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Guidance on Industry Standard for API 11PGT Packaged Combustion Gas Turbines

GIS 34-304

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GIS 34-304. The Guidance on Industry Standard (GIS) is based on parts of the heritage document from the merged BP companies as follows:

Amoco

A RE-TURB-ENC-P Rotating Equipment—Turbines—Gas Enclosures—Procurement Specification.

BP (Pre-1999)

GS 134-12 Packaged Gas Turbines to API RP 11PGT.

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Introduction

- a. Guidance for packaged combustion gas turbines is based on American Petroleum Institute (API) Recommended Practice (RP) 11PGT, "Recommended Practice for Packaged Combustion Gas Turbines", First Edition, May 1992.
- b. Guidance statements of this GIS are modifications to API 11PGT.
- c. Modifications to API 11PGT are identified as Add, Modify to Read, or Delete.
- d. Paragraph numbers in this GIS correspond to API 11PGT.
- e. Paragraphs of API 11PGT that are not revised remain applicable.

Section 1 - General

1.1 Scope

Add

If gas turbines are procured under the terms of a Rotating Equipment Initiative (REI) agreement with a vendor, then the commentary on API RP 11PGT agreed with the vendor shall take precedence over this document.

1.2 Alternative designs

Modify to Read

- a. Requirements alternative to those prescribed may be acceptable, provided that it can be shown to satisfaction of BP that required performance and function is attained.
- b. Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised, provided that it can be shown to satisfaction of BP that they meet or exceed requirements of referenced standards.

1.3 Conflicting requirements

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.

1.5 Reference publications

NEMA

Add

SM 24

Land Based Steam Turbine Generator Sets 0 to 33 000 kW.



NFPAAdd

12	Standards for Carbon Dioxide Extinguishing Systems.
750	Standard on Water Mist Fire Protection Systems.
850	Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations.
2001	Standard on Clean Agent Fire Extinguishing Systems.

Modify 72E to Read

72	National Fire Alarm Code.
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Add**BP**

GIS 34-503	Guidance on Industry Standard for API 671 Special Purpose Couplings.
GIS 34-705	Guidance on Industry Standard for Machinery Protection Systems (A RE-MNTR-670-E).
GS 134-13	Packaging of Rotating Machinery for Offshore Use.
GS 136-1	Materials for Sour Service.
GP 12-45	Guidance on Practice for Electrical for Packaged Systems.
P546-1	Functional Specification Water Mist Fire Extinguishing System For Turbine Enclosure, author F. Tucker (GIS standard to be created from this document in due course).

British Standards Institute (BSI)

BS 5306 Part 4	Fire extinguishing installations and equipment on premises – Part 4: Specification for carbon dioxide systems.
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Section 2 - Basic package design**2.1 Site specific requirements****2.1.3 Site rating condition**Modify Second Sentence to Read

Gas turbine shall be designed to provide site rated power with no negative tolerance at heat rate and firing temperature quoted.

It is important to specify minimum loads in addition to maximum loads to permit correct design of combustors, burners, and fuel control system.

2.1.4 Starting requirements

It is important to specify any requirement for rapid starting and rapid loading from cold and the frequency of such operation. It generates high thermal stresses and can lead to low cycle fatigue if repeated too often. Lightweight aero-derivatives are generally more tolerant than heavyweight industrial designs, but all will be affected, and this potential mode of failure can become life limiting.

2.1.5 Transient requirements

It is important to specify the rate at which load is accepted and rejected. It can influence the life of the machine (see 2.1.4) and design of control systems. It is



particularly relevant for generator drives, where load changes can be large and rapid.

2.1.9 Site condition/environment

2.1.9.1 Add

For equipment installed on floating units, maximum motions, including trim, inclination, roll and pitch, shall also be specified.

2.1.10 Sound level

Maximum allowable sound pressure level of 85 dB(A) at 1 m (3 ft 3 in) from exterior surface of package enclosure is commonly specified.

2.1.12 Fuels

Although gas turbines can burn numerous fuels, it is important that the full range of fuels, composition, and calorific value are specified because, once set up, gas turbine flexibility with respect to fuel is greatly reduced.

Additionally, fuel composition can affect rate of deterioration of hot gas path components and hence time between overhauls and maintenance costs.

2.2 Package design

2.2.3 Other equipment

Note that exhaust system is not included unless specified. It is common practice for gas turbine Vendor or packager to supply up to and including the silencer.

2.2.7 Rating condition

Modify to Read

Components of the package shall be:

- a. Mechanically designed and satisfactory for continuous service at potential maximum power, as defined in 1.4.19, corresponding to base load performance characteristics of gas turbine.
- b. Satisfactory for intermittent service at potential maximum power corresponding to peak load characteristics, i.e., components, such as couplings, gears and driven machines, shall not impose mechanical limit on output from unit.

See also clause 2.1.4.

2.2.9 Starting requirements

Add

Turning devices necessary to meet this requirement shall be provided.

2.2.10 Temperature/speed limits

Add

- a. Rotors shall be capable of withstanding momentary speeds up to 110% trip speed throughout full firing temperature range.
- b. BP shall be advised of inspections that would be required after such overspeed conditions occurred.

The ability to run above trip speed is of particular importance for electrical generator sets, where instantaneous loss of load may occur.



2.2.11 Package arrangementAdd

- a. Insulation for personnel protection shall be provided.
- b. Insulation shall be designed such that routine maintenance may take place without damage to insulation.

2.2.17 Compartment enclosure(s)

Acoustic enclosures are normally necessary for noise control.

Add**2.2.18 Packaging for offshore installations**

Packaging for offshore installations shall comply with **BP Group GS 134-13**.

2.3 Combustion gas turbine drive train mechanical equipment components**2.3.1 Combustion gas turbine drivers****2.3.1.2**

API 616 is not normally required. It is too prescriptive for what are highly standardised machines.

Add

2.3.1.4 Equipment shall be provided for continuous monitoring of vibration, preferably shaft displacement, otherwise casing acceleration.

- 2.3.1.5 a. Rotors shall be capable of safe operation on instantaneous loss of 100% site rated load and driven inertia, e.g., in event of load coupling failure.
- b. Ensuing overspeed shall not cause blades, discs, or shafts to fracture or separate.

This requirement may be difficult to meet for multi-shaft turbines, as inertia of power turbine may be relatively low. An alternative approach for such machines is to ensure that the probability of shafting, gear, or coupling failure is acceptably low. This would require:

- *Confirmation of integrity of systems subjected to high torques from mal synchronisation and short circuiting of generators (see clause 2.3.5.4.6).*
- *Avoidance of shear pin overload protection.*
- *Flexible membrane couplings to incorporate features to maintain drive in event of failure of flexible membranes.*

- 2.3.1.6 a. Rotor blades failure shall precede disc failure in event of excessive overspeed.
- b. Failed rotor blades shall be contained, preferably by turbine casing, otherwise by additional containment shield.

It is not usually practical to contain fragments of a failed disc. Prior failure of blades reduces disc loads and hence probability of disc failure.

2.3.1.7 If turbine is to operate in a corrosive atmosphere (e.g. marine environment, airborne corrosive gases, etc.) or with corrosive fuels, full details of rotor and stator blading and coating materials, together with experience of their use in similar service, shall be furnished with proposal.



2.3.2 Couplings and guards**2.3.2.2 Add**

- a. Couplings in main drive lines shall comply with GIS 34-503.
- b. Couplings should preferably be flexible membrane type but, for alternator applications, may be solid.

Add

2.3.2.9 Couplings incorporating a spacer piece(s) shall be of such design that the spacer piece is positively constrained to prevent separation from the coupling assembly in event of failure of flexible elements.

2.3.2.10 Full supporting information shall be provided to demonstrate that flexible elements of load and helper drive couplings have an infinite life under all conditions of torque, speed, axial movement, and lateral and angular misalignment that can be encountered in normal service and at start-up.

2.3.3 Auxiliary gears**2.3.3.2**

Accessory drives may incorporate gears and bearings that are lightly loaded in a specific application.

Gears that are too lightly loaded may experience problems of backlash. In addition rolling element bearings may suffer skidding of elements rather than rolling if they are too lightly loaded. Therefore, check Vendor experience with contract configuration and loading.

2.3.4 Load gears**2.3.4.1**

API 613 is very conservative. It is normally better to specify GIS 34-501, which incorporates API 613 and permits alternative cost effective design. For high pitch line velocities, above 120 m/sec, GIS 34 501 results in more reliable designs.

2.3.5 Driven equipment**2.3.5.2 Centrifugal compressors****2.3.5.2.1**

Centrifugal compressors should normally be ordered to GIS 34-101, which incorporates API 617.

2.3.5.2.2 Add

Gas turbine lube oil systems shall be separate from seal oil systems of compressors handling flammable gases.

It is impossible to exclude gas totally from seal oil. If combined system were used, there would be the possibility of introducing flammable gas into turbine.

2.3.5.3 Centrifugal pumps**2.3.5.3.1**

Centrifugal pumps should normally be ordered to GIS 34-201, which incorporates API 610.



2.3.5.4 Generators**2.3.5.4.3**

Generators should normally be ordered to GIS 12-801 and GIS 12-802.

Add

- 2.3.5.4.6 For generator drive applications, shafts, gears, and couplings shall be capable of withstanding 120% of maximum possible torque generated in event of 2 phase short circuit, without exceeding allowable yield stress of any component.

2.3.5.5 Reciprocating compressors

Reciprocating compressors should normally be ordered to GIS 34-104, which incorporates API 618.

Although torsional vibration must be carefully considered, problems in driving reciprocating compressors can be resolved.

Section 3 - Accessory systems**3.1 Starting systems****3.1.1 Add after First Sentence**

Unless approved otherwise by purchaser, helper drivers shall not be permitted.

3.1.3

Because it is necessary to accelerate the whole train to self sustaining speed, use of single shaft machines for mechanical drive applications requires careful study.

3.1.4 Modify First Sentence to Read

Steam turbines used as starting gas expanders shall be general purpose turbines in accordance with GIS 34-301.

3.2 Mounting systems**3.2.3 Baseplate design****3.2.3.6 Modify First Sentence to Read**

Non-skid decking or grating covering all walk and work areas shall be provided on top of the baseplate.

3.3 Enclosure and fire protection**3.3.1 General****3.3.1.1 Modify to Read**

Enclosure system consisting of the following shall be provided:

- a. Enclosure surrounding gas turbine and/or driven equipment. Enclosure also shall:
 1. Extend from gas turbine output shaft to edge of skid (beyond starter) and enclosing auxiliary equipment.
 2. Extend to cover load gears and driven equipment, if required by noise level limitations or weatherproofing criteria.
 3. Be mounted on one or more skids.
 4. Have lifting devices to allow removal of major components.

