



Exploration & Production

GENERAL SPECIFICATION

ROTATING MACHINERY

GS MEC 212

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

02	10/04	Rewriting
01	08/03	Change of Group name and logo
00	10/02	First issue
Rev.	Date	Notes



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1. Scope

This specification clarifies how to use the recommendations of [API 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 616](#) standard fourth edition, August 1998.

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

The paragraph numbering is identified in the same way as in [API 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 616](#) shown with a bullet.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
API Standard 616	Gas Turbines for the Petroleum, Chemical, and Gas Industry Services

Professional Documents

Reference	Title
	Refer to Referenced Standards as listed in API 616 , § 2.1.

Regulations

Reference	Title
94/9/EC (ATEX 100a¹/ATEX 95²)	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
1999/92/EEC (ATEX 118¹/ATEX 137²)	European Directive 1999/92/EEC (16/12/99) on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres

¹ Reference to Articles 100/118 of the Treaty of Rome

² Reference to Articles 95/137 of the Treaty of Amsterdam



Codes

Reference	Title
	Refer to Referenced Standards as listed in API 616 , § 2.1.

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
DS MEC 212	Gas Turbine as per API 616 , data sheet
GS MEC 101	Power margin
GS MEC 291	Rotating Machines Packages
GS MEC 281	Lubrication, Shaft Sealing, And Control Oil Systems For Special-Purpose Applications According to API Standard 614
GS MEC 290	Rotating machines packages
GS STR 103	Design and fabrication of skids and equipment supporting structures
GS SAF 222	Safety rules for machinery and equipment handling hydrocarbon in enclosed areas

3. Comments to [API 616](#)

API	GS
1. Scope	
1.1 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 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 measures that must be taken to comply with governmental codes, regulations, ordinances, or rules that are applicable to the equipment.	The PURCHASER will inform the VENDOR about all known local demands. It is the responsibility of the VENDOR to comply with these demands.
3. Definitions	
3.14 Inlet volume flow The 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.
3.17 ISO-rated power The 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): Inlet temperature 15°C (59°F) Inlet (total) pressure 1.0133 bar (14.696 psia) Inlet relative humidity 60 percent	

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Exhaust (static) pressure 1.0133 bar (14.969 psia) This power and speed are measured at the output shaft of the gas turbine ahead of any separated gear or piece of driven equipment, except for the power output of electric generator drives. Rated power for electric generator drives shall be measured at the electrical output terminals of the generator. The inlet conditions shall be measured at the exhaust flange. These measuring locations shall be used for all power and gas flow measurements. The ISO rating provided only general sizing information and should not be confused with site rated power.	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.
3.39 Relief value set pressure	Relief valve set pressure
3.44 Site rated firing temperature The 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.
3.45 Site rated power The 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 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 will indicate what will 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, generator efficiency (if

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	applicable) shall be detailed and included in calculations.
3.46 Standard flow The flow rate expressed in volume flow units at standard conditions as follows: a. ISO Standard Conditions: Flow: Cubic meter per hour (m ³ /h) Cubic meter per minute (m ³ /min) Pressure: 1.013 bar Temperature: °C b. U.S. Standard Conditions: Flow: Standard cubic feet per minute (scfm) Million standard cubic feet per day (mmscfd) Pressure: 14.7 psi Temperature: 60°F	Temperature at ISO standard conditions is 15°C.
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 3 years of uninterrupted operation. It is recognized that this is a design criterion and that hot section inspections may be required; however, the required time between inspections shall be no less than 8,000 operating hours.	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 equipment's normal operating point on the data sheets (see 3.26).	This paragraph is applicable.
4.1.5 The output-shaft operating speed range of gas turbine units for mechanical-drive applications shall be as specified on the data sheets. Where only one operating speed is specified for an application, the speed range	This paragraph is applicable.

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for single shaft machines shall be 25 percent (from 80 to 105 percent of rated speed), and the speed range for two or more shaft machines shall be 55 percent (from 50 to 105 percent of rated speed).	
4.1.7 The turbine design shall accommodate transient thermal gradients following tripouts and shall permit immediate restarting subject to the driven equipment restrictions. 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, 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. 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 and site operating conditions. The gas turbine VENDOR shall supply, if required, the turbine combustion emission suppression system to meet the specified levels of NOx, CO, and unburned hydrocarbons in the turbine's exhaust gas.	(Modification of first paragraph) The PURCHASER will 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 Company policy and local legislation. This paragraph is applicable.
● 4.1.9 When 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 (for example, 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.	Refer to job specification and job datasheet.
● 4.1.10 Control of the sound pressure level (SPL) of all equipment furnished shall be a	Refer to job specification and job datasheet.

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joint effort of the PURCHASER and the VENDOR. The equipment furnished by the VENDOR shall conform to the maximum allowable sound pressure level specified by the PURCHASER. 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.																															
4.1.11 A cooling water system or systems shall be designed for the following conditions: <table><tr><td>Water velocity over heat, exchange surfaces</td><td>1.5-2.5 m/s</td><td>5-8 ft/s</td></tr><tr><td>Maximum Allowable Working pressure</td><td>>=7 bar (Note 2)</td><td>>=100psig</td></tr><tr><td>Hydrotest pressure (1.5 x MAWP)</td><td>>=10.4 bar</td><td>>=150psig</td></tr><tr><td>Maximum pressure drop</td><td>1 bar</td><td>15 psi</td></tr><tr><td>Maximum inlet temperature</td><td>30°C</td><td>90°C</td></tr><tr><td>Maximum outlet temperature</td><td>50°C</td><td>120°F</td></tr><tr><td>Maximum temperature rise</td><td>20°K</td><td>30°F</td></tr><tr><td>Minimum temperature rise</td><td>10°K</td><td>20°F</td></tr><tr><td>Fouling factor on water side</td><td>0.35 m³K/Kw</td><td>0.002 hr-ft²-F/Btu</td></tr><tr><td>Water side corrosion allowance</td><td>3 mm</td><td>1/8in</td></tr></table> Provision shall be made for complete venting and draining of the system. Note 1: 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 2: Gauge pressure.	Water velocity over heat, exchange surfaces	1.5-2.5 m/s	5-8 ft/s	Maximum Allowable Working pressure	>=7 bar (Note 2)	>=100psig	Hydrotest pressure (1.5 x MAWP)	>=10.4 bar	>=150psig	Maximum pressure drop	1 bar	15 psi	Maximum inlet temperature	30°C	90°C	Maximum outlet temperature	50°C	120°F	Maximum temperature rise	20°K	30°F	Minimum temperature rise	10°K	20°F	Fouling factor on water side	0.35 m ³ K/Kw	0.002 hr-ft ² -F/Btu	Water side corrosion allowance	3 mm	1/8in	When cooling water is not available, direct lube oil air cooling system only shall be considered.
Water velocity over heat, exchange surfaces	1.5-2.5 m/s	5-8 ft/s																													
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● 4.1.14 Motors, electrical components, and electrical installations shall be suitable for the area classification specified (class, group and division or zone) by the PURCHASER, and shall meet the requirements of NFPA 70, Articles 500, 501, 502 and 504, as well as local codes specified and furnished by the PURCHASER.	In addition, all electrical equipment located inside the enclosure must be ATEX certified. The enclosure ventilation system must be certified for zone 1.
● 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) may adversely affect site performance. To minimize the influence of these factors, the VENDOR shall review and comment on the PURCHASER's piping and foundation drawings. When specified, the VENDORS representative shall: a. Observe a check of the major piping connections by parting the flanges. b. Check alignment at the operating temperature. c. Witness the initial alignment check.	This paragraph is applicable.
● 4.1.19 The PURCHASER will specify whether the installation is indoors (heated or unheated) or outdoors (with or without a roof), as well as the weather and environmental conditions in which the equipment must operate (including maximum and minimum temperatures and unusual humidity and dust, or corrosive conditions). The unit and its auxiliaries shall be suitable for shipment, installation, and operation under these specified conditions.	Refer to job specification and job datasheet.
● 4.1.22 The PURCHASER will specify bleed air requirements.	This paragraph is normally not applicable.

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4.3 Combustors and Fuel Nozzles	
• 4.3.7 When specified, the MANUFACTURER shall indicate the flexibility in the proposed combustion system by advising maximum and minimum Wobbe index limits of the combustion system.	This paragraph is applicable.
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 3.21.	This paragraph is applicable. Refer to Job specification and job data sheet.
• 4.4.5.4 Connections other than those covered by ASME B16.5 or B16.47 require the PURCHASER's approval. Unless otherwise specified, mating parts for these nonstandard flanges shall be furnished by the VENDOR.	This paragraph is applicable.
4.5 Rotating elements	
4.5.1 Shafts	
4.5.1.1 Shaft 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.	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. The VENDOR will indicate the weakest point of the shaft line.

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4.5.1.4 When shaft radial vibration and/or axial-position probes are furnished, the rotor shaft sensing areas (both radial vibration and axial position) shall be free from stencil and scribe marks or any other surface discontinuity, such as an oil hole or key-way, for a minimum of on probe-tip diameter on each side of the probe. These areas shall not be metallized, sleeves, or plated. The final shall be maximum of 1.0 micrometer (32 microinches) R_a, preferably obtained by honing or burnishing. These shall be properly demagnetized to the levels specified in API Standard 670 or otherwise treated so that the combined total electrical and mechanical runout, relative to the journals, does not exceed 25 percent of the maximum allowable peak-to-peak vibration amplitude or the following value, whichever is greater. - For areas to be observed by radial-vibration probes, 5 micrometers (0.25 mil). - For areas to be observed by axial-vibration probes, 10 micrometers (0.5 mil) Note: If reasonable efforts fail to achieve the limits noted in 4.5.1.4 the VENDOR and the PURCHASER shall mutually agree on alternate acceptance criteria.	Footnote is not applicable.
4.5.3 Disk and Blading	
4.5.3.3 The blading must have at least 8,000 trouble-free operating hours on similar operating conditions. When 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 unit. The VENDOR shall indicate on the Goodman diagrams the standard acceptance margins.	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.

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4.7 Dynamics	
4.7.1 Critical Speeds	
• 4.7.1.2 This standard recognizes that gas turbine engines are designed and developed as standard products and applied to well-developed turbine packaged drive systems. The engine design shall meet the life expectations of 4.1.1. This standard requires that the engine MANUFACTURER conduct the following rotor dynamic analysis and testing as required during the engine development or rotor system modification and submit the data or reports as requested by the PURCHASER. The following, 4.7.1.2.1 through 4.7.1.2.3, are a guide to the analytical development and testing report submittals.	This paragraph is applicable.
4.7.2 Lateral Analysis	A train lateral analysis shall be performed for machinery trains with rigid couplings.
4.7.3 Torsional Analysis	
4.7.3.3 Torsional criticals at two or more times running speeds shall preferably be avoided or, in systems in which corresponding excitation frequencies occur, shall be shown to have no effect. In addition to multiple of running speeds, torsional excitations that are not a function of operating speeds or that are non-synchronous in nature shall be considered in the torsional analysis when applicable and shall be shown to have no adverse effect. Identification of these frequencies shall be mutual responsibility of the PURCHASER and the VENDOR.	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.

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4.7.3.4 When torsional resonances are calculated to fall within the margin specified in 4.7.4.2 (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 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 4.7.3.2, 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.
● 4.7.3.5 For electric generator drives and units including gears, or when specified for other units, the VENDOR that has unit responsibility (see 4.7.1.2.3) shall perform a torsional vibration analysis of the complete coupled train and shall be responsible for directing the modifications necessary to meet the requirements of 4.7.4.1 through 4.7.4.4. The analysis shall include the effects of the starting device as part of the train and, if appropriate, the starting device uncoupled. Report requirements are specified in 7.2 and Appendix B.	This paragraph is applicable.

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4.7.4 Vibration and Balancing	
4.7.4.2.1 The rotating element shall be multiplane dynamically balanced during assembly. This shall be accomplished after the addition of no more than two major components. Balancing correction shall only be applied to the elements added. Minor correction of other components may be required during the final trim balancing of the complete assembled element. In the sequential balancing process, any half-keys used in the balancing of the bare shaft (see 4.7.4.1) shall be continue to be used until they are replaced with the final key and mating element. On the rotors with single keyways, the keyways shall be filled with fully crowned half-key. The weight of all half-keys used during final balancing of the assembled element shall be recorded on the residual unbalance work sheet (see Appendix C). the maximum allowable residual unbalance per plane (journal) shall be calculated as follow: In SI units, $U_{\max} = 6350 \frac{W}{N}$ In US Customary units, $U_{\max} = 4 \frac{W}{N}$ Where: $U_{\max}$ = residual unbalance, in gram-millimeters (ounce-inches). W = journal static weight load, in kilograms (pounds). N = maximum continuous speed, in revolution per minute. When spare rotors are supplied, they shall be dynamically balanced to the same tolerances as the main rotor. With approval of the PURCHASER, component balance with assembly trim balance may be substituted for the method previously outlined, using the tolerances specified if this is the VENDOR's standard practice. Note 1: Wheel and spacer assembly may be considered a major component.	The last sentence is cancelled.

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4.7.4.5 Where vibration monitoring systems are standard on package gas turbines, the VENDOR shall provide the PURCHASER with the criteria used to define the VENDOR's acceptable vibration limits. These criteria shall include, but not be limited to, the following: - Location and type of sensors. - Filtration and signal conditioning. - Operational conditions. - Acceptance limits. - Experience from previous similar units. During the factory test of the assembled gas turbine, at any steady state speed within the specified operation range, the amplitude of vibration (measured at the VENDOR's standard sensor locations) shall not exceed the VENDOR's standard acceptance limit filtered or unfiltered. The VENDOR shall make available, prior to or during the test, summary data from previously tested units.	VENDOR shall clearly indicate in his proposal the vibration acceptance criteria, sub-synchronous and overall, and the location of the critical speeds.
4.9 Lubrication	
4.9.2 When 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.	This paragraph is applicable.
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.	Refer to GS MEC 281.

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● 4.9.8 Where oil is supplied from a common system to two or more machines (such as compressor, a gear, a turbine), the oil's characteristics will be specified on the data sheets by the PURCHASER on the basis of mutual agreement with all VENDORS supplying equipment served by the common oil system. Note: The usual lubricant employed in a common oil system is a hydrocarbon oil that corresponds to the ISO Grade 32, as specified in ISO 3448.	In addition, the oil characteristics for the complete shaft line is the sole responsibility of the shaft line leader who is responsible for the co-ordination of the oil system and to fulfill all SUB-VENDORS requirements (normal operation, shut-down, start).
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 data sheets or this standard (see 5.5.1 for requirements for auxiliary piping materials). The PURCHASER will specify 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.	Refer to job specification and job datasheet for environment and fuel analysis. This paragraph is applicable.
4.10.4 Welding	
● 4.10.4.6.1 In addition to the requirements of 4.10.4.1, the PURCHASER may specify that 100-percent radiography, magnetic particle inspection, or liquid penetrant inspection of welds is required.	VENDOR standard shall apply for the bare gas turbine.

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• 4.10.4.6.4 When specified, proposed connection designs shall be submitted to the PURCHASER for approval before fabrication. The drawing shall show weld design, size, materials, and pre- and post-weld heat treatments.	VENDOR design shall apply for the bare gas turbine.
4.10.5 Impact Test Requirements	
• 4.10.5.3 The PURCHASER will specify the minimum design metal temperature used to established impact test 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 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.	Refer to job specification and job datasheet.
5.1.1.4 Motor drives shall conform to API Standard 541 . Motors that are below the power scope of API Standard 541 shall be in accordance with IEEE 841.	Motor drives shall conform to project specification.
• 5.1.1.5 The motor's starting-torque requirements shall be met at a specified reduced voltage. Note: For most applications, the starting voltage is typically 80 percent of the normal voltage.	This paragraph is applicable. The motor's starting-torque requirements shall be met at 80% of nominal voltage.

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• 5.1.1.6 The PURCHASER will designate the applicable specifications and standards for other types of starting and helper drivers.	Refer to job specification and job datasheet.
5.1.1.8 For drivers that weight more than 250 kilograms (500 pounds) the equipment feet shall be provided with jack-screws.	Replace 250 kilograms by 100 kilograms.
5.1.1.11	(New) Starter shall be suitable for continuous operation during crank and soak washing.
5.1.2 Ratings	
• 5.1.2.2 Helper driver ratings and arrangements shall be mutually agreed to by the PURCHASER and the VENDOR.	This paragraph is applicable. 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. 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 when specified, any load gear.	This paragraph is applicable.

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5.2.2 Couplings and Guards	
5.2.2.3 Coupling, coupling-to-shaft junctures, and guards shall conform to API Standard 671 . Couplings shall be sized to the API 671 except as modified by 5.2.2.1 and 5.2.2.2. The make, type and the mounting arrangement of couplings shall be agreed upon by the PURCHASER and the VENDORS of the driver and driven equipment.	In addition, refer to GS MEC 290 .
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 When the equipment supported weighs more than 250 kilograms (500 pounds), the mounting plates shall be furnished with jackscrews. Vertical jackscrews in the equipment feet shall be arranged to prevent marring of shimming surfaces. The lugs holding these jackscrews shall be attached to the mounting plates so that the lugs do not interfere with the installation or removal of the equipment jackscrews or shims. If the equipment is too heavy to use jackscrews, other means shall be provided.	Replace 250 kilograms per 100 kilograms.
5.3.2 Baseplate	
5.3.2.1 When a baseplate is specified, the PURCHASER will indicate the major equipment to be mounted on it. A baseplate shall be a single fabricated steel unit, unless the PURCHASER and the VENDOR mutually agree that it may be fabricated in multiple sections. When specified, 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 meters (40 feet) or a nominal width of more than 4 meters (12 feet) or overweight may have to be	Refer to job specification and job datasheet.

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fabricated in multiple sections because of shipping restrictions.	
• 5.3.2.3 When specified, the baseplate shall be provided with leveling pads or targets protects with removable covers. The pads or targets shall be accessible for field leveling after installations, with the equipment mounted and the baseplate on the foundation.	This paragraph is applicable.
• 5.3.2.4 When specified, the baseplate shall be suitable for column mounting (that is, of sufficient rigidity to be supported at specific 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. The VENDOR must clearly indicate where are located the specific support points. The baseplate shall be reinforced at the support point locations. Refer to GS STR 103 .
• 5.3.2.7 The mounting pads on the bottom of the baseplate shall be in one plane to permit use of a single-level foundation. When specified, subplates shall be provided by the VENDOR.	Each baseplate shall be in one plane to permit use of a single-level foundation.
5.4 Controls and Instrumentation	
• 5.4.1.6 When 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 Starting Control System	
• 5.4.2.1 The starting control system may be manual, 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. Manual start, if specified, shall require the operator to commission the accessory and auxiliary equipment; initiate, hold and advance (crank, purge and fire) the starting sequence; and accelerate the turbine to the minimum governor setting. b. Semi-automatic start, if specified, shall	a., b. and c. are applicable.

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require manual commissioning of the accessories and auxiliaries and shall permit the operator to commit the turbine to the complete starting sequence by a single action. c. Automatic start shall require only a single action by the operator to commission auxiliary equipment and initiate the complete sequence.	
5.4.3 Load control	In addition, for generator drive applications the VENDOR must guarantee 100% load acceptance and rejection steps, within acceptable frequency, voltage drops and time recovery (refer to electrical datasheet and specification). This requirement shall be fully demonstrated during the factory load tests, using resistive load banks.
5.4.3.6 Governor systems shall prevent the gas turbine from tripping overspeed when an instantaneous loss of electric, hydraulic, or aerodynamic load occurs.	Loss of load means full load rejection (from the maximum power in site conditions).
5.4.4 Alarms and Shutdowns	
5.4.4.3 The fuel control system shall include shutoff valve, separate from fuel control valve, that stops all fuel flow to the turbine on any shutdown condition and can not open until all permissive firing conditions are satisfied. The valve shall have means for local and remote tripping and a local manual mechanical device for tripping.	In addition, this shut-off valve must be tight shut-off as per ANSI B16.104-1976, class VI.
• 5.4.4.8.5 The VENDOR shall furnish a first-out annunciator when an annunciator system is specified. The annunciator shall contain approximately 20 percent spare points and, when specified, shall be suitable for purging. Connections shall be provided for actuation of a remote signal when any function alarms or trips. The sequence of operation shall be as specified in 5.4.4.8.6 through 5.4.4.8.8.	This paragraph is applicable.

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• 5.4.4.9 Unless otherwise specified, all instruments and controls other than shutdown sensing devices shall be installed with sufficient valving to permit their replacement while the system is in operation. When shutoff valves are specified for shutdown sensing devices, the VENDOR shall provide a means of locking the valves in the open position.	VENDOR standard design shall apply. VENDOR shall clarify the instruments which can be replaced without turbine shutdown.
5.4.5 Instrumentation and Control Panels	
5.4.5.2 A control console may include a visual display unit (VDU) for monitoring operating variables and/or a keyboard for entering operator commands. The VDU 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 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 colour printed. The time base and measured value ranges forming the axes shall be adjustable by the operator.
5.4.6 Electrical Systems	
• 5.4.6.1 The characteristics of electrical power supplies for motors, heaters, and instrumentation will 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 control panels.	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.
• 5.4.6.6 Electrical materials including insulation shall be corrosion resistant and non-hygroscopic insofar as is possible. When 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	
• 5.4.7.2.2 The type of tachometer will be specified. Unless otherwise specified, the minimum range shall be from 0 to 125 percent of the maximum continuous speed (in revolutions per minute).	VENDOR standard design shall apply.

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● 5.4.7.5 Thermocouples and Resistance Temperature Detectors Where practical, the design and location of thermocouples and resistance temperature detectors (RTD) shall permit replacement while the unit is operating. The lead wires of thermocouples and resistance temperature detectors shall be installed as continuous leads between the thermowell or detector and the terminal box. Conduit runs from thermocouple and resistance temperature detector heads to a pull box or boxes located on the baseplate shall be provided. When specified, monitors shall be supplied, installed, and calibrated in accordance with API Standard 670.	This paragraph is applicable.
● 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, 110-millimeter (4 ½-inch) dials, 152-millimeter (6-inch) dials for the range over 55 bar (800 pounds per square inch), and ½-inch National Pipe Thread (NPT) male alloy steel connections. Black printing on a white background is standard for gauges. When specified, oil-filled gauges shall be furnished in locations subject to vibration. 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 percent. Each pressure gauge shall be provided with a device such as a disk insert or blowout back designed to relieve excess case pressure.	This paragraph is applicable.
● 5.4.7.8.2 When specified, vibration and axial-position monitors shall be supplied and calibrated in accordance with API Standard 670.	This paragraph is applicable.

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5.5 Piping and appurtenances	
5.5.3 Inlet and exhaust systems	
5.5.3.1 An air inlet and exhaust system consisting of an air inlet filter, silencers, ducting, and expansion joints shall be supplied. Pressure-drop test connections at the gas turbine inlet and exhaust flanges shall be included. Other devices not covered by the standard exhaust-over-pressure protective devices and diversion valve and exhaust-heat recovery systems may be required. A duct-mounted anti-icing system and an emission control reduction system may also be needed.	This paragraph is applicable. For other devices, anti-icing system and emission control systems requirements, refer to the Job Specification. Unless otherwise specified, the air inlet system including filtration housing, plenum, silencer and ducting up to turbine inlet (bellmouth), and the exhaust system including internals shall be made of 316L or 321 stainless steel.
5.5.3.3 Unless otherwise specified, the inlet system shall be designed for a minimum practical pressure drop with a maximum total pressure drop of 1 kilopascal (4 inch water) with a clean air inlet filter and at least 110 percent of the air flow at site rated power. The exhaust system shall be designed for the minimum practical pressure loss. Where pressure at the turbine exhaust flange is expected to exceed 3.7 kilopascals (15 inches water), the gas turbine MANUFACTURER shall be consulted. The economics of individual applications could dictate other design factors for each system that may be used with the PURCHASER agreement. Pressure losses of 0.5 kilopascal (2 inches water) at the inlet or 1 kilopascal (4 inches water) at the outlet are approximately equivalent to 1 percent power loss each.	This paragraph is applicable. In addition, the inlet system shall be designed for at least 110 percent of the air volume flow at site rated power at minimum ambient temperature.
5.5.3.4 System components, except for filter media, shall be designed for a useful life of at least 20 years. The PURCHASER will advise the VENDOR of the site conditions (rainfall, atmospheric contaminants, corrosive elements, and dust) 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 job specification and job datasheet.

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5.5.3.6 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. Note: The inlet screen (see 5.5.3.7) shall not be considered a stage 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 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.
5.5.3.8 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 non-stainless 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.
• 5.5.3.9 A compressor 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 anti-freeze compounds and utilities.	VENDOR shall propose an off-line washing system. The requirement for an on-line washing system is indicated in the Job Specification.
• 5.5.3.10 Based on ambient conditions provided, the VENDOR shall advise if an anti-icing system is to be provided. If anti-icing is required, the VENDOR shall fully describe the system, VENDOR's scope, effect on engine's performance over the ambient range, and required utilities. Note: Effects of the inlet cooling system, if provided, on icing conditions must also be addressed.	Refer to job specification and job datasheet. Operation with the anti-icing system shall comply with noise requirements.

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• 5.5.3.11 The PURCHASER shall specify, if required, any site limits on exhaust emissions. Available or required processes to be used for emissions suppression (i.e., water, steam, dry) should also be specified. The VENDOR shall fully describe the system being proposed, including variations of emissions with all fuels being used, effects over ambient range on emissions and engine power and heat rate. Required utilities for the emission suppression system shall also be addressed. In order for the VENDOR's response to be complete, the PURCHASER will specify any site required load variations at given ambient conditions and complete fuel analyses of all fuels to be used. The VENDOR will take into account any effects caused by the operation of the anti-icing system.	Refer to job specification and job datasheet.
5.5.4 Inlet filters	
• 5.5.4.1 The PURCHASER will specify the type of inlet filtration (for example, inertial-type separator, media filters, self-cleaning filter, pad-type prefilters, or a combination thereof). If single-stage filtration only is specified, the PURCHASER will specify if provisions are to be made for the future addition of extra stages.	The VENDOR shall indicate in his proposal which assumptions have been taken to select the air filter arrangement. The inlet system shall be based on at least three stages filtration as follows: • Insect screen, if required. Refer to the Job Specification. • 1st stage composed of inertial separator vanes. • 2nd stage or pre-filter coalescer. • 3rd stage or high efficiency filtration. • 4th stage marine vane separator, if required. Refer to the Job Specification. Note: For low velocity filters, the face velocity at first stage shall not exceed 2.5 m/s at the maximum air flow conditions. For high velocity filters, the face velocity at first stage shall not exceed 5.5 m/s. The filter medium shall be fully synthetic. The VENDOR proposal shall include a general arrangement drawing and state: • The filter air flow for minimum and

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	maximum site conditions. • The face velocity at the first stage. • The filter efficiency curves. • The guaranteed pressure drop of intake system in clean conditions. • The maximum allowable operating pressure drop. • The recommended differential alarm and shutdown setting.
5.5.4.2 Unless otherwise specified, a mist eliminator shall be furnished for marine environment.	The drain from each marine vane separator, if installed, shall be equipped with a siphon breaker and level transmitter.
• 5.5.4.5 When specified, an implosion door shall be provided to prevent excessively high delta pressure in the turbine inlet in the event of filter icing or plugging. This door shall be instrumented to indicate remotely when it is open.	This paragraph is Not Applicable.
• 5.5.4.6 Unless otherwise specified, the filter house will be elevated with a minimum 4.6 meter (15 foot) elevation from grade to the lowest part of the filter air entrance. When 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.	This paragraph is applicable. In addition, the VENDOR shall design the access and maintenance facilities to the filtration housing.
5.5.4.7 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 COMPANY will inspect/witness the complete assembly in the VENDOR shop.
5.5.4.8 The VENDOR shall include the following items in his proposal: a. Material of construction and coating. b. All performance details. c. Weights and dimensions.	In addition, the inlet filter shall be guaranteed to remove 95% of all particles from 2 µm and larger, and 99% of all particles above 10 µm. The salt content after filtration must be guaranteed by the filter supplier and accepted by the turbine MANUFACTURER.
5.5.5 Inlet and exhaust silencers	
5.5.5.1.2 Silencer shall be of welded carbon steel and shall be flanged in sufficiently rigid	Refer to comment to paragraph 5.5.3.1.

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to be supported to be supported by the end flange when mounted in a horizontal or vertical duct system.	
• 5.5.5.1.4 Silencer 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.
5.5.5.2.2 The basic material for construction of the exhaust silencer shall be hot rolled AISI 1020 or equal for metal service temperatures of -25 to 455°C (-13 to 851°F). If metal temperatures fall below this range for extended periods, the use of low temperature carbon steel such as ASTM A662 may be used. If metal temperature exceed 455°C (850°F) for extended periods, use of more corrosion resistant steel shall be provided	Refer to comment to paragraph 5.5.3.1.
• 5.5.5.2.3 Perforated plates or sheets shall be constructed of 400 series stainless steel except where a corrosive environment may produce stress corrosion cracking.	Refer to comment to paragraph 5.5.3.1.
• 5.5.5.2.5 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 job specification and job datasheet.

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5.5.6 Ducting	
5.5.6.7 For exhaust temperatures greater than 480°C (900°F) at site rated power, special precautions shall be exercised in the selection of duct and silencer materials to avoid carburization or corrosion at these elevated temperatures.	Refer to comment to paragraph 5.5.3.1.
5.5.6.8 When specified, an atmospheric relief device shall be provided in the exhaust duct upstream of any isolation damper. (When the atmospheric relief devices and associated dampers are being selected, caution should be exercised regarding the degree of leakage to be tolerated and the location and routing of atmospheric relief discharge).	Refer to job specification and job datasheet.
5.5.6.10 When specified, emissions sampling ports shall be provided in the exhaust ducting (access ladder and platforms to be provided as necessary).	This paragraph is applicable.
5.5.7 Expansion joints	
5.5.7.3 The exhaust expansion joints shall be of metal or high-temperature fabric. If fabric is used, it shall be multilayered and reinforced with nickel alloy 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 100,000 hours of operation.
5.6 Inlet Coolers	
5.6.1 Evaporative Coolers	
5.6.1.1 When specified as evaporative, the cooler shall be supplied complete with cooler media, circulation pump, sump drains, and corrosion resistant mist eliminator. The mist eliminator is to minimize moisture carryover into the inlet air stream at 105 percent of maximum engine mass flow and worst case ambient conditions.	Refer to job specification and job datasheet.

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• 5.6.1.5 When specified, walkways, handrails, and access ladders shall be provided for access to the manways and other areas of the unit required for servicing.	This paragraph is applicable.
5.6.2 Inlet Air Cooler Heat Exchanger	
• 5.6.2.1 When 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 job specification and job datasheet.
• 5.6.2.3 PURCHASER shall specify the following coolant conditions in order for the VENDOR to properly size the cooler and estimate project performance: a. Maximum available flow b. Maximum and minimum temperatures c. Maximum and minimum pressures d. Composition or analysis and cleanliness. Based on this input, the VENDOR shall advise in the proposal the pressure drop across the cooler, the performance of the cooler in terms of inlet temperature reduction, as well as effect on turbine shaft output and fuel flow. Additionally, the VENDOR shall advise all controls being supplied with the cooling system as well as the controls and instrumentation required to be provided by the PURCHASER.	Refer to job specification and job datasheet.

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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 weather-proofed. The PURCHASER will specify the extent of insulation for heat conservation to be supplied by the VENDOR.	Refer to GS SAF 222 .
5.7.3 Fire protection	
• 5.7.3.1 The fire suppression system shall be designed in accordance with the applicable NFPA standard (NFPA 2001 for clean agent extinguishing systems and NFPA 12 for carbon dioxide extinguishing systems). Alternative systems, such as fire water spray, may be also utilized. The PURCHASER will specify any special design considerations to be included in the suppression system, including the specific fire suppression medium.	Refer to relevant GS SAF documents called by GS MEC 290 .
• 5.7.3.3 The fire detection system shall be designed in accordance with NFPA 72E. 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 relevant GS SAF documents called by GS MEC 290 .
5.7.3.4 The gas detection system shall be designed in accordance with NFPA 72E.	Refer to relevant GS SAF documents called by GS MEC 290 .
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 relevant GS SAF documents called by GS MEC 290 .
• 5.7.4.2 Any special “far field” or neighborhood sound restrictions that are applicable will be specified.	Refer to job specification and job datasheet.

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5.7.5 Enclosures	
• 5.7.5.1 When 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 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.	This paragraph is applicable.
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.	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.
• 5.7.5.6 The enclosure shall be provided with a fan driven forced ventilation and purging air system designed to provide 100 percent 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.	Refer to relevant GS SAF documents called by GS MEC 290.
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 shall be made of 316L or 321 stainless steel. • Ventilation air shall be taken downstream the last air filtration stage.

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• 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 draft damper and a fire suppression medium damper. The PURCHASER will specify if additional ventilation ducting is required.	Refer to job specification and job datasheet.
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 5.8.3 in the inquiry specification. The VENDOR shall advise the PURCHASER of the effects of contaminants and corrosive agents on turbine operation.	This paragraph is applicable. Refer to job specification and job datasheet.
5.8.1.2 Fuel gas system	
5.8.1.2.1 A gaseous fuel system shall include: - A "Y" type strainer. - Necessary instrumentation. - A manifold and nozzles. - A fuel shutoff valve with an intermediate vent valve for automatic operation. - A fuel control valve. - A fuel gas pressure regulator, if required. - Necessary additional instrumentation.	This paragraph is to be replaced as follows: A gaseous fuel system shall conform to GS SAF 222 and include: - Y type strainer (with removable 100 fine mesh for commissioning). - Last chance liquid detection pot with to be provided with level transmitter to trip the turbine in case of liquid detection and automatic drain system. - The fuel-gas line to each gas turbine package shall be fitted with an ESDV located outside the enclosure. - 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

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	last chance pot) from the ESDV valve down to turbine shut off valve. e. 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. The technical offer must include a complete description with diagram of the fuel gas system including all the devices listed above.
● 5.8.1.2.2 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 when specified by the PURCHASER.	This paragraph is applicable.
● 5.8.1.2.4 When specified, twin Y-type strainer(s) with a continuous flow transfer valve shall be 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.	This paragraph is not applicable.
● 5.8.1.2.5 When specified, a fuel bypass valve and vent valve for purging the fuel gas line prior to light off shall be supplied.	This paragraph is applicable.
5.8.1.4 Liquid Fuel System	
● 5.8.1.4.4 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.	Refer to job specification and job datasheet.
● 5.8.1.4.5 If fuel transfer equipment is required, it shall be furnished by the VENDOR when specified by the PURCHASER.	Refer to job specification and job datasheet.

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5.8.1.5 Dual Fuel Operation	
• 5.8.1.5.1 When 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.
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. Gas should be dry at the turbine fuel nozzles to prevent over-temperature 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.	This paragraph is applicable. In addition, the VENDOR shall indicate any treatment considered necessary for start-up and operation.
• 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. Some of the contaminants that are likely to be found include the following: a. Tar, carbon black, and coke b. Water c. Solids d. Napththalene and gas hydrates. The concentration of contaminants in the gas will be specified on the data sheets by the PURCHASER.	Refer to job specification and job datasheet.

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5.8.2.2.3 To reduce the potential for damage to the ho-gas-path components, a coalescing filter shall be furnished by the VENDOR when specified by the PURCHASER. 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 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 job specification and job datasheet.
• 5.8.2.4 Heating Value 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 percent. For variations in heating value of more than 10 percent, the rate of change will be specified by the PURCHASER because special equipment may be required for proper fuel control.	In addition, the VENDOR shall calculate the lower heating value 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	
• 5.8.3.3 Grades or Types The PURCHASER shall specify which ASTM fuel grades or types or other liquid fuels are to be burned in the gas turbine: a. ASTM D 2880 grades: 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.	Refer to job specification and job 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.

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2. Grade 1-GT is a light distillate fuel suitable for use in nearly all gas turbines. 3. 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. 4. Grade 3-GT may be a distillate that is heavier than Grade 2-GT, a residual fuel oil that meets the low ash requirements, 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. 5. Grade 4-GT includes most residuals and some topped crudes. Because of the wide variation and lack of control of properties, the gas turbine MANUFACTURER should be consulted about acceptable limits on properties. b. ASTM D 1655 types: 1. 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. 2. Jet B is a relatively wide boiling range volatile distillate. c. Other types The PURCHASER will furnish a complete analysis for other liquid fuels.	
5.8.4 Emission Suppression Systems	
● 5.8.4.1 When specified, the gas turbine shall be provided with the necessary equipment for emission suppression for gas-fueled units.	This paragraph is applicable.

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● 5.8.4.2 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). Note: Emission refers to contaminants in the exhaust stream such as: a. NOx (oxides of nitrogen). b. CO (carbon monoxide). c. UHC (unburned hydrocarbons). d. Others (sulfur, particulate, etc.).	Refer to job specification and job datasheet.
● 5.8.4.4 When a wet suppression system is specified, the gas turbine shall be provided with the necessary equipment to permit injection of PURCHASER-SUPPLIED water or steam for emissions suppression.	Refer to job specification and job datasheet.
6. Inspection, testing and preparation for shipment	
6.1 General	
● 6.1.1 The PURCHASER will specify the extent of participation in this inspection and testing and the amount of advance notification required.	Unless otherwise specified, COMPANY will 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 When specified, the PURCHASER's representative, the VENDOR's representative, or both shall indicate compliance in accordance with the inspector's checklist (Appendix B) by initialing, dating, and submitting checklist to the PURCHASER before shipment.	This paragraph is applicable.

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6.2 Inspection	
• 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. When specified, final-assembly maintenance and running clearances.	This paragraph is applicable.
• 6.2.1.3 In addition to the requirements of 4.10.4.1, the PURCHASER may specify the following: a. Parts that shall be subjected to surface and subsurface examination. b. The type of examination required, such as magnetic particle, liquid penetrant, radiographic, and ultrasonic examination.	VENDOR standard shall apply.
• 6.2.3.3 When specified, the PURCHASER may inspect for cleanliness the equipment and all piping and appurtenances furnished by or through the VENDOR before heads are welded to vessels, openings in vessels or exchangers are closed, or piping is finally assembled.	VENDOR standard shall apply.
• 6.2.3.4 When specified, the hardness of parts, welds, and heat-affected zones shall be verified as being within the allowable values by testing of the parts, welds, or heat-affected zones. The method, extent, documentation, and witnessing of the testing shall be mutually agreed upon by the PURCHASER and the VENDOR.	VENDOR standard shall apply.

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6.3 Testing	
6.3.1 General	
6.3.1.3 The VENDOR shall notify the PURCHASER not less than 5 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 5 working days before the new test date.	Refer to Company General Conditions.
6.3.3 Mechanical Running Test	
6.3.3.3.4 When specified plots showing synchronous vibration amplitude and phase angle versus speed for deceleration shall be made before and after the 4 hour run. Plots shall be made of both the filtered (one per revolution) and the unfiltered vibration levels. When specified, these data shall also be furnished in polar form. The speed range covered by these plots shall be 400 to the specified driver trip speed.	This paragraph is applicable.
6.3.3.3.6 When specified, tape recordings shall be made of all real-time vibration data (Item 32, Appendix C). The tape recordings of the real-time vibration data shall be given to the PURCHASER.	This paragraph is applicable.
6.3.4 Optional Tests When specified, the shop tests described in 6.3.4.1 through 6.3.4.11 shall be performed. Test details shall be mutually agreed upon by the PURCHASER and the VENDOR.	Refer to job specification and job datasheet.
6.3.4.1 Performance Test The machine shall be tested in accordance with ASME Power Test Codes 1 and 22, as specified by the PURCHASER.	This paragraph is applicable.

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● 6.3.4.2 Complete-Unit Test Such components as compressors, gears, drivers, and auxiliaries that make up a complete unit shall be tested together during the mechanical running test. When specified, torsional vibration measurements shall be made to verify the VENDOR's analysis. The complete unit test shall be performed in place of or in addition to separate tests of individual components specified by the PURCHASER.	Refer to job specification and job datasheet.
● 6.3.4.2.1 Package Test When 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: - Control panel - Auxiliary gear - Starting equipment - Lube-oil system - Hydraulic oil system - Gas fuel system - Liquid fuel system - Atomizing air system - Intake system - Exhaust system - Enclosure with the associated equipment - Fire protection - De-icing. Note: The scope of this test shall be developed 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.	Refer to job specification and job datasheet.
● 6.3.4.3 Gear Test The gear shall be tested with the gas turbine unit during the mechanical running test.	Refer to Job specification.

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● 6.3.4.4 Sound-Level Test The sound-level test shall be performed in accordance with the ANSI B133.8. In the event that overall sound pressure levels are not satisfied, diagnostic testing will be performed to determine the sound power levels of each principal noise source in accordance with ISO 10494.	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.
● 6.3.4.5 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.
● 6.3.4.6 Post-Test Inspection The gas turbine shall be inspected after satisfactory completion of the running test. Complete dismantling, inspection, and reassembling shall be required if the mechanical running test is unsatisfactory.	This paragraph is applicable.
● 6.3.4.7 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.
● 6.3.4.8 Governor Response and Emergency Overspeed Trip Systems Tests	This paragraph is applicable.
● 6.3.4.9 Spare Parts Test Spare parts, such as couplings, gears, bearings, and seals, shall be tested as specified by the PURCHASER.	Refer to job specification and job datasheet.

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6.3.4.10 Fire Protection Tests The fire protection systems shall comply with NFPA requirements.	This paragraph is applicable. Tests procedure and results must comply with 5.7.3.1.
6.3.4.11 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 job specification and job datasheet.
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 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 will 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.	The storage procedure must be defined by the VENDOR and included in the operating and maintenance manual.
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	Refer to Company bidding instructions.

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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.	
● 7.2.4 Curves a. The proposal shall contain a power output versus speed curve for the rated site conditions. It should follow the formats shown in Figures 2, 3 or 4, as applicable. Additional curves shall be presented showing site rated power and speed at specified maximum and minimum site ambient temperatures and showing both using specified fuels. 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. When specified, the curves described in Items a through d below shall also be furnished. b. 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. c. 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. d. Curves showing the effect of full-range ambient conditions on exhaust flow and temperature. e. Run-down curves showing exhaust flow and temperature versus time after trip, under full load and no load initial conditions.	This paragraph is applicable.



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7.3 Contract data	
7.3.6 Installation, operation, maintenance, and technical data manuals	
7.3.6.4 Technical Data Manual When 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.

Appendix D Lateral rotor dynamic analysis for use with modified rotor bearing designs or prototype gas turbines

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APPENDIX D Lateral Rotor Dynamic Analysis for use with modified rotor bearing designs or prototype gas turbine.	
● D1.3 When specified, the effects of other coupled equipment in the train shall be included in the damped unbalanced response analysis (that is, a train lateral analysis shall be performed). Note: This analysis should be considered for machinery trains with rigid couplings.	This paragraph is applicable for machinery trains with rigid couplings.
● D1.4 e. When specified, a stiffness map of the undamped rotor response from which the damped unbalanced response analysis specified in Item c above was derived. This plot shall show frequency versus support system stiffness, with the calculated support system stiffness curves superimposed.	This paragraph is applicable.