

MATERIAL AND EQUIPMENT STANDARD**FOR****GAS TURBINES****Final Draft**
SECOND EDITION**2009**

0. INTRODUCTION

This Standard specification gives the amendments and supplements to API Standard 616, Fourth Edition, Aug. 1998, "Gas Turbines for the Petroleum, Chemical and Gas Industry Services".

Note: This is a revised version of the standard specification for combustion Gas Turbine for process services , which is issued as revision(2). Revision (1) of the said standard specification is withdrawn.

Guidance for Use of this Standard

The amendments/supplement to API Standard 616 given in this Standard are directly related to the equivalent sections or clauses in API Standard 616. For clarity, the section and paragraph numbering of API Standard 616 has been used as far as possible. Where clauses in API are referenced within this Standard, it shall mean those clauses are amended by this Standard. Clauses in API that are not amended by this Standard shall remain valid as written.

The following annotations, as specified hereunder, have been used at the bottom right hand side of each clause or paragraph to indicate the type of change made to the equivalent clause or paragraph of API.

Sub. (Substitution): The clause in API shall be deleted and replaced by the new clause in this Standard.

Del. (Deletion) : The clause in API shall be deleted without any replacement.

Add. (Addition) : The new clause with the new number shall be added to the relevant section of API.

Mod. (Modification): Part of the clause or paragraph in API shall be modified and/or the new description and/or statement shall be added to that clause or paragraph as given in this Standard

1. SCOPE

This Standard Specification covers the minimum requirements for gas turbines for mechanical drives and electric power generator drives to be used in pipeline transmission services, oil refineries, chemical plants, gas plants and in explorations, productions and new ventures, where applicable.

Compliance by the gas turbine manufacturer with the provisions of this Standard does not relieve him of the responsibility for furnishing gas turbine and accessories of proper design, mechanically suited to meet guarantees at the specified service conditions. No deviations or exceptions from this Standard shall be permitted without the written prior approval of the purchaser.

Intended deviations shall be separately listed by the vendor and supported by reasons thereof for purchaser consideration. **(Mod.)**

1.1 Alternative Design

The International System (SI) of Units, dimension and rating in accordance with [IPS-E-GN-100](#) shall be used, unless otherwise specified. **(Mod.)**

1.2 Conflicting Requirements

In case of conflict among documents relating to the inquiry or order, the following priority of documents (whichever more stringent realized by Company) shall apply:

- **First priority:** Purchase order and variations thereto.
- **Second priority:** Data sheets and drawings.
- **Third priority:** This standard specification.

All conflicting requirements shall be referred to the purchaser in writing. The purchaser will issue confirmation document if needed for clarification. **(Sub.)**

2 REFERENCES

2.1 Referenced Standards

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

IPS (IRANIAN PETROLEUM STANDARDS)

[IPS-E-GN-100](#) "Engineering Standard for Units"

[IPS-E-EL-110](#) " Engineering Standard for Hazardous Area"

[IPS-G-SF-900](#) "General Standard for Noise Control and Vibration"

[IPS-M-EL-132](#) "Material and Equipment Standard for Medium and High Voltage Induction Motors"

[IPS-M-PM-240](#) "Material and Equipment Standard for General Purpose Steam Turbines"

[IPS-M-PM-250](#) "Material and Equipment Standard for Special Purpose Steam Turbines"

[IPS-M-PM-290](#) "Material and Equipment Standard for Reciprocating Internal Combustion Engines"

IPS-[M-PM-300](#) "Material and Equipment Standard for Special Purpose Gear Units"

IPS-[M-PM-310](#) "Material and Equipment Standard for Special Purpose Couplings"

[IPS-M-PM-320](#) "Material and Equipment Standard for Lubrication, Shaft Sealing and Control-Oil Systems and Auxiliaries for Process Services"

[IPS-G-SF-900](#) "Noise and Vibration Control"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

6708 "Pipe Components-Definition of Nominal Size"

7268 "Pipe Components-Definition of Nominal Pressure"

NACE (NATIONAL ASSOCIATION OF CORROSION ENGINEERS)

MR-01-75-88 "Sulfide Stress Cracking Resistant Metallic Material for Oil Field Equipment"
(Mod.)

3. DEFINITION

3.45 Site rated power: The shaft power developed by the gas turbine when it is operated in a new and clean condition, including clean air filters and air compressor at site rated firing temperature, rated speed and site conditions of air inlet temperature, air inlet pressure, exhaust back pressure and specified fuel composition. The site rated power shall be regarded as the guaranteed power capability of the gas turbine and shall be the power available at the gas turbine load coupling after extracting parasitic losses such as fuel and lubricant pumps, internal speed changers, etc.

(SUB.)

4. BASIC DESIGN

4.1 General

4.1.1 Turbine ratings shall not exceed the limits of the Vendor's design, but shall be well within the range of the manufacturer's actual experience. Only equipment which has proven its reliability in service is acceptable. Manufacturer shall prepare and submit in his proposal the lists showing gas turbines of the same frame size or model previously manufactured and operating under similar conditions of service, speed and power and location of such installation. **(Mod.)**

4.1.4 Change "3 weeks" with "2 months". Turbine vendor shall state special provisions necessary to be carried out for longer period of idleness in his proposal. **(Mod.)**

4.1.5 where only one operation speed is specified for an application, the minimum speed range for single shaft machine shall be 25 percent (from 80 to 105 percent of rated speed) and the minimum speed range for two or more shafts machine shall be 55 percent (from 50 to 105 percent of rated speed) **(Mod.)**

4.1.6 This period between major overhauls shall be at least 48,000 hours when running on natural gas fuel, at base load, unless the Company and the vendor agree to different periods depending on the company's maintenance philosophy and specific application. **(MOD)**

4.1.10 Control of sound level of all equipment furnished, shall comply with the requirement of [IPS-G-SF-900](#) "Noise and Vibration Control". **(Mod.)**

4.1.13 Unless otherwise specified, the arrangement of the equipment including piping and auxiliaries shall be developed by the Vendor and approved by the Company. **(Mod.)**

4.1.14 Motors, electrical components, and electrical installation shall also meet the requirements of [IPS-E-EL-110](#) and [M-EL-132](#). **(Mod.)**

4.1.17 The combined performance of the turbine and its driven equipment after installation shall be the responsibility of the vendor, who has been nominated to have unit responsibility. **(Mod.)**

4.1.18 The gas turbine Manufacturer shall review and comment upon the purchaser's proposed arrangement of the installation, particularly upon the arrangement for fuel gas supply, ducting layout, drive coupling arrangement, instrumentation, controls, piping and foundations drawing. 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.

(Sub.)

4.1.19 Unless otherwise specified, the gas turbine and its auxiliaries shall operate outdoor in the climate condition specified in data sheet. Any winterizing, enclosures, weather or sun protection required by the manufacturer shall be included in the package. **(Mod.)**

4.1.21 Gas turbine ratings shall be well within the Manufacturer's design limits and actual experience. Flat rating of gas turbines, i.e. allowing for a constant power irrespective of ambient temperature, by compensating for the increased firing temperatures at high ambient temperatures with reduced firing temperatures at low ambient temperatures, is not permitted.

Note: Refer to clause number 6.4.2.1 IPS-E-PM-100 for power margin between gas turbine and driven.

(MOD)

4.1.22 Bleed air shall not be extracted from sealing air lines, but only from anti-surge blow off lines or compressor discharge lines. **(MOD)**

4.2 Pressure Casings

4.2.4 The gas turbine casing shall be designed to contain failed blades, discs or components ejected from a ruptured part which could cause hazard to life or property. Otherwise, containment shields shall be provided by the Manufacturer. **(MOD)**

4.2.7 Suitable inspection ports shall be provided in the casing to allow internal visual inspection of the compressor, combustion chambers, nozzles and blading in the hot gas path, using flexible or rigid fiber optic inspection devices. Adapters and guide tubes for fiber optic inspection shall be provided by the manufacturer. Inspection ports shall be readily accessible without the need to dismantle any component or accessory, and their location shall be shown on the manufacturer's drawings. The internal area which may be viewed from each port shall also be shown on the drawings. **(Mod.)**

4.3 Combustors and Fuel Nozzles

4.3.7 Delete "when specified" from the beginning of the clause. **(MOD)**

4.3.8 An automatic combustor drain valve shall be furnished to drain any trapped liquid. (Add.)

4.4 Casing Connections

4.4.5.4 For nozzle connections over DN 600 (24 inches), vendor shall furnish mating flanges per the following:

a) Flanges shall be welding neck type with bolt hole spacing and bolt circle diameter exactly matching the machine flanges.

b) Each flange shall be furnished with at least 3 dowel pins, each machined with a close fit tolerance to the diameter of the bolt hole bore.

c) The turbine shall be shipped with flanges bolted in place and with dowel pins installed. Each flange (turbine and pipe), dowel pin and bolt replacement for the dowel pin shall be positively identified. (Mod.)

4.4.8 Drain connections shall be provided appropriately positioned for the removal of any accumulated liquid. Drains shall be DN 40 (1½ inches) flanged minimum. (Add.)

4.5 Rotating Elements

4.5.2 Rotors

4.5.2.4 On gas turbines for generator drives, rotors shall be mechanically designed to withstand safely and without failure the transient torques produced in the event of a generator short circuit. The transient torques considered shall not be less than 600% of full-load torque. Out-of-phase synchronization and full-load rejection shall also be considered in the design of the rotating components. (Add.)

4.5.2.5 In the event of an order for a number of gas turbines, with the same rating, all rotors shall be interchangeable. (Add.)

4.5.2.6 Gas turbines specified in the data sheets for operation in a hostile environment shall have the turbine air compressor rotor and stator blades of non-corroding material or shall have non-corrodible coating. The manufacturer shall furnish full details of rotor, stator blading and coating materials. (Add.)

4.5.2.7 Rotor blades shall be moment-balanced and all marked to allow field retrofitting of the blades without the need to rebalance the rotor. Moment-balancing data shall be furnished with the operating manuals. (ADD)

4.6 Seals

4.6.1 using of non-metallic seals are subjected to purchaser's approval. (Mod.)

4.6.3 Air-cooled seals shall be provided wherever there is a risk that hot combustion products may enter bearings or other components containing lubricants which are likely to char when exposed to the combustion product temperature. Sealing air shall be extracted from an appropriate stage of the combustion air compressor. The manufacturer shall include in his supply any coolers that may be required for the sealing air. Placing the coolers in the combustion air intake may be done only with the purchaser's approval.

Losses incurred by the extraction of air for sealing or cooling purposes shall be taken into account when calculating the overall cycle efficiency. The manufacturer shall assure the purchaser that the sealing air extraction position in the turbine air compressor does not create unacceptable aerodynamic disturbance of the air compressor blades. (Add.)

4.7 Dynamics

4.7.1 Critical speed

4.7.1.3 critical speeds shall be determined analytically by means of a damped unbalanced rotor response analysis and shall be confirmed by test stand data. **(Add.)**

4.8 Bearings and Bearing Housings

4.8.3 Hydrodynamic Radial Bearings

4.8.3.5 Machines equipped with sleeve – type journal bearings shall be designed for fields installation of tilting pad-type radial bearings without re-machining of the bearing brackets **(Add.)**

4.8.4.2.2 Vendor shall submit the type of locking in his proposal, in case of using replaceable collars. **(Mod.)**

4.8.5 Bearing Housings

4.8.5.1 However the bearing outlet oil temperature shall not exceed 83° C (181°F). **(Mod.)**

4.8.5.5 At least Two temperature sensors shall be installed in each journal bearing. The temperature sensors shall be embedded in the steel backing, close to the Babbitt interface in the area of minimum oil film thickness. In addition, the individual bearing drains, shall be fitted with temperature indicators. **(Mod.)**

4.9 Lube Oil System

4.9.7 Pressurized lubrication systems shall comply with the requirements of API Standard 614 and [IPS-M-PM-320](#). **(Mod.)**

4.9.8 The same lubricating oil from a common supply system shall be used for the gas turbine, the driven equipment and the speed changers, except as otherwise agreed by the Company. **(MOD)**

4.9.9 Vendor shall submit equivalent lubricating oil types in his proposal. **(Add.)**

4.9.10 Lubricating oil tanks may be accommodated within the base plate framework, if the arrangement complies with this Section (4.9) and the rise in oil temperature does not create misalignment. **(Add.)**

4.9.11 A main oil pump, shaft-driven via the main drive or accessory gearbox, may be offered where the design is well proven. An AC electric motor driven pump of the same capacity shall be provided for start up, standby during normal operation, and shutdown. The arrangement of the installation shall be such that with both pumps running simultaneously, the lubricating oil pressure does not rise above 85% of the maximum design pressure of the system. The design shall allow both pumps to run simultaneously for an unlimited period without causing damage to the equipment.

(ADD)

4.9.12 Where the electricity supply cannot be considered as secure, and when required by the Manufacturer's design, a separate, emergency DC pump shall be provided for supplying lubricating oil for post-shutdown cooling. The Manufacturer shall supply nickel-cadmium batteries with sufficient capacity for the duration of the post lube cycle, together with a battery charger.

(ADD)

4.9.13 Oil tank de-mister fans may be required to maintain sufficiently low pressure in the oil tank. Where de-mister fans are required in relation to the system pressure, these shall have a 100%

4.10 Materials

4.10.1 General

4.10.1.1 Materials for components in contact with gas containing hydrogen sulphite shall conform to the requirements of NACE Standard MR-01-75-88. **(Mod.)**

4.10.1.2 When vendor's quoted material specification other than the ASTM, ASME, AISI, or SAE standards, the proposal shall indicate the nearest above named American specification equivalent along with exact and specific deviations (chemical properties, physical properties, tests, type of heat treatment, etc.) if such exists, for purchaser's evaluation of equivalent for service intended. **(Mod.)**

4.10.2 Castings

4.10.2.3.1 Approval of the Company shall be obtained before any *Major Weld Repair* is carried out. A *Major Weld Repair* is either removal of more than 50% of the wall thickness, or a length of more than 150 mm in one or more directions, or the total surface area of all repairs exceeding 20% of the casting.

Castings subject to a major repair shall be inspected by the purchaser's representative, who shall be notified in accordance with paragraph 6.1 of API Std. 616. All repairs shall meet the inspection requirements and acceptance standards for the original material.

After weld repair, castings shall be suitably heat-treated, if specified in the material specification. A major weld repair shall always be followed by a suitable heat treatment. Details of all major weld repairs and the heat treatment shall be recorded and reported to the Company. **(Mod.)**

4.10.4 Welding

4.10.4.5.3 All piping welded joints shall be full penetration. **(Mod.)**

4.10.4.6.1 a) Butt welded joints of pressure casing shall be 100% radio graphed. Inspection procedure for other pressure casing welds shall be approved by inspector. Examination method and acceptance criteria shall be per ASME Code Section VIII, Paragraph UW-51, except that fluorescent intensifying screens such as calcium tungstate shall not be used.

b) Support leg attachment welds, and welds in end covers of vertically split casings shall be examined by the magnetic particle method, or if non-magnetic materials, examination shall be by the dye penetrant method. **(Mod.)**

4.10.4.6.2 All welds in auxiliary piping, including seal welds and pipe to case welds, shall be heat treated, hardness tested in accordance with ASME B 31.3 and examined by magnetic particle or dyepenetrant. **(Mod.)**

4.10.5 Impact Test Requirement

4.10.5.1 For materials and thickness not covered by the code, the vendor shall indicate in the proposal, the recommended inspection and testing level. For materials, other than Austenitic stainless steel, in service below -29°C, Vendor shall require a charpy V-notch impact test of the base metal and of the weld joint. **(Mod.)**

4.11 Nameplates and Rotation Arrows

4.11.3 The text on nameplates shall be in English language unless otherwise specified the data in SI Units. The information on nameplates shall include the year of manufacture. **(Mod.)**

5. ACCESSORIES

5.1 Starting and Helper Drivers

5.1.1 General

5.1.1.2 Starting steam turbines shall be general-purpose steam turbines conforming to API Standard 611 and [IPS-M-PM-240](#). (Sub.)

5.1.1.3 Unless otherwise specified helper steam turbines shall be special-purpose steam turbines conforming to API Standard 612 and [IPS-M-PM-250](#). (Sub.)

5.1.1.6 If a diesel engine is specified for starting, it shall be per [IPS-M-PM-290](#). (Mod.)

5.1.1.7 Starter drives shall be declutched when the gas turbine is running. Re-engagement of the clutch shall be prevented before the gas turbine rotor is completely stationary. (Mod.)

5.1.1.10 The gas for the starter shall not be extracted from the fuel system. The vendor shall furnish a separate connection and piping system from the starter to his limit of supply. Exhaust from a gas expansion starter shall not be connected to any common vent system. (Mod.)

5.1.1.11 Lubrication for gas expansion starters shall be taken from the common lubricating oil supply system for the gas turbine. Systems requiring operator attention for starter lubricant oil levels are not permitted. (Add.)

5.1.1.12 Starting equipment located within the air intake plenum shall have all bolts and fastenings wire-locked to prevent inadvertent loosening or detachment. (Add.)

5.1.2 Ratings

5.1.2.2 Gas turbine vendor shall specify helper driver rating whenever it is not specified by the purchaser, as a minimum it shall satisfy the requirements of 5.1.2.1. (Mod.)

5.1.3 Turning Equipment

5.1.3.1 Means shall be provided for manually turning all rotor's for maintenance and alignment checks. (Mod.)

5.2 Gears, Couplings and Guards

5.2.1 Gears

5.2.1.2 Load gear and helper driver gears shall separate coupled units and shall comply with API Standard 613 and [IPS-M-PM-300](#)". (Sub.)

5.2.2 Couplings and Guards

5.2.2.3 Dry flexible disk coupling with restrained spacer shall be used unless approved otherwise by Company. Flexible disc material shall be stainless-steel. Non-sparking guards are required. Unless otherwise specified, all couplings and guards shall conform to the requirements of API Standard 671 and [IPS-M-PM-310](#). (Mod.)

5.2.2.4 For both power generation and mechanical drive units, spacers of adequate length shall be provided to allow removal of coupling hub and driven equipment bearing and seals without disturbing the shafts. (ADD)

Note: Lengthening the coupling spacer may lead to undesirable torsional vibrations.

5.3 Mounting Plates

5.3.1 General

5.3.1.1 The gas turbine unit with starting equipment, lubrication system and other auxiliaries shall be supported by a single rigid steel base plate, unless otherwise specified. The base plate shall be a continuous structural member designed to support the driven equipment. **(Sub.)**

5.3.1.2.5 Base plates shall be provided for epoxy grout unless otherwise specified. **(Mod.)**

5.3.1.2.10 Anchor bolts shall be provided by the Vendor, unless otherwise specified **(Sub.)**

5.3.2 Base Plate

5.3.2.3 Delete "when specified" from this clause. **(Mod.)**

5.3.2.7 Replace the last sentence of this clause by:

All necessary shims, sole-plates and leveling screws shall be provided by the Vendor.

(MOD.)

5.3.2.8 For parts requiring maintenance or operation access that are installed at elevation 70 cm or higher from grade level, the vendor shall provide decking, walkways and platforms, unless otherwise specified. **(Mod.)**

5.3.2.10 Pedestals requiring either heating or cooling for controlling the effects of thermal expansion, require the approval of the Company. **(Add.)**

5.3.4 Offshore/steel structure applications **(ADD)**

5.3.4.1 **When**
specified, for offshore application and for installation on a steel support structure, the baseplate shall be designed for three-point resilient mounting. **(ADD)**

5.3.4.2 All connecting cabling and pipework shall be anchored to the baseplate to prevent pipework misalignment caused by piping or cabling movements.

(ADD)

5.4 Controls and Instrumentation

5.4.1 General

5.4.1.1 Add to the end of this clause and "[IPS-M-PM-320](#)". **(Mod.)**

5.4.1.4 The control and instrumentation system shall protect personnel and plant against injury or loss under all conditions of operation or malfunction. The monitoring and supervisory instruments shall provide information for the diagnosis of the gas turbine health during operation and for warning of deterioration of its condition. **(Mod.)**

5.4.1.5 The gas turbine shall have a fully self-contained control system including:

- A fully automatic start-up, which may be initiated from a single push button or by a remote signal.

- Automatic acceptance of load, including adjustment of speed as necessary.
- Adjustments to speed or load in response to a remote signal.
- Manual adjustments of speed or load from the control panel.

The control system shall not permit a turbine inlet temperature in excess of the maximum allowable temperature with increasing ambient temperature.

Whenever hydraulic type governors are specified, a separate hydraulic oil system shall be furnished for them. **(Mod.)**

5.4.1.7 The instrumentation and control system may require signals from primary elements outside the Vendor's scope of supply. Conversely, the Vendor's instrumentation and control system may be required to supply information to the Purchaser's control system. In such cases, the Vendor shall liaise with the Purchaser regarding these interface requirements. **(ADD)**

5.4.1.8 Unless otherwise specified, primary instrumentation elements shall be mounted within the limits of the baseplate(s) of the gas turbine and its driven equipment. All signal processing and monitoring shall be performed within a separately mounted control panel.

(ADD)

5.4.2 Starting control systems

5.4.2.2 The purge period shall be active irrespective of the mode of starting. If specified the manual system shall include a mandatory purge period. **(Mod.)**

5.4.2.6 The starting sequence shall be monitored by an annunciator panel which shall indicate each stage of the startup in sequence. If there is a failure in starting the gas turbine, the controls shall initiate a normal shutdown procedure for the gas turbine and its driven equipment, and shall lock the train out of service. The sequence annunciator shall hold at the state at which failure occurred. **(Add.)**

5.4.3 Load control

5.4.3.7 An over speed trip device shall operate at a minimum of 105 percent of maximum continuous speed. Multiple shaft turbine shall have individual over speed trip device for each shaft. **(Add.)**

5.4.3.8 Control-signal actuation or failure of the signal or actuator shall not prevent the governor from limiting over speed to a minimum of 105 percent of maximum continuous speed. **(Add.)**

5.4.4 Alarms and shutdowns

5.4.4.2 a) The normal shutdown procedure shall not use the Emergency Shutdown (ESD), but shall allow the gas turbine to shut down in accordance with a controlled program. The program shall provide for any necessary post-shutdown lubrication, and where applicable, shall maintain the ventilating system of the acoustic enclosure in operation. All electricity supplies shall remain alive after normal shutdown of the gas turbine. **(Mod.)**

5.4.4.4 The vent from this valve shall not be connected to any other venting or blow down system. **(Mod.)**

5.4.4.7 annunciated alarm and shutdown conditions shall include as minimum those listed in Table -2, plus the following alarms and/or shutdowns.

TABLE- 2

CONDITION	ALARM	ANNUNCIATED SHUTDOWN	ESD
ATOMIZING AIR LOW PRESSURE	x		
INSTRUMENT AIR LOW PRESSURE	x		
INSTRUMENT AIR UNACCEPTABLE LOW PRESSURE		x	
HIGH LUBE OIL TEMPERATURE AFTER COOLER	x		
UNACCEPTABLE HIGH LUBE OIL TEMPERATURE AFTER COOLER		x	
FIRE DETECTION	x	x	x*
GAS DETECTION	x		
COMBUSTOR STAGE FLAME OUT	x	x	

* The emergency lube oil pump shall remain in operation. **(Mod.)**

5.4.5.2 When specified, the table mounted Visual Display Unit (VDU), shall be furnished in addition to the panel mounted. Microprocessor-based turbine control system, shall be provided with a communications port. **(Mod.)**

5.4.6 Electrical System

5.4.6.1 If equipment for the gas turbine requires other voltages than specified by the purchaser, the vendor shall provide appropriate transformer-rectifier systems, batteries and circuit breakers. Electrical motors used as auxiliary drivers shall be per [IPS-M-EL-132](#). **(Mod.)**

5.4.6.6 Delete "When specified" from this Clause. **(Mod.)**

5.4.6.7 Power cabling to motors and heaters will be run directly from the motor control center to the motor or heater terminal boxes without intermediate junction boxes. The vendor shall provide routes and supports for the purchaser's site-run cabling.

All other site-run cabling shall terminate at junction boxes located at the edge of the base plate, at a location agreed with the purchaser. The size of junction box cable gland for the purchaser's cable shall be agreed with the purchaser. **(Mod.)**

5.4.7 Instrumentation

5.4.7.1.1 With regard to the gas flow path, instrumentation shall be provided to monitor flow path temperature at least at the following locations:

- 1 - air compressor inlet;
- 2 - air compressor outlet;
- 3 - power turbine nozzle inlet, where applicable;
- 4 - power turbine exhaust diffuser.

At least two temperature detectors shall be provided for each of the locations 2, 3 and 4. At location 4 there shall be sufficient detectors to monitor the temperature distribution in the circumference of the exhaust plenum and give an indication of the performance of the individual combustion chambers. Each detector shall be suitable for the operating temperature at the point of application, and the Vendor shall state the maximum allowable spread of temperature from the average. **(ADD)**

5.4.7.1.2 Pressure indication shall be provided at the following locations:

- 1 - air compressor inlet;
- 2 - air compressor outlet;
- 3 - exhaust outlet.

All the above sensors shall have transmitters, if not otherwise agreed. The signal from each transmitter shall display the corresponding pressure on the control panel.

(ADD)

5.4.7.5 Thermocouples and Resistance Temperature Detectors

Replace the last sentence of this clause by:

Monitors shall be supplied, installed, and calibrated in accordance with API Standard 670.

(SUB)

5.4.7.8 Vibration and Position Detectors

5.4.7.8.2 Delete "when specified" from this clause.

(Mod.)

5.4.7.8.4 Delete "when specified" from this clause.

(Mod.)

5.4.7.8.5 All vibration detection devices mounted on the gas turbine shall be suitable for the prevailing temperatures. Equipment mounted on the gas turbine shall be suitable for the prevailing temperatures. Equipment mounted on the hot parts of the turbine shall have an operating temperature of not less than 250°C. Field amplifiers, proximitors, etc., shall be installed in steel or cast aluminum boxes, according to the requirements of the area classification, to protect them against mechanical damage.

(Add.)

5.4.7.8.6 Vibration read-out instrumentation shall be mounted on the control panel. It shall provide for a continuous analogue read-out of the rms velocity of vibration and for preset alarm and shutdown signals.

(Add.)

5.5 Piping and Appurtenances

5.5.2 Oil Piping

5.5.2.2 Lubricating oil, control oil and fuel oil piping around the gas turbine shall be arranged to prevent a hazardous situation developing from oil leaking or spraying onto hot turbine insulation in the event of a pipe or pipe joint failure. Where this requirement cannot be met by selected routing of the pipe-work, appropriate baffle plates shall be installed to prevent a hazard as described from occurring.

(Add.)

5.5.3 Inlet and Exhaust Systems

5.5.3.4 Lifting davits, platforms, access ladders and airtight doors shall be furnished for maintenance of the inlet air filter media. Air intake plenums shall be fitted with wired glass windows and interior lighting to allow for on-stream inspection of the gas turbine air inlet.

(Mod.)

5.5.3.10 Anti-icing systems to warm the air entering the gas turbine inlet air filter shall be set to operate automatically when the ambient temperature drops to +5 °C.

The following anti-icing systems are approved:

- direct injection of gas turbine air compressor bleed air;
- separately fired tubular heat exchanger;

- exhaust gas heated tubular heat exchanger;
- enclosure ventilation exhaust stream re-circulated to the air intake.

The recirculation of gas turbine exhaust gases directly into the air inlet is not permitted. Air heat exchanger material shall resist against corrosion. **(MOD)**

5.5.3.12 Provision shall be made to prevent exhaust gases escaping into the turbine room, or acoustic enclosure. **(Add.)**

5.5.4 Inlet Filters

5.5.4.1 The air filter shall be guaranteed to remove 95% of all particles 2 µm and larger, and 99% of all particles 10 µm and larger in the atmospheric air intake. The vendor shall state the allowable air approach velocity on the active face of the filter intake, and the respective velocities in all stages of the air filtration system. The pressure drop in the as new, clean condition shall be guaranteed. **(Mod.)**

5.5.4.6 The air filter shall be installed at highest possible elevation. **(Mod.)**

5.5.4.8 d. Details of construction and assembly, which include a list of the construction materials

e. Material description of all filter media.

f. Details of the closures and the details shall be subjected to purchaser's approval **(Mod.)**

5.5.4.9 Unless otherwise specified, all internal cladding downstream of the air filter shall be fabricated in AISI 316L stainless steel. **(Add.)**

5.5.4.10 The air filter and its housing shall be an integral unit designed and supplied by the air filter vendor. The air filter house shall have a single-piece roof, fabricated from either a single piece of plate, or continuous fillet welding. The roof shall be sloped to shed rain water. Roofs comprising bolted or similarly fastened sections with mastic sealant are prohibited. Joints between the air filter and filter house shall be fully airtight. Joints requiring greater than 2 mm thickness of sealant are not acceptable. **(Add.)**

5.5.4.11 The complete air filter assembly within the filter house shall be erected for inspection in the Vendor's works. Where specified by the purchaser, a smoke test for air leaks shall be conducted. **(Add.)**

5.5.5 Inlet and Exhaust Silencers

5.5.5.1.3 The baffle packing material shall not contain asbestos. **(Mod.)**

5.5.5.1.4 Unless otherwise specified, air intake silencers installed downstream of the intake filters shall be fabricated from AISI type 316L stainless steel. **(Mod.)**

5.5.7 Expansion Joints

5.5.7.1 The exhaust expansion shall permit movement of at least 50 mm in the axial and 19 mm in the lateral directions. Internal liners shall allow for offset or rotational movements required. **(Mod.)**

5.5.7.2 Delete "may" from this clause and substitute "shall". **(Mod.)**

5.6.2 Inlet Air Cooler Heat Exchanger

Replace the last sentence of this clause by:

5.6.2.3 Additionally, the Vendor shall provide all controls and instrumentation required to ensure that the GT and cooling system operate as a integrated unit. The Vendor shall advise details of all controls and instrumentation being supplied. **(MOD.)**

5.7 Insulation, Weather Proofing, Fire Protection and Acoustical Treatment

5.7.1 Insulation

5.7.1.1 Ceramic tile insulation shall be provided for turbine casings. **(Mod.)**

5.8 Fuel System

5.8.1 General

5.8.1.1 The manufacturer shall state in his proposal if any treatment is considered necessary for the intended fuels. **(Mod.)**

5.8.1.2.5 Delete "when specified" from this clause. **(Mod.)**

5.8.2 Gaseous Fuel

5.8.2.1 The manufacturer shall state the maximum variation which can be accepted in composition, heating value, wobbe index, hydrocarbon and water dew points, and its pressure and temperature for the fuel intended. **(Mod.)**

5.9 Special Tools

5.9.2 when special tools are provided, they shall be packaged in separate, rugged metal boxes and marked "Special Tools for (tag/item number)." Each tool shall be stamped or tagged to indicate its intended use. **(Add.)**

6. INSPECTION, TESTSING AND PREPARATION FOR SHIPMENT

6.1 General

6.1.1 The purchaser or his representative shall have the right to reject the equipment or any parts of equipment that do not conform to purchase order. **(Mod.)**

6.1.5 Vendor shall notice the purchaser at least 15 working days before conducting any inspection or test that is specified to be witnessed or observed. **(Mod.)**

6.2 Inspection

6.2.1 General

6.2.1.1 d) Delete "when specified" from this paragraph.

e) The manufacturer shall provide certificates to verify that the materials of construction meet the requirements of the material specifications and are in accordance with the approved proposal of the Vendor.

f) The different types of certificate which shall be used are distinguished as follows:

- Type A

Certificates by which the manufacturer confirms that the product supplied corresponds to the specification, on the basis of test results taken from the in-production testing of

products of the same material and same manufacturing method as the delivery concerned.

- Type B

Certificates by which the manufacturer's inspector confirms that the product supplied corresponds to the specification, on the basis of tests carried out on purchaser's equipment itself or on standard-specified test specimens related to that equipment.

The necessary testing shall have been carried out by a testing center which is independent of production in the manufacturing works and which has the necessary facilities at its disposal. When the independence of the testing center cannot be established, a Type C certificate shall be submitted.

- Type C

Certificates as described under Type B with the additional requirement that the tests shall be witnessed by an independent inspector who shall be approved by the Company

Certificates shall be valid only when stamped and signed by this independent inspector.

g) All certificates shall contain the following information:

- Name of manufacturer.
- Purchase order number and date.
- Manufacturer's order number.
- Identification number of certificate and its date of issue.
- Material specification (s).
- Dimensions in SI units, unless otherwise specified or applicable.
- Mechanical properties recorded from tests results.
- Chemical composition recorded from chemical analyses.
- NDT methods and results, where applicable.
- Heat treatment procedures, furnace charge number and heat treatment records, where applicable.
- Such supplementary or additional information as may be required.

All Type C certificates shall contain the following additional information:

- Name of the independent inspector who has witnessed the tests.
- The independent inspector's identification symbol.

Unless otherwise specified, materials covered by Type C certificates shall be hard-die stamped with a symbol identical with the identification symbol of the independent inspector, using low-stress dies.

h) As a minimum, materials certificates in accordance with Type A are required for

- i) As a minimum, material certificates in accordance with Type B are required for carbon steel pressure-containing parts with a design temperature of 400°C and above, for rotor shafts, discs and blading, for stationary blading and nozzle rings, and for the main nuts and bolts.
- j) Material certificates in accordance with Type C are required for pressure-containing parts of low and high alloy steels. **(Add.)**

6.2.1.3 a) All gas turbine combustion chambers and rotor parts (shaft, wheel, and blades) shall be examined by means of radiographic, magnetic practice, dye penetrant, or ultrasonic methods for surface and sub surface defects as specified by the purchaser.

- b) Shaft and wheel forgings shall be ultrasonically tested and inspected. Vendor shall identify blading inspection method (s) in proposal. **(Mod.)**

6.2.3 Mechanical Inspection

6.2.3.2 Add to the end of this clause.

and "[IPS-M-PM-320](#)" **(Mod.)**

6.2.3.4 Delete "when specified" from this clause. **(Mod.)**

6.3 Testing

6.3.1 General

6.3.1.3 Change "5 working days" into "15 working days" in first and second sentences of this Clause. **(Mod.)**

6.3.1.5 The chloride content of liquids used to test austenitic stainless steel materials shall not exceed 50 parts per million. To prevent deposition of chlorides as a result of evaporative drying, all residual liquid shall be removed from tested parts at the conclusion of the test. **(Add.)**

6.3.1.6 Test shall be maintained for a period of minimum four hours to permit complete examination of parts under pressure. The hydrostatic test shall be considered satisfactory when neither leaks nor seepage through the casing or casing joint is observed for the said period. Seepage past internal closure required for testing of segmented cases and operation of test pump to maintain pressure are acceptable. Use of any type of gaskets in axially split joints, including string or tape, is not permitted during hydrostatic testing. Post weld heat treatment shall be done prior to hydro testing. **(Add.)**

6.3.3 Mechanical Running Test

6.3.3.1.5 When all testing is completed, the idling adapters shall be furnished to the purchaser as part of special tools. **(Mod.)**

6.3.3.1.7 Auxiliary system mounted on a separated base shall be tested with whole turbine set. **(Mod.)**

6.3.3.1.8 Add after API Standard 614. "as amended/supplemented by [IPS-M-PM-320](#)" in this paragraph. **(Mod.)**

6.3.3.2.6 During the run test, the gas turbine shall run for at least 30 minutes at the minimum lubricating oil temperature, and for 30 minutes at the maximum lubricating oil temperature as dictated by the climatic conditions given in the requisition. During the tests, the performance of the

gas turbine shall be monitored, especially for vibration and maintenance of the specified lubricating oil pressures and temperatures. (ADD)

6.3.4 Optional Tests

6.3.4.1 Performance Test

Delete "when specified" from this clause. (Mod.)

6.3.4.2 Complete-unit Test

A complete unit test of the gas turbine complete with the driven equipment and all control auxiliary and accessory equipment under control of the contract control panel shall be carried out. All functions of the complete package shall be demonstrated to the satisfaction of the purchaser. The intake air filter, waste heat recovery equipment and exhaust silencer may be omitted from this test with the agreement of the purchaser.

The complete unit test shall be undertaken prior to delivery. The site of the complete unit test shall be by agreement with the purchaser. The vendor shall remain responsible for the equipment through out the complete unit test, and afterwards until the purchaser agrees to accept delivery.

The complete unit test shall be performed for all operating speeds up to one percent below trip speed. The test shall include a continuous run at maximum operating speed for a period of not less than 4 hours, following stabilization of temperatures and pressures.

Torsioanl vibration measurement shall be accomplished to verify the vendor's analysis.

All protection devices shall be demonstrated, including release of fire extinguish ant. The capability of the acoustic enclosure in containing the extinguish ant shall be demonstrated. Carbon dioxide may be substituted for the contract extinguish ant for this test. (Mod.)

6.3.4.2.1 Delete "when specified" from this clause. (Mod.)

6.3.4.3 Gear Test

Delete "when specified" from this clause. (Mod.)

6.3.4.4 Sound-level Test

The sound-level test shall be performed in accordance with [IPS-G-SF-900](#).

6.3.4.8 Governor Response and Emergency Over Speed Trip System Tests

6.3.4.8.3 For gas turbines driving alternators, tests shall be carried out to demonstrate the governor response at acceptance and rejection of load in 25, 50, 70 and 100% load steps. (Add.)

6.3.4.11 Other Tests and Inspection

6.3.4.11.1 Over-speed Test

Unless otherwise specified an over speed test of at least 115% of the maximum continuous speed shall be undertaken for a minimum period of 3 minutes upon all rotor discs, complete with blading.

After the over speed test, rotor discs shall be checked for cracks and defects by magnetic particle inspection. (Add.)

6.3.4.11.2 Air Filter Tests

When specified, the air filter and intake duct assembly shall be erected as a complete unit in the

manufacturer's works. All normal openings shall be sealed, and a smoke test shall be carried out at 1.2 kPa gage internal pressure. There shall be no visible leakage from any joints. The mechanical and electrical operation of the air filter cleaning mechanism, if fitted, shall be demonstrated to the satisfaction of the purchaser. **(Add.)**

6.4 Preparation for Shipment

6.4.1 The equipment shall be prepared suitable for 12 months of outdoor storage from the time of shipment. **(Mod.)**

6.4.3.9 No material shall be shipped separately. Miscellaneous parts shall be properly tagged or marked with the item number for which they are intended. All such parts shall be suitably boxed, firmly attached to the base plate, and shipped with the unit. **(Mod.)**

6.4.5 Auxiliary piping connections furnished on the purchased equipment shall be impression stamped or permanently tagged to agree with the vendor's connection table or arrangement drawing. Service and connection designations shall be indicated. **(Sub.)**

7. VENDOR'S DATA

7.2 Proposals

7.2.1 General

Vendor shall specifically state in his proposal that the system and all components are in strict accordance with API Std. 616 as amended or supplemented by this standard. **(Mod.)**

7.2.3 Technical Data

f) A list of spare parts for two years of continuous operation including spare rotor and price list shall also be submitted. **(Mod.)**

7.3 Contract Data

7.3.3 Technical Data

The vendor shall furnish a complete illustrated part list for all equipment supplied. **(Mod.)**

7.3.6 Installation, Operation, and Maintenance Manuals

7.3.6.3 Operating and Maintenance Manual

The manual shall contain information regarding acceptance/rejection criteria for wear and tear inside the turbine, e.g. acceptable crack length in blades, combustors, transmission pieces and other critical parts, unacceptable excessive clearances, etc. **(Mod.)**

8. GUARANTEE AND WARRANTY

8.1 Mechanical

Unless exception is recorded by the vendor in his proposal, it shall be understood that the vendor agrees to the guarantees and warranties described in 8.1.1 and 8.1.2. **(Add.)**

8.1.1 All turbine and component parts shall be warranted by the vendor against defective materials, design, and workmanship when operated under normal usage for 1 year after being placed in specified service but not exceeding 18 months (30 months for export) after date of shipment. **(Add.)**

8.1.2 If any mal-performance or defects occur during the guarantee and warranty period, the vendor shall make available repaired, altered, or replacement parts free of charge, free on board the

purchaser's job site.

(Add.)

8.1.2.1 The vendor shall make available, free of cost to the purchaser, qualified representatives as the vendor deems necessary to supervise the removal, repair, and replacement of defective parts in such manner that the warranty is maintained. **(Add.)**

8.1.2.2 The warranty period for repaired or replaced parts shall be 12 months after start-up of the repaired equipment but not more than 18 months after the equipment repairs are completed. **(Add.)**

8.1.2.3 The warranty period for the remaining equipment shall be extended by the number of days, or fraction thereof, that the equipment was inoperable because of warranty defects. **(Add.)**

8.1.2.4 Field labor charges for warranty work shall be subject to negotiation between the purchaser and the Vendor. **(Add.)**

8.2 Performance

The turbine shall be guaranteed for satisfactory performance at all operating conditions specified on the data sheet and the range between those points. The performance guarantee point shall be site rated power with no negative tolerance and site rated speed at the fuel rate quoted or some other point (such as load guarantee point) as mutually agreed upon by the purchaser and the Vendor. **(Add.)**

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APPENDICES**APPENDIX - C****PROCEDURE FOR DETERMINATION OF RESIDUAL UNBALANCE****C.4 Residual Unbalance Check.****C.4.2 Procedure**

C.4.2.3 Balancing machine shall be checked for sensitivity. As a base, the procedure in C5 and Figure C-1 shall be used for this purpose, unless otherwise specified in the data sheets. **(Mod.)**

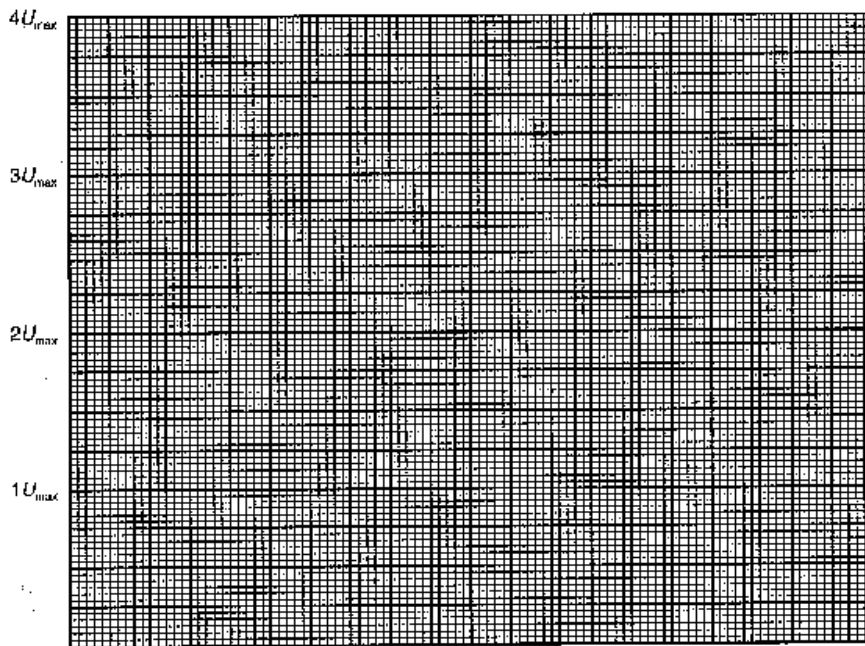
C.5 Balancing-Machine Sensitivity Check. **(Add.)**

C.5.1 Using the maximum allowable residual unbalance (U_{max}) determined for the specific rotor being tested, prepare trial weights for unbalance factors of $1/2U_{max}$, U_{max} , $2U_{max}$, and $4U_{max}$.

C.5.2 Sequentially install each trial weight at the phase angle of unbalance for the rotor being tested. Record the balancing-machine readings on the form shown in Figure C-1

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U_{max} factors	Balancing machine readout ^a
$\frac{1}{2}U_{max}$	
$1U_{max}$	
$2U_{max}$	
$4U_{max}$	



^aUse balancing-machine readouts to scale graph.

Figure C-1—Sensitivity Check Worksheet

C.5.3 Plot the readings on the graph shown in Figure C-1. Then draw a best-fit straight line through the four points. If the line intersects the vertical axis below $1/2U_{max}$, the balancing machine is sensitive enough, and the rotor should be rebalanced using the residual unbalance verification procedure. If the line intersects the vertical axis above $1/2U_{max}$, the balancing machine is not sensitive enough, and the results are unacceptable. **(Add.)**

C.5.4 The following three options are available when the results of the balancing-machine sensitivity check are unacceptable: **(Add.)**

- a. Have the balancing machine serviced in accordance with the manufacturer's procedure, and repeat the sensitivity check. **(Add.)**
- b. Use a more sensitive balancing machine. **(Add.)**
- c. Perform the sensitivity check at the balancing machine's highest allowable speed. This speed must then be used when the rotor is balanced. **(Add.)**

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APPEDIX - D**LATERAL ROTOR DYNAMIC ANALYSIS FOR USE WITH MODIFIED ROTOR BEARING
DESIGN OR PROTOTYPE GAS TURBINE.**

D.1.2.(f) Asymmetrical loading (for example, partial arc admission, side streams and eccentric clearances). **(Add.)**

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Note to Users

The IPS Standards reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS publications are based on internationally acceptable standards and include selections from the options stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement or diversity of conditions of each project or work.

For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The users of IPS publications are therefore requested to send their views and comments, including any addendum prepared for particular cases to the Ministry of Petroleum, Standards and Research Organization. These comments and recommendations will be reviewed by the relevant technical committee and will be incorporated in the formal revision of the relevant IPS. The IPS publications are reviewed and revised approximately every five years.

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