FINAL DRAFT
International Standard

ISO/FDIS 3977-9

Gas turbines — Procurement —

Part 9: Reliability, availability and maintainability

Turbines à gaz — Spécifications pour l'acquisition —

Partie 9: Fiabilité, disponibilité, maintenance

ISO/TC **192**

Secretariat: **ANSI**

Voting begins on:
2024-02-27

Voting terminates on:
2024-04-23

Member bodies are requested to consult relevant national interests in ISO/TC 67,ISO/TC 67/SC 6 before casting their ballot to the e-Balloting application.

Reference number
ISO/FDIS 3977-9:2024(en)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 192, *Gas turbines*.

This second edition cancels and replaces the first edition (ISO 3977-9:1999), which has been technically revised.

The main changes are as follows:

— safety aspects of the document were removed since this is a procurement standard.

A list of all parts in the ISO 3977 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This is a procurement standard developed for the aspects of reliability, availability and maintainability of gas turbines.

Gas turbines — Procurement —

Part 9:
Reliability, availability and maintainability

1 Scope

This document provides a basis for exchange of information about reliability, availability and maintainability between gas turbine manufacturers, users, consultants, regulatory bodies, insurance companies and others. It defines terms and definitions and also describes component life expectancy, repairs and criteria for determining overhaul intervals.

This document is applicable to all elements of the gas turbine and auxiliaries.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

ISO 11086, *Gas turbines — Vocabulary*

ISO 19859, *Gas turbine applications — Requirements for power generation*

ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3977-1, ISO 3977-3, ISO 11086, ISO 12100 and ISO 19859, and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
ageing
loss of *performance* (3.21) of a gas turbine due to wear and tear experienced in normal operation which is not recoverable by compressor cleaning, turbine cleaning, filter cleaning, etc.

Note 1 to entry: It is normally the result of increased seal clearances due to vibration and wear, loss of profile and increased blade surface roughness due to corrosion, erosion, etc

3.2
available
state in which a unit is capable of providing service, whether or not it is actually in service, regardless of the capacity level that can be provided

3.3
coating
in general, a consumable and generally replaceable overlay provided to protect the base material against corrosion and/or erosion and/or act as a thermal barrier.

3.4
condition monitoring
assessment of the condition of a gas turbine or its components by measuring those parameters which, over time, have been established to correlate with an incipient failure condition, and where the monitoring action is non- intrusive with respect to the equipment

Note 1 to entry: Any subsequent maintenance activity which is based upon a diagnosis of parts condition over time and executed in accordance with the monitored degree of deterioration, is referred to as "on-condition maintenance".

3.5
equivalent operating hours
weighted operating events affecting the life of the machine forming an equivalent operating time to determine inspection intervals or life expectancy

3.6
fired start
any start which achieves full ignition and applies heat to the gas path components

Note 1 to entry: For fired hours, see *service hours* (3.26).

3.7
failure
sudden and unexpected ending of the ability of a component or equipment to fulfil its function

3.8
forced outage
FO
unplanned component *failure* (3.7) (immediate, delayed, postponed) or another condition that requires the unit to be removed from service immediately or before the next planned *shutdown* (3.28)

3.9
forced outage hours
FOH
time, in hours, during which the unit or a major item of equipment was unavailable due to forced (unplanned) outages

3.10
combustion inspection
activity of determining the condition of the combustor section of the gas turbine (including the transition duct)

3.11
hot gas path inspection
activity of determining the condition of the combustion system together with the turbine components of the gas turbine

3.12
inspection
activity of determining the condition of a component or assembly and necessary replacement

3.13
major inspection
activity of determining the condition of the entire gas turbine

3.14
maintenance
sum of all measures intended to determine the actual gas turbine condition, together with the measures required to preserve/restore the specified condition

3.15
off-line
any activity whilst the machine is out of operation

3.16
on-line
any simultaneous activity whilst the machine is in operation

3.17
on-line inspection
any *inspection* (3.12) activity (e.g. of lubricating oil filter) carried out concurrent with the gas turbine being in operation

3.18
on-line maintenance
any *maintenance* (3.14) activity (e.g. of the auxiliary pump or sensing device) carried out simultaneously with the gas turbine being in operation

3.19
operating hour
accumulated period of time from *start* (3.29) initiation operation to full stop

3.20
overhaul
act of dismantling, reconditioning, renewal and/or replacement of components or sub-assemblies of a gas turbine in preparation for continued operation Fin accordance with the manufacturer's guidelines

3.21
performance
power output and efficiency (heat rate) of a gas turbine as stated in the manufacturer's specification

3.22
period hours
PH
hours in the period under consideration

3.23
fast start
starting sequence in which the load is applied to a gas turbine according to an accelerated programme

3.24
repair
any activity of correction by appropriate measures, including replacement if necessary, of any part of the gas turbine, which is damaged, destroyed or malfunctions or otherwise breaks down

3.25
scheduled maintenance
planned *maintenance* (3.14) action with preplanned shutdown of the gas turbine at a specified time

3.26
service hours
SH
accumulated period of time from main flame ignition through to flame extinction

3.27
service factor
SF
ratio of *service hours* (3.26) to *period hours* (3.22) in a period under consideration

$$F_{SF} = (t_{SH}/t_{PH}) \times 100$$

where F_{SF} is the service factor (SF)

3.28
shutdown
event in which the unit is brought from operation to a stationary condition under control of a programmed unloading and stopping sequence

3.29
start
act of getting the gas turbine and its driven equipment from the ready-to-start condition to the ready-to-load condition

Note 1 to entry: This includes synchronization with the network, breaker closure and stable running thereafter in the case of gas turbines driving alternators, and stable running of the driven equipment for mechanical drive gas turbines.

3.30
starting reliability

$$F_{SR} = \frac{n_{SS}}{(n_{SS} + n_{FS})} = \frac{n_{SS}}{n_{SA}}$$

where

F_{SR} is the start reliability (SR);

n_{SS} is the number of successful starts (SS);

n_{FS} is the number of failures to start (FS);

n_{SA} is the number of starting attempts (SA).

3.31
successful start
SS
occurrence of bringing a unit through a starting attempt to the in-service state within a specified period, as evidenced by the maintained closure of the generator to the system or stable operation of the driven equipment

3.32
trip
sudden *shutdown* (3.28) of the unit from load by stopping the fuel supply and opening the load or generator breaker

3.33
trip-to-idle
sudden reduction of the unit from load to idle on receipt of an appropriate grade of *trip* (3.32) signal