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Gas turbines — Acceptance tests

Turbines à gaz — Essais de réception

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International Standard ISO 2314 was prepared by Technical Committee ISO/TC 192, *Gas turbines.*

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This second edition cancels and replaces the first edition (ISO 2314 : 1973), of which it constitutes a technical revision.

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Gas turbines — Acceptance tests

1 Scope and field of application

1.1 This International Standard specifies standard procedures and rules for the conduct and reporting of acceptance tests in order to determine and/or verify the power, thermal efficiency and other performance characteristics of gas turbine power plants. It defines standard conditions which should be used if no other conditions are agreed at the time of purchase. [1] This International Standard is not intended to provide a basis for the conduct of test work generally aimed at development or research.

The extent of acceptance tests that are carried out on the manufacturer's premises and at site respectively are to be agreed between the parties.

1.2 The acceptance requirements will have been satisfied if the mandatory tests given in 1.4 have been fulfilled under the procedures laid down.

Optional tests may, however, be included but should not be considered necessary unless specifically agreed upon by the parties to the test at the time of the purchase.

1.3 This International Standard applies to open cycle gas turbine power plants using normal combustion systems and also includes closed cycle and semi-closed cycle gas turbine power plants. In cases of gas turbines using free piston gas generators or special heat sources (for example chemical process, nuclear reactors, furnace for a supercharged boiler), this International Standard may be used as a basis but will need to be suitably modified.

1.4 The primary object of the acceptance (mandatory) tests is to determine

a) power under specified operating conditions (gas power, if only a gas generator is supplied);

b) thermal efficiency, heat rate or specific fuel consumption under specified operating conditions;

c) adequacy of essential protective devices as defined in 7.1.3.

1.5 Optional tests may also be included, provided that these are specifically agreed upon by both parties at the time of purchase. For example, such tests may include any of the following items or others specified by national or local requirements:

a) performance of the governing system and protective systems as given in 7.2.1 and 7.2.2;

b) handling characteristics (for example, starting characteristics, time of loading);

c) amplitude and frequency of vibration;

d) stack emission;

e) waste heat recovery evaluation;

f) noise level;

g) thermal discharges;

h) anti-icing system.

2 References

ISO 5167, *Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits running full.*

ISO 6190, *Acoustics — Measurement of pressure levels of gas turbine installations for evaluating environmental noise — Survey method.*

1) Points on which an agreement between parties to the test is to be reached at the time of the purchase or prior to the test are indicated by a vertical line to the left of the relevant text.

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IEC Publication 34-2, *Rotating electrical machines — Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles).*

IEC Publication 46, *Recommendations for steam turbines — Part 2: Rules for acceptance tests.*

3 General definitions, description of terms and symbols

3.1 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1.1 gas turbine: Machine which converts thermal energy into mechanical work; it consists of one or several rotating compressors, thermal device(s) to heat the working fluid, one or several turbines, a control system and essential auxiliary equipment which allow the production of mechanical power in useful form. The gaseous working fluid passes continuously through the system, is compressed, heated and then expanded to develop useful mechanical power. Any heat exchangers (waste heat exchanger excluded) in the main working fluid circuit are considered to be part of the gas turbine.

3.1.2 gas generator: Combination of turbocompressor(s) driven by a turbine(s) with its combustion chamber, the whole providing hot gas under pressure. This combination may drive a separate power turbine, commonly having no compressor or combustion chamber.

3.2 Description of terms

3.2.1 Standard reference conditions

In cases where power, efficiency, heat rate or specific consumption refer to standard conditions, such conditions shall be:

a) for the intake air at the compressor flange (alternatively, the compressor intake flare) as detailed in 6.6.2 (see also figure 1):

- a total pressure of 101,3 kPa[1];
- a total temperature of 15 °C;
- a relative humidity of 60 %;

b) for the exhaust at turbine exhaust flange (or recuperator outlet, if recuperator cycle is used):

- a static pressure of 101,3 kPa[1].

An inlet water temperature of 15 °C shall apply if cooling of the working fluid is used. Except in the case where intercooling is involved, or where water spray coolers are used, the effect of humidity may generally be ignored.

In the case of the closed cycle, the standard conditions for the air heater shall be 15 °C and 101,3 kPa[1] for the ambient atmospheric air.

3.2.2 Power

Power may be expressed in terms of output at the turbine coupling, electrical power (see 8.1) at the generator terminals or gas power in the case of a gas turbine or gas generator producing gas or compressed air (bleed air from a circuit compressor).

3.2.3 Thermal efficiency and specific consumption of heat

Thermal efficiency or specific consumption of heat shall be based on the net specific energy, at constant pressure, of the fuel for either liquid, gaseous or solid fuel.

The specific energy used shall be based on a pressure of 101,3 kPa[1] and a temperature of 15 °C. Sensible heat above 15 °C shall be taken into account.

3.2.4 Cycle nomenclature

Figure 1 shows the basic nomenclature used in this International Standard. The station numbers refer to locations.

Ambient air conditions are read at station 1. Air conditions at the inlet of the compressor and leaving the compressor section

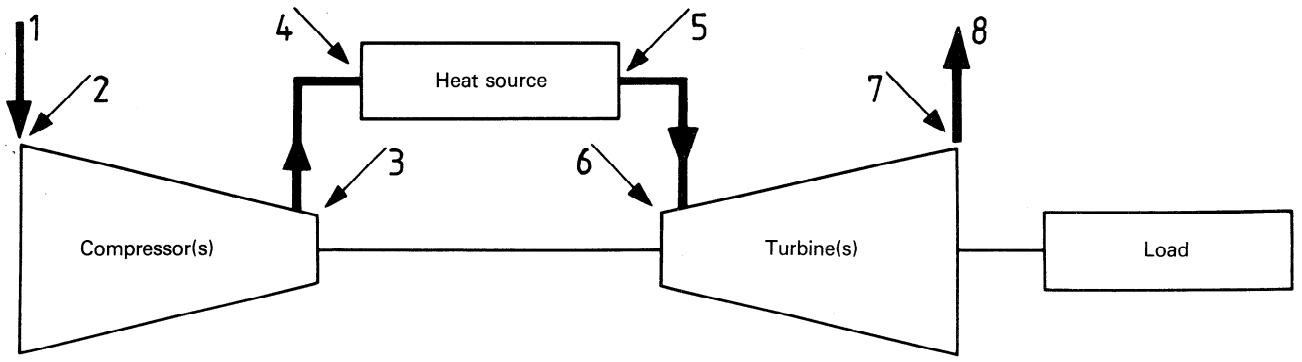


Figure 1 — Basic cycle nomenclature

1) 101,3 kPa = 1,013 bar ≈ 760 mmHg

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are read at stations 2 and 3, respectively. In the event that there is more than one compressor section, the location for reading air conditions at the exit of the first compressor section is designated as station 2.1 and the inlet of the second compressor section as 2.2. Station 4 is the entrance to the heat source (after recuperation, if any). Station 5 is the exit from the heat source, and the inlet to the turbine is station 6. If there should be more than one turbine, the exit conditions from the first turbine would be read at 6.1 and the entrance conditions to the second turbine at 6.2, etc. However, if a reheater were used in the cycle, then it would be 6.1 for the exit from the first turbine stage, 6.2 into the reheater, 6.3 out of the reheater, and 6.4 at the entrance of the second turbine. Exhaust gas conditions leaving the turbine are taken at 7 and leaving the stack at 8. In the event that heat recovery equipment is employed in the cycle, the entrance conditions to this equipment would be read at 7.1 and the exit conditions at 7.2, etc.

In addition to this nomenclature, the following letters designate the type of fluid in various parts of the cycle:

f = fuel;

g = gas after the heat source;

a = air (or other working fluid);

w = water;

b = lubricating fluid.

Example: The temperature of the fuel at the entrance to the heat source would be designated as T_{f4}.

It is recognized that many different systems of station location designators are in use instead of those shown in figure 1.

3.3 Symbols

The symbols and their meanings used in this International Standard are given in table 1, together with the unit and reference clause in which they are covered.

4 Preparation for tests

4.1 The acceptance tests shall normally be carried out immediately after the completion of the setting-up period by the manufacturer and, in any event, within a period of three months, unless otherwise agreed by both parties. In any case, before the tests, the machine shall be placed at the disposal of the manufacturer for examination and cleaning.

4.2 If pipes or ducts are fitted for the purpose of by-passing any component, or if bleed-off is used for any service, any values in such ducts or pipes shall be set so as to produce conditions specified in the guarantee.

4.3 Dimensions and physical conditions of parts of the gas turbine required for calculations or other special purposes of the tests shall be determined and recorded prior to the tests. Serial numbers and data on name-plates shall be recorded to identify the gas turbine engine auxiliary equipment tested.

4.4 Preliminary tests may be run for the purpose of

a) determining whether the gas turbine and associated plant are in a condition suitable for conducting an acceptance test;

b) checking instrumentation;

c) familiarization with test procedure.

After a preliminary test is made, it may, by agreement between the purchaser and contractor, be deemed an acceptance test.

5 Test operating conditions

5.1 General

5.1.1 Every reasonable effort shall be made to run the test as close as possible to the reference operating conditions (standard conditions or other specified conditions agreed at the time of purchase). Fuel employed for test shall, wherever possible, be such as specified in the guarantee or substantially similar to it in properties. In case this is not possible, prior agreement shall be reached between the parties to the test as to the fuel to be used at an acceptance test and as to the interpretation of the results.

5.1.2 For convenience, thermal efficiency tests in dual fuel installations may be carried out with one fuel only, but only after agreement between the parties to the test.

5.1.3 Control settings for the gas turbine shall be established prior to the test. Special adjustments inappropriate for normal engine operation require written agreement.

5.1.4 The test observation records shall be entered on carefully prepared forms which constitute original logsheets to be authenticated by the observer's signature. The original sheets and recorded charts shall be such as to permit facsimile reproduction as, for example, by carbon copies or by photocopying process.

Hand copying is not permissible. For the acceptance tests, a complete set of unaltered logsheets and recorded charts will become the property of the parties to the test. The observations shall include the date and time of day. They shall be the actual readings without application of any instrument corrections. The logsheets and any recorded charts shall constitute a complete record.

5.1.5 If, during the conduct of a test or during the subsequent analysis or interpretation of the observed data, an obvious inconsistency is found which affects the validity of the results, every reasonable attempt shall be made to adjust or eliminate the inconsistency by mutual agreement. Failure to reach agreement will invalidate the run or test.

5.2 Operating conditions

5.2.1 Certain tests, for example those of 1.4a), b) and 1.5e), f), will normally be carried out at steady-state conditions.

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