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Reciprocating internal combustion engine driven alternating current generating sets —

Part 6: Test methods

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*Groupes électrogènes à courant alternatif entraînés par moteurs
alternatifs à combustion interne —*

Partie 6: Méthodes d'essai

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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 8528-6 was prepared by Technical Committee ISO/TC 70, *Internal combustion engines*, Sub-Committee SC 2, *Performance and tests*.

ISO 8528 consists of the following parts, under the general title *Reciprocating internal combustion engine driven alternating current generating sets*:

- *Part 1: Application, ratings and performance*
- *Part 2: Engines*
- *Part 3: Alternating current generators for generating sets*
- *Part 4: Controlgear and switchgear*
- *Part 5: Generating sets*
- *Part 6: Test methods*
- *Part 7: Technical declarations for specification and design*
- *Part 8: Low-power general-purpose generating sets*
- *Part 9: Measurement and evaluation of mechanical vibration*

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- *Part 10: Measurement of airborne noise — Enveloping surface method*
- *Part 11: Security generating sets with uninterruptible power systems*

Parts 7, 8, 9 and 10 are in course of preparation. Part 11 is at an early stage of preparation and may be split into two parts.

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Reciprocating internal combustion engine driven alternating current generating sets —

Part 6: Test methods

1 Scope

This part of ISO 8528 specifies test methods for the characteristics of an entire generating set. Existing test methods for the engine (ISO 3046-2 and ISO 3046-3) and generator (IEC 34-2) should be used for those components. The generating set manufacturer is responsible for specifying these characteristics and the tests to be performed.

It applies to alternating current (a.c.) generating sets driven by reciprocating internal combustion (RIC) engines for land and marine use, excluding generating sets used on aircraft or to propel land vehicles and locomotives.

For some specific applications (for example, essential hospital supplies, high-rise buildings, etc.) supplementary requirements may be necessary. The provisions of this part of ISO 8528 should be regarded as a basis.

For a.c. generating sets driven by other reciprocating type prime movers (e.g. sewage gas engines, steam engines) this part of ISO 8528 should be used as a basis.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8528. 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 8528 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 3046-2:1987, *Reciprocal internal combustion engines — Performance — Part 2: Test methods.*

ISO 3046-3:1989, *Reciprocating internal combustion engines — Performance — Part 3: Test measurements.*

ISO 8528-1:1993, *Reciprocating internal combustion engine driven alternating current generating sets — Part 1: Application, ratings and performance.*

ISO 8528-5:1993, *Reciprocating internal combustion engine driven alternating current generating sets — Part 5: Generating sets.*

IEC 34-2:1972, *Rotating electrical machines — Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles).*

IEC 34-5:1981, *Rotating electrical machines — Part 5: Classification of degrees of protection provided by enclosures for rotating machines.*

IEC 947-1:1988, *Low-voltage switchgear and control-gear — Part 1: General rules.*

3 Other regulations and additional requirements

3.1 For a.c. generating sets used on board ships and offshore installations which have to comply with rules of a classification society, the additional requirements of the classification society shall be observed. The classification society shall be stated by the customer prior to placing of the order.

For a.c. generating sets operating in non-classed equipment, such additional requirements are in each case subject to agreement between the manufacturer and customer.

3.2 If special requirements from regulations of any other authority (e.g. inspecting and/or legislative authorities) have to be met, the authority shall be stated by the customer prior to placing of the order.

Any further additional requirements shall be subject to agreement between the manufacturer and customer.

4 General test requirements

4.1 Generating sets shall be tested in accordance with either the ISO standard functional test (see clause 5) or the ISO standard acceptance test (see clause 6).

Subject to agreement between the generating set manufacturer and customer, any or all of the functional tests may be combined with the acceptance test.

The acceptance test shall be carried out at the manufacturer's works and/or site of installation. The kind of test shall be agreed in writing between the manufacturer and customer.

4.2 Detailed requirements for the acceptance test depend on the following principal areas:

- application;
- the power output;
- extent of supply;
- use;
- performance class according to ISO 8528-1 and ISO 8528-5.

4.3 A minimum test to be performed by the generating set manufacturer is the ISO standard functional test. A test report shall be prepared in accordance with 5.4. Several variants of this test are possible when agreed to by the generating set manufacturer and the customer. This functional test applies to the correct rating and performance class of the generating set.

4.4 The ISO standard functional test procedure is intended for use on the generating set manufacturer's test bed. Subject to agreement between the manufacturer and customer, the functional and/or acceptance test may be performed at the customer's site or at a third party's test location.

5 ISO standard functional test

This functional test shall be performed at the manufacturer's works under test-bed conditions. The

rated power factor load is normally used for testing with due regard to rated active power and associated generator efficiency. Optionally, if this is not possible because of the test equipment, this test may be performed at unity power factor. This shall be by agreement between the manufacturer and customer.

5.1 General inspection

A general inspection for compliance with the specifications in accordance with the generator set manufacturer's instructions shall be carried out, covering:

- completeness of item supplied and to be tested;
- alignment;
- functional operations of the auxiliary equipment supplied (by agreement);
- tightness of pipework joints and components;
- degree of protection as described in IEC 34-5 and IEC 947-1;
- operating and monitoring functions.

NOTE 1 When measuring non-precision parts, such as a fan guard, a statistical approach to protection prediction is acceptable.

5.2 Measurements

The test shall be performed on generating sets that have been warmed up. The time required to warm up a generating set will vary. It is the responsibility of the test engineer to ensure that the set has run for an adequate time to stabilize temperatures.

The following shall be recorded:

- ambient temperature, humidity and barometric pressure;
- voltage, current and frequency at rated output;
- voltage, frequency and current while loading and unloading to assess transient behaviour;
- proper functioning of monitoring and control equipment.

5.3 Accuracy of measurement equipment

The minimum accuracy of the instrumentation for the measurement of the listed parameters shall be as follows:

current: 1,5 %

voltage: 1,5 %

real power: 1,5 %

reactive power: 1,5 %

power factor: 3 %

frequency: 0,5 %

Measuring transformers and transducers should be in a corresponding accuracy class.

5.4 ISO standard functional test report

The ISO standard functional test report shall include the following information:

- a) the generating set performance class according to ISO 8528-1;
- b) the customer and order number (if known);
- c) the manufacturer;
- d) the engine, generator, controlgear and switchgear serial numbers;
- e) technical data, both declared (rated) and measured:
 - 1) power,
 - 2) voltage,
 - 3) frequency,
 - 4) current,
 - 5) power factor,
 - 6) speed,
 - 7) circuit diagram number,
 - 8) type of cooling system;
- f) enclosure protection; <https://standards.iteh.ai/catalog/standards/sist/2622c465-68a9-4f57-b9df-3541d0f822fc/iso-8528-6-1993>
- g) test site conditions:
 - 1) altitude,
 - 2) barometric pressure,
 - 3) ambient temperature,
 - 4) relative humidity,
 - 5) inlet air temperature,
 - 6) inlet coolant temperatures;
- h) fuel type (specification number):
 - 1) density,
 - 2) calorific value (lower calorific value);
- i) lubricating oil type (specification number).

6 Acceptance test

Parts 1 to 5 of ISO 8528 lay down requirements for the various applications of generating sets. The manufacturer shall certify that the generating set complies with the requirements given in parts 1 to 5 of ISO 8528, unless it is established by the acceptance test in accordance with this part of ISO 8528. This applies in particular to the compliance with the contractually agreed performance

class laid down in ISO 8528-1 and ISO 8528-5, in any given case as well as to agreed requirements or variations in the performance classification for specific operating limits.

6.1 Contractual arrangements

6.1.1 The details of an acceptance test to this part of ISO 8528 shall be agreed in writing at the time of purchase. The test equipment shall be such that the measurements and checks agreed for the acceptance test can be verified.

6.1.2 The observance of further requirements and the performance of additional measurements or the provision of further tests which go beyond the requirements of 6.5 shall be agreed in writing.

6.1.3 If the requirements of the test specified in 6.1.1 and 6.1.2 are changed during the acceptance test, an appropriate agreement shall be concluded.

6.1.4 The costs of a complete or partial repetition or extension of the acceptance test shall be borne by the party responsible for the repetition or extension.

6.1.5 The acceptance test shall be performed within the agreed period following notification of readiness for the acceptance test.

6.1.6 The manufacturer of the generating set shall not be responsible for servicing equipment provided by the customer.

6.1.7 By agreement between the manufacturer of the generating set and the customer, the works test of the complete generating set with test certificates may be considered as substitutes for the acceptance test.

6.1.8 Acceptance tests on components (e.g. engine, generator, switchgear) shall not be considered substitutes for the acceptance test on the complete power station or generating set. The test records of the component manufacturers concerned may be used in special cases if mutually agreed or for verification of certain properties.

6.1.9 If computation documents are necessary for measurements and tests, it shall be specified which documents have to be made available by which party to the agreement and at what time.

6.1.10 Within the scope of the contractual arrangements, an independent inspector acceptable to both parties may be asked to attend the acceptance test at the manufacturer's works and/or at the site of installation.

6.1.11 The acceptance test may be performed at the manufacturer's works and/or at the site of installation. The place where the test is to be carried out shall be agreed in writing.

6.2 Responsibility

6.2.1 The manufacturer shall be responsible for the acceptance test at his works.

6.2.2 The responsibilities of the customer and the manufacturer's agent shall be agreed before starting the acceptance test at the agreed site.

6.3 Preparation

6.3.1 Provision of auxiliary personnel, measuring equipment and operating materials shall be as follows.

In the case of an acceptance test at the manufacturer's works, the manufacturer shall provide the normal operating materials, the measuring equipment necessary for the test and the auxiliary personnel.

In the case of an acceptance test at the site of installation, the customer shall provide the necessary operating materials (e.g. load banks, fuel). If the customer is to provide auxiliary personnel to assist the manufacturer and any additional measuring equipment that may be necessary, this shall be agreed between the customer and manufacturer.

6.3.2 Preparation for acceptance test at the site of the installation shall be as follows.

The manufacturer shall be given the opportunity to inspect the generating set before the acceptance test and carry out any necessary adjustments and checks. This also applies when the manufacturer has not carried out the installation himself.

6.3.3 Maintenance of operating conditions shall be as follows.

When the acceptance test is carried out at the manufacturer's works, the normal air ducting and exhaust gas ducting used at the works shall be accepted. Moreover, the use of the works' own auxiliary equipment (e.g. cooling water pumps, lubricating oil filters, coolers, switchgear) instead of that to be supplied with the generating set is permissible unless otherwise agreed.

If the specified ambient conditions and properties of the operating materials cannot be realized for the acceptance test, agreement shall be reached before starting the acceptance test regarding the influence of the deviation conditions and the necessary conversion of the test results.

6.4 Further details

6.4.1 If the acceptance test is interrupted by minor faults which can be quickly rectified and are not regarded as fundamental by the parties to the agreement, the acceptance test shall be continued after the interruption.

If the acceptance test is interrupted by major faults which necessitate the repair or replacement of important components, the acceptance test shall be repeated either wholly or in part. This shall be subject to agreement.

6.4.2 During the acceptance test, the only adjustments or maintenance that may be carried out on the generating set shall be those which are necessary for maintaining the test conditions and the adjustments or maintenance specified in the operation manual.

6.4.3 Special provisions may be necessary for generating sets which will operate at their site of installation using fuel other than distillate type fuel (e.g. gas, residual fuel).

6.5 Extent of acceptance test

The extent of the acceptance test depends on the designated application and is divided into the groups listed in 6.5.1 and 6.5.2. Checks and measurements over and above those mentioned necessitate an additional agreement. The prevailing conditions shall be taken into account in the case of an acceptance test at the site of installation.

6.5.1 Checks (C)

Group CA:

- completeness of items supplied and to be tested.

Group CB:

- alignment;
- operating functions of auxiliary equipment;
- tightness of pipework joints and components;
- protection against accidental contact (mechanical and electrical);
- operating and monitoring functions;
- vibrations (steadiness);
- unusual running noises;
- temperature rise of important components.

Group CC:

- switching functions
 - control functions
 - monitoring functions
- } of associated switchgear

Group CD:

- suitability for parallel operation.

6.5.2 Measurements (M)

Typical measurements are listed below. The requirements of 6.6 apply to the extent of the measurements to be carried out during the acceptance test.

Group MA:

Under steady-state operating conditions, measure the following:

- voltage;
- frequency.

Group MB:

- current;
- range of voltage setting;
- range of frequency setting;
- active power or power factor;
- steady-state frequency band;
- rate of change of voltage setting;
- rate of change of frequency setting.

Group MC:

- starting behaviour.

Group MD:

- lubricating oil pressure;
- coolant temperature at input and output of engine and generator.

Group ME:

- exhaust gas temperature.

Group MF:

- noise emission.

Group MG:

- exhaust gas emission.

Group MH:

Measure the following by oscillograph or similar device;

- | | | |
|---|---|--|
| <ul style="list-style-type: none"> — voltage — current — frequency | } | with defined power factor while loading and unloading the generator to assess transient behaviour. |
|---|---|--|

Group MJ:

- harmonic content of voltage waveform.

Group MK:

- amplitude modulation of voltage waveform.

Group ML:

- power distribution in parallel operation;
- load sharing in parallel operation.

Group MM:

- fuel consumption of the generating set relative to the electric power available at the a.c. generator terminals taking into account the calorific value of the fuel.

Group MN:

- effectiveness of the electrical protection device.

6.6 Accuracy of measurement equipment and acceptance test procedure**6.6.1 Accuracy of measurement equipment**

The required accuracy of the electrical instrumentation shall be subject to agreement between the manufacturer and the customer.

If the test is carried out at the manufacturer's works the accuracies of 5.3 should be used. If the test is not carried out at the manufacturer's works the minimum accuracies listed below are recommended:

current: 2,5 %

voltage: 2,5 %

active power: 2,5 %

reactive power: 2,5 %

power factor: 5 %

frequency: 1 %

NOTE 2 The waveform dependence of the measuring instruments used should be taken into account.

6.6.2 Warm-up time

The acceptance test shall be performed on generating sets that have been warmed up. The required time to warm up a generator will vary. It is the responsibility of the test engineer to ensure that the set has run for an adequate time to stabilize temperatures.

6.6.3 Duration of load test

The duration of the load test depends on the generating set's rating and application. It is generally be-