INTERNATIONAL STANDARD

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Gas turbines — Exhaust gas emission —

Part 2:
Automated emission monitoring

Turbines à gaz — Émissions de gaz d'échappement —

Partie 2: Surveillance automatisée des émissions

Reference number
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Annex

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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.

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.

International Standard ISO 11042-2 was prepared by Technical Committee ISO/TC 192, *Gas turbines*.

ISO 11042 consists of the following parts, under the general title *Gas turbines — Exhaust gas emission*:

— *Part 1: Measurement and evaluation*

— *Part 2: Automated emission monitoring*

Annex A of this part of ISO 11042 is for information only.

Gas turbines — Exhaust gas emission —

Part 2:
Automated emission monitoring

1 Scope

This part of ISO 11042 establishes the monitoring programme and the requirements for the selection and operation of hardware to be used for continuous measurement over an extended, not limited, time. The concentration and absolute magnitude of specified emissions in the exhaust gas are monitored as well as related gaseous components from gas turbines together with essential operating conditions. Appropriate terms and symbols in addition to those defined in ISO 11042-1 are used. It presents requirements for the monitoring environment, the instrumentation and recording as well as for quality assessment and correction of data.

This part of ISO 11042 is applicable for all gas turbines producing mechanical shaft power and/or which are used as drivers for electrical generation as well as marine application but excluding application in aircraft. It can be used as a basis for installations equipped to utilize exhaust heat.

This part of ISO 11042 is applicable for gas turbines which utilize the open cycle process. It is also applicable as a basis for gas turbines which utilize the semi-closed cycle and for gas turbines equipped with free piston compressors or with special heat sources.

This part of ISO 11042 is not intended to be used for acceptance testing for gas turbine exhaust emissions except by mutual agreement between the parties involved.

Constituents, which are released into the air in significant quantities, greater than a certain limiting value, should be monitored. Such values are determined by mutual agreement between the parties involved.

In general, this part of ISO 11042 requires that the following parameters be continuously monitored: emissions, diluent gas (O_2, CO_2), exhaust gas flow (calculated or, if required, measured), fuel consumption and gas turbine plant performance. Chemical analysis of the fuel is required on fuel samples taken at regular intervals.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11042. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11042 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2314:1989, *Gas turbines — Acceptance tests.*

ISO 4225:1994, *Air quality — General aspects — Vocabulary.*

ISO 6879:1995, *Air quality — Performance characteristics and related concepts for air quality measuring methods.*

ISO 7504:1984, *Gas analysis — Vocabulary.*

ISO 10396:1993, *Stationary source emissions — Sampling for the automated determination of gas concentration.*

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

3 Definitions

For the purposes of this part of ISO 11042 the following definitions, as well as those given in ISO 11042-1:1996, clause 3, apply.

3.1 monitoring

(1) In the wide sense of the term, repeated measurements to follow changes over a period of time.

(2) In the restricted sense of the term, regular measurements of the pollutant level in relation to some standard in order to assess the effectiveness of the system of regulation and control.

See ISO 4225:1994.

3.2 reference measurement: Independent measurement for acceptance tests and recalibration and for checking of actual measurement.

3.3 analyser: Assembly comprising:

a) lines permitting removal and transfer of gas to be analysed and/or of calibration gas;

b) a measuring device which, from the physical or chemical properties of the components of the gas sample analysed, gives signals allowing the quantification of the components;

c) signal processing devices (amplification, recording) or, if needed, data processing devices.

See ISO 7504:1984.

3.4 sampling principle: Representative sampling of gases in the duct including both extractive and non-extractive methods.

See ISO 10396:1993.

NOTE 1 In extractive sampling, these gases must be conditioned to remove aerosol, particle matter and other interfering substances before being conveyed to the instruments. In non-extractive sampling, the measurements are *in situ*, therefore no sample conditioning will be required.

3.4.1 extractive sampling: Includes extraction of the sample, removal of interfering materials and maintenance of gas concentration throughout the sampling system for subsequent analysis by appropriate instrumentation (see figure 1).

3.4.2 non-extractive sampling: Does not involve removal of a sample and sampling is confined to the gas stream in the duct (see figures 2 and 3).

3.5 system operating characteristics: Aspects of performance from statistical, functional and operational points of view as defined in ISO 6879.

The following aspects are taken into consideration.

3.5.1 response time: Time taken for a system to respond to a rapid change in value of the air quality characteristics. It can be divided into two parts as follows.

3.5.1.1 lag time: Time taken for a representative sample to enter the instrument.

3.5.1.2 instrument response: Time taken for the instrument to give an output equal to 90 % of the total change in sample concentration.

3.5.2 zero instability (drift): Change in instrument output in response to a zero sample over a stated period of unattended operation.

3.5.3 span: Difference between the instrument readings for a stated value of air quality characteristic and for a zero sample; by convention, this value of air quality characteristic is selected to be 95 % of the upper limit of a gas concentration measurement range as it may be specified for affected source categories.

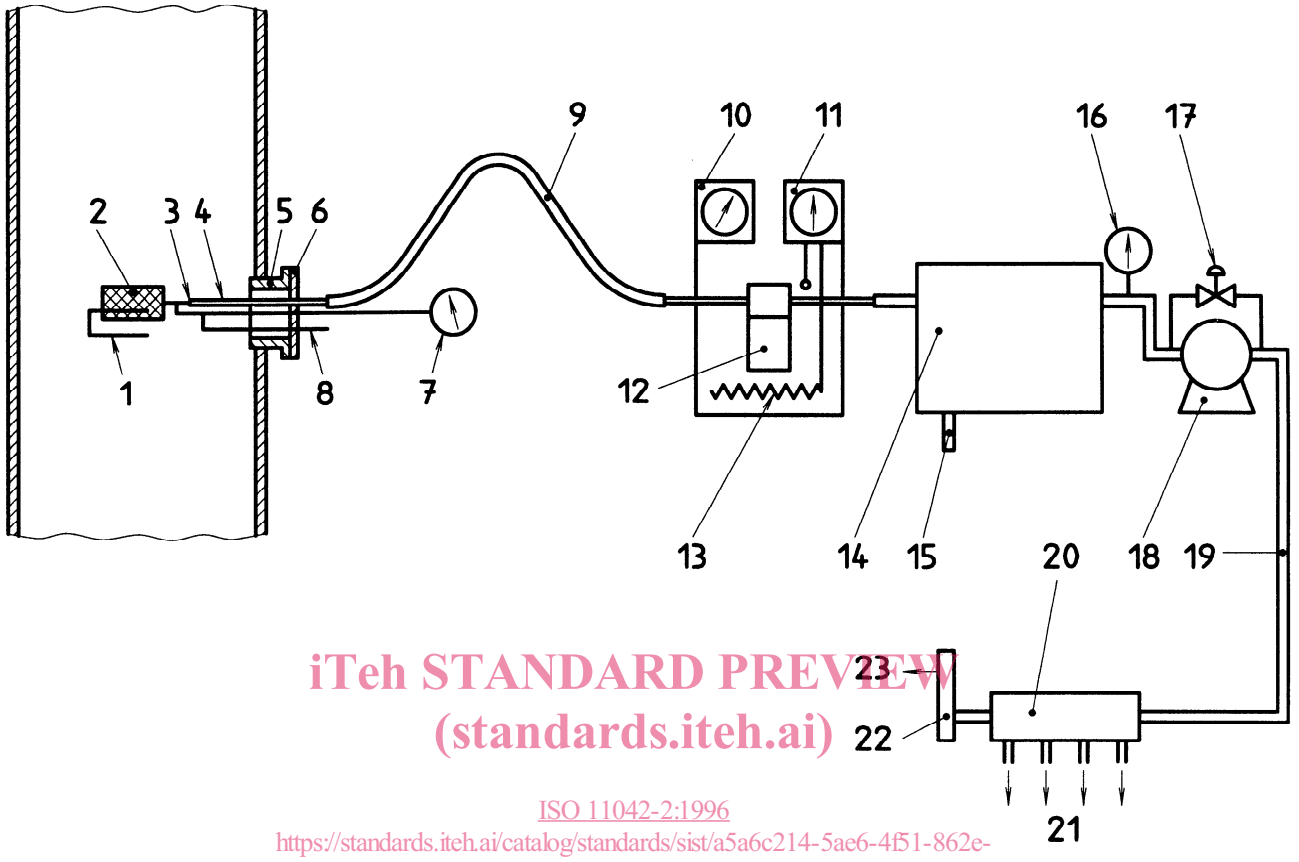
3.5.4 span instability (drift): Change in instrument output in response to a calibration gas of 90 % of the measuring range(s) of the instrument over a stated period of unattended operation.

3.6 system calibration characteristics: Aspects of measurement functions with pertinence to calibration.

The following aspects are taken into consideration.

3.6.1 calibration function: Instrument reading as a function of some measurable property of the specific component(s) under investigation and obtained by the reference manual method (see ISO 11042-1) with all the interferences remaining constant.

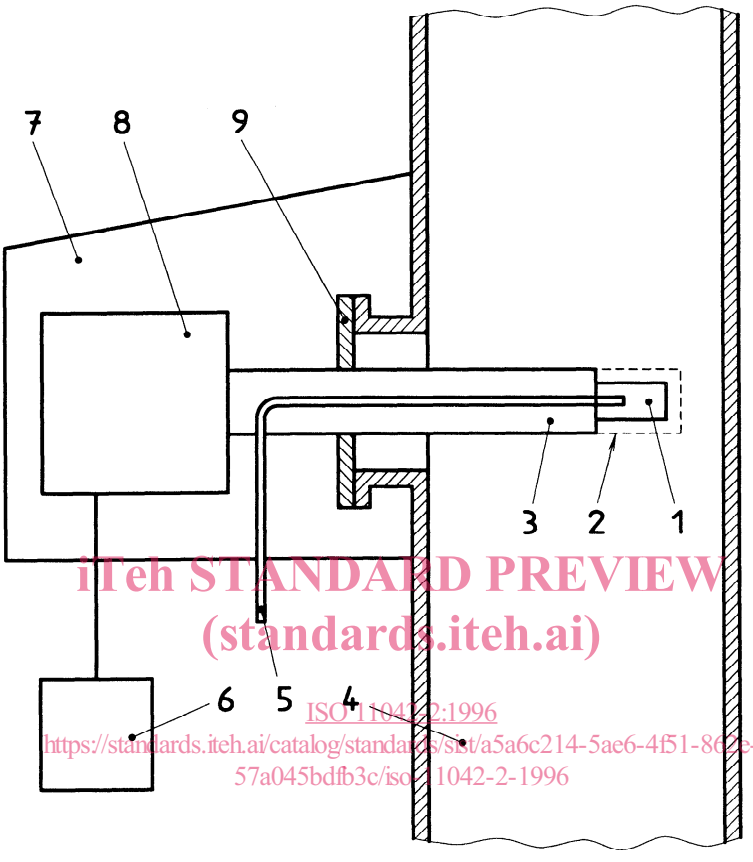
3.6.2 linear function: Calibration function wherein the instrument reading is linear with respect to the concentration of specific component(s) measured by the reference manual method (see ISO 11042-1).



Key

1 Baffle
2 In-stack filter
3 Tee
4 Probe
5 Port
6 Cap
7 Pressure gauge
8 To zero and reference gases
9 Thermally insulated sampling line
10 Temperature controller (line)
11 Temperature controller
12 Filter
13 Heater
14 Refrigeration unit
15 Water discharge
16 Vacuum gauge
17 Bypass valve
18 Pump
19 Sampling line (heating optional)
20 Manifold
21 To analyser(s)
22 Rotameter
23 Excess sample gas discharge

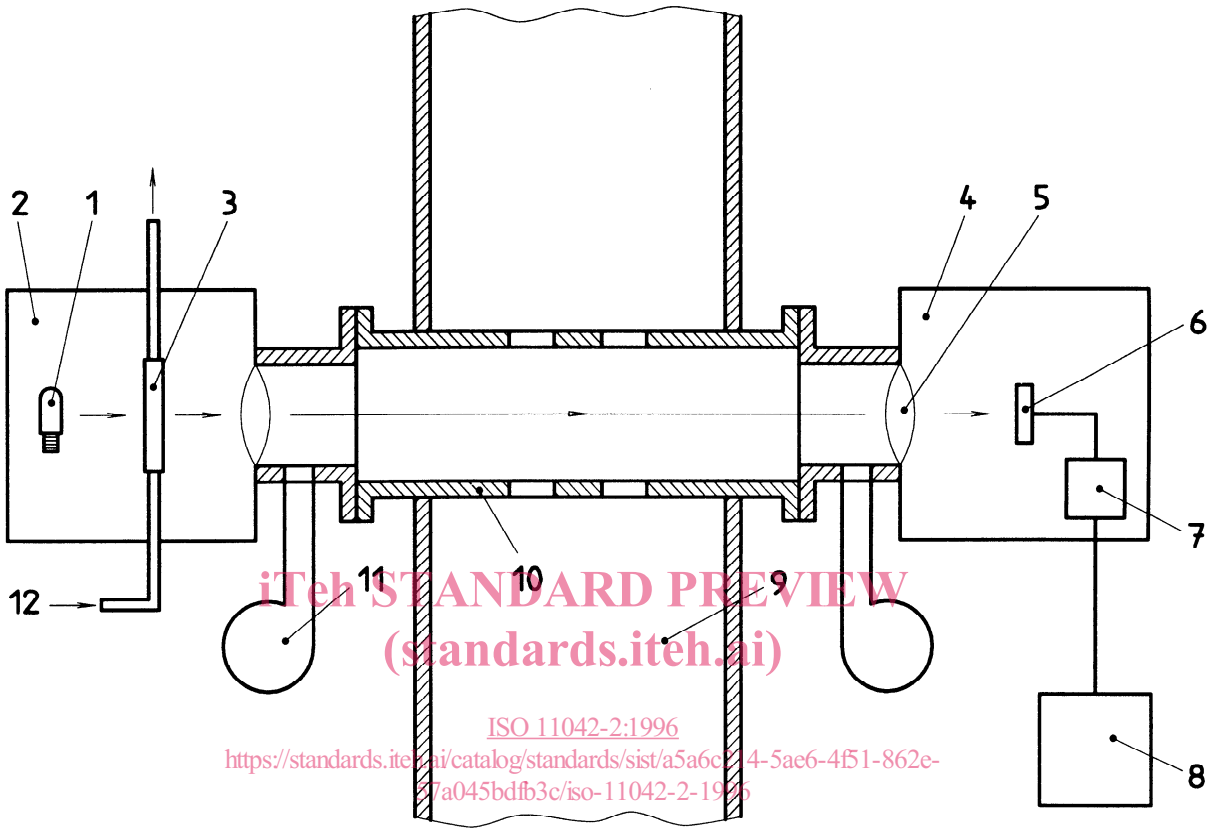
Figure 1 — Example of an extractive sampling and conditioning system



Key

1 Measurement cell
2 Probe filter
3 Probe
4 Exhaust gas duct
5 Gas calibration line
6 Data recorder
7 Protective hood
8 Instrument transceiver
9 Probe mounting

Figure 2 — Example of a point non-extractive monitor



Key

1 Lamp
2 Transmitter assembly
3 Internal gas calibration cell
4 Receiver assembly
5 Protective window
6 Detector
7 Electronic module
8 Data recorder
9 Exhaust gas duct
10 Alignment/calibration pipe
11 Purge air blower
12 Gas calibration line

Figure 3 — Example of a path non-extractive monitor

3.6.3 non-linear function: Calibration function wherein the instrument reading is not linear with respect to the concentration of specific component(s) measured by the reference manual method (see ISO 11042-1).

NOTE 2 Non-linearity may be expressed by higher order regression coefficients.

3.6.4 confidence interval: Interval with lower and upper limits within which the mean values of the regression line lie with a given level of confidence.

3.6.5 tolerance interval: Interval with lower and upper limits within which is contained a specified percentage of the population with a given level of confidence.

3.6.6 plausibility test: Test designed to compare the measured carbon content in the exhaust gas (from CO_2, CO and UHCs) with the calculated carbon content for the gas turbine fuel, the acceptable difference between these values being agreed between both parties.

4 Symbols and abbreviations

The symbols and abbreviations of ISO 11042-1:1996, clause 4, shall apply.

5 Monitoring programme

5.1 Monitoring system

See figure 4.

Monitoring requires sampling and analyser systems, which continuously sense the exhaust gas as well as status data of the gas turbine plant and produce signals for the electronic evaluation system.

5.2 Constituents to be measured

The constituents to be mandatorily measured shall be agreed upon between the parties in accordance with local regulations. The following list of constituents may be monitored.

— Dust and smoke: measurement only required in case of potential presence.

NOTE 3 In general not required for operation on natural gas unless specifically agreed between both parties or where alternative stand-by or start-up fuels may be needed.

— SO_2: measurement only required in the case where continuous sulfur removal is applied or sufficiently detailed fuel analysis is not provided or where specifically agreed by both parties.

— NO_x: measurement always required.

NOTE 4 If agreed upon, only the NO content is to be analysed providing the NO_2 content does not exceed 10 % of the total NO_x. A value of NO_2, which should be determined by a reference test, must be added to the NO reading.

— CO_2: measurement required if no direct O_2 measurement is performed.

— CO: measurement required if agreed upon between the parties, particularly when monitoring partial loads.

— UHCs: measurement required if agreed upon between the parties.

— VOCs: measurement required if agreed upon between the parties.

— O_2: measurement required for correction of data either by direct measurement or by calculation.

— NH_3: measurement only required for plant with catalytic reactor for NO_x reduction using NH_3.

Other constituents may be monitored by agreement, especially where fuels containing toxic components are utilized.

NOTE 5 It should be noted that CO_2, CO and UHC measurements are required to determine, by calculation, the plant mass flow. This value may then be compared with the manufacturer's design mass flow as a test for measurement plausibility.

5.3 Operating data to be recorded

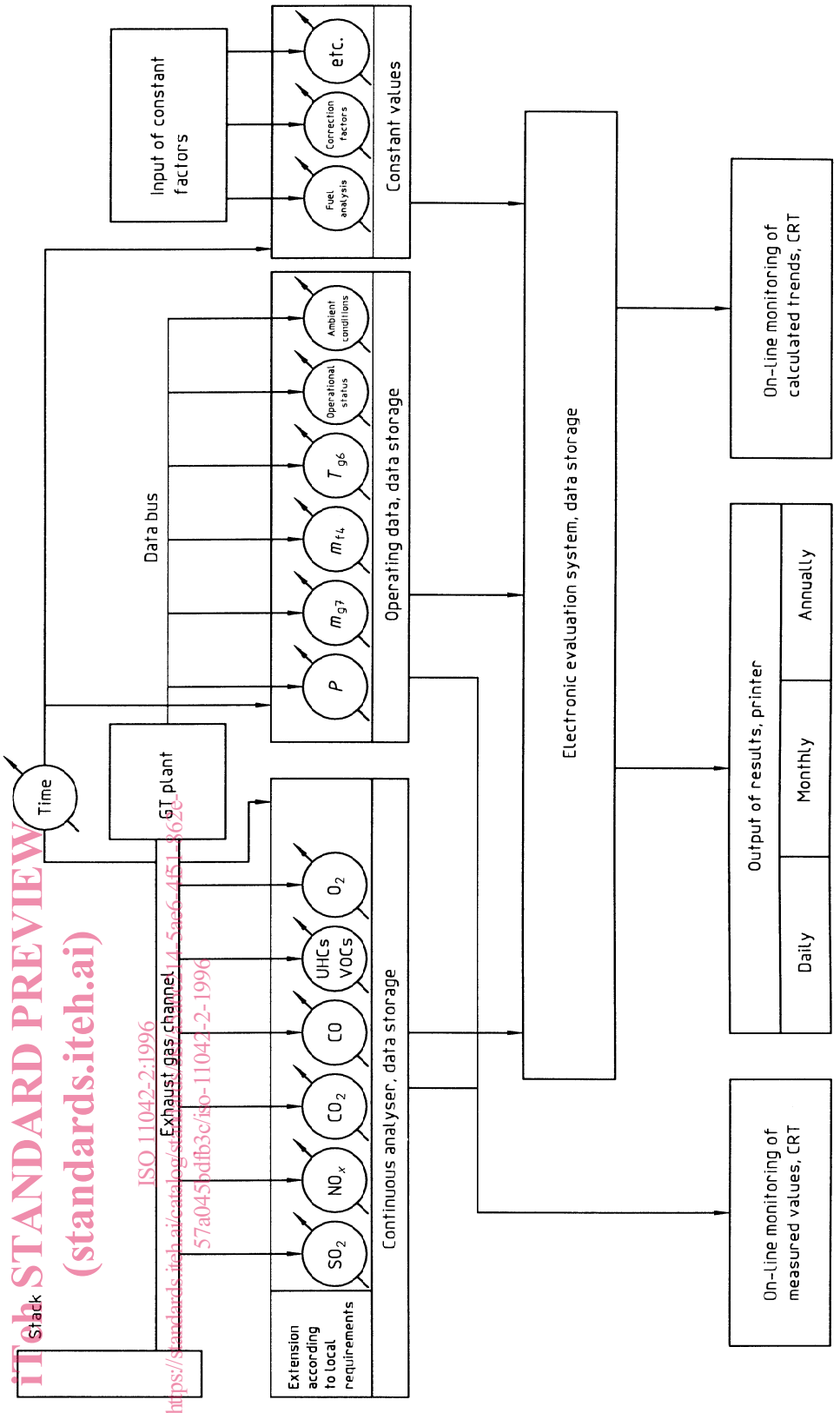
These data shall be recorded at the time of measurement of the constituents.

5.3.1 Ambient air conditions

— temperature;

— pressure;

— relative humidity.



NOTES

— m_{f4} denotes mass rate of fuel entering the control volume.
— m_{g7} denotes mass rate of gas leaving the turbine.
— P denotes net shaft power output.
— T_{g6} denotes reference turbine inlet temperature.
— CRT = cathode-ray tube.

Figure 4 — Principal layout of the monitoring system