INTERNATIONAL STANDARD

ISO 3977-4

First edition
2002-06-01

Gas turbines — Procurement —

Part 4: Fuels and environment

Turbines à gaz — Spécifications pour l'acquisition —

Partie 4: Carburants et environnement

Reference number
ISO 3977-4:2002(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 3977 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 3977-4 was prepared by Technical Committee ISO/TC 192, *Gas turbines*.

ISO 3977 consists of the following parts, under the general title *Gas turbines — Procurement*:

— *Part 1: General introduction and definitions*

— *Part 2: Standard reference conditions and ratings*

— *Part 3: Design requirements*

— *Part 4: Fuels and environment*

— *Part 5: Applications for petroleum and natural gas industries*

— *Part 6: Combined cycles*

— *Part 7: Technical information*

— *Part 8: Inspection, testing, installation and commissioning*

— *Part 9: Reliability, availability, maintainability and safety*

Annex A of this part of ISO 3977 is for information only.

Introduction

This part of ISO 3977 was developed in order to establish conformity with regard to the use of gas turbine power plants. Gas turbines are being manufactured and installed at ever increasing rates. Also, there is worldwide concern over environmental related issues on both a regional and global scale. This part of ISO 3977 addresses the issues related to fuels used to operate such plants, and the emissions which are produced as a result gas turbine operation. It details the requirements which all parties should determine in advance to ensure successful installation which minimizes delays, maximizes operability, and has minimal impact on the environment.

Gas turbines — Procurement —

Part 4:
Fuels and environment

1 Scope

This part of ISO 3977 provides guidelines for procurement of gas turbines with consideration of the fuel quality and of the environmental performance. Guidance is given to both the packager and purchaser on what information should be provided with regard to the fuel used by a gas turbine, and with regard to the type of information necessary to quantify the expected environmental impact. Fuel specifications are referenced but not provided.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 3977. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 3977 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3977-1:1997, *Gas turbines — Procurement — Part 1: General introduction and definitions*

ISO 3977-3:2002, *Gas turbines — Procurement — Part 3: Design requirements*

ISO 4261:1993, *Petroleum products — Fuels (class F) — Specifications of gas turbine fuels for industrial and marine applications*

ISO 6190:1988, *Acoustics — Measurement of sound pressure levels of gas turbine installations for evaluating environmental noise — Survey method*

ISO 10494:1993, *Gas turbines and gas turbine sets — Measurement of emitted airborne noise — Engineering/survey method*

ISO 11042-1:1996, *Gas turbines — Exhaust gas emission — Part 1: Measurement and evaluation*

ISO 11042-2:1996, *Gas turbines — Exhaust gas emission — Part 2: Automated emission monitoring*

ISO 11086: 1996, *Gas turbines — Vocabulary*

3 Terms and definitions

For the purposes of this part of ISO 3977, the terms and definitions given in ISO 3977-1, ISO 3977-3, ISO 11086 and the following apply.

3.1
density
ρ

$$\rho = \frac{P_{\text{ref}}}{R \cdot T_{\text{ref}}}$$

where the reference temperature is typically selected as 15 °C and the reference pressure is 101,325 kPa

3.2
integrated gasification combined cycle
IGCC
process where a low quality fuel is gasified to produce a high quality fuel that meets the fuel specifications for a gas turbine

3.3
fuel-bound nitrogen
FBN
nitrogen component within the fuel which contributes to NO_x formation

NOTE This does not include nitrogen as gaseous N_2.

3.4
net specific energy
NSE
heating value determined with the combustion generated water in the vapour phase

NOTE 1 It is also known as the lower heating value. See also ISO 2314, ISO 4261 and ISO 6976.

3.5
relative density
specific gravity
⟨gaseous fuels⟩ ratio of the density of the fuel gas to the density of air

$$d = \frac{\rho_{\text{fuel}}}{\rho_{\text{air}}}$$

NOTE 1 For gases, temperature and pressures for both gases need to be specified.

NOTE 2 For liquid fuels, it is the density of the liquid fuel relative to water. The temperature of both fluids should be specified.

3.6
gross specific energy
GSE
heating value determined with the combustion generated water condensed, thus including the heat of vaporization.

NOTE It is also known as the higher heating value.

3.7
sound power level
L_W
ten times the logarithm to the base 10 of the ratio of a given sound power to the reference sound power

NOTE 1 The reference sound power is 1 pW (= 10^{-12} W).

NOTE 2 Sound power level is expressed in decibels.

NOTE 3 Based on ISO 10494.

3.8
sound pressure level
L_p
ten times the logarithm to the base 10 of the ratio of the square of the sound pressure to the square of the reference sound pressure

NOTE 1 The reference sound pressure is 20 µPa (= 2×10^{-5} Pa).

NOTE 2 Sound pressure level is expressed in decibels.

NOTE 3 Based on ISO 10494.

3.9
selective catalytic reduction
SCR
post-combustion catalyst system for reduction of NO_x emissions

3.10
volatile organic compounds
VOC
hydrocarbons such as propane and butane, which can interact with NO_x to form ground level ozone

NOTE VOCs are sometimes measured and reported as unburned hydrocarbons (UHC).

3.11
Wobbe index
WI

heating value of the fuel divided by the square root of the specific gravity (relative to air)

$$WI = \frac{NSE}{\sqrt{d}}$$

NOTE Because the specific gravity of a gas is dependent upon both temperature and pressure, the conditions where the density is determined for the both the fuel and air should be specified. See annex A for examples of calculations of the Wobbe index.

3.12
normal cubic metre
m^3 (normalized)
cubic metre of gas, usually dry, referenced to 1 atmosphere (101,325 kPa) and 0 °C

NOTE Although the unit Nm^3 is used in industry, this should not be used in International Standards.

4 Symbols (and abbreviated terms)

The following terms and symbols are used in this part of ISO 3977.

ρ	density of fluid or gas
p	pressure, in kPa
T	temperature, in K or °C
CEM	continuous emissions monitoring
PEM	predictive emissions monitoring

5 Purchasers' and packagers' requirements for fuels

5.1 General

Proper use and operation of a gas turbine requires that accurate information on fuel types and fuel requirements be obtained. Both the purchaser and the packager play critical roles in this process.

If there are no International Standards available, national standards as shown in annex C of ISO 3977-3:2002 may be used as guidelines with the mutual agreement of the purchaser and packager.

5.2 Purchaser's obligations

The purchaser has the responsibility to identify all fuels to be considered for the gas turbine project of interest.

The purchaser shall provide relevant, accurate data, consistent with the proposed project. As a general outline, the purchaser shall be knowledgeable about the following:

a) site ambient conditions (i.e. temperature, pressure, relative humidity, and mean and extreme conditions of these variables and altitude);

b) expected fuel classification for the project (i.e. raw natural gas, pipeline natural gas, coke oven gas, landfill gas, IGCC medium and low energy gases, refinery gases, etc.);

c) performance/load range of the gas turbine (i.e. hours of operation, time at specific load, use of power augmentation, etc.);

d) applicable local or regional regulatory authority requirements.

The purchaser shall be able to report detailed fuel properties and contaminant levels, including limits of variability (chemical and physical characterization), to the packager for review.

5.3 Packager's obligations

The packager shall define the fuel types and ranges of fuel qualities acceptable for the gas turbine application. These may include liquid and gaseous fuels; fuel emulsions may also be considered.

Note that the packager may specify a unique reference temperature (0 °C or 15 °C, for example).

5.4 Gaseous fuels

5.4.1 General

This subclause applies to all fuels that are in the gaseous state at the gas turbine interface. In certain cases, the fuel as delivered to the site may not be in the gaseous state. If multiple fuels are available, or required over the gas turbine operating envelope, complete information shall be provided for each. Based on the fuels expected to be used on a specific project, the purchaser shall provide the range of expected properties for each of the requirements listed in 5.4.2. It shall be the responsibility of the purchaser to control the chemical and physical properties, and the contaminant levels, for the fuel gas supplied, to be within the previously agreed upon limits at all times, and to protect the gas turbine from being fueled at any time with fuel not within the agreed upon limits.

5.4.2 Chemical properties

Fuel specifications shall comply with relevant national standards. The packager shall identify general fuel properties appropriate for the purchaser's application. The information required shall include normal chemical characteristics, and normal safety and handling properties. The purchaser shall provide the packager with the following information:

a) the full chemical composition of the proposed fuel gas(es);

b) specific energy (net and gross, both volumetric and mass basis); this may be determined analytically, or calculated from the chemical analysis;

c) Wobbe index at fuel supply temperature and pressure and the range of Wobbe index expected for fuel variations;

d) the presence of contaminants/components such as dust, rust, tar, naphthalenes, waxes or water, that may cause potential coking or fouling problems;

e) the presence of higher hydrocarbons, up to C14, if the gas turbine is to be equipped with lean-premix type combustors;

f) the minimum temperature necessary to prevent condensation at the fuel injection pressures.

Specific fuel components (or fuel additives) that may be corrosive or induce air emissions, including toxic emissions, shall be identified by the purchaser and reported to the packager for comment. The packager shall comment on the general acceptability of this fuel. The packager shall review the fuel property data, and comment on its appropriateness for the proposed gas turbine application. The packager's analysis shall be the basis for comments to the purchaser. The purchaser shall provide site emission constraints for each fuel.

5.4.3 Physical properties

For gaseous fuels, the packager shall provide technical data on pressure and temperature requirements for all fuels and fuel system components. These requirements shall include a review of the complete fuel analysis for the purchaser's application. Information furnished by the packager shall include:

a) supply pressure and temperature requirements (upper and lower limits);

b) dew point at given pressure and minimum temperature necessary to prevent condensation at fuel injection pressures;

c) minimum pressure requirements to start the gas turbine;

d) minimum pressure requirements to run the gas turbine;

e) the temperature range permissible for continuous operation;

f) filtration and liquids separation requirements;

g) allowable condensed liquids within the fuel supply to the gas turbine;

h) implications on gas fuel supply pressure from full speed no load to full load across the entire air ambient temperature range;

i) design Wobbe index range of the fuel for the gas turbine;

j) allowable gas fuel pressure variations (both short and long term).

In addition, the packager shall report on the compatibility of the fuel with specific combustion equipment, such as lean premix combustors, or other means of emissions suppression, such as water or steam injection.

5.4.4 Fuel treatment

To comply with packager and ISO 4261 fuel requirements, fuel treatment may be required. Based upon the physical and chemical properties of the fuel, the purchaser is responsible for providing fuel gas conditioned to the required specifications.