



Document No.	GIS 34-302
Applicability	Group
Date	1 November 2004

Guidance on Industry Standard for ISO 10437 Petroleum, Petrochemical and Natural Gas Industries – Steam Turbines – Special-purpose Applications

GIS 34-302

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the second issue of Engineering Technical Practice (ETP) BP GIS 34-302.

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Introduction

- a. Guidance for special purpose steam turbines is based on ISO 10437:2003 which is technically equivalent to the American Petroleum Institute (API) Standard 612, Special Purpose Steam Turbines for Petroleum, Chemical, and Gas Industry Services, fifth edition, June 2003. (In the introduction to the ISO 10437:2003 the base document is stated to be the fourth edition of API 612, June 1995. Strictly speaking this is true in that, after revision, the fourth edition of ISO 10437:2003 became the fifth edition.)
- b. Guidance statements of this GIS are modifications to ISO 10437.
- c. Modifications to ISO 10437 are identified as Add, Modify to Read, or Delete.
- d. Paragraph numbers in this specification correspond to ISO 10437.
- e. Paragraphs of ISO 10437 that are not revised remain applicable.



2 Normative references

Add

BP

GIS 34-501	Guidance on Industry standard for API 613 Gears.
GIS 34-503	Guidance on Industry Standard for API 671 Special Purpose Couplings.
GIS 34-701	Guidance on industry standard for ISO 10438 (API 614).
GP 12-45	Guidance on Practice for Electrical for Packaged Equipment.
GP 14-YY	Guidance on Practice for Noise Control.
GP 30-65	Guidance on Practice for Control Panels.
GP 30-70	Guidance on Practice for Control and Instrumentation in Vendor Packaged Equipment.
GP 36-XX	Guidance on Practice for Positive Material Identification (A MM-TEST-PMI-S).
GP 42-10	Guidance on Practice for Piping Systems (ASME B31.3).
GP 44-60	Guidance on Practice for API 500 Area Classification.
GP 44-65	Guidance on Practice for IP 15 Area Classification.

Engineering Equipment and Materials Users' Association (EEMUA)

EEMUA Pub 140	Noise Procedure Specification (replaces OCMA specification NWG-1).
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Section 5 – Statutory requirements

Add

In case of conflicts, order of precedence shall be:

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

Section 6 – Basic design

6.1 General

6.1.1 Add

Turbines shall be sufficiently robust to withstand without damage results of occasional abnormal conditions of limited duration, such as surging of compressors or electrical faults on generators.

Normally turbines to ISO 10437:2003 are for use on continuous running duties. The number of starts experienced during the machine lifetime is therefore relatively small. Starting procedures designed to minimise casing transient thermal stresses are specified by the Vendor, therefore casing life is not critical.

However, it is essential to validate these assumptions on specific applications.



6.1.2 Modify to Read

- a. For electric power generation applications, turbine Vendor shall be responsible for coordination of design and for satisfactory functioning of complete unit, i.e., turbine, generator, transmission, and ancillaries. Turbine Vendor that supplies equipment that it has not manufactured shall in all respects be responsible for ensuring that designs of such items are compatible with each other and with turbine Vendor's own equipment.
- b. Satisfactory functioning of complete unit shall form part of turbine Vendor's contractual guarantee.
- c. For other applications, the driven equipment vendor should be normally responsible for overall coordination. Turbine Vendor shall cooperate with driven equipment vendor to facilitate development of complete unit.

Responsibilities defined in this GIS are generally valid. However, allocation of overall responsibility for train may vary on a case by case basis, depending upon application, technical complexity, and relative value of driving and driven equipment.

Turbine Vendor's responsibility should in any case include condenser and its auxiliaries.

Of particular concern is clarity of responsibility for the design of shaft ends and coupling/shaft fits; especially if the turbine is the only part of the equipment train being replaced/uprated.

6.1.4

It is important that BP completes the table of steam conditions in the data sheets and that the maximum and minimum values account for upset conditions e.g. failure of a boiler feeding into a main header. Vendors (particularly European ones) use this data to design their machines but also to set trip levels for protection against over stressing turbine blading.

6.1.6b)

ISO 10437:2003 acknowledges that careful consideration needs to be given to specification of minimum inlet steam conditions and coincident maximum exhaust conditions, to prevent oversizing of turbine.

Oversizing can lead to reduced efficiency at normal operating points, high governing stage stresses at first control valve point and potential overloading of blading. Nevertheless the ability of a turbine to deliver rated power at minimum conditions is needed if minimum conditions are likely e.g. if the steam to the turbine is at the end of a header.

For governing stage, tangential steam loading and blade heights increase if a reduced nozzle arc is used for normal operation, i.e., if size of inlet arc has been increased to accommodate off-design steam conditions.

An increase in tangential load or blade height increases bending stress.

Tangential load increases on two counts:

- *Number of moving blades exposed to nozzle arc reduces with reducing arc and hence load per blade increases.*
- *Energy drop across stage increases as percentage arc reduces. This happens because wheel bowl pressure reduces with reducing flow to wheel bowl.*

Blade height increases to compensate for reduced nozzle arc.

Increased nozzle area permits increased flow to turbine. Flow increases in response to increased load or same load at reduced conditions. Both situations should be



reviewed to ensure blading design is adequate for any operating limits identified and appropriate safeguards provided.

Machine costs and complexity can increase if 2π radian (360 degree) arc inlets or bypass control become necessary to meet these conditions.

A 40% increase in nozzle area over rated duty at normal conditions can generally be accommodated without compromising efficiency, strength, or costs.

Some Vendors (European principally) offer bypass governing to accommodate these requirements.

6.1.5e)

Operation of a compressor at high suction pressure can lead to increased power consumption and torques.

6.1.5f)

Sizing of control nozzles for condensing sections of extraction or induction turbines requires attention to avoid potential for overloading exhaust blading. Sizing of these nozzles should be reviewed with Vendor.

Maximum and minimum operating values of extraction or induction pressure should be established. This, together with nozzle areas, determines maximum possible flow and hence loading on blading. This needs to be considered in condensing section blade stressing and any operating limits identified and appropriate safeguards provided.

6.1.5h) Add

If uncoupled or unloaded operation is to be undertaken then a safety review of the operating procedure (especially of overspeed protection) shall be done before it is undertaken. This applies to factory testing and to site installations.

6.1.9c)

Measurement of shaft alignment at operating temperature is not easy. Care should be taken when choosing the alignment technique to employ so that errors are minimised.

Laser techniques exist that allow the "ambient to in service" movements to be monitored without the need to stop the machine but special equipment mounting brackets are needed in two orthogonal planes near the coupling.

6.1.15 Modify to Read

a. Noise limits shall be as defined in GP 14-YY.

At the time of creation of this GIS, GP 14-YY had not been written. The following can serve in place of GP 14-YY until it is developed.

1. Noise limits are normally specified in detail in an enquiry. However, in the absence of such requirements, noise levels at or beyond 1 m (3 ft) from machine (driver plus driven machine, transmission, and auxiliaries) surfaces should not exceed 85 dB(A).

The 85 dB(A) limit is based upon an 8 hour exposure. If operating shifts exceed 8 hours and maintenance activity may be required in the area of an operating turbine, limit may require to be reduced to 83 dB(A).

Sound intensity method for measuring noise level of equipment offers significant advantages over conventional sound pressure measurement techniques. These are:

- *Measurement of sound radiated from each surface or area of equipment. This enables principal contributors to overall noise level to be identified and reduced by locally applied absorption materials.*



- *Improved compensation for background and reverberative effects.*
- 2. If limits cannot be met without addition of noise attenuation features, levels with and without these features shall be stated in proposal. Noise attenuation measures proposed shall not conflict with other requirements of this GIS.
- 3. Vendor shall provide details of noise emission in octave bands from its equipment, obtained by methods of test specified in EEMUA Publication 140 or method of test approved by BP.
- 4. Noise attenuating enclosures are only acceptable if there is no alternate form of noise control. Design of these enclosures shall be such that normal operation and maintenance are not unduly compromised. Instrumentation and controls shall be either mounted externally to enclosure or shall be clearly visible and controllable from outside enclosure.
- b. Enclosures shall be adequately purged and cooled. Instrumentation, sensors, and cables installed inside enclosures shall not be subjected to an environment that causes component to be operated outside specified ambient temperature limits.
- c. If area classification would otherwise be Zone 2 (Division 2), equipment within enclosure shall normally be suitable for Zone 1 (Division 1) area. Refer to GP 44-65 (GP 44-60) for definition of Zone (Division).

7 Casings

7.1 Pressure casings

7.1.3

For turbines with dedicated condensers, relief valve mounted on condenser shell is required as part of condenser vendor supply (sized to H.E.I. requirements).

For other applications, ensure that relief valves are included in lines upstream of block valves.

7.1.6 Add

Proposals shall include details of case bolting arrangement showing the method of assembly and disassembly.

7.1.12 Add

Casing drains shall be individually valved and piped to edge of turbine base. Valves shall be accessible from operating floor.

7.1.14

Studded connections on casing nozzles hinder installation and maintenance since piping has to be sprung to remove casings or pipe spools.

Above circa 413 °C (775 °F) bolting is subject to creep stress relaxation and may require periodic replacement.

During dismantling if a nut or tapped thread binds, replacement of studs becomes problematic compared to through bolting, which can be sawed or burnt off.

7.1.15f)

Bolting, particularly at main casing horizontal joint may be large; spanner (wrench) tightening becomes impractical and hydraulic stretching or electric heating becomes essential.

