

GENERAL SPECIFICATION

ROTATING MACHINERY

GS EP MEC 212

Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616

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General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 2 of 89

Contents

1. Scope	3
2. Reference documents.....	3
3. Comments to API Std 616.....	5
Appendix 1 Gas Turbine Air Inlet Filters Arrangement.....	68
Appendix 2 Datasheets	75

General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 3 of 89

1. Scope

This specification clarifies how to use the recommendations of [API Std 616](#) for the supply to Company of Gas Turbine, in mechanical drive application or power generation application.

The purpose of this specification is to clarify the requirements of [API Std 616](#) standard fifth edition, January 2011.

Technical proposal shall be supported by DS EP MEC 213 part of the Appendix 2 of this specification.

This document modifies or complements some requirements of [API Std 616](#) standard, when deemed necessary considering Company experience.

The paragraph numbering is identified in the same way as in [API Std 616](#) except for additional requirements, which may be presented with new paragraph numbers. The summary sheet at front indicates where to find the information for each paragraph of [API Std 616](#) shown with a bullet.

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/FCI 70-2	Control Valve Seat Leakage
API Std 616	Gas Turbines for the Petroleum, Chemical, and Gas Industry Services
ASME PTC 1	General Instructions
ASME PTC 22	Performance Test Code on Gas Turbines
ATEX Ex II 2G	European Directive 94/9/EC (23/03/94) on the approximation of the laws of the Member State concerning equipment and protective systems intended for use in potentially explosive atmosphere
EN 1822-1	High efficiency air filters (EPA, HEPA, and ULPA) - Part 1: Classification, performance testing, marking
EN 779	Particulate air filters for general ventilation: Determination of filtration performance
ISO 10441	Flexible couplings for mechanical power transmission Special-purpose applications

General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 4 of 89

Reference	Title
ISO 5167 (All parts)	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - (All parts)
SOLAS	Safety of Life at Sea

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 013	Electrical requirements for generating units
GS EP MEC 010	Rotating Machine Package Specification - Turbogenerator
GS EP MEC 020	Rotating Machine Package Specification - Turbopump
GS EP MEC 030	Rotating Machine Package Specification - Turbocompressor
GS EP SAF 050	Fire and Gas System and Fire Suppression System for Packaged Rotating Machinery Enclosures

General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 5 of 89

3. Comments to [API Std 616](#)

API	GS
1 Scope	
1.1 General	
NOTE: A bullet (●) at the beginning of a paragraph indicates that either a decision is required or further information is to be provided by the purchaser. The information should be indicated on the datasheets (see Annex A); otherwise it should be stated in the quotation request or in the order.	Refer to this specification and to the datasheets template in Appendix 2 of this specification.
1.2 Alternative Design	
The vendor may offer alternative designs.	All the equipment shall comply with ISO standards and have dimensions and data generally expressed in metric units (flange and piping designation may still be indicated in inches). American standards referenced in API Std 616 may be replaced by International or European standards which can be demonstrated as equivalent or more stringent. If alternative standards, codes and specifications are proposed, their use shall be clearly indicated.
2 References	
2.2 Compliance	
The Purchaser and the Vendor shall mutually determine the measure that must be taken to comply with governmental codes, regulations, ordinances, or rules that are applicable to the equipment.	The Purchaser shall inform the Vendor about all known local demands. It is the responsibility of the vendor to comply with these demands.
3 Terms, Definitions, Acronyms, Abbreviations, and Symbols	
3.17 inlet volume flow Flow rate expressed in volume flow units at the conditions of pressure, temperature, compressibility and gas composition, including moisture content, at the compressor inlet flange.	The flow rate expressed in volume flow units before filtration under the specified ambient conditions.

API	GS								
3.20 ISO-rated power Continuous power developed by the gas turbine when it is operated at ISO-rated firing temperature and speed under the following standard operating conditions (see ISO 2314): <table> <tr> <td>Inlet temperature</td><td>15°C (59°F)</td></tr> <tr> <td>Inlet (total) pressure</td><td>1.0133 bar (14.696 psia)</td></tr> <tr> <td>Inlet relative humidity</td><td>60 %</td></tr> <tr> <td>Exhaust (static) pressure</td><td>1.0133 bar (14.696 psia)</td></tr> </table> This power and speed is measured at the output shaft of the gas turbine ahead of any separate gear or piece of driven equipment, except for the power output of electric generator drives. Rated power from electric generator drives shall be measured at the terminals of the generator. The inlet conditions shall be measured at the inlet to the compressor bell mouth. The exhaust conditions shall be measured at the turbine exhaust flange. These measuring locations shall be used for all power and gas flow measurements. The ISO rating provides only general sizing information and should not be confused with site rated power.	Inlet temperature	15°C (59°F)	Inlet (total) pressure	1.0133 bar (14.696 psia)	Inlet relative humidity	60 %	Exhaust (static) pressure	1.0133 bar (14.696 psia)	For mechanical drives, the power and speed are measured at the output shaft of the gas turbine ahead of any separate gear or piece of driven equipment. For electric generator drives, the manufacturer shall indicate the losses due to the main gear box and the efficiency of electric generator. The inlet conditions shall be measured at the inlet flange of the gas turbine. The exhaust conditions shall be measured at the exhaust flange of the gas turbine.
Inlet temperature	15°C (59°F)								
Inlet (total) pressure	1.0133 bar (14.696 psia)								
Inlet relative humidity	60 %								
Exhaust (static) pressure	1.0133 bar (14.696 psia)								
3.54 site rated firing temperature Turbine inlet total temperature, measured at a location immediately upstream of the first-stage turbine nozzles, required to meet site rated power conditions.	The site rated firing temperature may be measured or calculated. When the value is calculated, the vendor shall indicate the method of calculation and the values of any parameter.								
3.55 site rated power Shaft power developed by the gas turbine when it is operated at site firing temperature, rated speed, and site rated conditions of inlet temperature, inlet pressure, exhaust pressure, and normal fuel composition.	In addition, base load at site: The maximum continuous power delivered at turbine coupling (or at electrical output terminals) under the specified atmospheric conditions with the specified gas at rated firing temperature. Peak load at site: The maximum power delivered at turbine coupling (or at electrical								

API	GS
	output terminals) under the specified atmospheric conditions with the specified gas at peak rated firing temperature (up to 2,000 hours a year). The manufacturer shall indicate what shall be the turbine life time when running at peak load. In no case, peak load operation shall be considered to comply with power requirements. All losses due to auxiliaries, inlet and exhaust systems, gear, and generator efficiency (if applicable) shall be detailed and included in calculations.
4 Basic Design	
4.1 General	
4.1.1 The equipment (including auxiliaries) covered by this standard shall be designed and constructed for a minimum service life of 20 years and at least three years of uninterrupted operation. It is recognized that this is a design criterion and that hot section inspections (see Annex E) may be required; however, the required time between inspections shall be no less than 8,000 operating hours. The 8000-hour requirement applies to base-loaded machines using sweet, dry fuel gas that meets manufacturer's specification. The vendor shall supply the service life and minimum uninterrupted operation interval based on each specific application. The maintenance procedure necessary to achieve these intervals shall also be supplied. For aeroderivative gas turbines, the time required for intrusive (requiring parts removal) inspections shall no be less than 12,000 operating hours. Nonintrusive inspections, e.g. those requiring the use of a boroscope may be more frequent as required by the manufacturer. NOTE: Auxiliary system design and design of the process in which the equipment is installed are very important criteria in meeting this objective.	In addition, the vendor shall provide details of the expected and guaranteed availability and reliability figures for the proposed complete package and individual main components, as detailed in the Contract documents.
4.1.3 The purchaser will specify the	This paragraph is applicable.

API	GS
equipment's normal operating point on the datasheets (see 3.31 and Annex A).	
4.1.5 The output-shaft operating speed range of gas turbine units for mechanical-drive applications shall be as specified on the datasheets. Where only one operating speed is specified for an application, the speed range for single shaft machines shall be 25 % (from 80 % to 105 % of rated speed), and the speed range for two or more shaft machines shall be 55 % (from 50 % to 105 % of rated speed). NOTE: Electrical generator drive gas turbines are typically limited to a much higher speed range due to generator restrictions. This speed range is typically 95% to 105% of rated speed.	This paragraph is applicable.
4.1.7 The gas turbine design shall accommodate transient thermal gradients following tripouts and shall permit immediate restarting subject to the driven equipment restrictions. Gas turbine cold-start and hot-start restrictions shall be defined in the proposal. The purchaser shall agree with the vendor on consequences if the restrictions must be exceeded.	In addition, the vendor shall clearly indicate in his proposal any limitation and the various starting times (normal cold start, emergency cold start, normal hot start, emergency hot start) and consequences for the life time of the engine of each transient thermal gradient. The control system shall be designed so that to avoid exceeding the restrictions.
4.1.8 The purchaser will specify the maximum allowable emissions levels at the package boundaries. The control of exhaust emissions levels of the package shall be a joint effort of the gas turbine vendor and the purchaser. Any restrictions on the gas turbine's speed or load range related to emission control shall be stated in the proposal. It is the responsibility of the purchaser to obtain any permits that may be required to operate the equipment and it is the responsibility of the gas turbine vendor to support the purchaser with emissions data. The gas turbine vendor shall state in his proposal expected emissions levels consistent with the purchaser's specified fuel properties (see 5.8.2.1 or 5.8.4.3) and site operating conditions (see 4.1.19). The gas turbine vendor shall supply, if required, the gas turbine combustion emission	(Modification of first paragraph) The purchaser shall specify the maximum allowable emissions levels at the package boundaries. It is the sole responsibility of the Vendor to comply with these emissions levels in line with Purchaser policy and local regulation. This paragraph is applicable.

API	GS
suppression system to meet the specified levels of NO_x, CO, and unburned hydrocarbons in the turbine's exhaust gas. Any restrictions on the speed range or load range of units with emission control shall be stated in the proposal.	
• 4.1.9 If specified, the gas turbine unit shall be designed to permit steam or water injection for either increasing the unit's power capability or controlling emissions. The effects (e.g. maintenance recommendations and parts replacement) of steam or water injection shall be stated in the proposal. The vendor shall specify the required quantity and quality of injection fluids.	Steam or water injection is not allowed.
• 4.1.10 Limiting and attenuation of the sound pressure level (SPL) of all equipment furnished shall be the responsibility of the vendor. The equipment furnished by the vendor shall conform to the maximum allowable sound pressure level specified by the purchaser and measured in accordance with ISO 10494 or ASME B133.8. In order to determine compliance, the vendor shall provide both maximum sound pressure and sound power level data per octave band for each principal component supplied.	The testing protocol and the acceptance criteria are specified in the GS EP MEC 010, GS EP MEC 020 or GS EP MEC 030 as applicable.
4.1.11 A cooling water system or systems shall be designed for the following conditions: - water velocity over heat, exchange: 1.5 m/s to 2.5 m/s, 5 ft/s to 8 ft/s. - maximum allowable working pressure: >7 bar (see NOTE 1), >100 psig; - hydrotest pressure (1.5 x MAWP): ≥ 10.5 bar (see NOTE 1), ≥150 psig; - maximum pressure drop: 1 bar, 15 psi; - maximum inlet temperature: 30°C, 90°F; - maximum outlet temperature: 50°C, 120°F; - maximum temperature rise: 20 K, 36°F; - minimum temperature rise: 10 K, 18°F; - fouling factor on water side: 0.35 m²K/KW, 0.002 hr-ft²-°F/Btu; - water side corrosion allowance: 3 mm, 1/8in. Provision shall be made for complete venting	When cooling water is not available, direct lube oil air cooling system only shall be considered.

API	GS
and draining of the system. The vendor shall notify the purchaser if the criteria for minimum temperature rise and velocity over heat exchange surfaces result in a conflict. The criterion for velocity over heat exchange surfaces is intended to minimize water side fouling; the criterion for minimum temperature rise is intended to minimize the use of cooling water. If such a conflict exists, the purchaser will approve the final selection. NOTE 1: Gauge pressure NOTE 2: Refer to API <i>MPMS</i> for guidelines for the use of the International system of units (SI).	
● 4.1.14 Motors, electrical components, and electrical installations shall be suitable for the area classification specified (class, group and division or zone). The applicable electrical codes are specified in 5.4.1.5.3.	In addition, all electrical equipment located inside the enclosure must be ATEX certified. The enclosure emergency ventilation system necessary for cool down after shutdown must be certified for zone 1 and be driven through DC supply. Ventilation used in normal operation must be certified for zone 1.
● 4.1.17 The gas turbine and its driven equipment shall perform on the test stand(s) and on their permanent foundation within the agreed acceptance criteria. If specified, after installation at the site, the performance of the combined units shall be verified. The testing protocol and acceptance criteria are the joint responsibility of the purchaser and the vendor that has unit responsibility. NOTE: Field acceptance criteria can be different than the test stand acceptance criteria. Details of field acceptance are mutually agreed between the purchaser and vendor.	The testing protocol on test stands and acceptance criteria are specified in the GS EP MEC 010, GS EP MEC 020 or GS EP MEC 030 as applicable. Performance test of the combined unit at site is applicable.
● 4.1.18 Many factors (such as piping and duct loads, alignment at operating conditions, supporting structure, handling during shipment, and handling and assembly at the site) can adversely affect site performance. To minimize the influence of these factors, the vendor shall provide the maximum acceptable load data at each interface point. Particular attention should be given to any changes in piping alignment when major flanges of the equipment are unfastened. If	This paragraph is applicable.

API	GS
specified, the vendor's representative shall: a) review and comment on the purchaser's ducting layout, piping systems, and foundations drawings; b) observe a check of the major piping connections by parting the flanges; c) check alignment at the operating temperature; d) witness the initial alignment check.	
● 4.1.19 The equipment, including all the auxiliaries, shall be suitable for operation under the environmental conditions specified. These conditions shall include whether the installation is indoors (heated or unheated) or outdoors (with or without a roof), maximum and minimum temperatures, unusual humidity, and dusty or corrosive conditions. The unit and its auxiliaries shall be suitable for shipment and installation under the specified conditions.	Refer to Project specification and Project datasheet.
● 4.1.22 The purchaser shall specify the pressure, temperature and flow for bleed air utilized outside the gas turbine. The vendor shall specify in the proposal the quantity, extraction stage, and pressure available for use by the purchaser. Bleed air shall not be extracted from sealing or cooling air lines.	Bleed air for Purchaser use is not required.
4.2 Pressure Casings	
● 4.2.7.1 The threading shall conform to ISO 261 (metric) or ASME/ANSI B1.1 (inch series) as specified.	Vendor standard shall apply for the bare gas turbine. GS EP MEC 010 , GS EP MEC 020 or GS EP MEC 030 shall apply for gas turbine associated systems.
4.4 Casing Connections	
● 4.4.1 Air inlet and exhaust connections of the pressure casings shall be flanged or machined and studded, oriented as specified and suitable for the positive or negative working pressure of the casing as defined in 3.24.	This paragraph is applicable. Refer to Project specification and Project datasheet.
● 4.4.3.4.1 Threaded openings and bosses for tapered pipe threads shall conform to ISO	This paragraph is applicable.

API	GS
7- I: 1994 and 7005-2: 1988 or ASME B1.20.1 as specified.	
4.4.3.4.2 If ISO 7- I: 1994 has been specified, tapered or straight internal threads shall also be specified.	This paragraph is applicable.
4.4.5.1 Gray, malleable, ductile and cast iron flanges shall be flat faced and conform to the dimensional requirements of ISO 7005-2 or ASME B16.1 or ASME B16.42 as specified. PN 20 (Class 125) flanges shall have a minimum thickness equal to PN 50 (Class 250) for sizes DN 200 (NPS 8) and smaller.	This paragraph is applicable.
4.4.6 Machined and studded connections shall conform to the facing and drilling requirements of ISO 7005-1: 1992, ISO 7005-2: 1988, ASME B16.1, ASME B16.5, ASME B16.42, or ASME B16.47 as specified. Studs and nuts shall be furnished installed, and the first 1.5 threads at both ends of each stud shall be removed.	This paragraph is applicable.
4.5 Rotating Elements	
4.5.1 Shafts	
4.5.1.1 Shafts shall be designed and manufactured with the capability to transmit the maximum torque that can be developed at any steady state or transient condition in the total operating envelope. The envelope is as defined by the manufacturer within the range of specified site values (see 4.1.19). For generator drives, the vendor shall also specify the transient torque due to short circuit overloads. Also for generator applications the vendor shall specify the power limit, identify the weakest shaft element and, if necessary, provide overload protection.	In addition, for power generation applications, rotors shall withstand without damage a 3 phase short circuit torque, or a protection device shall be included in the coupling. For mechanical drive applications, the vendor shall indicate in his bid the calculation method of the maximum torque that the rotating element must withstand.
4.5.1.4.1 The shaft radial vibration sensing areas shall be properly demagnetized to the levels specified in API 670 or otherwise treated so that the combined total electrical and mechanical runout, relative to the journals, does not exceed 15 µm (0.6 mil)	This paragraph is applicable with the exception of Footnote 2.

API	GS
peak-to-peak or 25% of the permissible vibration according to 4.7.5.2.1 whichever is less.	
4.5.1.4.2 For areas to be observed by axial-position probes, the shaft mechanical runout shall not exceed 15 μm (0.6 mil). NOTE 1: See 4.7.5.2.2 and 4.7.5.2.3 for measurement and recording of mechanical and electrical runout. NOTE 2: If all reasonable efforts fall to achieve the limits noted in 4.5.1.4.1, the vendor and the purchaser shall mutually agree on alternate acceptance criteria.	This paragraph is applicable with the exception of Footnote 2.
4.5.3 Disk and Blading	
4.5.3.3 New gas turbine blade designs shall have 8000 documented, continuous, trouble-free operating hours per blade on similar operating conditions as agreed by the purchaser and vendor.	Hot blading shall have at least the number of trouble-free operating hours corresponding to the duration of time between major overhaul. For all other blading, there shall be no time constraint.
4.5.3.4 If specified, the vendor shall present Campbell and Goodman diagrams for the blading backed by demonstrated experience in the application of identical blades operating with the same source or frequency of excitation that is present in the proposed unit. The vendor shall indicate on the Goodman diagrams the standard acceptance margins.	This paragraph is applicable.
4.7 Dynamics	
4.7.2 Lateral Analysis	
4.7.2.6 If specified, the effects of other equipment in the train shall be included in the damped unbalanced response analysis (that is, a train lateral analysis shall be performed) NOTE: In particular, this analysis should be considered for machinery trains with rigid couplings. Refer to API 684 for examples.	A train lateral analysis shall be performed for machinery trains either with rigid couplings including quill shaft or with coupling spacer greater than 36 inches or both.
4.7.3 Torsional Analysis	
4.7.3.1 For gas turbine-driven units, the vendor having unit responsibility shall ensure that a torsional vibration analysis of the complete coupled train is carried out and	This paragraph is applicable. The requirement of data for a third party torsional analysis may be required during project development, on a case by case basis, at the

Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616

Rev.: 09

Effective date: 10/2012

Page: 14 of 89

API	GS
shall be responsible for directing any modifications necessary to meet the requirements of 4.7.3.1 through 4.7.3.6. If specified, the data for a third party torsional analysis shall be provided. NOTE: See Annex D for a torsional analysis flowchart.	sole decision of Purchaser.
4.7.3.4 Torsional natural frequencies at two times running speed shall preferably be avoided or, in systems in which corresponding excitation frequencies occur, shall be shown to have no adverse effect.	Torsional criticals at multiple of running speeds or at multiple of gear speeds shall be avoided. Identification of these frequencies shall be the sole responsibility of the vendor.
4.7.3.5 When torsional resonances are calculated to fall within the margin specified in 4.7.3.3 (and purchaser and the vendor have agreed that all efforts to remove the critical from within the limiting frequency range have been exhausted); a stress analysis shall be performed to demonstrate that the resonances have no adverse effect on the complete train. The assumptions made in this analysis regarding the magnitude of excitation and the degree of damping shall be clearly stated. The acceptance criteria for this analysis shall be mutually agreed upon by the purchaser and the vendor.	If a torsional resonance is calculated to fall within the margin specified in 4.7.3.3, the vendor shall seek a solution using the adaptation effect of the couplings. If no solution can be found, the vendor shall demonstrate that the resonance has no adverse effect on the integrity of the shaft line. He shall provide calculations of normal and cyclic stress for each element of the shaft line (with clear indications of excitation assumptions). The results of the analysis shall be submitted in the form of a modified Goodman diagram with life time elements calculations.
4.7.3.6.3 An appropriate cumulative fatigue algorithm shall be used to develop a value for the safe number of starts/short circuits. The safe number of starts/short circuits shall be as mutually agreed by the purchaser and vendor. NOTE 1: Values used depend on the analytical model used and the vendor's experience. Values of 1000 to 1500 starts are common. API 541 requires 5000 starts. This is a reasonable assumption for a motor since it does not add significant cost to the design. The driven equipment, however, would be designed with overkill to meet the requirement. EXAMPLE 20-year life, 1 start/week = 1040 starts. Equipement of this type normally would start once every few years rather than once a week. A reasonable number of starts should be	Calculations shall be considered with a number of starts not less than 5000 and a number of short circuit not less than 1000.

API	GS
therefore be agreed upon. NOTE 2: The number of short circuit events can be substantially lower.	
4.7.4 Balancing	
4.7.4.2 Low-speed Balancing	
4.7.4.2.4 The maximum allowable residual unbalance (see Annex C), U_r, per plane (journal) shall be calculated as follows. In SI units: $U_r = 6350 \frac{W}{N} \text{ for } N < 25,000 \text{ revolutions per minute (9a-1)}$ $U_r = \frac{W}{3.937} \text{ for } N \geq 25,000 \text{ revolutions per minute (9a-2)}$ In USC units: $U_r = 4 \frac{W}{N} \text{ for } N < 25,000 \text{ revolutions per minute (9b-1)}$ $U_r = \frac{W}{6250} \text{ for } N \geq 25,000 \text{ revolutions per minute (9b-2)}$ Where: U_r is the maximum allowable residual unbalance, g-mm (oz-in); N is the maximum continuous operating speed, revolutions per minute; W is the journal static load, kg (lbm). NOTE: The residual unbalance requirement of this paragraph implies engine life is somehow increased by balancing the rotor to this level. This, in fact, might not be the case. Engine is life limited by highly stressed parts or components operating at very high temperatures. The vendor can request purchaser's approval to balance to the vendor's standard, provided that the vendor can show, by successful proven operating experience, engine life is not compromised. Typically, the unbalance should not exceed $15W/N$ or ISO 1940, Grade 2.5.	The note is not applicable. All power turbines including the spare power turbine, if ordered, shall be individually balanced, followed by a check at full speed.
4.7.4.3 High-speed Balancing	
4.7.4.3.1 If specified, high-speed balancing shall be performed according to procedures described in ISO 11342.	Vendor standard shall apply.
4.7.4.3.2 If high-speed balancing has been specified, the acceptance criteria shall	Item a) and c) are not applicable. For item b), the shaft displacement has to be considered.

API	GS
be according to item a), item b), or item c), as specified: a) residual unbalance criteria according to Quality Grade G2.5; b) pedestal vibration derived according to the methods described in ISO 11342, Section 8.2.5; c) pedestal vibration of 1.0 mm/s.	The level of permissible vibration shall be submitted to Purchaser for approval.
● 4.7.4.3.4 If specified, for a rotor that has been low-speed sequentially balanced (see 4.7.4.2), and when specified for rotors that are high-speed balanced (see 4.7.4.3), a low-speed residual unbalance check shall be performed in a low-speed balance machine or in a high-speed balance machine capable of low-speed balance. The unbalance magnitude and phase relative to each journal shall be recorded. NOTE: This check is done to provide a reference of residual unbalance and phase for future use in a low-speed balance machine.	This paragraph is applicable.
4.7.5.2 Vibration Measured During Factory Test	
4.7.5.2.1 Acceptance Criteria Acceptance criteria, during the mechanical running test, are based on shaft vibration or on bearing housing vibration as specified by the vendor. During steady state operation, operating at its maximum continuous speed or at any other speed within the specified operating range (see 4.1.5), the vibration shall not exceed the following values. a) Shaft relative vibration [A(p-p)] for Zone A in 7919-4 is as follows. In SI units: $A(p-p) = 4800 / \sqrt{N} \mu\text{m} \quad (10a)$ In USC units: $A(p-p) = 190 / \sqrt{N} \text{mils} \quad (10b)$ where A(p-p) is the magnitude of the unfiltered vibration, μm (mils) peak-to-peak; N is the maximum continuous operating speed, in revolutions per minute.	For the acceptance criteria, GS EP MEC 010, GS EP MEC 020, or GS EP MEC 030 as applicable shall apply.

API	GS
b) Bearing housing or casing vibration for Zone A in ISO 10816-4 is 4.5 mm/s (0.18 in/s) RMS, broadband. The RMS measurement is broadband vibration over a frequency range from 10 Hz to at least 500 Hz or six times the maximum normal operating speed, whichever is greater.	
4.9 Lubrication	
• 4.9.2 If specified by the purchaser or required by the vendor, a synthetic lubrication oil may be used. In the proposal, the vendor shall provide a complete description of the proposed system.	Such synthetic oil systems might be as per vendor's standard amended as follows: • Completely made of stainless steel 316L including tank and coolers • Oil coolers may be combined with mineral oil coolers in a common bay • Oil supply pumps and scavenge pumps might be shaft driven through the gas generator auxiliary gearbox or electric motor driven • Oil systems shall be designed to ensure safe coast down and post lube if required, using run down tanks or DC electrical motor driven pumps • Metal chip detectors with monitoring, read out and alarm system shall be provided.
• 4.9.5 The purchaser will specify whether the driven equipment lube-oil systems and seal oil systems, if applicable, are to be separate or combined. If separate systems are specified, the means of preventing interchange of oil between the two systems shall be described in the vendor's proposal.	Seal oil system shall be separate to the other oil systems (lube oil, control, hydraulic, starting, etc.). Following arrangements are acceptable: • Synthetic oil systems only dedicated to the aero derivative gas generators and/or power turbines fitted with anti friction ball bearings. • Mineral oil systems dedicated to gas generator, power turbine and driven equipment. Hydraulic starting and control oil systems might be separate or combined with any of the previous arrangements and might be as per vendor's standard. Dedicated oil tanks shall be made of AISI 316L stainless steel. Each oil system shall consist as a minimum

Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616

Rev.: 09

Effective date: 10/2012

Page: 18 of 89

API	GS
	of: • Main oil reservoir with associated instrumentation • Main and stand by oil pumps with pressure and status monitoring system • Oil scavenge pumps with pressure and status monitoring system as applicable • Control oil supply pumps with pressure and status monitoring system as applicable • DC emergency pump with pressure and status monitoring system or rundown tank with associated instrumentation if required • Oil supply module • Dual oil filters with differential pressure read out and alarm monitoring and transfer valves • Single control oil filter with differential pressure read out and alarm monitoring as applicable • Duplex oil cooler • Temperature control • Oil pressure control, read out, alarm and trip monitoring system to equipment • Piping and tubing • Common vent header shall be provided with oil demister self draining to the main oil reservoir and fan extractor. Oil characteristics and grade of each oil system shall be defined by supplier and meet the requirements of the components serviced by the oil system. All oil vents of each oil system shall be piped and routed up to the top of the gas turbine exhaust by the supplier and shall be fitted with flame arresters with internals made of stainless steel. All drains of each oil system shall be piped and routed back to the relevant oil system reservoir. A mobile oil conditioner shall be supplied and designed for use in Zone 1 and certified

API	GS
	ATEX Ex II 2G. It shall consist as a minimum of: • A synthetic or mineral oil separator (liquid/liquid and solid/liquid) with a design flow range of 100-1000 litres/hour driven by an EExd electric motor • An inlet strainer • An electric oil heater with temperature controller and limiter and pressure safety valve • A local control panel to operate the oil conditioner • Gear pumps • Associated instrumentation and wiring • Piping and valves, valve arrangement shall allow the following functions: transfer, recirculation and separation • 2 x 20 m long connection pressure hoses with parent connections. Hose material shall be suitable for synthetic oil • A set of tools and bowl accessories.
4.10 Materials	
4.10.1 General	
4.10.1.1 Materials of construction shall be manufacturer's standard for the specified operating conditions, except as required or prohibited by datasheets or this standard (see 5.5.1 for requirements for auxiliary piping materials). The purchaser will specify (see 5.6.1.9) any corrosive agents present in the motive and process fluids, and/or in the environment. The materials of construction of all major components and all other components which come in contact with the purchaser's specified corrosive agents shall be clearly stated in the vendor's proposal. Any changes to the vendor's standard parts lives service life which are due to the purchaser's specified corrosive agents shall also be clearly stated in the vendor's proposal.	Gas generators and power turbines materials and coating shall be designed for marine environment. Refer to Project specification and Project datasheet for environment and fuel analysis.

API	GS
4.10.1.9 If the purchaser has specified the presence of hydrogen sulfide in any fluid, materials exposed to that fluid shall be selected in accordance with the requirements of NACE MR 0175	This paragraph is applicable.
4.10.1.14.1 If specified, the following alloy steel items shall be subject to PMI testing: a) the pressure casing of rotating equipment, b) shafts, c) blading and shrouds, d) locking pins used to secure locking buckets, e) discs of built-up rotors, f) tie bolts, g) locking nuts on built up rotors, h) shaft sleeves, i) alloy claddings and weld overlays, j) pressure casing joint bolting (studs and nuts), k) inlet guide vanes, l) turbine stationary nozzles, m) balance pistons.	Vendor standard shall apply.
4.10.1.14.2 Any additional PMI testing, in addition to 4.10.1.14.1 shall be specified.	Refer to Project specification and Project datasheet.
4.10.4 Welding	
4.10.4.6.2 Accessible surfaces of welds shall be inspected by magnetic particle or liquid penetrant examination after back chipping or gouging and again after postweld heat treatment. If specified, the quality control of welds that will be inaccessible on completion of the fabrication shall be agreed on by the purchaser and vendor prior to fabrication.	Vendor standard shall apply for the bare gas turbine.
4.10.4.7.1 In addition to the requirements of 4.10.4.1, the purchaser may specify that 100% radiography, magnetic particle inspection, or liquid penetrant inspection of welds is required.	Vendor standard shall apply for the bare gas turbine.

API	GS
4.10.5 Impact Test Requirements	
4.10.5.1 To avoid brittle failures, materials and construction for low-temperature service shall be suitable for the minimum design metal temperature in accordance with the codes and other requirements specified. The purchaser and the vendor shall agree on any special precautions necessary with regard to conditions that may occur during operation, maintenance, transportation, erection, commissioning and testing. Care shall be taken in the selection of fabrication methods, welding procedures, and materials for vendor furnished steel pressure retaining parts that may be subject to temperatures below the ductile-brittle transition temperature. The published design-allowable stresses for materials manufactured in accordance with ASME Code and ANSI standards or other internationally recognized standard as approved by the purchaser are based on minimum tensile properties. Some standards do not differentiate between rimmed, semi-killed, fully killed hot-rolled and normalized material, nor do they take into account whether materials were produced under fine- or course-grain practices. The vendor should exercise caution in the selection of materials intended for services between $-30\text{ }^{\circ}\text{C}$ ($-20\text{ }^{\circ}\text{F}$) and $40\text{ }^{\circ}\text{C}$ ($100\text{ }^{\circ}\text{F}$).	This paragraph is applicable.
4.10.5.3 The purchaser will specify the minimum design metal temperature and concurrent pressure used to establish impact test requirements and other material requirements.	Vendor design shall apply for the bare gas turbine.
5 Accessories	
5.1 Starting and Helper Driver	
5.1.1 General	
5.1.1.1 The vendor shall furnish a starting or helper driver as specified. The types of drivers available include electric motors, steam turbines, gas expansion turbines, internal combustion engines, hydraulic	Refer to Project specification and Project datasheet.

API	GS
motors, pneumatic motors and small gas turbines. NOTE 1: Starting drivers are used to accelerate gas turbines (and driven equipment for single-shaft machines) to self-sustaining speed and are normally idle during operation. NOTE 2: Helper drivers are used to accelerate gas turbines and driven equipment to self sustaining speed and usually remain coupled during operation to provide supplementary shaft power to the gas turbine trains.	
● 5.1.1.4 Starter and helper motor drives shall conform to API 541, API 546, or IEC 60034-1, as specified. Since IEC 60034-1 is silent on mechanical design criteria of motors, the above API standards shall prevail for mechanical design for these applications. Motors rated at 375 kW (500 hp) and above shall be in accordance with API 541. Motors rated between 190 kW (250 hp) and 375 kW (500 hp) shall be in accordance with API 547. Motors that are below the power scope of API 547 shall be in accordance with IEEE 841.	Motor drives shall conform to Project specification.
● 5.1.1.5 The motor's starting torque shall meet the requirements of the driven equipment, at a reduced voltage of 80% of the normal voltage, or such other value as may be specified, and the motor shall accelerate to full speed within 15 seconds or such other period of time agreed upon by the purchaser and the vendor. NOTE: Variable frequency-driven (variable speed) speed motors are typically used. These systems have specific electrical requirements for their successful operation.	This paragraph is applicable.
5.1.1.6 The purchaser shall specify the applicable specifications and standards for other types of starting and helper drivers.	Refer to Project specification and Project datasheet.
● 5.1.1.7 The turbine vendor shall supply any clutches, speed-changing gears, torque converters, or other power transmission equipment, including controls required or specified for the starting and helper drivers. Gears in continuous service shall be in	This paragraph is applicable.

API	GS
accordance with API 613 and gears in intermittent service shall be in accordance with API 677.	
5.1.1.11	(New paragraph) Starter shall be suitable for continuous operation during crank, slow-roll and soak washing.
5.1.2 Ratings	
5.1.2.1 Starting driver ratings shall be determined by the gas turbine vendor. As a minimum, the drivers shall be rated to supply 110% of the starting and acceleration torque required by the gas turbines (and the driven equipment trains for single-shaft machines) throughout the specified ambient temperature range. The gas turbine vendor shall prepare a speed-torque curve for the turbines and driven equipment, with the starting driver torque superimposed to confirm delivery of the starting torque.	This paragraph is applicable.
5.1.2.2 Helper driver ratings and arrangements shall be mutually agreed to by the purchaser and the vendor.	In case of electric starting motor, the vendor shall indicate the motor rating, the maximum power during starting sequence and the maximum in-rush current.
5.1.3 Turning Equipment	
5.1.3.1 A turning gear and/or ratchet device shall be furnished, if specified by the purchaser or if required to avoid rotor deformation after a tripout. For single-shaft turbines, the turning gear shall be sized to turn the entire train. Details of turning gear operation, such as manual or automatic engagement/disengagement, shall be mutually agreed upon by the purchaser and the vendor.	Vendor standard design shall apply. The system shall be suitable for zone 1 operation.
5.2 Gears, Couplings and Guards	
5.2.1 Gears	
5.2.1.1 The gas turbine vendor shall furnish any gear required for starting and helper drivers, shaft-driver auxiliary equipment, and if specified, any load gear.	This paragraph is applicable.

API	GS
5.2.2 Couplings and Guards	
5.2.2.4 Coupling, coupling-to-shaft junctures, and guards shall conform to ISO 10441. If specified, couplings for speeds below 4000 revolutions per minute can be designed to ISO 14691. Couplings shall be sized to the ISO 10441 except as modified by 5.2.2.1 and 5.2.2.3. The make, type and mounting arrangement of couplings and coupling guards, including vents and drains, shall be agreed upon by the purchaser and the vendors of the driver and driven equipment.	ISO 10441 shall apply to couplings for the all range of speeds. In addition, refer to the GS EP MEC 010 , GS EP MEC 020 or GS EP MEC 030 as applicable.
5.3 Mounting plates	
5.3.1 General	
5.3.1.1 The gas turbine unit, as well as its starting equipment, lubrication system, and other auxiliaries, shall be furnished with soleplates or base-plates as specified.	This paragraph is applicable.
5.3.1.2.2 The mounting plates or plates shall be furnished with horizontal (axial and lateral) jackscrews, the same size or larger than the vertical jackscrews. The lugs holding these jackscrews shall be attached to the mounting plates in such a manner that they do not interfere with the installation of the equipment, jackscrews or shims. Precautions shall be taken to prevent vertical jackscrews in the equipment feet from marring the shimming surfaces. Alternative methods of lifting equipment for the removal or insertion of shims or for moving equipment horizontally, such as provision for the use of hydraulic jacks, may be proposed. Such arrangements should be proposed for equipment that is too heavy to be lifted or moved horizontally using jackscrews. Jack screws shall be plated for rust resistance.	This paragraph is applicable to equipment with weight of more than 100 kilograms.
5.3.2 Baseplate	
5.3.2.1 If a baseplate has been specified, the purchaser will indicate the major equipment to be mounted on it. A baseplate shall be a single fabricated steel unit, unless	Refer to the GS EP MEC 010 , GS EP MEC 020 or GS EP MEC 030 , as applicable, and to Project Specification.

API	GS
the purchaser and the vendor agree that it may be fabricated in multiple sections. Multiple-section baseplates shall have machined and doweled mating surfaces to ensure accurate field reassembly. NOTE: A baseplate with a nominal length of more than 12 m (40 ft) or a nominal width of more than 4 m (12 ft) is oversize and may have to be fabricated in multiple sections because of shipping restrictions.	
● 5.3.2.3 If specified, the baseplate shall be designed to facilitate the use of optical, laser based, or other instruments for accurate leveling in the field. The details of such facilities shall be agreed by the purchaser and vendor. Where the requirement is satisfied by the provisions of leveling pads and/or targets, they shall be accessible with the baseplate on the foundation and the equipment mounted. Removable protective covers shall be provided. Leveling pads or targets shall be located close to the machinery support points. When required for long units, additional pads shall be located at intermediate points.	This paragraph is applicable.
● 5.3.2.4 If specified, the baseplate shall be designed for column mounting (that is, of sufficient rigidity to be supported at specified points) without continuous grouting under structural members. The baseplate design shall be mutually agreed upon by the purchaser and the vendor.	The baseplate shall be suitable for column mounting. Refer to the GS EP MEC 010, GS EP MEC 020 or GS EP MEC 030, as applicable.
5.3.2.7 The underside mounting surfaces of the baseplate shall be in one plane to permit use of a single-level foundation. When multisection baseplates are provided, the mounting pads shall be in one plane after the baseplate sections are doweled and bolted together.	Supporting points shall be supplied with 20 mm shim packs.

API	GS
5.3.3 Soleplates and Subsoleplates	
• 5.3.3.1 If soleplates and/or subsoleplates have been specified to be provided by the vendor, they shall meet the requirements of 5.3.3.1.1 and 5.3.3.1.2 in addition to those of 5.3.2.	Soleplates and subsoleplates shall be provided by vendor.
5.4 Controls and Instrumentation	
5.4.1 General	
• 5.4.1.1 Instrumentation and installation shall conform to the requirements of ISO 10438, API 614, or purchaser's specifications as specified.	This paragraph is applicable. Refer to the GS EP MEC 010 , GS EP MEC 020 or GS EP MEC 030 , as applicable.
• 5.4.1.5.3 All applicable electrical codes shall be specified by the purchaser. Local electrical codes that apply shall be provided by the purchaser upon request.	Refer to the GS EP MEC 010 , GS EP MEC 020 or GS EP MEC 030 , as applicable.
• 5.4.1.9 If specified, the control system shall be designed to maintain turbine operation and protection for a purchaser-specified time period in the event of an interruption of AC power.	This paragraph is applicable.
5.4.2 Control Systems	
• 5.4.2.1 The gas turbine starting control system may be semi-automatic or fully automatic, as specified. The starting cycle of the turbine shall be automatic unless otherwise specified. The commissioning of accessories and auxiliaries and the starting sequence shall be as follows: a) semi-automatic start, if specified, shall require manual activation of the accessories and auxiliaries and shall permit the operator to commit the turbine to the complete starting sequence by a single action; b) automatic start shall require only a single action by the operator to activate auxiliary equipment and initiate the complete sequence.	a. and b. are applicable.

API	GS
5.4.3 Load Control	
	In addition, for generator drive applications, GS EP ELE 013 shall apply. This requirement shall be fully demonstrated during the factory load tests, using resistive load banks.
• 5.4.3.3 The full range of the specified control signal will correspond to the required operating range of the driven equipment. Unless otherwise specified, the maximum control signal will correspond to the maximum continuous speed.	The maximum control signal shall correspond to the maximum continuous speed.
5.4.3.6 Governor systems shall prevent the gas turbine from tripping on overspeed when an instantaneous loss of electric, hydraulic, or aerodynamic load occurs. A safe, controlled shutdown may occur in the event of hydraulic or load loss for safety reasons.	Loss of load means full load rejection (from the maximum power in site conditions).
5.4.4 Alarms and Shutdowns	
• 5.4.4.7 Instrumentation, control devices, and annunciation display units shall be furnished and mounted by the vendor as specified by the purchaser on the datasheets.	The vendor shall provide and mount instrumentation, control devices, and annunciation display units.
• 5.4.4.8 Alarm and shutdown arrangements shall be in accordance with the ISO 10438 as specified. Additional requirements are described in 5.4.4.8.1 to 5.4.4.8.8. NOTE: API 614 is identical to ISO 10438.	This paragraph is applicable.
• 5.4.4.8.1 If alarm and shutdown switches are specified, they shall be single-pole, double throw design.	Switches are normally not allowed, and should be considered only for very specific cases, to be agreed with Purchaser. Threshold functions shall be based on analogue signals.
• 5.4.4.8.5 If specified, in addition to the control system screen, the vendor shall furnish a first-out annunciator when an annunciator system is specified. a) The annunciator shall contain approximately 20 % spare points to cover available optional equipment. • b) If specified, the annunciator shall be	This paragraph is applicable.

API	GS
suitable for purging.	
• 5.4.4.9 Unless otherwise specified, the necessary valving and switches or bridging links (jumpers) or other approved protocol shall be provided to enable all instruments and other components, except shutdown sensing devices, to be replaced with the equipment in operation. If specified, shutdown sensing devices shall be provided with isolation valving, bridging links or other approved protocol to allow replacement with the equipment in operation.	Vendor standard design shall apply. Vendor shall clarify the instruments which can be replaced without turbine shutdown.
• 5.4.4.10 If isolation valves for shutdown sensing devices are specified, the vendor shall provide means of locking the valves in the open position.	This paragraph is applicable.
5.4.5 Instrumentation and Control Panels	
5.4.5.2 A control console may include a human machine interface (HMI) visual display unit for monitoring operating variables and/or a keyboard for entering operator commands. The HMI may be driven from a microprocessor based system independent of the gas turbine control system, with communication between the visual display monitor and the turbine controls to be accomplished through a data link.	In addition, the UCP (Unit Control Panel) shall be equipped of a Trend Display and Data Recording. All machine analogue signals and parameters for at least the 30 preceding days shall be capable of being trended on screen and color printed. The time base and measured value ranges forming the axes shall be adjustable by the operator.
• 5.4.5.3.2 Control and instrumentation wiring, that is not within a fully enclosed panel or other enclosure, shall be in the form of armored cable or shall be run in metal conduit as specified.	Refer to Project specification.
5.4.6 Electrical Systems	
• 5.4.6.1 The characteristics of electrical power supplies for motors, heaters, and instrumentation shall be specified by the purchaser. A pilot light shall be provided on the incoming side of each supply circuit to indicate that the circuit is energized. Unless otherwise specified, the pilot lights shall be installed on the motor control centers, power distribution control panels and or any uninterrupted power supplies (UPS). As an	This paragraph is applicable. In addition, in case of AC power failure, emergency oil systems are required to ensure a safe coast down and adequate post-lubrication. Such systems might consist of either a DC Eex"d" motor driven oil pump or rundown tank. Should a DC system be used, the complete system including the motor control centre shall be Eex"d" certified.

API	GS
alternative to pilot lights, an alarm could be initiated if any of the power supplies is cut off.	
5.4.6.6 Electrical materials including insulation shall be corrosion resistant and nonhygroscopic insofar as is possible. If specified for tropical location, materials shall be given the treatments specified in 5.4.6.6.1 and 5.4.6.6.2.	This paragraph is applicable.
5.4.7 Instrumentation	
5.4.7.2 Tachometers	
5.4.7.2.2 The type of tachometer will be specified. Unless otherwise specified, the minimum range shall be from 0 % to 125 % of the maximum continuous speed (in revolutions per minute).	Vendor standard design shall apply.
5.4.7.5 Thermocouples and Resistance Temperature Detectors (RTDs)	
Where practical, the design and location of thermocouples and RTDs shall permit replacement while the unit is operating. The lead wires of thermocouples and RTDs shall be installed as continuous leads between the thermowell or detector and the terminal box. Conduit runs from thermocouple and RTD heads to a pull box or boxes located on the baseplate shall be provided. If specified, monitors shall be supplied, installed, and calibrated in accordance with API Standard 670.	This paragraph is applicable. In addition, when hydrodynamic journal bearings are used, each bearing shall be provided with duplex RTD's embedded in the most loaded pad. Each oil returns from hydrodynamic and antifriction ball bearings shall be provided with duplex RTD's. Both sides of the thrust bearings shall be provided with duplex RTD's. Each temperature sensor shall be wired to a monitoring system with read out, alarm and trips functions.
5.4.7.6 Pressure Gauges	
Pressure gauges (not including built-in instrument air gauges) shall be furnished with AISI Standard Type 316 stainless steel bourdon tubes and stainless steel movements for most duties. Materials shall be selected to suit the working fluids. A minimum of 110-mm (4 ½-in.) dials, 152-mm (6-in.) dials for the range over 55 bar (800 psi), and NPT ½ male alloy steel connections. Black printing on a white background is standard for gauges. If	This paragraph is applicable.

API	GS
specified, oil-filled gauges or other snubbing device shall be furnished. Gauge ranges shall preferably be selected so that the normal operating pressure is at the middle of the gauge's range. In no case, however, shall the maximum reading on the dial be less than the applicable relief valve setting plus 10 %. Each pressure gauge shall be provided with a device such as a disk insert or blowout back designed to relieve excess case pressure.	
5.4.7.8 Vibration and Position Detectors	
● 5.4.7.8.2 If specified, vibration and axial-position monitors shall be supplied and calibrated in accordance with API 670.	This paragraph is applicable. In addition, when hydrodynamic journal bearings are used, they shall be provided with X and Y non-contact probes. When antifriction ball bearings are used, one accelerometer on the outer casing in front of each bearing shall be provided. Each vibration sensor shall be wired to a monitoring system with read out, alarm and trips functions. When accelerometers are used, frequency band of the complete system response shall from 20 Hz to 20 kHz.
● 5.4.7.8.3 If specified, casing vibration transducers shall be supplied, installed and calibrated in accordance with API 670.	This paragraph is applicable.
● 5.4.7.8.4 If specified, casing vibration monitors shall be supplied, installed and calibrated in accordance with API 670.	This paragraph is applicable.
● 5.4.7.8.6 If specified, monitors for use with casing vibration and rolling element bearings shall be supplied and calibrated in accordance with API 670. If specialized vibration monitors for use with rolling element bearings not covered by API 670 are to be supplied, the vendor shall provide the purchaser with details and specifications for purchaser review.	This paragraph is applicable.

API	GS
5.6 Inlet and Exhaust Systems	
5.6.1 General	
5.6.1.1 An inlet and exhaust system consisting of an inlet air filter, inlet and exhaust silencers, inlet and exhaust expansion joints, and inlet and exhaust ducting shall be supplied.	For other devices, anti-icing system and emission control systems requirements, refer to the Project specification. The air inlet system including filtration housing, plenum, silencer and ducting up to turbine inlet (bell mouth), and the exhaust system including internals shall be made of AISI 316L stainless steel.
5.6.1.4 Unless otherwise specified, the inlet system shall be designed for a maximum total pressure drop of 1 kPa (4 in. water) with a clean air inlet filter and at least 110 % of the air mass flow (including any required ventilation air) at site rated power, ISO power or power at site minimum temperature, whichever is greater.	The maximum pressure drop of air intake system (clean filters, duct, silencer, etc.) shall not exceed 100 millimeters of H ₂ O at 110% of the turbine rated air flow at the minimum specified site ambient air temperature. The 100 mm maximum pressure drop of H ₂ O shall be guaranteed. The performance of the filtration arrangement at any operating point shall be guaranteed to reach the required filtration level as indicated in Appendix 1.
5.6.1.5 Unless otherwise specified, the exhaust system shall be designed for 1.5 kPa (6 in. water) pressure drop when there is no heat recovery system. If a heat recovery system is specified, the system pressure drop shall not exceed 2.5 kPa (10 in. water). NOTE: The economics of individual applications could dictate other design factors for each system that may be used with the purchaser's agreement.	This paragraph is applicable.
5.6.1.6 Requirements of exhaust mounted overpressure protective devices, diversion valves or heat recovery systems shall be specified by the purchaser.	Refer to GS EP MEC 010 , GS EP MEC 020 , or GS EP MEC 030 as applicable and to the Project specification and to the Project datasheet.
5.6.1.7 If specified or if required by the vendor for safe operation (see 5.6.1.8), a duct mounted anti-icing system shall be provided. If an anti-icing system is required, the vendor shall fully describe the system, vendor's scope, effect on engine's performance over the ambient range, and required utilities.	Refer to Project specification and Project datasheet. Operation with the anti-icing system shall comply with noise requirements.

Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616

Rev.: 09

Effective date: 10/2012

Page: 32 of 89

API	GS
● 5.6.1.8 The purchaser shall specify meteorological data obtained by long-term measurements at site for the gas turbine vendor to use in selecting the inlet system components. Monthly mean wind roses shall be provided for wind speed and direction. Meteorological parameters include the following: a) wind speeds and major wind direction; b) wind speed and wind direction for the local and distant contaminant sources noted in 5.6.1.9.2; c) dry bulb temperature (minimum and maximum), including typical daily variations; d) barometric pressure; e) rainfall, including maximum rate; f) snowfall; g) relative humidity, seasonal variations and typical daily variations; h) frequency of fog or mist conditions; i) frequency of icing conditions (occurrence of temperatures between +5°C and -5°C and relative humidity >80%).	Refer to Project specification.
● 5.6.1.9 The purchaser shall specify the air quality as required by the 5.6.1.9.1 and 5.6.1.9.2. NOTE: Performance, operability, reliability, availability, expected overhaul intervals, expected maintenance costs, and emissions for the gas turbine and the gas turbine package are all influenced by a variety of parameters, including atmospheric air quality entering the equipment. Knowledge of ambient air quality is important for predicting equipment life, correct filtration system selection, and correct materials selection. In cases where air is not "clean", there can be an impact on equipment life, maintenance intervals, and maintenance costs. Air quality is particularly important with respect to gaseous contaminants, which cannot be removed by filtration.	Data are provided as far as they are available. Refer to Project specification and Project datasheet.
● 5.6.1.9.1 The purchaser shall specify the following chemical contaminants in the air. The minimum, maximum and average values	Data are provided as far as they are available. Refer to Project specification and Project datasheet.

API	GS
shall be provided: a) sodium (Na), b) potassium (K), c) calcium (Ca), d) chloride (Cl), e) sulphate (SO ₄), f) nitrate (NO ₃ ⁻), g) trace metals (e.g., V, Pb, Ni, Zn), h) sulphur dioxide (SO ₂), i) ammonia (NH ₃), j) nitrous oxide (NO _x), k) hydrocarbons (VOC), l) hydrogen sulphide (H ₂ S) m) chlorine gas (Cl ₂), n) hydrochloric acid (HCl), o) neon (Ne), p) ozone (O ₃), q) helium (He), r) methane (CH ₄), s) krypton (Kr), t) hydrogen (H ₂), u) nitrous oxide (N ₂ O), v) carbon monoxide (CO), w) xenon (Xe), x) nitrogen dioxide (NO ₂).	

Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616

Rev.: 09

Effective date: 10/2012

Page: 34 of 89

API	GS																										
● 5.6.1.9.2 The purchaser shall specify the presence, distance and direction to major local or distant potential sources for contamination as noted in Table 7. Size distribution data shall be provided for particulates. Table 7 – Inlet Air Contaminants and Sources <table border="1"> <thead> <tr> <th>Potential Source of Contaminants</th><th>Potential Contaminants</th></tr> </thead> <tbody> <tr> <td>a) sea water, coastal water</td><td>water spray, NaCl</td></tr> <tr> <td>b) dry lake beds</td><td>NaCl</td></tr> <tr> <td>c) roads with heavy traffic</td><td>Particulates, VOC, SO₂, NO_x, chlorides</td></tr> <tr> <td>d) cooling towers at site close to the GT plant</td><td>drift, thermal plume</td></tr> <tr> <td>e) petrochemical industry</td><td>sulphur compounds, VOC</td></tr> <tr> <td>f) fossil fired power plants</td><td>fly ash, coal dust, SO₂</td></tr> <tr> <td>g) general chemical industry</td><td>SO₂, HCl, H₂S, NH₃</td></tr> <tr> <td>h) paper and pulp industry</td><td>fibers, SO₂, H₂S</td></tr> <tr> <td>i) cement production, quarries</td><td>CaCO₃, SiO₂</td></tr> <tr> <td>j) agricultural activities</td><td>particulates, nitrates, phosphates, seeds, insects, pollen</td></tr> <tr> <td>k) production of fertilizers</td><td>ammonia, phosphates, nitrates, calcium</td></tr> <tr> <td>l) mining and metallurgical activities</td><td>Particulates</td></tr> </tbody> </table>	Potential Source of Contaminants	Potential Contaminants	a) sea water, coastal water	water spray, NaCl	b) dry lake beds	NaCl	c) roads with heavy traffic	Particulates, VOC, SO ₂ , NO _x , chlorides	d) cooling towers at site close to the GT plant	drift, thermal plume	e) petrochemical industry	sulphur compounds, VOC	f) fossil fired power plants	fly ash, coal dust, SO ₂	g) general chemical industry	SO ₂ , HCl, H ₂ S, NH ₃	h) paper and pulp industry	fibers, SO ₂ , H ₂ S	i) cement production, quarries	CaCO ₃ , SiO ₂	j) agricultural activities	particulates, nitrates, phosphates, seeds, insects, pollen	k) production of fertilizers	ammonia, phosphates, nitrates, calcium	l) mining and metallurgical activities	Particulates	Data are provided as far as they are available. Refer to Project specification and Project datasheet.
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5.6.1.10 Unless otherwise specified, the inlet system shall be series 300 stainless steel construction.	The inlet system shall be made of AISI 316L stainless steel.																										
5.6.1.11 System components, except for filter media, shall be designed for a useful life of at least 20 years. The purchaser shall specify site conditions as identified in 5.6.1.9 that could affect the system design and the selection of the materials. Provisions shall be made to permit maintenance of inlet filter media during operation of the turbine.	Refer to Project specification and Project datasheet.																										
5.6.1.13 Bolts, rivets, or other fasteners that can become loose and be carried in the air stream shall not be used in the inlet system downstream of the final stage of filtration.	In addition, all joints and seams in the air intake system shall be air tight. All welding (internal and external) shall be continuous. Bolted joints shall use an elastomer sealant. The pitch of bolting shall be adequate to																										

API	GS
	ensure an air tight joint. Mastic sealant shall not be used. The roof sections of the intake system shall be sloped to drain rain water. Gluing of parts (housing, internal) is not permitted.
● 5.6.1.14 If specified, a reinforced coarse-mesh 6.4 mm to 12.7 mm (1/4 in. to 1/2 in.) stainless steel screen shall be provided immediately ahead of the gas turbine air inlet. The actual location shall be mutually agreed upon by the vendor and the purchaser, both of whom must consider cleaning systems, access plates, viewing windows, vaned elbows, and aerodynamic disturbance of the bellmouth entrance.	For the coarse-mesh stainless steel screen, Vendor standard shall apply. Refer to paragraph 5.6.1.16 for cleaning system requirements. Refer to paragraph 5.6.1.20 for access plates requirement. Viewing windows on access doors shall apply. For vaned elbows and aerodynamic disturbance of the bellmouth entrance, vendor standard design shall apply.
5.6.1.15 Corrosion protection of the filter, ducting, and silencer is required. Protective material or coating and details of the surface preparation proposed shall be submitted by the vendor with the proposal. As a minimum all nonstainless steel inlet components shall be finish coated at the manufacturer's plant prior to shipment.	Zinc in any form (including in any coating) is prohibited.
5.6.1.16 A gas generator compressor and power turbine cleaning system shall be provided. The vendor shall describe the type of compressor cleaning system being provided. The vendor shall address in the proposal features and requirements such as: manual or automatic operation, integral-to-package or separate, solvents, and antifreeze compounds and utilities.	Vendor shall propose an off-line washing system. The requirement for an on-line washing system is indicated in the Project Specification.
5.6.2 Inlet Systems	
5.6.2.1 Inlet Filters	
5.6.2.1.1 Unless otherwise specified, the vendor shall select the type of inlet filtration required to meet site conditions and operational requirements. The filtration system shall be selected to meet the requirements of 5.6.2.2, 5.6.2.3, or 5.6.2.4. NOTE: There are two basic types of air inlet filter	Instead of the vendor selecting the type of inlet filtration, the purchaser specifies the air inlet filter system, and requires Vendor to approve the selected system, considering the ambient environment. In any case, the air inlet filtration system is under Vendor responsibility. Refer to Appendix 1 of the

API	GS
systems; static and “self cleaning” pulse filter systems. Static air filter systems comprise of several filter stages, while “pulse” air filter systems comprise either a single pulse filter stage or an initial pulse filter stage followed by a static fine filter stage. Pulse filter systems are mainly adapted for sites where the ambient air may contain significant amounts of large particles, e.g., in dusty areas. Investigations and practical experiences indicate that the addition of a static fine filter after the pulse filter stage often offers better and more reliable filtration than single-stage pulse filters. Addition of a second filter stage after the initial pulse filter stage reduces the risks for penetration of water soluble salts in liquid form during humid conditions. The disadvantage is an increased first cost, mainly because of the need of a large air inlet filter house.	present document.
● 5.6.2.1.2 If single-stage filtration only is specified, the purchaser will specify if provisions are to be made for the future addition of extra stages.	Refer to Appendix 1 of the present document.
5.6.2.1.5 Unless otherwise specified, a mist eliminator shall be furnished for marine environments.	The drain from each marine vane separator, if installed, shall be equipped with a siphon breaker and level transmitter.
5.6.2.1.7 Unless otherwise specified, each filter system shall include the following. a) An entrance screen to prevent debris or birds from entering the inlet. b) Downward orientation of the air inlet or a louver or cowling to minimize the entry of driving rain, snow, or sand to the filter. c) Walkways, handrails, platforms, and ladders to facilitate access and maintenance. d) Manometer connections and a differential-pressure alarm for each stage filtration.	c) Internal and external ladders and platforms for accessing to the insect screens, filters, local instrumentation (differential pressure transmitters and gas detectors) and lighting shall be provided. A davit located at the air inlet housing access door level for filter handling shall be provided. d) This paragraph is applicable using transmitters only. In addition, differential pressure gauges and transmitters shall be plumbed to the

API	GS
e) Wiring in conduit using conduit fittings (with the exception of joints between modules where using flexible conduit is permitted) or armoured cable system. f) A design that uses bolted and welded fabricated steel plate, reinforced with steel members. The vendor shall furnish all of the supporting structural steel required for the assembled and mounted filter systems. All external structural steel shall be hot-dipped galvanized, with thickness per ASTM A123 or ISO 1461. All external joints shall be leak proof. Zinc is not permitted in the flow path surfaces downstream of the filters. g) Modular construction with each module fully factory assembled, with all required wiring, piping and structural supports. Each module shall have lifting provisions that permit it to be loaded, unloaded, and lifted into its final assembled position. h) Airtight seams and joints on the clean air side of each filter system. i) The clean air side of the filter assembly is to be completely free of loose objects or objects that can become loose during operation.	sensing points using instrumentation tubing. In addition, an overall air inlet differential pressure transmitter, atmospheric absolute pressure transmitter, atmospheric hygrometry transmitter shall be provided and signal shall be treated, make available and display by the gas turbine PLC. e) Wiring shall be in accordance with the applicable Contract specifications. f) Supporting structures shall be made of painted carbon steel. Filter housings shall be provided with a door fitted with a limit switch interlocked within the UCP logic. Doors shall be lockable and provided with internal over ride panic handles. 1 m width maintenance corridor shall be provided between the first and second stages. Filter elements shall be designed to be easily replaced in operation. g) When technically feasible, air inlet filter housing shall be made integral in one piece only with no bolting and provided with lifting eyes for final assembled installation.
• 5.6.2.1.8 If specified, an under pressure protection device (e.g. implosion door) shall be provided to prevent excessively high delta pressure in the turbine inlet in the event of filter icing or plugging. This device shall be	This paragraph is not applicable.

API	GS
instrumented to provide remote indication when the device is actuated.	
● 5.6.2.1.9 Unless otherwise specified, the filter house will be elevated with a minimum 4.6 m (15 ft) elevation from grade to the lowest part of the filter air entrance. If the filter house is elevated, the vendor shall provide lugs for mounting the house to supporting steelwork. The purchaser shall specify if supporting steel work is to be provided by the vendor. NOTE 1: Consideration should be given to filter units mounted on large horizontal surfaces, such as roofs, to ensure adequate clearance from those mounting surfaces even though the filter may be in excess of the specified 4.6 m (15 ft) above grade. NOTE 2: Provide consideration for conditions such as snow drifts.	This paragraph is applicable. In addition, the vendor shall design the access and maintenance facilities to the filtration housing. For the supply of the filter house supporting steel work, refer to GS EP MEC 010, GS EP MEC 020, or GS EP MEC 030, as applicable.
5.6.2.1.10 Sections of the filter house, including door, that require field assembly and welding shall be prefitted in the vendor's shop.	The filter house shall not require field welding. The Purchaser shall inspect/witness the complete assembly in the vendor shop.
● 5.6.2.2 Self-cleaning Filter System	
● 5.6.2.2.2 If specified, the vendor shall provide a relative humidity sensor. The sensor shall automatically activate the cleaning cycle when the relative humidity is above 60%, whether the turbine is running or not. NOTE: High humidity and blowing dust can cause severe caking of material on the filter elements.	This paragraph is applicable.
5.6.2.3 High-velocity Inlet Filter System	
● 5.6.2.3.1 The high-velocity inlet filter system shall consist of three stages. In addition, higher efficiency filters may be added if required by the site conditions. NOTE: A high-velocity filter system is usually designed for an air velocity of 5 m/s (16 ft/s). The initial pressure drop is mainly decided by the filter class of the particle filter. A more efficient particle filter results in lower fouling rates but also in higher initial as well as operational pressure drop over the filter system. The filter efficiency should	Refer to Appendix 1 of the present document.

API	GS
correspond to approximately F9 according to EN 779. The use of less efficient filter elements will increase the fouling rates.	
• 5.6.2.3.2 The first-stage vane separator consists of vanes so that the inertial action of the droplet-laden air passing between them causes the droplets to be thrown out of the airstream onto the vanes. Droplets drain down the pockets of the vanes into a drain trough below. The second-stage filter media shall be designed to have high-efficiency filter media to filter out large particles. The third-stage filter media shall be designed to have high-efficiency filter media to filter out fine particles. If specified, an additional vane separator to remove droplets reentrained from upstream stages under conditions of high humidity will be provided.	Refer to Appendix 1 of the present document.
5.6.2.5 Inlet Silencers	
5.6.2.5.2 Silencer shall be of welded stainless steel and shall be flanged.	Refer to comment to paragraph 5.6.1.1.
5.6.2.5.3 The construction of the silencer baffles shall prevent the baffle packing material from entering the gas stream.	Baffles shall be welded only, bolts even secured or pop-rivets are forbidden.
• 5.6.2.5.4 Perforated-plate elements shall be constructed of stainless steel except for elements for use in corrosive environments that may promote stress corrosion cracking. Alternative materials will be specified by the purchaser for corrosive environments.	This paragraph is applicable. Silencer shall be made of AISI 316L stainless steel.
5.6.2.6 Inlet Coolers	
	The whole paragraph is not applicable.
5.6.2.6.1 Evaporative Coolers	
• 5.6.2.6.1.1 If specified as evaporative, the cooler shall be supplied complete with cooler media, circulation pump, sump drains, and corrosion resistant mist eliminator. The mist eliminator shall minimize moisture carryover into the inlet air stream at 105 %t of	Refer to Project specification and Project datasheet.

API	GS
maximum engine mass flow and worst case ambient conditions (low temperature and high humidity).	
5.6.2.6.2 Inlet Air Cooler Heat Exchanger	
• 5.6.2.6.2.1 If specified, the vendor shall provide a liquid-to-air heat exchanger for the purpose of cooling the inlet air temperature for engine performance enhancement. The cooler section shall be fitted downstream of the inlet filtration system and shall contain a mist eliminator section to eliminate condensed water droplets from entering the air stream.	Refer to Project specification and Project datasheet.
• 5.6.2.6.2.3 Purchaser shall specify the following coolant-side conditions in order for the vendor to properly size the exchanger and guarantee gas turbine performance: a) maximum available flow, b) maximum and minimum temperatures, c) maximum and minimum pressures, d) composition or analysis and cleanliness.	Refer to Project specification and Project datasheet.
5.6.2.9 New paragraph.	Inlet plenum chambers applicable to aero derivative gas generators. Inlet plenum chambers shall be designed integral in one piece only, made of AISI 316L stainless steel and provided with lifting eyes for final assembled installation. Inlet plenum chambers shall be provided with an access door fitted with a limit switch interlocked within the UCP logic and a window. Inlet plenum chamber floors shall be properly sloped and provided with a drain piped outside to a flange connection fitted with a valve. Gas generator bell mouth shall be provided with a strainer made of stainless steel 316L as per vendor standard and pressure differential transmitters with monitoring system. Gas generator inlet cover shall be provided to prevent any undue windmill during long

API	GS
	period of rest if required by gas generator manufacturer.
5.6.3 Exhaust Systems	
5.6.3.1 Exhaust Silencer	
5.6.3.1.2 The basic material for construction of the exhaust silencer shall consider the minimum ambient temperature as well as the site rated exhaust temperature. a) If the minimum site temperature is below the nil ductility temperature, a carbon steel capable of lower temperatures such as ASTM A516 shall be used. b) If the site minimum ambient temperature is above the nil ductility temperature and the site rated exhaust temperature is below 455 °C (850 °F), AISI 1020 or equal shall be used. c) If the site minimum ambient temperature is above the nil ductility temperature and the site rated exhaust temperature is above 455 °C (850 °F), a 400 series stainless steel, or equal shall be used. Additionally, for exhaust temperatures greater than 455 °C (850 °F) at site rated power, special precautions shall be exercised in the selection of silencer materials to avoid carburization or corrosion at these elevated temperatures.	Refer to comment to paragraph 5.6.1.1.
5.6.3.1.3 Perforated plates or sheets shall be constructed of 300 or 400 series stainless steel except where a corrosive environment may produce stress corrosion cracking. If stress corrosion cracking is expected, the purchaser and vendor shall mutually agree on the materials of construction.	Refer to comment to paragraph 5.6.1.1.
• 5.6.3.1.5 The exhaust silencer shall incorporate lifting provisions as well as support interface. The purchaser shall specify exit stack support requirements that will be imposed on the silencer exit flange. This may include not only an exhaust stack but special wind loading or shipping load imposed on the exit flange or silencer support system.	Refer to Project specification and Project datasheet.

API	GS
5.6.3.2 Exhaust Ducting	
5.6.3.2.1 For exhaust temperatures greater than 455°C (850°F) at site rated power, special precautions shall be exercised in the selection of duct materials to avoid carburization or corrosion at these elevated temperatures.	Refer to comment to paragraph 5.6.1.1.
5.6.3.2.2 If atmospheric relief devices and associated dampers are specified (see 5.6.1.6), caution shall be exercised regarding the degree of leakage to be tolerated and the location and routing of atmospheric relief discharge.	This paragraph is not applicable.
5.6.3.2.3 If specified, emissions sampling ports shall be provided in the exhaust ducting (access ladder and platforms to be provided as necessary).	Two 3.5" flanged sampling points, one for manual sampling and one for on line permanent monitoring) adequately located on the exhaust stack shall be provided. For the supply of the access platform and ladders, refer to GS EP MEC 010 , GS EP MEC 020 , or GS EP MEC 030 , as applicable.
5.6.3.3 Exhaust Expansion joints	
The exhaust expansion joints shall be of metal or high-temperature fabric. If fabric is used, it shall be multilayered and reinforced with stainless steel wires. All bolting, duct, and joint components in contact with the fabric shall have rounded edges to avoid tearing of the material.	In addition, the exhaust expansion joints must not be in direct contact with the gas flow and shall a minimum life of 50 000 hours of operation.
5.7 Insulation, Weatherproofing, Fire protection, and Acoustical Treatment	
5.7.1 Insulation	
5.7.1.2 External insulation applied to other portions of the gas turbine installation shall be properly flashed and weatherproofed. The purchaser will specify the extent of insulation for heat conservation to be supplied by the vendor. NOTE: Aeroderivative engines typically do not have external insulation applied.	Refer to GS EP MEC 010 , GS EP MEC 20 , or GS EP MEC 030 , as applicable.
5.7.3 Fire Protection	
5.7.3.1 The fire suppression system shall be designed in accordance with NFPA or ISO	Refer to the GS EP SAF 050 .

API	GS
standards as specified. The purchaser will specify (see 5.7.3.1.1 and 5.7.3.1.2) any special design considerations to be included in the suppression system, including the specific fire suppression medium.	
• 5.7.3.1.1 When NFPA standards have been specified in 5.7.3.1, the extinguishing system shall be selected from the following: NFPA 2001 (covers clean agent extinguishing systems), NFPA 750 (covers water mist systems) or NFPA 12 (covers carbon dioxide extinguishing systems).	Refer to the GS EP SAF 050 .
• 5.7.3.1.2 When ISO standards have been specified in 5.7.3.1, the extinguishing system shall be selected from the following: ISO 14520 (covers clean agent extinguishing systems) or ISO 6183 (covers carbon dioxide extinguishing systems).	Refer to the GS EP SAF 050 .
• 5.7.3.3 The fire detection system shall be designed in accordance with NFPA 72E or ISO 13387-7 as specified. Thermal detection shall be considered the minimum level of detection. Additional levels of detection, such as optical, may be specified by the purchaser.	Refer to the GS EP SAF 050 .
• 5.7.3.4 The gas detection system shall be designed in accordance with NFPA 72E or IEC 61779-1 and 6 as specified.	Refer to the GS EP SAF 050 .
5.7.4 Acoustical Treatment	
5.7.4.1 If vendor furnished acoustical treatment is specified the requirements of 4.1.10 shall apply.	Refer to the GS EP MEC 010 , GS EP MEC 020 or GS EP MEC 030 , as applicable.
• 5.7.4.2 Any special "far field" or neighborhood sound restrictions that are applicable shall be specified.	Refer to Project specification and Project datasheet.
5.7.5 Enclosures	
• 5.7.5.1 If specified, suitable enclosure(s) shall be provided to meet purchaser's acoustical, weatherproofing, safety, and/or fire protection requirements. Enclosure(s) shall be designed to ensure the package can meet the maintenance, operation, and	This paragraph is applicable. A0 SOLAS fire rating requirements and acoustic type enclosures are acceptable. Refer to the GS EP MEC 010 , GS EP MEC 020 or GS EP MEC 030 , as

API	GS
service life requirements. An enclosure system shall consist of the following: a) an enclosure surrounding the gas turbine and/or driven equipment; b) an enclosure ventilation and purging system; c) a fire protection system (see 5.7.3), including enclosure isolation devices.	applicable and refer to GS EP SAF 050.
5.7.5.3 Enclosures shall be designed to permit on-site maintenance. The degree of disassembly for maintenance shall be stated in the proposal. Enclosure floor compartment shall have drain connections and piping to facilitate removal of liquids.	In addition, the vendor shall demonstrate that the design of the acoustic enclosure shall not restrict access for operation and maintenance of the enclosed equipment. The construction of the enclosure shall permit disassembly and re-assembly without affecting its integrity.
5.7.5.3.1 Removable roof sections, side panels, or hinged bulkhead walls shall be provided for heavy maintenance. Construction of maintenance access ways shall permit return to the original condition. Caulking or removable portions are not acceptable.	Refer to the GS EP MEC 010, GS EP MEC 020 or GS EP MEC 030, as applicable.
5.7.5.3.2 Access doors and/or manways shall be provided for routine maintenance and inspection. The sealing devices utilized around the perimeter of these access ways shall be designed to withstand normal use without loss of sealing function.	Any enclosure compartment shall be provided: • Access doors with 180° opening and locking devices • Normal and emergency lighting. Enclosure ventilation inlet and outlet openings shall be provided with rectangular flanges fitted with fire dampers designed to A0 SOLAS fire rating requirements. Enclosure openings for cables and piping shall be by means of multi cable transits. Enclosures and inlet plenums shall be provided with handling facilities for field installation and removal of the gas generators and power turbines. Enclosures shall be gas tight, and an enclosure gas tight test shall be performed on each unit.
5.7.5.6 The enclosure shall be provided with a fan driven forced ventilation and purging air	A 100% fan system redundancy is required. Each ventilation fan shall be designed to

API	GS
system designed to provide 100 % of the ventilation and purging load in the most severe climatic/load conditions. The purchaser will specify fan system redundancy requirements and whether positive or negative pressure is required.	maintain inside the enclosure a maximum temperature of 75°C. Air distribution inside the enclosure shall avoid any local overheating. Refer to the GS EP MEC 010 , or GS EP MEC 020 or GS EP MEC 030 , as applicable regarding enclosure pressure requirement.
5.7.5.6.1 Ventilation system will include air filtration and or silencing equipment if required by the vendor. Ventilation air may be taken from primary air filtration system.	This paragraph is applicable. In addition: The air ducting and silencer shall be made of AISI 316L stainless steel. When air for ventilation system is not taken downstream of combustion air filter, air ventilation ducts shall be located in safe area. Air ventilation system shall be AISI 316L stainless steel and filtration shall be prefilters, filters and marine vane separators.
5.7.5.6.3 Ventilation and purging flow shall enter and exit the enclosure via port(s). Each port shall be equipped with a back fire suppression damper and a minimum of one back flow damper within each supplied system. The purchaser will specify if additional ventilation ducting is required.	Each port shall be provided with fire dampers. Each fan shall be fitted with a non-return check valve.
5.8 Fuel System	
5.8.1 General	
5.8.1.1 Vendor Requirements The vendor shall supply a complete system for receiving fuel from the purchaser's system. The fuel system shall be operable with the normal fuel or any alternative or starting fuels. The composition, range of heating values, temperatures, delivery pressures, and contaminant levels will be specified according to 5.8.2 and 5.8.4 in the inquiry specification. The vendor shall advise the purchaser of the effects of contaminants and corrosive agents on turbine operation. Refer to ISO 21789 for additional details on fuel systems.	This paragraph is applicable. Refer to Project specification and Project datasheet.

API	GS
5.8.1.2 Fuel Gas System	
5.8.1.2.1 Components and Functionality	
5.8.1.2.1.1 As a minimum, each gas fuel supply shall include the following functions: a) manual isolation (see 5.8.1.2.2); b) leak tight shut-off (see 5.8.1.2.4); c) automatic fast acting shut-off (see 5.8.1.2.4); d) flow control (see 5.8.1.2.3); e) venting for depressurization between leak tight and automatic fast acting shut-off valves (see 5.8.1.2.4); and f) venting for pipework depressurization (see 5.8.1.2.4 and 5.8.1.2.5).	The manual isolation is achieved by the ESDV described in paragraph 5.8.1.2.1.3.
5.8.1.2.1.2 Additional equipment shall be provided where a system risk assessment, of all reasonably foreseeable conditions and the reliability of the equipment used, indicates that additional control is required. Where the gas fuel supply system comprises more than one supply or a single supply is divided for multiple uses, equipment in each supply shall be duplicated such that the individual supplies comply with 5.8.1.2. A strainer shall be fitted in accordance with 5.8.1.2.6 where necessary for safe operation. Figure 10 shows the minimum arrangement and indicates the operation of the valves. Figure 11 and Figure 12 show typical alternative arrangements. Table 8 defines the symbols for Figures 10, 11, and 12. NOTE: National regulations may require certification of safety shut off valves and vent valves.	Figure 11 – Fuel Gas System – Typical Alternative Arrangement is applicable.
5.8.1.2.1.3 Additional equipment that shall be supplied includes but is not limited to: a) manifold and nozzles;	This paragraph is to be replaced as follows: Additional equipment that shall be supplied includes but is not limited to: a) The fuel-gas line to each gas turbine package shall be fitted with an ESDV located outside the enclosure. A Y type strainer (with removable 100 fine

API	GS
b) necessary additional instrumentation; c) if the fuel gas pressure required by the vendor is higher than that available, a fuel gas compression system will be furnished by the vendor if specified by the purchaser; d) if specified, a fuel bypass valve and vent valve for purging the fuel gas line prior to light off shall be supplied; e) a fuel gas pressure regulator, if required.	mesh for commissioning) located inside the enclosure. b) Last chance liquid detection pot to be provided with level transmitter to trip the turbine in case of liquid detection and automatic drain system. The liquid detection pot retention time shall not be less than 3 seconds whatever the gas turbine operating conditions. This liquid detection pot shall be installed outside enclosure. c) If the fuel gas pressure required by the vendor is higher than that available, a fuel gas compression system will be furnished by the vendor if specified by the purchaser; d) A fuel gas three way valve (or an equivalent arrangement) to send the gas to flare until the minimum permissive temperature is obtained, and to purge completely the gas fuel system (including last chance pot) from the ESDV valve down to turbine shut off valve. A fuel gas temperature transmitter to allow firing when the permissive temperature is reached and to initiate alarm and shut-down of the gas turbine in case of too low temperature during operation. Vents between primary and secondary fuel gas shut off valves located inside the gas turbine enclosures shall be piped and routed by supplier to a safe area (preferably draft of the oil coolers) and shall be provided with a flame arrester with internals made of stainless steel or to the flare in case of toxic gas. e) A fuel gas pressure regulator, if required. f) (new paragraph): Supplier shall treat, make available and display on the turbine PLC the fuel flows from the flow meters according to ISO 5167 supplied by others.

API	GS
	In addition, fuel gas system shall be heat traced and insulated down to the fuel metering valve. The technical offer must include a complete description with diagram of the fuel gas system including all the devices listed above.
5.8.1.2.1.4 Leak tight and automatic fast acting shut-off valves shall fail closed by permanent available energy, e.g. spring force. The fail-safe status of vent valves shall minimize any risks. All valves should be designed such that a tolerable level of risk and reliable operation will be achieved under all reasonably foreseeable operating conditions. Normally, automatic shut-off valves should not be energized to open until the associated downstream vent valve has been proved closed. Vent valves and associated pipework shall be sized to ensure the depressurized pipe remains at atmospheric pressure taking into account the potential for leakage in upstream valves. Integral valve combinations may be used providing the necessary functional safety is achieved without introducing additional risk.	In addition, this shut-off valve must be tight shut-off as per ANSI/FCI 70-2, class V.
5.8.1.2.4 Shut-off Valves and Associated Vent Valve	
Shut-off of the gas fuel supply shall be performed by two independently operated automatic shut-off valves; the piping between the valves shall be vented. At least one of the two shut-off valves shall be an automatic fast acting shut-off valve and one shall be a leak tight valve. Both valves shall be designed and positioned so that the fuel supply to the gas turbine will be shut-off in the event of a dangerous situation at a rate that will prevent dangerous failure of the gas turbine. One of the two shut-off valves may serve as the flow control valve. The flow control valve shall not be the automatic fast acting shut-off valve which shall be provided as an independent function. Upon shutdown, both shut-off valves (see Figure 10, Figure 11, and Figure	One of the two shut-off valves shall not serve as the flow control valve.

API	GS
12—Item 3 and Item 10) shall be closed and the automatic vent valve opened (see Figure 10, Figure 11, and Figure 12—Item 9) to create atmospheric pressure in the supply line to eliminate the possibility of fuel entering the gas turbine in its shutdown condition. Where the design of the fuel system is such that the flow of fuel to the gas turbine requires further reduction, due to the stored energy in the piping system downstream of the automatic fast acting shut-off valve, an appropriately sized and positioned fast acting vent valve or alternative equipment shall be used to safely dissipate the stored energy.	
5.8.1.2.5 Shut-off Valve—Outside the Gas Turbine Package	
• A shut-off valve shall be located outside the gas turbine enclosure or building limits, or in a separately enclosed gas fuel package at the interface of the enclosure or building, to automatically isolate the fuel supply to the gas turbine in the event of a dangerous situation. If specified, the vendor shall provide this valve. The associated vent valve can be located either inside or outside the gas turbine or gas fuel package to vent the section of the pipe between the shut-off valve and the automatic fast acting shut-off valve. Where risk assessment indicates there is the potential for loss of containment from high-speed rotating equipment that could cause damage to the valves or rupture of the fuel supply pipe to the gas turbine, the shutoff valve(s) outside the gas turbine package and the supply pipe to the valves shall be located outside the zone where hazardous projectiles may occur from a potential failure of rotating equipment to ensure fuel shutoff can be achieved. Where the gas turbine package is located in a building, the risk assessment shall consider if the valves shall be located outside the building to provide additional isolation. The fuel shut-off and the vent valve(s) shall be operated automatically on a gas turbine trip if: a) a fire has been detected within the gas	The shut-off valve outside the gas turbine package is the ESDV valve described in paragraph 5.8.1.2.1.3. The ESDV valves installed outside the package shall be provided by EPC Contractor but interlocked within the UCP logic.

API	GS
turbine fire protection area; or b) where risk assessment indicates that the cause of the trip may cause damage or failure of the pipe between the valves and the gas turbine package, or damage to the equipment on the gas turbine package, either leading to the uncontrolled leakage of fuel.	
5.8.1.2.6 Strainers	
5.8.1.2.6.2 Dual Strainers	
If specified, twin Y-type strainer(s) with a continuous flow transfer valve shall be supplied and mounted off-base and be capable of being cleaned while in operation. The transfer valve shall have a carbon steel body with a stainless steel internals suitable for the fuel gas composition.	This paragraph is not applicable.
5.8.2 Gaseous Fuel	
5.8.2.1 Composition	
The purchaser will specify the composition of the gas (normal, alternate, or start-up) to be supplied. Composition of the gas should include analysis to hydrocarbons with 12 carbon atoms. Analysis should also include expected moisture (H ₂ O) content. Gas should be dry at the turbine fuel nozzles to prevent overtemperature damage to the turbine due to burning condensate. The vendor shall advise the purchaser if heating is required to maintain the gas above the dew point (see 5.8.2.7).	This paragraph is applicable. In addition, the vendor shall indicate any treatment considered necessary for start-up and operation.
5.8.2.2 Contaminants	
5.8.2.2.1 The contaminants likely to be found in fuel gas depend on the kind of gas involved, such as natural gas, coke oven gas, water gas, producer gas, and refinery gas. The concentration of contaminants in the gas will be specified on the datasheets by the purchaser. Some of the contaminants that are likely to be found include the following: a) tar, carbon black, and coke;	Refer to Project specification and Project datasheet.

API	GS
b) water; c) solids; d) naphthalene and gas hydrates.	
● 5.8.2.2.3 If specified, a coalescing filter shall be furnished by the vendor to reduce the potential for damage to the hot-gas-path components from entrained liquids. It shall be sized to keep liquid contents in the fuel gas at or below the maximum levels allowed by the gas turbine manufacturer.	If a coalescing filter is provided, it must be installed upstream or in the last chance pot, to avoid any liquid after the coalescing system. The vendor must advise purchaser if such coalescing system is needed.
5.8.2.3 Corrosive Agents	
● 5.8.2.3.1 The concentration of hydrogen sulfide, sulfur dioxide, sulfur trioxide, total sulfur, alkali metals, chlorides, carbon monoxide, and carbon dioxide will be specified by the purchaser so that proper precautions can be taken, if necessary, to prevent elevated-temperature corrosion of turbine hot-gas-path components and ambient-temperature corrosion of fuel control valves and systems. Total sulfur content must also be considered to protect heat-recovery equipment from corrosion.	Refer to Project specification and Project datasheet.
5.8.2.4 Heating Value	
● 5.8.2.4.1 The lower heating value of each gas will be specified. During operation, the actual heating value should not differ from the specified value by more than plus or minus 10 %.	Refer to Project datasheet.
● 5.8.2.4.2 For variations in heating value of more than 5%, rate of change, together with upper and lower limits shall be specified by the purchaser because special equipment may be required for proper fuel control.	The vendor shall calculate the lower heating values based on the fuel gas compositions and indicate the permissible change and rate of change in heating value and Wobbe index.
5.8.3 Liquid Fuel System	
5.8.3.1 Fuel Control	
5.8.3.1.1 As a minimum each liquid fuel supply shall include the following functions: a) manual isolation (see 5.8.3.2), b) flow control (see 5.8.3.3), c) automatic fast acting shut-off (see	In addition, the filtration function shall be added.

API	GS
5.8.3.4), d) leak tight shut-off (see 5.8.3.5), e) spill and/or drain (see 5.8.3.4 and 5.8.3.6), f) fuel pump.	
5.8.3.2 Isolation	
For operation during maintenance activity or by fire service personnel a valve, which shall be capable of manual operation, shall be fitted to the inlet of each gas turbine installation upstream of the automatic valves. This valve shall be clearly marked, located in an accessible position and should be capable of being operated by an acceptable level of physical force. NOTE: Guidance on the physical strength for the hand-operation of equipment is given in EN 614-1:2006.	SDV valve provided by the EPC contractor and installed upstream the fuel gas system of each individual gas turbine is able of a manual operation as required.
5.8.3.4 Automatic Fast Acting Shut-off Valve and Spill Valve	
Shut-off of the liquid fuel supply shall be performed by two independently operated automatic shut-off devices. At least one valve shall be an automatic fast acting shut-off valve. After operation of the shut-off devices and after any fuel purging, a valve shall drain a section of the supply line to eliminate the possibility of fuel entering the gas turbine in its shutdown condition. This valve shall be sized to ensure the drained pipe volume remains near atmospheric pressure taking into account the potential for leakage in upstream valves. Where a spill valve does not spill to atmospheric pressure, a drain valve shall be supplied in accordance with 5.8.3.6. Operational requirements may require the liquid fuel system to remain pressurized when liquid fuel is not being furnished to the engine in order to minimize either starting time or fuel transfer. In these situations, any necessary design steps and risk assessment shall validate that this results in a tolerable level of risk. Where spill flow is returned to the pump suction sufficient cooling and/or make up flow shall exist to prevent overheating and the potential for	In addition, the fast acting shut-off valve must be tight shut-off as per ANSI/FCI 70-2, class V.

API	GS
vapor lock, or the fuel supply temperature before the pump suction should be monitored and a shutdown initiated if overheating occurs.	
5.8.3.5 Leak Tight Shut-off Valve—Outside the Gas Turbine Package	
An automatic shut-off valve shall be located outside the gas turbine package to automatically isolate the fuel supply to the gas turbine in the event of a dangerous situation (see Figure 13—Item 3). Where risk assessment indicates there is the potential for loss of containment from high-speed rotating equipment that could cause damage to the valves or rupture of the fuel supply pipe to the gas turbine, the shut off valve(s) outside the gas turbine package and the supply pipe to the valves shall be located outside the zone where hazardous projectiles may occur from a potential failure of rotating equipment to ensure fuel shutoff can be achieved. Where the gas turbine package is located in a building the risk assessment shall consider if the valve shall be located outside the building to provide additional isolation. The valve shall be operated automatically on a gas turbine trip if: - a fire has been detected within the gas turbine fire protection area; or - where risk assessment indicates that the cause of the trip may cause damage or failure of the pipe between the valves and the gas turbine package, or damage to the equipment on the gas turbine package, either leading to the uncontrolled leakage of fuel.	The shut-off valve outside the gas turbine package is the SDV valve described in paragraph 5.8.3.2. The SDV valve installed outside the package shall be provided by EPC Contractor but interlocked within the UCP logic.
5.8.3.7 Filter/Strainer	
A filter/strainer shall be fitted upstream of the fuel flow control device and automatic fast acting shut-off valve at a suitable location to prevent device or valve malfunction due to debris entering the device or valve. Duplex fuel filters shall be used with a continuous flow transfer valve if liquid is the primary fuel.	The liquid fuel system shall be equipped of duplex fine filters with continuous flow transfer valve and a last chance filter. The filter media shall be made of 2 x 100% replaceable static glass fiber (non sensitive to hydrocarbons) filters with a $\beta_{10(c)} = 200$ or a $\beta_{20(c)} = 5000$. The surface of the liquid fuel

API	GS
A single filter may be supplied if the liquid fuel is not the primary fuel. When provided, duplex fuel filters shall be accessible with the idle filter capable of being cleaned while in operation. The transfer valve shall have a carbon steel or stainless steel body with stainless steel internals.	fine filters shall be determined on the basis of the flow of high pressure pump according to the following rule: 1 m ³ /h flow requires 4 m ² of filtration surface. The transfer valve body has a stainless steel body and stainless steel internals.
5.8.3.14 If heating of the fuel is required to vaporize and superheat the fuel, or to lower the viscosity to within the manufacturer's limits, heating equipment will be furnished by the purchaser. Heater requirements shall be in accordance with 5.8.2.7.	Refer to Project specification and Project datasheet.
5.8.3.15 If specified, fuel transfer equipment shall be supplied.	Refer to Project specification and Project datasheet.
5.8.4 Liquid Fuel	
5.8.4.3 Grades or Types	
5.8.4.3.1 The purchaser shall specify which grades of ASTM D 2880 shall be used, as follows. a) Grade 0-GT includes naphtha, Jet B, and other light hydrocarbon liquids that characteristically have low flash points and low viscosities compared to those of kerosene and fuel oils. b) Grade 1-GT is a light distillate fuel suitable for use in nearly all gas turbines. c) Grade 2-GT is a distillate that is heavier than Grade 1-GT, and it can be used by gas turbines not requiring the clean burning characteristics of Grade 1-GT. Fuel heating equipment may be required by the gas turbine depending on the fuel system design or the ambient temperature conditions or both. d) Grade 3-GT may be a distillate that is heavier than Grade 2-GT, a residual fuel oil that meets the low ash requirement, or a blend of a distillate and a residual fuel oil. If Grade 3-GT is specified, the gas turbine will require fuel heating in almost every installation. e) Grade 4-GT includes most residuals and	Refer to Project specification and Project datasheet. The gas turbine shall be capable to run on liquid fuel containing a total sulfur content of 1% maximum without reducing the life cycle of gas turbine hot components.

API	GS
some topped crudes oil. Because of the wide variation and lack of control of properties, the gas turbine manufacturer should be consulted about acceptable limits on properties.	
● 5.8.4.3.2 The Purchaser shall specify which grades of ASTM D1655 shall be used, as follows. a) Jet A and Jet A-1 are relatively high flash point distillates of the kerosene type. They represent two grades of kerosene fuel that differ only in freezing point. b) Jet B is a relatively wide boiling range volatile distillate.	Refer to Project specification and Project datasheet. The gas turbine shall be capable to run on liquid fuel containing a total sulfur content of 1% maximum without reducing the life cycle of gas turbine hot components.
● 5.8.4.3.3 The purchaser will furnish a complete analysis for other liquid fuels.	Refer to Project specification and Project datasheet. The gas turbine shall be capable to run on liquid fuel containing a total sulfur content of 1% maximum without reducing the life cycle of gas turbine hot components.
5.8.5 Dual Fuel Operation	
● 5.8.5.1 If specified, the gas turbine shall be provided with the necessary equipment to permit normal (starting and continuous) operation on either of the fuels, i.e., liquid/gas, liquid/liquid, or gas/gas. The dual fuel system shall provide the capability of automatic transfer from either fuel source to the other fuel source while under full or part load operation. Initiation of the transfer will be a dry contact closure provided by the purchaser.	In case of dual fuel application, this paragraph is applicable. Changeover from liquid to gas fuel shall be manually initiated. No mechanical drive shall be provided with dual fuel system.
5.8.7 Emission Suppression Systems	
● 5.8.7.1 If specified, the gas turbine shall be provided with the necessary equipment for emission suppression for gas-fueled or liquid-fueled units. The vendor shall fully describe the proposed system, including the following performance information associated with the emission suppression system: a) emission variations with all fuels being used;	Conventional combustion systems are required, unless otherwise dictated by the local regulation at the gas turbine installation site. Refer to Project specification and Project datasheet.

API	GS
b) effect of ambient temperature range on emissions; c) effect of anti-icing system on emissions, if supplied; d) associated engine power and engine heat rate.	
5.8.7.2 The purchaser shall specify the site-specific requirements for: a) emissions levels; b) power output load range for which these emission level are acceptable; c) type of emission suppression system required (wet or dry); d) complete fuel analyses to be used per 5.8.1.1. NOTE: Emission refers to contaminants in the exhaust stream such as: 1) NO_x (oxides of nitrogen); 2) CO (carbon monoxide); 3) UHC (unburned hydrocarbons); 4) Others (sulfur, particulate, etc.).	If an emission suppression system is specified, the combustion system shall be designed to achieve emission levels lower than 25 ppmv at 15% Oxygen at ISO conditions over 50 to 100% load with dry type combustors. Supplier to submit lowest guaranteed level with proposal. As necessary for continuous operation, Supplier shall provide: - Any instrumentation such as but not limited to chromatograph, calorimeter or Wobble index meter to continuously monitor the fuel gas properties for emission level control. These analysers shall be adequately located and packaged to meet the requirements of the area classification where they are installed. - Fuel gas mass flow meter If it is required by the Project specification, supplier shall provide: - NO_x, CO, unburned hydrocarbon and oxygen analysers and associated ancillaries for continuous emission level monitoring.
5.8.7.3 With purchaser's approval, the level of emissions suppression given in volume part per million (VPPM) of exhaust flow may be allowed to vary within the power range from minimum to maximum load as long as the anticipated yearly load profile yields the required level of emissions output (normally stated in tons/year). By allowing this variance, the complexity of some dry emission suppression systems can be significantly reduced.	Refer to paragraph 5.8.7.2.
5.8.7.4 If a wet suppression system is	Refer to Project specification and Project

API	GS
specified, the gas turbine shall be provided with the necessary equipment to permit injection of purchaser-supplied water or steam for emissions suppression.	datasheet.
• 5.8.7.4.1 If specified, the supplier shall quote gas turbine performance with and without water/steam injection.	This paragraph is applicable.
6 Inspection, Testing and Preparation for Shipment	
6.1 General	
• 6.1.1 The purchaser shall specify the extent of participation in this inspection and testing and the amount of advance notification required.	Purchaser shall witness the tests as described in paragraph 6.3. Extend of inspection shall be jointly defined during a pre-inspection meeting, and listed in a quality manual, provided by vendor for approval and review.
• 6.1.2 If specified, the purchaser's representative, the vendor's representative, or both shall indicate compliance in accordance with accepted inspection documents by initialing, dating, and submitting a checklist to the purchaser before shipment.	This paragraph is applicable.
6.2 Inspection	
6.2.1 General	
6.2.1.1 The vendor shall keep the following data available for at least 20 years for examination or reproduction by the purchaser or his representative upon request: a) necessary certification of material, such as mill test reports; b) test data to verify that the requirements of the specification have been met; c) results of documented tests and inspections, including fully identified records of all heat treatment and radiography; • d) if specified, final-assembly maintenance and running clearances.	• d) is applicable.
• 6.2.1.3 In addition to the requirements of 4.10.4.1 and the ASTM material specification	Vendor standard shall apply.

API	GS
the purchaser shall specify: a) parts that are to be subjected to surface and subsurface examination; b) the type of examination required, such as magnetic particle, liquid penetrant, radiographic, and ultrasonic examination.	
6.2.2 Material Examination	
6.2.2.1 General	
6.2.2.1.2 When radiographic, ultrasonic, magnetic particle, or liquid penetrant inspection of welds or materials is required (see 4.10.4.1 and 6.2.1.3), the recommended practices in 6.2.2.2 through 6.2.2.5 shall apply unless other procedures are specified by the purchaser and agreed to by the vendor. Cast iron may be inspected in accordance with 6.2.2.4 and 6.2.2.5. Welds, cast steel, and wrought material may be inspected in accordance with 6.2.2.2 through 6.2.2.5. The material inspection of pressure-containing parts is covered in 4.10.4.6. NOTE: These recommended practices describe examination techniques that are applicable to great varieties of sizes and shapes of materials and widely varying examination requirements. Since the specification for the actual component being inspected depends on metallurgy, component configuration, and method of manufacture, specified procedures and acceptance standards for the application should be covered by written standards, developed by the manufacturer for the specific application.	This paragraph is applicable.
6.2.3 Mechanical Inspection	
6.2.3.3 If specified, the equipment and all piping and appurtenances shall be inspected before heads are welded onto vessels, openings in vessels or exchangers are closed, or piping is finally assembled.	Vendor standard shall apply.
6.2.3.4 If specified, the hardness of parts, welds, and heat-affected zones shall be verified as being within the allowable values by testing. The method, extent, documentation, and witnessing of the testing shall be mutually agreed upon by the	Vendor standard shall apply.

API	GS
purchaser and the vendor.	
6.3 Testing	
6.3.1 General	
6.3.1.2 At least six weeks before the first scheduled test, the vendor shall submit to the purchaser, for his review and comment, detailed procedures for all tests, which include the mechanical running test and all specified purchaser tests (see 6.3.5), as well as acceptance criteria for all monitored parameters.	Supplier's shall provide acceptance criteria and respective associated tolerances.
6.3.1.3 Notification requirements are covered in 6.1.1. However, the vendor shall notify the purchaser not less than five working days before the date the equipment will be ready for testing. If the testing is rescheduled, the vendor shall notify the purchaser not less than five working days before the new test date unless otherwise mutually agreed.	Refer to Contract Terms and Conditions.
6.3.1.5 (new paragraph)	The results of all the tests shall be included in the final fabrication dossier.
• 6.3.3 Pneumatic Testing	
If specified, in addition to hydrostatic testing of pipe systems the manufacturer shall also perform, complete or partial system, pneumatic tests of the gas fuel system using air or other gases at the system design pressure. This test shall be performed after completion of the hydrostatic test (see 6.3.2).	This paragraph is applicable.
6.3.4 Mechanical Running Test	
• 6.3.4.1.6 If specified, auxiliary systems mounted on the gas turbine main base shall be tested with the gas turbine during the mechanical run. These auxiliary systems may include but are not limited to the job oil system(s), fuel systems, starting and cool-down drive systems, atomizing liquid fuel system, and auxiliary gear box. The purchaser shall specify which systems shall be included in the test.	This paragraph is applicable.
• 6.3.4.3.4 Synchronous vibration amplitude	This paragraph is applicable.

Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616

Rev.: 09

Effective date: 10/2012

Page: 60 of 89

API	GS
and phase angle vs speed for deceleration shall be plotted before and after the 4-hour run. Both the filtered (one per revolution) and the unfiltered vibration magnitudes shall also be plotted. If specified, these data shall also be furnished in polar form. The speed range covered by these plots shall be 400 revolutions per minute to the specified driver trip speed.	
6.3.4.3.6 Real-time vibration data (see Annex B - Item 32) as agreed by the purchaser and vendor shall be recorded and a copy provided to the purchaser. The vendor shall identify the software required to read the vibration data. NOTE: Some vendors utilize data acquisition software that is not commercially available.	Real time vibration data to be provided to the purchaser according to a readable format.
6.3.4.4.2 If specified, spare rotors shall also be given a mechanical running test in accordance with the requirements of this standard.	All power turbines including the spare power turbine, if ordered, shall individually undergo a mechanical spin test as per Manufacturer's standard.
6.3.5 Optional Shop Tests	
If specified, the shop tests described in 6.3.5.1 through 6.3.5.14 shall be performed. Test details shall be mutually agreed upon by the purchaser and the vendor.	This paragraph is applicable.
6.3.5.1 Performance Test	
If specified, the machine shall be tested in accordance with ASME Performance Test Codes 1 and 22, or ISO 2314, as specified by the purchaser. Vibration shall be measured and recorded during this test as specified in 6.3.4.1.10 and 6.3.4.1.12.	This paragraph is applicable. In addition, all aero derivative gas generators, including the spare gas generator, if ordered, shall be individually mechanically and performance tested, and witnessed by Purchaser. All gas turbines shall be tested as per ASME Power Test Codes 1 & 22 . When a separate power turbine rotor is ordered as capital spare part, it shall be spin tested only to check its mechanical behavior. When a complete power turbine is ordered as capital spare, it shall be tested as per ASME Power Test Codes 1 & 22 . For dual fuel gas turbines, the test shall be

API	GS
	performed with each type of fuel. Performance guarantee is based on the guaranteed operating case(s) specified in the Project datasheet. During these tests the emission levels shall be measured and shall not be higher than the guaranteed values.
6.3.5.2 Complete-Unit Test	
If specified, such components as compressors, gears, generators, helper drivers, and auxiliaries that make up a complete unit shall be tested together during the (no-load) mechanical running test. The complete unit test shall be performed in place of or in addition to separate tests of individual components specified by the purchaser. NOTE: This test can also be combined with the performance test (see 6.3.5.1) for a full load string test.	This paragraph is applicable. Refer to the GS EP MEC 010, GS EP MEC 020 or GS EP MEC 030, as applicable.
• 6.3.5.2.1 Package Test	
If specified to minimize the operation required during the commissioning on site, the main contract auxiliary systems mounted on separate base shall also be used during the mechanical running test. These systems may include: a) control panel, b) auxiliary gear, c) starting equipment, d) lube-oil system, e) hydraulic oil system, f) gas fuel system, g) liquid fuel system, h) atomizing air system, i) inlet system, j) exhaust system, k) enclosure with the associated l) equipment, m) fire protection, n) de-icing. NOTE: The scope of this test shall be developed	This paragraph is applicable. Refer to the GS EP MEC 010, GS EP MEC 020 or GS EP MEC 030, as applicable.

API	GS
jointly by the purchaser and the vendor. This test is recommended for units to be installed in locations where the commissioning operations could be particularly difficult or expensive.	
• 6.3.5.2.2 If specified, torsional vibration measurements shall be made to verify the vendor's analysis.	Refer to Project specification and Project datasheet.
• 6.3.5.3 Gear Test If specified, the gear shall be tested with the gas turbine unit during the mechanical running test. NOTE: Load gears that have their own radial and thrust bearings are usually tested separately at the gear manufacturer's factory.	This paragraph is applicable.
• 6.3.5.4 Sound-Level Test If specified, the sound-level test shall be performed in accordance with ISO 3744 or other agreed standards.	In addition, when a string test is required, the noise measurement shall be performed during this string test even if testing arrangement is not fully adequate. The sound-level acceptance criteria is specified in the GS EP MEC 010 , GS EP MEC 020 or GS EP MEC 030 as applicable.
• 6.3.5.5 Rotor Overspeed Test If specified, the vendor shall perform an overspeed test of the rotor at 120 % of rated speed for 2 minutes to demonstrate the mechanical integrity and vibration behavior of the rotor.	Vendor standard shall apply.
• 6.3.5.6 Auxiliary-equipment Test Auxiliary equipment, such as oil systems and control systems, shall be tested in the vendor's shop. Details of the auxiliary equipment tests shall be developed jointly by the purchaser and the vendor.	This paragraph is applicable.
• 6.3.5.7 Ventilation System Validation If specified, the ventilation system shall be tested to demonstrate the safe running of the machine and proof that dilution ventilation will meet the safety requirements and design intent (see ISO 21789). The vendor shall indicate all specifications used.	This paragraph is applicable.

API	GS
• 6.3.5.8 Enclosure Leak Test	
If specified, the fire protection system shall be tested to prove the retention capability of the extinguishing medium.	This paragraph is applicable.
• 6.3.5.9 Post-Test Inspection	
The gas turbine shall be inspected after satisfactory completion of the mechanical running test. An inspection of the gas turbine internals by boroscope, visually via the inlet and exhaust connections and other access means available shall be performed to document the condition after the running test and documentation shall be provided to the purchaser. If the mechanical running test is unsatisfactory, dismantling, inspection, and reassembling to identify the reason for and to correct the failure shall be performed.	This paragraph is applicable.
• 6.3.5.10 Inspection of Hub/Shaft Fit for Hydraulically Mounted Couplings	
After the running tests, the shrink fit of hydraulically mounted couplings shall be inspected by comparing hub/shaft match marks to ensure that the coupling hub has not moved on the shaft during the tests.	This paragraph is applicable.
• 6.3.5.11 Governor Response and Emergency Overspeed Trip Systems Tests	
	This paragraph is applicable.
• 6.3.5.12 Spare Parts Test	
If specified, spare parts, such as couplings, gears, bearings, and seals, shall be tested to the same standards as the original parts.	This paragraph is applicable.
• 6.3.5.13 Fire Protection Tests	
The fire protection systems shall confirm compliance with NFPA or ISO standards as specified in 5.7.3.1.	This paragraph is applicable.
• 6.3.5.14 Other Tests and Inspections	
Other tests and inspections not listed or defined in this standard are to be completely described in the inquiry and the order.	Refer to Project specification and Project datasheet.

API	GS
• 6.3.6 Field Test	
If specified, a field performance test shall be performed to determine the gas turbine's efficiency and power at site. This test shall be in accordance with ISO 2314 or PTC 22. The vendor shall indicate all test specifications used.	This paragraph is applicable. Refer to site acceptance test of the GS EP MEC 010, GS EP MEC 020 or GS EP MEC 030, as applicable.
6.4 Preparation for shipment	
• 6.4.1 The gas turbine units shall be suitably prepared for the type of shipment specified, including blocking of the rotors when necessary. Blocked rotors shall be identified by corrosion resistant tags externally attached with stainless steel wire. The preparation shall make the equipment suitable for six months of outdoor storage (under the conditions specified in 4.1.19) from the time of shipment, with no disassembly required before operation except for inspection of bearings and seals. If storage for a longer period is contemplated, the purchaser shall consult with the vendor regarding the recommended procedures to be followed. Any gas turbine component accessory, or instrument not suitable for the extremes of temperature that can be expected during shipment or storage, shall be identified by the vendor in the proposal.	For shipment, aero derivative gas generators shall be removed from the packages and shipped in N2 pressurized steel containers. These containers shall be handed back to supplier after installation of the gas generators inside the enclosures. The storage procedure must be defined by the vendor and included in the operating and maintenance manual.
• 6.4.3.10 When a spare rotor is purchased, the rotor shall be prepared for unheated indoor storage for a period of at least three years. The rotor shall be treated with a rust preventative and shall be housed in a vapor-barrier envelope with a low-release volatile-corrosion inhibitor. The rotor shall be crated for domestic or export shipment, as specified. A purchaser-approved resilient material 3.0 mm (1/8 in.) thick [not tetrafluoroethylene (TFE) or polytetrafluoroethylene (PTFE)] shall be used between the rotor and the crude at the support areas. The rotor shall not be supported at journals.	This paragraph is applicable.

API	GS
7 Vendor's Data	
7.2 Proposals	
7.2.1 General	
The vendor shall forward the original proposal and the specified number of copies to the addressee specified in the inquiry documents. As a minimum, the proposal shall contain the data specified in 7.2.2 through 7.2.5 as well as specific statement that the system and all its components are in strict accordance with this standard. If the system and components are not in strict accordance, the vendor shall include a list that details and explains each deviation. The vendor shall provide details to enable the purchaser to evaluate any proposed alternative designs. All correspondence shall be clearly identified per 7.1.2.	Refer to Purchaser bidding instructions.
7.2.3 Technical Data	
v) When specified, the vendor shall include a probabilistic spare parts optimization analysis based on failure rates supported by inventory histories for the model being supplied.	This paragraph is applicable.
w) If specified, the vendor shall include in the proposal failure modes and effects analysis (FMEA) to address major failure modes of the equipment train being offered.	This paragraph is applicable.
x) If specified, the vendor shall include a life cycle cost analysis based on assumed energy costs documented in the report. The analysis shall be over 15 years and based on a discount rate of 9%.	This paragraph is applicable.
7.2.4 Curves	
The proposal shall contain a power output vs speed curve for the rated site conditions. It should follow the format shown in Figures 14, Figure 15, or Figure 16, as applicable. Additional curves shall be presented showing site rated power and speed at specified maximum and minimum site ambient	This paragraph is applicable. Furthermore, the vendor shall provide the necessary curves in order to assess the performance of the gas turbine either in full load condition or partial load condition. These curves shall allow purchaser to verify any loss of performances and especially its

API	GS
temperatures (see 4.1.19) and showing both using specified fuels (see 5.8). All curves shall include power deductions (or fuel increases) for inlet and exhaust pressure losses to reflect the inlet and exhaust equipment that is specified or proposed. If specified, the curves described in Item a) through Item f) below shall also be furnished. a) A speed/torque curve for the power-output shaft. For single shaft designs, the required starting torque and the combined torque to load produced by the starting device plus the turbine after light off shall be indicated. b) Curves showing the incremental power output for increments of steam or water injection. The purchaser will state the quantity and condition of injection steam available. c) Curves showing the effect of full-range ambient conditions on exhaust flow and temperature. d) Run-down curves showing exhaust flow and temperature vs. time after trip, under full load and no load initial conditions. NOTE: Run-down parameters for two-shaft machines can be measured during a mechanical run test. However, the inertia and rundown load for a single-shaft turbine may not be available during a mechanical run test. e) NO_x and CO₂ emission curves showing concentration in the exhaust gas vs. percentage load at each specified temperature. f) Impact of anti-icing system operation on power vs. speed curve, if applicable.	location (compressor, high pressure turbine, low pressure turbine). In that perspective, vendor shall provide at different ambient temperatures and different power turbine speeds and gas generator speeds curves showing: - Power - Heat rate - Compressor discharge pressure - Compressor discharge temperature - Compressor speed - High pressure turbine temperature - Exhaust temperature. The vendor shall clearly indicate the parameter use for the gas turbine control. Partial load shall be provided as a percentage of base load power.
7.3 Contract data	
7.3.4 Progress Reports	
The vendor shall submit progress reports to the purchaser at the intervals specified on the VDDR form as per Annex B.	Refer to Contract Terms and Conditions.



General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 67 of 89

API	GS
7.3.6 Installation, operation, maintenance, and technical data manuals	
7.3.6.4 Technical Data Manual	
If specified, a technical data manual shall be provided at a time mutually agreed upon by the purchaser and the vendor (See Appendix B for detail requirements).	The technical data manual must be supplied before installation.

General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 68 of 89

Appendix 1 Gas Turbine Air Inlet Filters Arrangement

1. General

The following detailed arrangements are applicable for gas turbine air inlet filter. Refer to attached tables at the end of this appendix.

The selection depends on location, environmental data (rain, humidity, fog, dust, oily contaminants and icing), fuel gas type (risk of hot corrosion) and gas turbine technology (aeroderivative type, light heavy duty or industrial type, heavy duty type).

Carbon black, flare fumes and Diesel soot are present in most of Purchaser plants. These contaminants shall be considered in the filter selection.

“Low velocity” filter means that the air velocity measured perpendicularly to the air filter element is closed to 3.0 m/s (+/- 5%). “High velocity” filter means that the air velocity measured perpendicularly to the vane separator and the air filter element is closed to 5.0 m/s (+/- 5%).

Louvers, vane separator, filter cartridges holding frames and other components shall be made of AISI 316L stainless steel.

2. Request for proposal

For all the different arrangements considered by this specification, the vendor proposal shall include a general arrangement drawing and shall provide the following information:

- The filter air flow in Am³/h for minimum and maximum site temperature with associated filter front speed in m/s
- The filter media material knowing high efficiency filter shall be based on glass fibre, cellulosid media shall not be selected and the use of synthetic media shall be limited to pre-filters
- The air flow at nominal and maximum capacities for the different filter cartridges in Am³/h:
 - Nominal flow is the largest flow through the filter meeting the code [EN 779](#) or [EN 1822-1](#) filtration classes in operation
 - Maximum flow that the filter can handle.
- The filter efficiency curves versus the nominal and maximum flows
- The guaranteed pressure drop of intake system in clean conditions
- The maximum allowable operating pressure drop
- The recommended differential alarm and shutdown setting
- The relevant filter certificates issued from an independent office certifying that filtration classes considered in the proposal are in accordance with the code [EN 779](#) or [EN 1822-1](#) filtration classes,

A synthesis of arrangements definition is provided in a table within Appendix 1.

3. Air filters arrangements

Six arrangements are considered covering oil and gas producer applications. Nevertheless, these six arrangements do not consider arctic offshore application. Air filter arrangement

General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 69 of 89

Appendix 1

definition for Project dealing with offshore arctic conditions shall be considered on a case by case basis and shall be referred to PURCHASER for discussion and decision.

Arrangement 1: Static high velocity type air filtration system

Locations/characteristics:

- Offshore not Arctic

The purpose of this system is primarily to stop water and salt from marine environment.

This arrangement shall not be used when risk of type 1 and/or type 2 hot corrosion are identified (Vendor shall refer to fuel gas and/or liquid fuel composition).

The overall efficiency of this air filter arrangement shall not be less than F9. This efficiency shall be achieved whatever the presence of electrostatic charge on filters or not.

The salt removal efficiency of filter arrangement shall be guaranteed to a concentration of 0.0001 ppm weight against an input of 0.1 ppm as a wet aerosol.

This system shall be considered only for aeroderivative gas turbines.

The gas turbine air inlet filter arrangement consists in:

- Plane 3: A stage of marine vane separators with drain facilities
- Plane 5: A stage of coalescor exchangeable elements
- Plane 6: A stage with high efficiency static elements
- Plane 7: A stage of marine vane separator with drain facilities.

A drain system with drainage from upstream and downstream all the filter stages, from filter house floor shall be provided with a complete atmospheric water trap facility.

Note: For area submitted to Harmattan or periodic high atmospheric dust loading, cleanable high efficiency pre-filters mounted on AISI 316L stainless steel frame shall be installed temporarily during the dusty period between the plane 3 (vane separators) and plane 5 (coalescor) as plane 4.

Arrangement 2: Static low velocity type air filtration system

Locations/characteristics:

- High humidity atmosphere
- Offshore not Arctic
- Seashore desertic and not desertic
- Onshore tropical.

The purpose of this system is primarily to stop dust and salt from high humidity environment. In addition, the fog risk shall be considered.

This arrangement shall be considered when type 1 and/or type 2 hot corrosion are identified (Vendor shall refer to fuel gas and/or liquid fuel composition).

The overall efficiency of this air filter arrangement shall not be less than E10.

General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 70 of 89

Appendix 1

The gas turbine air inlet filter arrangement consists in:

- Plane 1: Weather hood shaped at 45°
- Plane 2: Insect and bird screen
- Plane 3: A stage of louvers or vane separator
- Plane 4: A stage of coalescor exchangeable elements
- Plane 5: A stage of prefilter made of static filter elements
- Plane 6: A stage with static high efficiency elements
- Plane 7: A stage with vane separator as far as high efficiency filter is not water repellant,

A drain system with drainage from upstream and downstream all the filter stages, from filter house floor shall be provided with a complete atmospheric water trap facility.

Note: For area submitted to Harmattan or periodic high atmospheric dust loading, cleanable high efficiency pre-filters mounted on AISI 316L stainless steel frame shall be installed temporarily during the dusty period between the plane 3 (louvers) and plane 5 (prefilter) as plane 4 in addition of the existing coalescor.

Arrangement 3: Self-cleaning low velocity type air filtration system

Locations/characteristics:

- Low and medium humidity
- Seashore desertic.

The purpose of this system is primarily to stop dust and salt from low or medium humidity environment.

This arrangement shall not be used when risk of type 1 and/or type 2 hot corrosion are identified (Vendor shall refer to fuel gas and/or liquid fuel composition).

The overall efficiency of this air filter arrangement shall not be less than E10.

The gas turbine air inlet filter arrangement consists in:

- Plane 1: Weather hood shaped at 45°
- Plane 2: Insect and bird screen
- Plane 3: A stage of louvers
- Plane 5: A stage of air pulse self-cleaning filter elements
- Plane 6: A stage with static high efficiency elements.

A drain system with drainage from upstream and downstream all the filter stages, from filter house floor shall be provided with a complete atmospheric water trap facility.

This air entry arrangement is considered with an up draft or a cross flow configuration. Louvers shall be considered for cross flow configuration only.

Self-cleaning filter elements in cross flow configuration shall be equipped with AISI 316L stainless steel fan dust extractors and associated ducting.

General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 71 of 89

Arrangement 4: Static or self-cleaning low velocity type air filtration system

Locations/characteristics:

- Low and medium humidity
- Onshore moderate
- Inland industrial
- Agricultural.

The purpose of this system is primarily to stop high concentration of dust from low or medium humidity environment.

The overall efficiency of this air filter arrangement shall not be less than E10.

The gas turbine air inlet filter arrangement consists in:

- Plane 1: Weather hood shaped at 45°
- Plane 2: Insect and bird screen
- Plane 3: A stage of louvers
- Plane 4: A stage of coalescor exchangeable elements in case of Plane 5 equipped with static filter elements
- Plane 5: A stage of air pulse self-cleaning filter elements for medium humidity and high dust content or a stage of static filter elements for medium humidity and low dust content
- Plane 6: A stage with static high efficiency elements.

This air entry arrangement is considered with an up draft or a cross flow configuration. Louvers shall be considered for cross flow configuration only.

Self-cleaning filter elements in cross flow configuration shall be equipped with AISI 316L stainless steel fan dust extractors and associated ducting.

Arrangement 5: Self-cleaning low velocity type air filtration system

Locations/characteristics:

- Desertic.

The purpose of this system is primarily to stop sand and dust.

The overall efficiency of this air filter arrangement shall not be less than E10.

The gas turbine air inlet filter arrangement consists in:

- Plane 1: Weather hood shaped at 45°
- Plane 2: Insect and bird screen
- Plane 3: A stage of louvers
- Plane 5: A stage of air pulse self-cleaning filter elements in cross flow configuration
- Plane 6: A stage with static high efficiency elements.

Self-cleaning filter elements shall be equipped with AISI 316L stainless steel fan dust extractors and associated ducting.

General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 72 of 89

Appendix 1

Arrangement 6: Self-cleaning low velocity type air filtration system

Locations/characteristics:

- Arctic onshore.

The purpose of this system is primarily to prevent ice build up and to keep gas turbines in operation when icing conditions are met and secondarily to stop dust.

In arctic conditions, this arrangement shall be revisited by the purchaser when risk of type 1 and/or type 2 hot corrosion are identified (Vendor shall refer to fuel gas and/or liquid fuel composition).

The overall efficiency of this air filter arrangement shall not be less than F9.

The gas turbine air inlet filter arrangement consists in:

- Plane 1: Weather hood with bottom entry for snow fall protection
- A plane of vanes or tubes allowing injection of hot air in operation in order to prevent ice build up
- A plane of electrical resistances for air filter inlet de-icing prior to start gas turbine
- Plane 5: A stage of air pulse self-cleaning filter elements.

In this particular case, the air filter elements shall not incorporate metallic parts knowing it initiates ice build-up.

This air entry arrangement is considered with an up draft configuration. Cross flow is not authorized.

Table of gas turbine air filter arrangement

Air filtration arrangement	Arrangement 1 Static High Velocity Type	Arrangement 2 Static Low Velocity Type	Arrangement 3 Self-Cleaning Low Velocity Type
Applicable to the following gas turbine technology (2)	AD only	AD LHD HD	AD LHD HD
Applicable to the following environment	Offshore not Arctic Onshore tropical Seashore not desertic	Offshore not Arctic Onshore tropical Seashore desertic	Seashore desertic
Humidity	High humidity	High humidity	Low & medium humidity
Main contaminants	Water Salt	Salt Dust Fog	Water Salt Sand
Hot corrosion	Not allowable for hot corrosion prevention	Suitable for hot corrosion prevention	Not suitable for hot corrosion prevention
Plane 1 Weather hood	NA (1)	Yes	Yes
Plane 2 Insect & bird screen	NA	Yes	Yes
Plane 3 Louver/vane separator	Yes (vane separator)	Yes (vane separator)	Yes (louvers)
Plane 4 Prefilter	Removable prefilter for Harmattan application	Coalescor coupled with removable prefilter for Harmattan application	NA
Plane 5 Second stage	Yes (coalescor)	Yes (static filter)	Yes (self-cleaning)
Plane 6 Final stage	Yes (static filter)	Yes (static filter)	Yes (static filter)
Plane 7 Vane separator	Yes	Yes unless fine filter is water repellent	NA
Overall filtration efficiency class EN 779 and EN 1822-1	F9	E10	E10

(1) NA: Not applicable.

(2) AD: Aeroderivative gas turbine; LHD: Light Heavy Duty or non HD Industrial gas turbine; HD: Heavy Duty gas turbine.

Table of gas turbine air filter arrangement (cont'd)

Air filtration arrangement	Arrangement 4 Static or Self-Cleaning Low Velocity Type	Arrangement 5 Self-Cleaning Low Velocity Type	Arrangement 6 Self-Cleaning Low Velocity Type
Applicable to the following gas turbine technology (2)	AD LHD HD	AD LHD HD	AD LHD HD
Applicable to the following environment	Onshore moderate Inland industrial Agricultural	Desertic	Arctic onshore
Humidity	Low & medium humidity	Not relevant	Not relevant
Main contaminants	Salt Dust Fog	Sand Dust	Ice prevention (3) Dust Fog
Hot corrosion	Suitable for hot corrosion prevention (static filter only)	Not relevant	Not allowable for hot corrosion prevention (4)
Plane 1 Weather hood	Yes	Yes	Yes (with up draft configuration for snow fall protection)
Plane 2 Insect & bird screen	Yes	Yes	NA
Plane 3 Louver/vane separator	Yes (louvers)	Yes (louvers)	NA
Plane 4 Prefilter	Coalescor	NA	NA
Plane 5 Second stage	Yes Static for medium humidity and low dust Self cleaning for low humidity and heavy dust	Yes (self-cleaning filter)	Yes (self-cleaning filter)
Plane 6 Final stage	Yes (static filter)	Yes (static filter)	No
Plane 7 Vane separator	NA	NA	NA
Overall filtration efficiency class EN 779 and EN 1822-1	E10	E10	F9

(1) NA: Not applicable,

(2) AD: Aeroderivative gas turbine; LHD: Light Heavy Duty gas turbine or non HD Industrial gas turbine; HD: Heavy Duty gas turbine.

(3) Anti-icing system shall be provided by the gas turbine Manufacturer (hot air injection and electric resistance).

(4) Sour fuel gas application in Arctic environment shall be treated specifically on project basis.



General Specification		GS EP MEC 212
Gas Turbines for the Petroleum, Chemical and Gas Industry Services according to API Standard 616		
Rev.: 09	Effective date: 10/2012	Page: 75 of 89

Appendix 2

Appendix 2 Datasheets

**Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616**

Rev.: 09

Effective date: 10/2012

Page: 76 of 89

Appendix 2

		PROJECT TITLE Title 1 Title 2																																																																																																					
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET SI UNITS		DS EP MEC 213																																																																																																					
Document n°		Page 1 / 14																																																																																																					
1 APPLICABLE TO: ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILT																																																																																																							
2 FOR _____ UNIT _____																																																																																																							
3 SITE _____ SERIAL NUMBER _____																																																																																																							
4 SERVICE _____ NUMBER REQUIRED _____																																																																																																							
☐ CONTINUOUS ☐ INTERMITTENT ☐ STANDBY DRIVEN EQUIPMENT _____																																																																																																							
6 MANUFACTURER _____ MODEL _____ ISO RATING (3.21) _____ kW @ _____ r/min _____																																																																																																							
7 NOTE: INFORMATION TO BE COMPLETED: ☐ BY PURCHASER ☐ BY MANUFACTURER ☒ BY MFR IF NOT BY PURCHASER																																																																																																							
GENERAL																																																																																																							
9 CYCLE: ☐ REGEN ☐ SIMPLE ☐ EXHAUST HEAT RECOVERY TYPE: ☒ SINGLE SHAFT ☐ MULTI SHAFT																																																																																																							
10 DRIVEN EQUIPMENT POWER: NORMAL SHAFT _____ kW @ _____ r/min RATED SHAFT _____ kW @ _____ r/min _____																																																																																																							
11 OUTPUT SHAFT SPEED RANGE (4.1.5) ☒ MIN _____ r/min ☒ MAX _____ r/min																																																																																																							
☐ DESIRED MINIMUM SITE POWER _____ kW @ _____ r/min ☐ SEE BELOW kW																																																																																																							
13 OPERATION ☐ ATTENDED ☐ UNATTENDED ☐ POTENTIAL MAXIMUM POWER (3.41) _____ SEE BELOW kW																																																																																																							
14 NOTE: All Datasheets References to GG = Gas Generator, SS = Single Shaft and PT = Power Turbine																																																																																																							
PERFORMANCE		LOCATION (4.1.19)																																																																																																					
16 GAS TURBINE INCLUDING ALL LOSSES		☐ INDOOR ☐ OUTDOOR ☐ GRADE																																																																																																					
☐ INLET LOSSES _____ mmH₂O EXHAUST LOSSES _____ mmH₂O		☐ HEATED ☐ UNDER ROOF ☐ MEZZANINE																																																																																																					
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		ELECTRICAL AREA CLASSIFICATION (4.1.14) ☐ UNCLASSIFIED ☐ HAZARDOUS																																																																																																					
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		☐ THIRD PARTY CERTIFICATION REQUIRED																																																																																																					
		☐ WINTERIZATION REQD ☐ TROPICALIZATION REQD (5.4.6.6)																																																																																																					
		UNUSUAL CONDITIONS: ☐ DUST ☐ FUMES ☐ NORMAL / MAX DUST LOADING kg/Nm ² /hr _____ ☐ SNOW LOAD kg/m ² _____																																																																																																					
		NOISE LIMIT REQUIREMENTS: (4.1.10) ☐ GAS TURBINE ENCLOSURE (1) dBA ☐ PRESSURE ☐ POWER ☐ INLET SYSTEM (1) dBA ☐ PRESSURE ☐ POWER ☐ EXHAUST SYSTEM (1) dBA ☐ PRESSURE ☐ POWER																																																																																																					
APPLICABLE SPECIFICATIONS:		PAINTING:																																																																																																					
☐ API 616 GT FOR THE PETROLEUM, CHEMICAL, & GAS INDUSTRY SERVICES		☐ MANUFACTURER'S STANDARD																																																																																																					
☐ GOVERNING SPECIFICATION (IF DIFFERENT) _____		☐ MANUFACTURER'S STANDARD FOR MARINE ENVIRONMENT																																																																																																					
☐ VENDOR HAVING UNIT RESPONSIBILITY (4.1.2) _____		MISCELLANEOUS: ☐ BOLT THREADING (4.2.7.1)																																																																																																					
☐ OTHER _____		THREADED OPENINGS & BOSSES (4.4.3.4) ☐ ISO ☐ ASME																																																																																																					
SHIPMENT: (6.4) ☐ DOMESTIC ☐ EXPORT ☐ EXPORT BOXING REQUIRED		ISO 7-1: 1994 THREADS (4.4.3.4) ☐ TAPERED ☐ STRAIGHT																																																																																																					
☐ OUTDOOR STORAGE MORE THAN 6 MONTHS (6.4.1)		IRON FLANGES (4.4.5.1) ☐ ISO ☐ ASME																																																																																																					
SPARE ROTOR ASSEMBLY PACKAGED FOR (6.4.3.10)		MACHINED & STUDDED CONNECTIONS (4.4.6) ☐ ISO ☐ ASME																																																																																																					
☐ DOMESTIC SHIPMENT ☐ EXPORT SHIPMENT		☒ PURCHASER REVIEW OF CAMPBELL / GOODMAN (4.5.3.4)																																																																																																					
COMMENTS: (1) Refer to Project specification and GS EP MEC 300.		☐ LOW TEMPERATURE MATERIALS REQD (4.10.5.1)																																																																																																					
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Rev</th> <th>Status</th> <th>Date</th> <th>Wrt</th> <th>Verif</th> <th>App</th> <th>Rev</th> <th>Status</th> <th>Date</th> <th>Wrt</th> <th>Verif</th> <th>App</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>				Rev	Status	Date	Wrt	Verif	App	Rev	Status	Date	Wrt	Verif	App																																																																																								
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**Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616**

Rev.: 09

Effective date: 10/2012

Page: 77 of 89

Appendix 2

		PROJECT TITLE Title 1 Title 2	
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET SI UNITS		DS EP MEC 213	
		Document n°	Page 2 / 14

FUEL SYSTEM (5.8)				
TYPE ☐ GAS (5.8.2) ☐ LIQUID (5.8.3) ☐ DUAL (5.8.5.1)				
DUAL SYSTEM REQMTS (5.8.5.1) ☐ GAS/GAS ☐ LIQUID/GAS ☐ LIQUID/LIQUID				
☐ FUEL GAS COMPRESSION SYSTEM REQ'D [5.8.1.2.1.3 c)] ☐ MAXIMUM TIME ALLOWED TO COMPLETE TRANSFER _____ seconds				
GAS FUELS (5.8.2)			GAS FUEL SYSTEM AND COMPONENTS	
☐ HC DEW PT, °C@ kPa _____			☐ FUEL GAS BYPASS & VENT [5.8.1.2.1.3 d)] _____	
☐ FUEL ANALYSIS - MOL % (5.8.2.1)			☐ MANUAL ISOLATION VALVE MFR (5.8.1.2.2) _____	
COMPOSITION: M.W. NORMAL START-UP ALTERNATE			☐ SECONDARY VENT VALVE _____	
AIR 29 _____ _____ _____			☐ PRIMARY FAST SHUT OFF MFR (5.8.1.2.4) _____	
OXYGEN 32 _____ _____ _____			☐ LEAK TIGHT SHUT OFF MFR (5.8.1.2.4) _____	
NITROGEN 28 _____ _____ _____			☐ EXTERNAL SHUT OFF VALVE MFR (5.8.1.2.5) _____	
WATER VAPOR 18 _____ _____ _____			☐ DUAL Y-TYPE STRAINERS REQ'D (5.8.1.2.6.2) _____	
CARBONE MONOXIDE 28 _____ _____ _____			HEATER REQ'D (5.8.2.7) ☐ YES ☐ NO	
CARBONE DIOXIDE 44 _____ _____ _____			☐ MANUFACTURER _____	
HYDROGEN 2 _____ _____ _____			☐ REQ'D FUEL TEMP ABOVE DEW POINT _____	
METHANE 16 _____ _____ _____			☐ COALESCING FILTER (5.8.2.2.3) _____	
ETHYLENE 26 _____ _____ _____			☐ MANUFACTURER _____	
ETHANE 30 _____ _____ _____			☐ RATE OF CHANGE OF LHV (5.8.2.4.2) _____	
PROPYLENE 42 _____ _____ _____			FUEL ANALYZER EQUIPMENT:	
PROPANE 44 _____ _____ _____			☐ CALORIMETER	
I-BUTANE 58 _____ _____ _____			☐ GAS CHROMATOGRAPH	
N-BUTANE 58 _____ _____ _____			☐ WOBBE METER	
I-PENTANE 72 _____ _____ _____			☐ SUPPLY FILTRATION (5.8.1.2.6) _____	
N-PENTANE 72 _____ _____ _____				
HEXANE PLUS _____ _____ _____ _____				
TOTAL % 100.00 100.00 100.00			PIPING, TUBING & DESIGN DETAILS	
AVG. MOL. WT.			☐ PRESENCE OF HYDROGEN SULFIDE _____	
☐ LHV (5.8.2.4.1) MJ/Nm³ _____			☐ NACE MATERIAL STANDARDS (4.10.1.9) _____	
☐ REQ'D FUEL TEMP °C _____			☐ ANSI FLANGE RATING _____	
☐ WOBBE INDEX REQ'D _____			☐ PIPING / TUBING GRADE _____	
☐ FUEL PRESSURE: _____			☐ TUBE FITTING MANUFACTURER _____	
REQUIRED kPag _____			☐ MAXIMUM VENT BACKPRESSURE (5.8.1.2.8) _____ kPag	
"SHIP LOOSE" FUEL GAS SYSTEM COMPONENTS				
CONTAMINANTS (5.8.2.2.1)			☐ Y-TYPE STRAINERS _____	
☐ TAR PPM _____			☐ DUPLEX FUEL GAS FILTERS _____	
☐ CARBON BLACK PPM _____			☐ PIPING _____	
☐ COKE PPM _____			☐ HEATERS _____	
☐ SOLIDS PPM _____			☐ GAS ANALYSIS EQUIPMENT _____	
☐ NAPHTHALENE PPM _____				
☐ GAS HYDRATES PPM _____				
☐ _____ PPM _____				
CORROSIVE AGENTS (5.8.2.3.1)			REMARKS:	
☐ HYD. SULPHIDE PPM _____				
☐ SULPHUR DIOXIDE PPM _____				
☐ SULPHUR TRIOXIDE PPM _____				
☐ TOTAL SULPHUR PPM _____				
☐ ALKALI METALS PPM _____				
☐ CHLORIDES PPM _____				

SH. 2 OF 14

**Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616**

Rev.: 09

Effective date: 10/2012

Page: 78 of 89

Appendix 2

		PROJECT TITLE Title 1 Title 2	
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET SI UNITS		DS EP MEC 213	
		Document n°	Page 3 / 14

FUEL SYSTEM (5.8)			
TYPE ☐ GAS (5.8.2) ☐ LIQUID (5.8.3) ☐ DUAL (5.8.5.1)			
DUAL SYSTEM REQMTS (5.8.5.1) ☐ GAS/GAS ☐ LIQUID/GAS ☐ LIQUID/LIQUID			
☐ MAXIMUM TIME ALLOWED TO COMPLETE TRANSFER _____ seconds			
LIQUID FUEL SYSTEM (5.8.3)		LIQUID FUELS (5.8.4)	
FUEL GRADES (5.8.4.3)		LIQUID FUEL TREATMENT REQUIRED ☐ YES ☒ NO	
☐ ASTM D2880 GRADE (5.8.4.3.1)		TREATMENT SYSTEM BY ☐ VENDOR ☐ OTHER _____	
☐ GRADE 0-GT _____		HEATER REQUIRED (5.8.3.14) ☐ YES ☐ NO	
☐ GRADE 1-GT _____		☐ LIQUID FUEL PRESS REQUIRED, MAX/MIN, kPag _____	
☐ GRADE 2-GT _____		☐ FUEL ANALYSIS DATA (5.8.4.3) <u>ASTM</u> ☐ <u>MEASURED</u>	
☐ GRADE 3-GT _____		<u>PROPERTY</u> <u>METHOD</u> <u>VALUE</u>	
☐ GRADE 4-GT _____		VISCOSITY, cSt @ 38°C D-445 ☐ _____	
☐ ASTM D1655 (5.8.4.3.2)		DISTILLATION DATA D-86 _____	
☐ JET A OR JET A-1 _____		10% / 50% / 90% RECOVERY, °C MAX ☐ _____	
☐ JET B _____		END POINT, °C MAX ☐ _____	
☐ OTHER, INDICATE ANALYSIS (5.8.4.3.3) _____		SULFUR CONTENT %WEIGHT, MAX. (SELECT APPL METHOD)	
☐ ISOLATION VALVE LOCATION (5.8.3.2) _____		BOMB METHOD D-129 ☐ _____	
☐ FLOW CONTROL DEVICE (5.8.3.3) _____		LAMP METHOD D-1266 ☐ _____	
☐ SHUT-OFF VALVE (5.8.3.4) _____		HIGH-TEMP METHOD D-1552 ☐ _____	
☐ SPILL VALVE (5.8.3.4) _____		CARBON RESIDUE	
☐ DRAIN VALVE (5.8.3.6) _____		(ON 10% BOTTOMS) % WT. MAX. ☐ _____	
☐ FILTER / STRAINER (5.8.3.7) _____		CONRADSON D-189 ☐ _____	
☐ VALVE PROVING & POSITION MONITORING (5.8.3.8) _____		RAMSBOTTOM D-524 ☐ _____	
☐ THERMAL RELIEF VALVES (5.8.3.9) _____		COPPER STRIP CORROSION PLATE	
☐ MULTI FUEL SYSTEMS (5.8.3.10) _____		3 HOURS AT 100°C MAXIMUM D-130 ☐ _____	
☐ FUEL PURGING (5.8.3.11) _____		AROMATIC CONTENT % WT D-5186 ☐ _____	
☐ FUEL DRAINAGE (5.8.3.12) _____		ASH CONTENT D-482 ☐ _____	
☐ OTHER SYSTEM COMPONENTS (5.8.3.13) _____		SPECIFIC GRAVITY, kg/m3 @ 15°C D-4052 ☐ _____	
☐ FUEL TRANSFER EQUIP REQUIRED (5.8.3.15) _____		FLASH POINT, °C D-56 ☐ _____	
		CLOUD POINT, °C D-2500 ☐ _____	
		POUR POINT, °C D-97 ☐ _____	
		WATER D-95 ☐ _____	
		PARTICULATES, MG/100ML D-2276 ☐ _____	
		TRACE METALS (ATOMIC	
		ABSORPTION PREFERRED) D-3605 ☐ _____	
		SODIUM ☐ _____	
		POTASSIUM ☐ _____	
		VANADIUM ☐ _____	
		CALCIUM ☐ _____	
		LEAD ☐ _____	
		OTHER METALS ☐ _____	
		LOWER HEATING VALUE, MJ/kg D-2382 ☐ _____	
		REID VAPOR PRESSURE, Bar D-323 ☐ _____	
		OLEFIN CONTENT, % VOL D-1319 ☐ _____	
FUEL PUMP SYSTEM DETAILS			
☐ FUEL PUMP REQUIRED			
☐ RV AT PUMP DISCHARGE (YES/NO) _____			
☐ RV SET POINT bar _____			
☐ PUMP RATED CAPACITY l/min _____			
PIPING, TUBING & DESIGN DETAILS			
☐ PRESENCE OF HYDROGEN SULFIDE _____			
☐ NACE MATERIAL STANDARDS (4.10.1.9) _____			
☐ ANSI FLANGE RATING _____			
☐ PIPING / TUBING GRADE _____			
☐ TUBE FITTING MANUFACTURER _____			
REMARKS: _____			

SH. 3 OF 14

**Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616**

Rev.: 09

Effective date: 10/2012

Page: 79 of 89

Appendix 2

		PROJECT TITLE Title 1 Title 2	
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET SI UNITS		DS EP MEC 213	
		Document n°	Page 4 / 14

☐ SPEEDS: MAX. CONT. _____ r/min TRIP _____ r/min ☐ LATERAL CRITICAL SPEEDS (DAMPED) FIRST CRITICAL _____ r/min _____ r/min SECOND CRITICAL _____ r/min _____ r/min THIRD CRITICAL _____ r/min _____ r/min FOURTH CRITICAL _____ r/min _____ r/min ☐ PROTOTYPE OR MODIFIED ROTOR SUPPORT (4.7.1) ☒ TRAIN LATERAL ANALYSIS REQUIRED (4.7.2.6) ☒ TRAIN TORSIONAL ANALYSIS REQUIRED (4.7.3.1) ☐ TORSIONAL CRITICAL SPEEDS: FIRST CRITICAL _____ r/min SECOND CRITICAL _____ r/min THIRD CRITICAL _____ r/min FOURTH CRITICAL _____ r/min VIBRATION: (4.7.5.2.1) (4.7.5.3.1) [7.2.3.0]: ☐ ACCEPTANCE LIMITS: SHAFT _____ μm P-P CASE _____ mm/s ☐ ROTATION, VIEWED FROM DRIVE END ☐ CW ☐ CCW AIR COMPRESSOR: STAGES _____ MAXIMUM TIP SPEED _____ m/s TYPE _____ PRESSURE RATIO _____ CASING SPLIT (4.2.3) ☒ AXIAL ☐ RADIAL ROTOR ☐ SOLID ☐ BUILT UP TURBINE: STAGES _____ MAX. TIP SPEED _____ m/s CASING SPLIT (4.2.3) ☐ AXIAL ☐ RADIAL ROTOR ☐ SOLID ☐ BUILT UP COMBUSTORS: (4.3.2) ☐ DRY LOW EMISSIONS REQUIRED ☐ SINGLE ☐ MULTIPLE, NUMBER _____ ☐ GAS ☐ LIQUID ☐ DUAL FUEL ☐ FUEL NOZZLES PER COMBUSTOR _____ ☐ CONFIGURATION _____ ☐ MAXIMUM ALLOWABLE TEMP. VARIATION _____ °C APPLICABLE PLANE _____ ☐ WOBBE INDEX NO REQ'D (4.3.7) MJNm³ ☐ MAX ☐ MIN COMBUSTION SYSTEM DETAILS: REMARKS: 	MATERIALS OF CONSTRUCTION (4.10) COMPRESSOR ROTOR BLADES _____ COMPRESSOR STATOR VANES _____ COMPRESSOR BLADE/VANE COATING _____ GG SHAFT _____ PT SHAFT _____ GG COMPRESSOR CASING _____ GG HPT CASING _____ PT CASING _____ COMBUSTOR LINER _____ COMBUSTOR HEAT SHIELD _____ GG HP TURBINE (HPT) and POWER TURBINE (PT): <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <th>TURBINE STAGE</th> <th>NOZZLES</th> <th>BLADES</th> <th>DISKS or SHROUDS</th> </tr> <tr> <td>HPT-S1</td> <td></td> <td></td> <td></td> </tr> <tr> <td>HPT-S2</td> <td></td> <td></td> <td></td> </tr> <tr> <td>PT-S1</td> <td></td> <td></td> <td></td> </tr> <tr> <td>PT-S2</td> <td></td> <td></td> <td></td> </tr> </table> BALANCING: ☐ LOW SPEED BALANCING (4.7.4.2) ☐ HIGH SPEED BALANCING (4.7.4.3.1) ACCEPTANCE CRITERIA (4.7.4.3.2) ☐ GRADE 2.5 ☐ ISO 11342 ☐ 1.0 mm/s ☐ LOW SPEED RESIDUAL BALANCE CHECK (4.7.4.3.4) MAINTENANCE INTERVALS, HOURS / DURATION, HOURS ☐ BORESCOPE INSP. _____ / ☐ HOT SECTION OVERHAUL _____ / ☐ MAJOR OVERHAULS _____ / REMARKS: 	TURBINE STAGE	NOZZLES	BLADES	DISKS or SHROUDS	HPT-S1				HPT-S2				PT-S1				PT-S2			
TURBINE STAGE	NOZZLES	BLADES	DISKS or SHROUDS																		
HPT-S1																					
HPT-S2																					
PT-S1																					
PT-S2																					

FOR MULTIPLE SHAFT TURBINES PROVIDE DATA FOR EACH SHAFT

SH. 4 OF 14

**Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616**

Rev.: 09

Effective date: 10/2012

Page: 81 of 89

Appendix 2

		PROJECT TITLE Title 1 Title 2	
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET SI UNITS		DS EP MEC 213	
		Document n°	Page 6 / 14

POWER TURBINE - CONSTRUCTION FEATURES					
BEARINGS AND BEARING HOUSINGS (4.8)					
RADIAL BEARINGS		DE	NDE	THRUST	ACTIVE
		BRG No.	BRG No.		DE/NDE
					DENDE
☐ TYPE				☐ TYPE	
☐ MANUFACTURER				☐ MANUFACTURER	
☐ SHAFT DIAMETER mm				☐ SHAFT DIAMETER mm	
☐ BEARING LENGTH mm				☐ BEARING SIZE mm	
☐ AREA, mm ²				☐ AREA, mm ²	
☐ UNIT LOAD (ACT/ALLOW) N/mm ²				☐ UNIT LOAD (ACT/ALLOW) N/mm ²	
☐ BASE MATERIAL				☐ BASE MATERIAL	
☐ BABBITT THICKNESS mm				☐ BABBITT THICKNESS mm	
☐ NO. PADS				☐ NO. PADS	
☐ LOAD: BETWEEN/ON PAD				☐ PIVOT: CENTER/OFFSET %	
☐ PIVOT: CENTER/OFFSET %				LUBRICATION: ☐ FLOODED ☐ DIRECTED	
☐ BEARING SPAN (BETWEEN BRG No.X and No.Y) mm				THRUST COLLAR: ☐ INTEGRAL ☐ REPLACEABLE	
☐ DAMPER BEARING					
BEARING TEMPERATURE SENSORS (4.8.5.5)			PROXIMITY PROBES (4.8.5.3)		
☐ SEE ATTACHED API-670 DATASHEETS			☐ SEE ATTACHED API-670 DATASHEETS		
☐ THERMOCOUPLES			☐ TYPE _____ ☐ MODEL _____		
☐ SELECTOR SWITCH & IND. BY: _____ PURCH _____ MFR _____			☐ MFR _____		
☐ RESISTANCE TEMPERATURE DETECTORS			☐ NO. AT EACH SHAFT BEARING _____ TOTAL NO. _____		
☐ RESISTANCE MATL. _____ OHMS			☐ OSCILLATOR-DEMODULATOR SUPPLIED BY _____		
☐ SELECTOR SWITCH & IND. BY: _____ PURCH _____ MFR _____			☐ MFR _____ ☐ MODEL _____		
☐ LOCATION-JOURNAL BEARING			☐ MONITOR SUPPLIED BY (5.4.7.8.2) _____		
NUMBER _____ EA PD _____ EVERY OTH PAD _____ PER BRG _____			☐ LOCATION _____ ENCLOSURE _____		
OTHER _____			☐ MFR _____ MODEL _____		
☐ LOCATION-THRUST BEARING			☐ SCALE RGE _____ ☐ ALARM SET @ _____ µm		
NO. (ACT) _____ EA PD _____ EVERY OTH PAD _____ PER BRG _____			☐ SHUTDOWN ☐ SET @ _____ µm ☐ TIME DELAY _____ seconds		
OTHER _____					
NO. (INACT) _____ EA PD _____ EVERY OTH PAD _____ PER BRG _____					
OTHER _____					
☐ MONITOR SUPPLIED BY (5.4.7.5) _____					
☐ LOCATION _____ ENCLOSURE _____					
☐ MFR _____ ☐ MODEL _____					
☐ SCALE RANGE _____ ☐ ALARM SET @ _____ °C					
☐ SHUTDOWN ☐ SET @ _____ °C ☐ TIME DELAY _____ seconds					
CASING AND /OR ROLLING ELEMENT VIBRATION TRANSDUCERS (5.4.7.8)					
☐ SEE ATTACHED API-670 DATA SHEETS					
☐ CASING VIBRATION (5.4.7.8.3) ☐ ROLLING ELEMENT VIB. (5.4.7.8.5)					
☐ MFR _____ ☐ MODEL _____					
☐ LOCATION _____ ☐ NUMBER _____					
☐ MONITOR SUPPLIED BY (5.4.7.8.4) _____					
☐ MONITOR SUPPLIED BY (5.4.7.8.6) _____					
☐ LOCATION _____ ENCLOSURE _____					
☐ MFR _____ ☐ MODEL _____					
☐ SCALE RGE _____ ☐ ALARM SET @ _____ mm/s					
☐ SHUTDOWN ☐ SET @ _____ mm/s ☐ TIME DELAY _____ seconds					
REMARKS:					

SH. 6 OF 14

**Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616**

Rev.: 09

Effective date: 10/2012

Page: 83 of 89

Appendix 2

		PROJECT TITLE									
		Title 1 _____ Title 2 _____									
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET S I UNITS		DS EP MEC 213									
		Document n° _____								Page 8 / 14	
		INSTRUMENTS									
INSTRUMENTATION & INSTALLATION: (5.4.1.1.) ☐ API 614/ISO 10438 ☐ _____ ☐ INSTRUMENTATION MOUNTING (5.4.4.7) ☐ OPTIONAL ALARM & SHUTDOWN POINT (5.4.4.7) SEE ADD. SHEET		INSTRUMENT TYPE		INSTRUMENT LOCATION			TRANS- MITTERS FURNISHED BY		CONTROL ROOM RECEIVERS FURN BY		
DESCRIPTION		INDICATING	RECORDING	LOCAL	LOCAL PANEL	CONTROL ROOM	VENDOR	OTHERS	VENDOR	OTHERS	
GAS GENERATOR OR SINGLE SHAFT GAS TURBINE											
TACHOMETER(S)		●	●	●	○	●	●	○	●	○	
Δ P AIR INLET SYSTEM		●	●	●	○	○	●	○	●	○	
COMPRESSOR DISCHARGE PRESSURE		●	●	●	○	○	●	○	●	○	
FUEL FILTER Δ P		●	○	●	○	○	●	○	●	○	
FUEL SUPPLY PRESSURE		●	●	●	○	○	●	○	●	○	
STARTING GAS SUPPLY PRESSURE		○	○	○	○	○	○	○	○	○	
STARTING GAS EXHAUST PRESSURE		○	○	○	○	○	○	○	○	○	
TEMP COMBUSTOR MEASUREMENT (6 PTS MIN) (4.3.2)		●	●	●	○	○	○	○	○	○	
TEMP GAS TURB CONTROL PLANE (6 PTS MIN)		●	○	●	○	○	●	○	●	○	
INLET AIR TEMPERATURE		●	●	●	○	○	●	○	●	○	
TEMPERATURE, GG COMPRESSOR DISCHARGE		●	●	●	○	○	●	○	●	○	
TEMPERATURE, THRUST BEARING OIL DRAIN		○	○	○	○	○	○	○	○	○	
TEMPERATURE, EACH BEARING SUMP (ROLLING ELEMENT TYPE)		○	○	○	○	○	○	○	○	○	
TEMPERATURE, FUEL MANIFOLD		●	●	●	○	○	●	○	●	○	
TEMPERATURE, LUBE OIL RESERVOIR		●	●	●	○	○	●	○	●	○	
FIRED HOUR METER		●	●	○	○	●	●	○	●	○	
A) NUMBER STARTS COUNTER		●	●	○	○	●	●	○	●	○	
B) START SEQUENCE TIMER		●	○	○	○	●	●	○	●	○	
LUBE OIL RESERVOIR LEVEL		●	○	●	○	○	●	○	●	○	
LUBE OIL PUMP PRESSURE INDICATORS (NO. 2)		●	○	●	○	○	●	○	●	○	
LUBE OIL COOLER OIL INLET TEMPERATURE		●	○	●	○	○	●	○	●	○	
LUBE OIL COOLER OIL OUTLET TEMPERATURE		●	○	●	○	○	●	○	●	○	
LUBE OIL COOLER COOLANT INLET TEMPERATURE		○	○	○	○	○	○	○	○	○	
LUBE OIL COOLER COOLANT OUTLET TEMPERATURE		○	○	○	○	○	○	○	○	○	
LUBE OIL FILTER Δ P		●	●	●	○	○	●	○	●	○	
LUBE OIL PRESSURE EACH LEVEL (NO. 1)		●	●	○	○	●	●	○	●	○	
CONTROL OIL PRESSURE		○	○	○	○	○	○	○	○	○	
SITE FLOW INDICATOR EACH DRAIN (NO.)		○	○	○	○	○	○	○	○	○	
INLET GUIDE VANE POSITION INDICATOR		○	○	○	○	○	○	○	○	○	
EXHAUST DUCT DIFFERENTIAL PRESSURE INDICATOR		○	○	○	○	○	○	○	○	○	
ENCLOSURE COOLING AIR EXHAUST TEMPERATURE		○	○	○	○	○	○	○	○	○	
POWER TURBINE											
TACHOMETER(S) (NO. 1)		●	●	●	○	○	●	○	●	○	
EXHAUST TEMPERATURE (2 POINTS MIN)		●	●	●	○	○	●	○	●	○	
JOURNAL BEARING TEMPERATURE		●	●	●	○	○	●	○	●	○	
THRUST BEARING TEMPERATURE		○	○	○	○	○	○	○	○	○	
BEARING DRAIN TEMPERATURE		○	○	○	○	○	○	○	○	○	
SITE FLOW INDICATOR EACH DRAIN (NO. Common)		○	○	○	○	○	○	○	○	○	
LUBE OIL INLET PRESSURE		●	●	●	○	○	●	○	●	○	
LUBE OIL INLET TEMPERATURE		●	●	●	○	○	●	○	●	○	

SH. 8 OF 14

**Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616**

Rev.: 09

Effective date: 10/2012

Page: 84 of 89

Appendix 2

		PROJECT TITLE		Title 1		Title 2		
		DS EP MEC 213						
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET SI UNITS		Document n°						Page
								9 / 14
ALARMS AND SHUTDOWNS (5.4.4)								
DESCRIPTION		APPLIES TO:		(5.4.4.8.5) FIRST OUT ANNUNCIATED POINT IN VENDOR FURNISHED CONTROL PANEL (1)		SENSING DEVICES TO BE FURNISHED BY VENDOR		INDICATING LIGHT ONLY (2)
		SS OR GG	SEP PT	ALARM	SHUT- DOWN	VENDOR	OTHERS	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
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45								
46								
47								
NOTES:		(1) VENDOR TO ADVISE METHOD OF ANNUNCIATION		GAUGE BOARD:				
		(2) VDU MAY USE MESSAGE INDICATOR		☐ LOCATION _____				
SH. 9 OF 14								

**Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616**

Rev.: 09

Effective date: 10/2012

Page: 85 of 89

Appendix 2

		PROJECT TITLE Title 1 Title 2	
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET SI UNITS		DS EP MEC 213	
		Document n°	Page 10 / 14

ACCESSORIES SUPPLIED BY GAS TURBINE MANUFACTURER			
STARTING AND HELPER DRIVERS (5.1.1)		☐ GEARS: SEE SEPARATE API 613 GEAR DATA SHEETS (5.2.1.1) ☐ DRIVEN EQUIPMENT, SEE SEPARATE API DATASHEETS ☐ FIRE PROTECTION EQUIPMENT (5.7.3.1) (2) ☐ TYPE ☐ WATER MIST ☐ CO ₂ ☐ TYPE OF SENSOR ☐ NUMBER OF DETECTORS ☐ ULTRA VIOLET NUMBER _____ ☐ INFRA RED NUMBER _____ ☐ HEAT RISE NUMBER _____ ☐ ADDITIONAL LEVELS OF DETECTION (5.7.3.3)	
☐ STARTER ONLY ☐ STARTER/HELPER (5.1.1.1) TYPE (5.1.1.4) ☐ MOTOR ☐ API 541 ☐ API 546 ☐ IEC 60034-1 ☐ GAS EXPANDER ☐ IC ENGINE ☐ HYDRAULIC ☐ GASTURBINE ☐ STARTER IS CLUTCHED (5.1.1.7) ☐ HELPER RATING (5.1.2.2) _____ kW ☐ STARTER RATING (5.1.2.1) _____ kW ☐ SHAFT TURNING DEVICE REQUIRED (5.1.3.1)			
☐ MOTOR (STARTER ONLY): TYPE _____ RATING _____ kW MFR _____ MODEL _____ ☐ REDUCED VOLTAGE STARTING (%) (5.1.1.5) _____			
☐ MOTOR (STARTER /HELPER): TYPE _____ RATING _____ kW MFR _____ MODEL _____ ☐ REDUCED VOLTAGE STARTING (%) (5.1.1.5) _____			
☐ GAS EXPANDER APPLICABLE SPEC. (5.1.1.6) _____ MFR _____ MODEL _____ kW _____ MAX. GAS FLOW _____ kg/hr TOTAL/START _____ kg ☐ GAS FOR EXPANSION TURBINE: MIN MAX NORMAL INLET PRESSURE, barA _____ EXHAUST PRESS, barA _____ GAS TEMPERATURE, °C INLET _____ GAS TEMPERATURE, °C EXHAUST _____ MOLECULAR WEIGHT _____ SPEED CONTROL ☐ GOVERNOR ☐ PRESSURE REGULATOR DESIGN DETAILS: YES NO INLET CONTROL VALVE FURNISHED _____ STAINLESS STEEL PIPING MANIFOLD _____ CARBON STEEL FLANGES _____ Y-STRAINER W/BREAKOUT FLANGES _____ LOW SPEED CAPABILITY _____ (FOR COMPRESSOR CLEANING) _____ RELIEF VALVE PRESSURE SET POINT _____ barG CASING MATERIAL _____ SEAL TYPE _____			
☐ INTERNAL COMBUSTION ENGINE TYPE ☐ SPARK IGNITED ☐ DIESEL APPLICABLE SPECIFICATION (5.1.1.6) _____ MANUFACTURER _____ MODEL _____ SPEED _____ r/min POWER _____ kW			
☐ STEAM TURBINE (REFERENCE API DATA SHEETS) MFR _____ MODEL _____ kW _____ MAX. STEAM FLOW _____ kg/hr TOTAL FLOW/START _____ kg			

MOUNTING PLATES (5.3)	
☐ TYPE (5.3.1.1) ☐ SOLEPLATE ☐ BASEPLATE ☐ SHIM PACK THICKNESS _____ mm	
BASEPLATE (5.3.2)	
☐ EQUIPMENT MOUNTED ON BASEPLATE _____ (5.3.2.1) ☐ GAS TURBINE, COMPRESSOR SKID(S), ACCESSORY SKID ☐ SOLEPLATES REQUIRED (5.3.3.1) ☐ DRIP RIM REQUIRED ☐ SUB-SOLEPLATES REQUIRED (5.3.3.1) ☐ LEVELLING PADS (5.3.2.3) ☐ COLUMN MOUNTING (5.3.2.4) (3-POINT)	
ENCLOSURES (5.7.5)	
☐ ENCLOSURE REQUIRED ☐ MATERIAL _____ ☐ ACOUSTICAL _____ ☐ WEATHERPROOF ☐ SAFETY ☐ FIREPROTECTION ☒ ADDITIONAL VENTILATION DUCTING (5.7.5.6.3) (1) _____	
COUPLINGS AND GUARDS (5.2.2)	
☐ SEE ATTACHED API-671 COUPLING DATASHEETS ☐ COUPLINGS PER ISO 10441 (5.2.2.4) ☐ MFR _____ ☐ TYPE _____ ☐ MODEL _____ ☐ GUARD SUPPLIED BY _____ ☐ MAXIMUM OUTSIDE DIAMETER _____ mm ☐ HUB WEIGHT _____ kg ☐ SPACER LENGTH _____ mm ☐ SPACER WEIGHT _____ kg ☐ IDLING ADAPTER REQUIRED ☐ SOLE PLATE REQUIRED ☐ GUARD SUPPLIED BY _____ TYPE: ☐ FULLY ENCLOSED ☐ SEMI-OPEN ☐ OTHER _____ LUBRICATING REQUIREMENTS: ☐ NON-LUBE ☐ GREASE ☐ CONTINUOUS OIL LUBE QUANTITY PER HUB _____ kg or m ³ /hr	
REMARKS: (1) For ventilation arrangement, refer to GS EP MEC 010, GS EP MEC 020 or GS EP MEC 030 as applicable. (2) Refer to GS EP MEC 050.	

SH. 10 OF 14

**Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616**

Rev.: 09

Effective date: 10/2012

Page: 88 of 89

Appendix 2

		PROJECT TITLE Title 1 Title 2	
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET SI UNITS		DS EP MEC 213	
		Document n°	Page 13 / 14

INSPECTION AND TESTING; CONTROLS AND INSTRUMENTATION					
1		REQ	WIT	OBS	MATERIALS INSPECTION REQUIREMENTS (6.2.1.3) ☐ ALTERNATE INSPECTION PROCEDURES (6.2.2.1.1) SPECIFY _____ ☐ SPECIAL CHARPY TESTING (4.10.5.3) _____ ☐ RADIOGRAPHY REQUIRED FOR _____ ☐ MAGNETIC PARTICLE REQUIRED FOR _____ ☐ LIQUID PENETRANT REQUIRED FOR _____ ☐ ULTRASONIC REQUIRED FOR _____ ☐ QUALITY CONTROL OF INACCESSIBLE WELDS (4.10.4.6.2) _____ ☐ 100% INSPECTION OF WELDS (4.10.4.7.1) _____ ☐ INSPECTION PRIOR TO CLOSING OPENINGS (6.2.3.3) _____ ☐ WELDING HARDNESS TESTING (6.2.3.4) _____ ☐ POSITIVE MATERIAL IDENTIFICATION (4.10.1.14.1) ATTACH LIST _____ ☐ ADDITIONAL COMPONENTS FOR PMI (4.10.1.14.2) ATTACH LIST _____
2	SHOP INSPECTION AND TESTS: (6.1.1)				
3	SHOP INSPECTION (6.1.2)	☒			
4	CLEANLINESS (6.2.3.1)	☒	☐		
5	HYDROSTATIC (6.3.2)	☒	☐	☐	
6	PNEUMATIC (6.3.3)	☒	☒	☐	
7	MECHANICAL RUN (6.3.4)	☒	☒	☐	
8	AUXILIARY SYSTEMS (6.3.4.1.6) SPECIFY	☒	☒	☐	
9	☒ CONTRACT CPLG ☐ IDLING ADAPTOR(S)				
10	VIB. PROBES ☒ CONTRACT ☐ SHOP				
11	VIBRATION PLOTS (6.3.4.3.4)	☒			
12	TAPE RECORD VIB DATA (6.3.4.3.6)	☒			
13	SPARE ROTOR (6.3.5.1.4.2)	☒	☒	☐	
14	PERFORMANCE TEST (6.3.5.1) 4 hours	☒	☒	☐	
15	COMPLETE UNIT TEST (6.3.5.2)	☒	☒	☐	
16	PACKAGE TEST (6.3.5.2.1)	☒	☒	☐	
17	TORSIONAL VIBRATION (6.3.5.2.2)	☐	☐	☐	
18	LOAD GEAR TEST (6.3.5.3)	☒	☒	☐	
19	SOUND LEVEL TEST (6.3.5.4)	☒	☒	☐	
20	ROTOR OVERSPEED (6.3.5.5)	☐	☐	☐	
21	AUXILIARY EQUIPMENT (6.3.5.6)	☒	☒	☐	
22	VENTILATION SYSTEM VALIDATION (6.3.5.7)	☒	☒	☐	
23	ENCLOSURE LEAK TEST (6.3.5.8)	☐	☐	☐	
24	POST TEST INSPECTION (6.3.5.9)	☐	☐	☐	
25	HYDRAULIC COUPLING INSP (6.3.5.10)	☐	☐	☐	
26	GOVERNOR RESPONSE TEST (6.3.5.11)	☒	☒	☐	
27	SPARE PARTS (6.3.5.12)	☒	☒	☐	
28	FIRE PROTECTION (6.3.5.13)	☒	☒	☐	
29	UNIT CONTROL PANEL F.A.T.	☒	☒	☐	
30	OTHER (6.3.5.14)	☐	☐	☐	
31	GT FIELD PERFORMANCE TEST (6.3.6)	☒	☒	☐	
32	FIT UP & ASSEMBLY OF COMPONENTS (6.4.9)	☐	☐	☐	
33					
34					
35					
36					
CONTROL SYSTEMS					
37	TYPE (5.4.1.8): ☒ MECH ☐ PNEU ☐ HYDRAULIC ☐ ELECTRIC ☐ ELECTRONIC ☐ MICROPROCESSOR BASED ☐ COMBINED ☐ MONITORS PER API 670: ☐ 5.4.7.5 ☐ 5.4.7.8.2 ☐ 5.4.7.8.4 ☐ SIGNAL SOURCE _____ ☐ SENSITIVITY _____ RANGE _____ TO _____ ☐ TIME OF AC OUTAGE PROTECTION (5.4.1.9) _____ MINUTES				
38					
39					
40					
41					
42					
43					
44					
45	CONTROL CONSOLES (5.4.5.1.1) ☐ ON-SKID ☐ OFF SKID LOCAL ☐ OFF SKID REMOTE WEATHER PROTECTION REQUIRED ☐ YES ☐ NO ☒ HUMAN MACHINE INTERFACE ☒ KEYBOARD				
46					
47					
48					
49					
50	STARTING SYSTEM (5.4.2.1) ☐ MANUAL ☐ SEMI-AUTOMATIC ☐ AUTOMATIC ☐ PURGE (5.4.2.2) _____ MINUTES ☐ SEPARATE SHUTDOWN VALVE TEST DURING OPERATION				
51					
52					
53					

SPECIALIZED INSTRUMENTS AND CONTROLS	
TACHOMETERS: (5.4.7.2.2) TYPE ☐ ELECTRICAL ☐ ELECTRONIC ☐ ANALOG ☐ DIGITAL ☐ MANUFACTURER _____ ☒ GLYCERIN-FILLED PRESSURE GAUGES (5.4.7.6) CONTROL WIRING (5.4.5.3.2): ☐ ARMORED ☐ METAL CONDUIT SWITCHES: (5.4.4.8.2) CIRCUIT SHALL: ☐ ENERGIZE ☐ DEENERGIZE TO ALARM ☐ ENERGIZE ☐ DEENERGIZE TO SHUTDOWN INSTRUMENT / ELECTRICAL ENCLOSURES ☐ EXPLOSION PROOF ☐ WEATHER PROOF CONTROL / INSTRUMENT WIRING (5.4.5.3.2) ☐ ARM. CABLE ☐ CONDUIT CONTROL SYSTEM DETAILS: ☐ ALARM & SHUTDOWN ARRANGEMENTS (5.4.4.8) ☐ ALARM & SHUTDOWN SWITCHES (5.4.4.8.1) ☐ FIRST-OUT ANNUNCIATOR REQ'D (5.4.4.8.5) ☐ PURGE FIRST-OUT ANNUNCIATOR REQ'D [5.4.4.8.5 b)] ☐ SHUT OFF VALVES FOR SHUT DOWN SENSORS (5.4.4.9) ☐ SHUTDOWN DEVICE ISOLATION LOCKOUT (5.4.4.10)	
LOAD CONTROL - GOVERNOR (5.4.3)	
☐ MFR'S STD. ☐ OTHER ☐ MAKE _____ ☐ MODEL _____ ☐ CONSTANT SPEED ☐ VARIABLE SPEED ☐ ISOCHRONOUS ☐ DROOP REMOTE SHUTDOWN SIGNAL, SPECIFY TYPE: _____ ☐ CONTROL SIGNAL RANGE (5.4.3.3) _____ MANUAL SPEED CHANGER, r/min _____ MAX. _____ MIN. ☐ MAINTAIN TURBINE SPEED UPON FAILURE OF CONTROL SIGNAL OR ACTUATOR _____	

SH. 13 OF 14

**Gas Turbines for the Petroleum, Chemical and Gas Industry
Services according to API Standard 616**

Rev.: 09

Effective date: 10/2012

Page: 89 of 89

Appendix 2

		PROJECT TITLE Title 1 Title 2	
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET SI UNITS		DS EP MEC 213	
		Document n°	Page 14 / 14
LUBRICATION, WEIGHTS & VENDOR DATA			
1	☐ WEIGHTS	DRY INSTALLED	SHIPPING
2		(kg)	(kg)
3			
4	GAS GENERATOR		
5	POWER TURBINE		
6	GT ENCLOSURE		
7	INLET FILTER HOUSE		
8	INLET AIR DUCTING		
9	VENT DUCTING		
10	EXHAUST DUCTING		
11	EXHAUST STACK		
12	MIN OIL CONSOLE		
13	SYN OIL CONSOLE		
14	MIN OIL SEPARATOR		
15	SYN OIL SEPARATOR		
16	MIN OIL AIR COOLER		
17	SYN OIL AIR COOLER		
18	HYD START SKID		
19	CO2 CYLINDER SKID		
20	WATER WASH SKID		
21	TOTAL PACKAGE WT		
22	MAX ERECTION WT		ITEM
23	MAX MAINT WT		ITEM
24			
COMBUSTION GAS TURBINE (API 616-5TH) DATASHEET SI UNITS LUBRICATION SYSTEMS (4.9) ☐ API 614 DATASHEETS ☐ MINERAL LUBE SYSTEM (4.9.5) ☐ OIL VISCOSITY COMMON TO ☒ GAS GENERATOR or SINGLE SHAFT GT ☒ FREE POWER TURBINE ☒ LOAD GEAR ☒ DRIVEN EQUIPMENT ☒ AUXILIARIES ☐ SYNTHETIC LUBE OIL SYSTEM (4.9.2) ☐ LUBE SPECIFICATION COMMON TO ☒ GAS GENERATOR ☒ POWER TURBINE ☒ LOAD GEAR ☒ DRIVEN EQUIPMENT ☒ AUXILIARIES ☒ ☐ OIL DEBRIS MONITORING ☐ OIL REQUIREMENTS FLOW (m³/hr) PRESSURE (barG) HEAT LOAD (kW) GAS GENERATOR POWER TURBINE HYD START SYSTEM MINERAL OIL RESERVOIR CAPACITY _____ liters SYNTHETIC OIL RESERVOIR CAPACITY _____ liters HYDRAULIC OIL RESERVOIR CAPACITY _____ liters HYDRAULIC OIL SPECIFICATION MOUNTING ARRANGEMENT ☐ CONSOLE ☐ COLUMN ☐ BASEPLATE			
25	VENDOR'S DATA:		
26	☒ COORDINATION MEETING SITE (7.1.3)		
27	☒ SPARE PARTS OPTIMIZATION ANALYSIS (7.2.3 v)		
28	☒ FAILURE MODES AND EFFECTS ANALYSIS (7.2.3 w)		
29	☒ LIFE CYCLE COST ANALYSIS (7.2.3 x)		
30	PERFORMANCE CURVES (7.2.4)		
31	☒ SPEED-TORQUE CURVE OF OUTPUT SHAFT (7.2.4 a)		
32	☐ INCREMENTAL POWER FOR STEAM/WATER (7.2.4 b)		
33	☒ EFFECTS OF AMB. COND. ON EXHAUST FLOW (7.2.4 c)		
34	☒ RUN DOWN CURVES (7.2.4 d)		
35	☒ NOX AND CO2 EMISSIONS (7.2.4 e)		
36	☐ IMPACT OF ANTHICING SYSTEM (7.2.4 f)		
37	☒ PROGRESS REPORTS (7.3.4)		
38	☒ TECHNICAL DATA MANUAL (7.3.6.4)		
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42	REMARKS:		
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SH. 14 OF 14