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Guidance on Industry Standard for API 616 Gas Turbines

GIS 34-303

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GIS 34-303. This Guidance on Industry Standard (GIS) is based on parts of heritage documents from the merged BP companies as follows:

Amoco

A RE-TURB-616-P	Rotating Equipment—Turbines—API 616 Gas—Procurement Specification.
A RE-TURB-616-G	Rotating Equipment—Turbines—API 616 Gas—Guide.
A RE-TURB-ENC-P	Rotating Equipment—Turbines—Gas Enclosures—Procurement Specification.

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Introduction

- a. Guidance for gas turbines is based on American Petroleum Institute (API) Standard 616, "Gas Turbines for the Petroleum, Chemical, and Gas Industry Services", Fourth Edition, August 1998.
- b. Guidance statements of this GIS are modifications to API 616.
- c. Modifications to API 616 are identified as Add, Modify to Read, or Delete.
- d. Paragraph numbers in this GIS correspond to API 616.
- e. Paragraphs of API 616 that are not revised remain applicable.

1 Scope

Add After First Sentence

If gas turbines are procured under the terms of a Rotating Equipment Initiative (REI) agreement with a vendor, then the commentary on API 616 agreed with the vendor shall take precedence over this document.

1.2 Conflicts

Modify to Read

In case of conflicts, order of precedence shall be:

- a. Local codes and standards.
- b. Purchase order/requisition/contract.
- c. Project data sheet/drawings.
- d. This GIS.
- e. Referenced BP documents.

2 References

2.1 Referenced standards

API

Delete

Std 611	General Purpose Steam Turbines for Petroleum, Chemical, and Gas Industry Services.
Std 612	Special-Purpose Steam Turbines for Petroleum, Chemical, and Gas Industry Services.
Std 613	Special-Purpose Gear Units for Petroleum, Chemical, and Gas Industry Services.
Std 614	Lubrication, Shaft-Sealing, and Control Oil Systems for Special-Purpose Applications.
Std 671	Special-Purpose Couplings for Refinery Service.



NFPAModify 72E to Read

72 National Fire Alarm Code.

Add

850 Recommended Practice For Fire Protection For Electric Generating Plants And High Voltage Direct Current Converter Stations.

Add**BP**

GIS 34-301 Guidance on Industry Standard for General Purpose Steam Turbines (API 611).

GIS 34-302 Guidance on Industry Standard for Special Purpose Steam Turbines (API 612).

GIS 34-501 Guidance on Industry Standard for Special Purpose Gear Units (API 613).

GIS 34-503 Guidance on Industry Standard for API 671 Special Purpose Couplings.

GIS 34-701 Guidance on Industry Standard for ISO 10438 Lubrication, Seal Oil, and Gas Seal Systems (API 614).

GIS 34-705 Guidance on Industry Standard for API 670 Machinery Protection Systems (**A RE-MNTR-670-E**).

GIS 14-XXX Guidance on Industry Standard for Noise Control (RP 14-1 or **A EN-NC-00-P**).

4 Basic design**4.1 General****4.1.1** Add

- a. For liquid fuel units, vendor and purchaser shall jointly determine which additional measures or equipment may be necessary to meet these service criteria.
- b. Turbines shall have 16 000 hr, minimum, operating experience in the field under similar ambient and operating conditions, including speed range.
- c. Design changes in hardware, materials, or fuel control system from vendor's 16 000 hr experience design shall be described in proposal.

Upgrading to increase power output is prevalent in today's gas turbine industry. This is normally accomplished by increasing firing temperatures and/or adding cooling schemes. Vendors justify this approach by resorting to theoretically superior materials, better coatings, and blade cooling techniques. Some of these methods and materials may not have been adequately proven, since there is a complex array of materials and coatings on the market. Considering the complexity of a gas turbine, there is no substitute for relying on extended field experience as a means of ensuring selection of reliable equipment.

Experienced turbine vendors familiar with manufacturing proposed units should be considered. Manufacturer should have built turbines similar to proposed turbine, including instrumentation and control apparatus, and these units should have been in continuous service for at least 2 years.



4.1.5 Add

- a. Gas turbine site rated guaranteed kW (hp) shall be 110%, minimum, of driven equipment guaranteed maximum kW (hp), including drive losses.
- b. Multishaft gas turbines driving centrifugal compressors shall achieve specified design conditions at no more than 90% of maximum continuous speed (94.5% of rated speed).
- c. Single shaft units shall be selected at 100% of rated speed.
- d. For mechanical drive, output shaft speed range shall be as specified by Purchaser.

Experience has indicated that an additional margin of 10% higher than rated kW (hp) is necessary due to deviations or calculation errors in: combustion temperatures, fuel composition, kW (hp) requirements, etc. This margin provides operating flexibility.

Single shaft machines are designed for highest efficiency at rated speed because they are typically run at a single speed as generator drives. Additionally, a single shaft machine tends to lose efficiency at lower speeds more dramatically than a multishaft machine. Multishaft machines generally have a low efficiency loss under a fairly large operating range.

4.1.13 Add

- a. If practical, the inlet plenum shall have one access door/hatchway to allow personnel entry by removal of access door/hatchway only. Doors and hatchways may be impractical on smaller turbines (due to physical size of plenum), and in such cases, every effort shall be made to allow easy removal of inlet plenum for inspection purposes.
- b. If practical, the inlet plenum shall have viewing windows on each side to allow:
 - 1. Air intake to inlet of compressor to be observed during online operation.
 - 2. Observation of compressor washing.

4.1.16

Special tools required for onsite replacement should be purchased from equipment vendor. Purchase of tools and spare parts with equipment may be more economical than at a later date. Vendor should recommend spare parts. Spare parts lists should be checked by BP maintenance foreman. Ensure compliance with maintenance contract (if in place) as regards the holding of spares, service tools, special lifting equipment etc.

4.1.18

Cold alignment check is important because it is used as a benchmark for future hot alignment calculations and checks.

4.1.19 Add

Special protection that purchaser may need to supply for reliable operation of gas turbine unit under specified site conditions shall be listed in proposal.

4.2 **Pressure casings****4.2.9** Add

If practical, both inboard and outboard of compressor/turbine and driven equipment shafts shall be accessible for field balancing by removing only access panels. If it is not possible to gain access to inboard shafts (due to design and/or physical size constraints), balance within required limits shall be achievable using outboard shafts only.



4.3 Combustors and fuel nozzles

Dry Low Emissions (DLE) combustors shall be considered to minimise life cycle environmental costs.

Wet fuel gas and liquids may cause major problems in gas turbines. Properly sized fuel filter/separators and piping may minimise fuel problems. Gas fuel piping should be designed and heated (if necessary) to ensure no fuel condensation. On a gas fuel stream that has been compressed by reciprocating compressors, vertical coalescers should be considered to eliminate oil droplets in fuel.

4.4 Casing connections

4.4.3 Add

Use of threaded connections under these conditions shall be subject to BP approval.

Refineries and chemical plants, where industrial gas turbine machines typically may be installed, do not allow threaded connections in flammable or toxic services. Aero-derivative type gas turbines typically use threaded connections.

4.4.7 Add

Connections to be broken for onsite maintenance and repair shall be accessible for disassembly without moving machine.

4.5 Rotating elements

4.5.1 Shafts

4.5.1.3 Modify First Sentence to Read

Load shaft ends shall comply with GIS 34-503.

4.5.2 Rotors

If rotor has not been stored vertically, rotor sag limits should be checked and rotor sag avoidance procedures followed. Rotor sag may be a problem on industrial gas turbines but is seldom a problem on aero-derivative turbines.

4.5.3 Disk and blading

4.5.3.2

Surge and stall operating conditions, as well as excessive temperature gradients, may put excessive loading on blading, leading to premature failure. Combustion flow patterns should be checked, particularly on upgraded units.

4.5.3.3

Vendors normally provide interference diagrams showing that natural frequencies are not coincident with order related excitations. Low cycle fatigue may occur during startups, shutdowns, and off design operating conditions.

Add

4.5.3.5 Windmilling restrictions and measures necessary to comply with restrictions shall be stated.

Windmilling is free wheeling of rotor by entrance of air if machine is not running and causes problems by wiping babbitted bearings.

