machine Mechanical Losses}}) \times (104\%) \times (106\%)$
	Absorbed power on compressor input shaft and at specified speed.	$P_{\text{Fluid}} + P_{\text{Driven Machine Mechanical Losses}}$
	Compressor mechanical losses, including bearing and shaft seals.	$P_{\text{Driven Machine Mechanical Losses}}$
	Gas power, at any specified operating point where absorbed power is maximum.	P_{Fluid}

Appendix 3 Gas Turbine Sizing and Electrical Generator Rating



Legend:

P_{Driver} = Required power to be delivered at the driver (i.e. gas turbine) shaft output.

P_{GS} = Generator Shaft Input Power⁽¹⁾.

$P_{Transmission\ Losses}$ = Transmission, couplings, gears and shaft driven accessories losses.

P_{MR} = Minimum Required Output Power detailed in **GS EP ELE 001** § 7.2 "Equipment rating/sizing", i.e. including the necessary 20% margin in power for known future development, if any⁽¹⁾.

P_{WC} = Prime Driver Shaft Output Power for Worst Conditions (e.g. maximum site temperature)⁽¹⁾.

P_{BC} = Prime Driver Shaft Output Power for Best Conditions (e.g. minimum site temperature)⁽¹⁾.

P_{AR} = Generator Power Rating⁽¹⁾.

Where $K_{Driver\ Degradation}$ = 8% for gas turbine application and $K_{Tolerance\ API/ISO}$ = 10% of the generator losses for generator application (i.e. $K_{Tolerance\ API/ISO} = 10\% \times (1 - \eta_{generator})$).

(1) The defined variables refer to the Appendix 4 of the general specification **GS EP ELE 001**.