INTERNATIONAL STANDARD

ISO 8528-13

First edition
2016-05-15

Reciprocating internal combustion engine driven alternating current generating sets —

Part 13: **Safety**

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

Partie 13: Sécurité

Reference number
ISO 8528-13:2016(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 70, *Internal combustion engines*.

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: Requirements and tests for low-power generating sets*

— *Part 9: Measurement and evaluation of mechanical vibrations*

— *Part 10: Measurement of airborne noise by the enveloping surface method*

— *Part 12: Emergency power supply to safety services*

— *Part 13: Safety*

Reciprocating internal combustion engine driven alternating current generating sets —

Part 13: Safety

1 Scope

This part of ISO 8528 specifies the safety requirements for reciprocating internal combustion (RIC) engine driven generating sets up to 1 000 V consisting of an RIC engine, an alternating current (AC) generator including the additional equipment required for operating, e.g. controlgear, switchgear, auxiliary equipment.

It is applicable to generating sets for land and marine use (domestic, recreational and industrial application). It is not applicable to generating sets used on board of seagoing vessels and mobile offshore units as well as on aircraft or to propel road vehicles and locomotives.

NOTE This part of ISO 8528 does not apply to arc welding equipment (IEC 60974 series).

The special requirements needed to cover operation in potentially explosive atmospheres are not covered in this part of ISO 8528.

The hazards relevant to RIC engine driven generating sets are identified in Annex A.

This part of ISO 8528 deals with the special requirements of test and safety design which should be observed in addition to the definitions and requirements in ISO 8528-1, ISO 8528-2, ISO 8528-3, ISO 8528-4, ISO 8528-5 and ISO 8528-6, where applicable. It specifies safety requirements in order to protect the user from danger.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2261, *Reciprocating internal combustion engines — Hand-operated control devices — Standard direction of motion*

ISO 2710-1, *Reciprocating internal combustion engines — Vocabulary — Part 1: Terms for engine design and operation*

ISO 2710-2, *Reciprocating internal combustion engines — Vocabulary — Part 2: Terms for engine maintenance*

ISO 3046-1, *Reciprocating internal combustion engines — Performance — Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods — Additional requirements for engines for general use*

ISO 3046-6, *Reciprocating internal combustion engines — Performance — Part 6: Overspeed protection*

ISO 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

ISO 6826:1997, *Reciprocating internal combustion engines — Fire protection*

ISO 7967-1, *Reciprocating internal combustion engines — Vocabulary of components and systems — Part 1: Structure and external covers*

ISO 7967-2, *Reciprocating internal combustion engines — Vocabulary of components and systems — Part 2: Main running gear*

ISO 7967-3, *Reciprocating internal combustion engines — Vocabulary of components and systems — Part 3: Valves, camshaft drives and actuating mechanisms*

ISO 7967-4, *Reciprocating internal combustion engines — Vocabulary of components and systems — Part 4: Pressure charging and air/exhaust gas ducting systems*

ISO 7967-8, *Reciprocating internal combustion engines — Vocabulary of components and systems — Part 8: Starting systems*

ISO 7967-9, *Reciprocating internal combustion engines — Vocabulary of components and systems — Part 9: Control and monitoring systems*

ISO 8528-1:2005, *Reciprocating internal combustion engine driven alternating current generating sets — Part 1: Application, ratings and performance*

ISO 8528-2, *Reciprocating internal combustion engine driven alternating current generating sets — Part 2: Engines*

ISO 8528-3, *Reciprocating internal combustion engine driven alternating current generating sets — Part 3: Alternating current generators for generating sets*

ISO 8528-4:2005, *Reciprocating internal combustion engine driven alternating current generating sets — Part 4: Controlgear and switchgear*

ISO 8528-5:2013, *Reciprocating internal combustion engine driven alternating current generating sets — Part 5: Generating sets*

ISO 8528-6, *Reciprocating internal combustion engine driven alternating current generating sets — Part 6: Test methods*

ISO 8528-7, *Reciprocating internal combustion engine driven alternating current generating sets — Part 7: Technical declarations for specification and design*

ISO 8528-8:2016, *Reciprocating internal combustion engine driven alternating current generating sets — Part 8: Requirements and tests for low-generating sets*

ISO 8528-9, *Reciprocating internal combustion engine driven alternating current generating sets -- Part 9: Measurement and evaluation of mechanical vibrations*

ISO 8999:2001, *Reciprocating internal combustion engines — Graphical symbols*

ISO 11102-1, *Reciprocating internal combustion engines — Handle starting equipment — Part 1: Safety requirements and tests*

ISO 11102-2, *Reciprocating internal combustion engines — Handle starting equipment — Part 2: Method of testing the angle of disengagement*

ISO 11429, *Ergonomics — System of auditory and visual danger and information signals*

ISO 11684:1995, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Safety signs and hazard pictorials — General principles*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13732-1, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces*

ISO 13850, *Safety of machinery — Emergency stop — Principles for design*

ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 14122-2:2001, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*

ISO 14314:2004, *Reciprocal internal combustion engines — Recoil starting equipment — General safety requirements*

ISO 15534-2, *Ergonomic design for the safety of machinery — Part 2: Principles for determining the dimensions required for access openings*

IEC 60034-1:2010, *Rotating electrical machines — Part 1: Rating and performance*

IEC 60034-5:2006, *Rotating electrical machines — Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) — Classification*

IEC 60245-4, *Rubber insulated cables of rated voltages up to and including 450/750 V — Part 4: Cords and flexible cables*

IEC 60204-1:2009, *Safety of machinery — Electrical equipment of machine — Part 1: General requirements*

IEC 60335-1:2013, *Household and similar electrical appliances — Safety — Part 1: General requirements*

IEC 60364-1, *Low-voltage electrical installations — Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-4-41, *Low-voltage electrical installations — Part 4-41: Protection for safety — Protection against electric shock*

IEC 60068-2-75, *Environmental testing - Part 2-75: Tests - Test Eh: Hammer tests*

IEC 60073, *Basic and safety principles for man-machine interface, marking and identification — Coding principles for indicators and actuators*

IEC 61310-1, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals*

IEC 61310-2, *Safety of machinery — Indication, marking and actuation — Part 2: Requirements for marking*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2710-1, ISO 2710-2, ISO 3046-1, ISO 3046-6, ISO 7967-1, ISO 7967-2, ISO 7967-3, ISO 7967-4, ISO 7967-8, ISO 7967-9, ISO 8528-1, ISO 8528-2, ISO 8528-3, ISO 8528-4, ISO 8528-5, ISO 8528-6, ISO 8528-7, ISO 8528-8, ISO 8528-9, ISO 8528-10, ISO 12100, IEC 60364-1 and the following apply.

3.1
layman
person who does not necessarily recognize potential danger resulting from electricity, moving parts or hot parts

Note 1 to entry: The layman has normally a lack of training, knowledge and experience.

3.2
close proximity
30 mm space immediately around the operating and adjusting controls and carrying handles, including their whole movement range

3.3
rated power
electric power assigned by the manufacturer according to ISO 8528-1:2005, Clause 13 (COP, PRP, LTP, ESP), except for low power generating sets to ISO 8528-8:2016, 3.3 (COP)

3.4
low power generating sets
power generating sets for the purpose of this part of ISO 8528 which are determined by the following special features:

— low power is taken to mean rated power of a magnitude up to 10 kW/50 Hz, 12 kW/60 Hz;

— users normally are laymen;

— complete generating set is usually transportable, or mobile;

— electrical output is connected by means of plugs, sockets and screwed terminal except for extra low voltages;

— generating set is ready for use without any additional installation work by the user.

[SOURCE: ISO 8528-8:2016, Clause 1]

3.5
frame contour
outmost of low power generating sets, consisting of robust parts such as, the frame made of pipe, the fuel tank, the handle, the control box, etc.

3.6
operator interface
means by which information is communicated between a human operator(s) and the SIS (for example, CRTs, indicating lights, push-buttons, horns, alarms)

Note 1 to entry: The operator interface is sometimes referred to as the human-machine interface (HMI).

3.7
control device
device connected into the control circuit (circuit used for the control, including monitoring) and used for controlling the operation of the machine (ex. relay, contactor, position sensor,…)

3.8
controlgear
switching device and its combination with associated control, measuring, protective and regulating equipment, intended in principle for the control of electrical energy consuming equipment

3.9
electrical operating area
room or location for electrical equipment to which access is intended to be restricted to skilled or instructed persons (1) (2), by the opening of a door or the removal of a barrier without the use of a key or tool, and which is clearly marked by appropriate warnings signs

Note 1 to entry: Persons (1) and (2) are defined as follows:

(1) person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which electricity can create;

(2) person adequately advised or supervised by electrically skilled persons to enable him or her to perceive risks and to avoid hazards which electricity can create.

3.10
enclosure
part providing protection of equipment against external influences and, in any direction, protection against direct contact

3.11
hazardous-live-part
live part which, under certain conditions, can give a harmful electric shock

3.12
electrical equipment
material, fitting, device, component, appliance, fixture, apparatus, and the like using electric currents or electromagnetic fields, except for the safety extra low voltage circuits

4 General

If the installation of a generating set can create hazards in addition to those covered by this part of ISO 8528, the safety requirements and/or protective measures related to these additional hazards are the responsibilities of the installer, if necessary with the agreement of the manufacturer of the generating set. The installer will be responsible for ensuring compliance for the additional hazards arising because of the installation.

5 Hazards

The hazards relevant to RlC engine driven generating sets that shall be considered in order to prevent personal injury are listed in Annex A.

6 Safety requirements and tests

6.1 General

Machinery shall comply with the safety requirements and/or protective measures of this Clause. In addition, the machine shall be designed according to the principles of ISO 12100 for relevant but not significant hazards, which are not dealt with by this part of ISO 8528.

6.2 Starting system

6.2.1 Requirements

Starting systems can be triggered manually or automatically.

Electrical starting systems normally operate at voltages of 24 V or below. Electrical starting systems above 24 V are not dealt with in this part of ISO 8528 and the installer of the engine shall ensure safe operation after connecting the engine to the driven machinery.

For engines with compressed air starting, the starting pneumatic system shall comply with the installation requirements and with the operation and safety information specified in the manuals provided by the starting system components suppliers.

Crank handle starting systems shall meet the requirements specified in ISO 11102-1 and ISO 11102-2. In addition, the following requirements apply:

— starting handles shall have sufficient clearance from the mounting surface to ensure safe turning;

— diesel engines with a manual starter shall have a decompression facility which shall not be required to be hand-held during cranking.

The only permissible hand starting systems are crank handle (as defined above) and recoil starting devices as described in ISO 14314. The marking required in ISO 14314:2004, 7.3 shall not apply.

6.2.2 Verification

Compliance with the requirements shall be verified by inspection and testing of the starting systems.

6.3 Stopping

6.3.1 Requirements

6.3.1.1 Normal stopping

All generating sets shall have a normal stopping device which can be manually or automatically actuated. Stopping controls shall remain in the stop position when operated. This shall operate by a device ensuring the cutting off of the fuel or the ignition (for spark ignition engines) supply. This device should include an air supply cut-off.

6.3.1.2 Stopping in case of failure

Generating sets except low power generating sets shall be provided with an automatically actuated stopping device in case of failure.

This device shall monitor one or more signals of the generating set and if these signals are out of the allowable range it shall trigger the automatic stop.

The main signals used to actuate automatic stopping may include, but not be limited to, the following:

a) for the RIC engine
    1) overspeed,
    2) low lubricating oil pressure,
    3) high coolant temperature, and
    4) low coolant level;
b) for the generator
    1) excessive overvoltage, and
    2) overload.

These signals or other measures used to actuate automatic stopping shall be specified depending on the application.

6.3.2 Verification

Normal stopping shall be verified by inspection and testing of the stopping device in manual and in automatic modes (if provided in the application).

Automatic stopping in case of failure shall be verified by testing the action of typical failure modes in operating conditions (an appropriate method shall be used to create typical failure conditions, e.g. manual triggering, short-circuiting of contacts).

6.4 Emergency stopping

6.4.1 Requirements

Emergency stopping devices are required for remote controlled generating sets and generating sets with an enclosure or container accessible by persons. In accordance with the risk assessment in ISO 12100:2010, 6.3.5.2, an emergency stopping device is not required for low power generating sets, as it shall not lessen the risk by reducing the stopping time.

Emergency stopping devices shall be actuated manually. As for normal stopping, emergency stopping shall operate by a device ensuring the cutting off of the fuel supply or ignition (for spark ignition engines). This device should include an air supply cut-off.

Emergency stopping devices shall also meet the requirements of ISO 13850, category 0, and the reset shall not initiate a restart or any hazardous conditions.

Manually actuated emergency stopping devices shall be located inside and outside the enclosure or container in which a generating set is located and which is accessible for personnel to carry out maintenance or control operations when generating sets are in operation.

6.4.2 Verification

Emergency stopping devices shall be verified by inspection and testing in operating conditions.

6.5 Control devices

6.5.1 Design, safety and mechanical strength

6.5.1.1 Requirements

Control devices for the RIC engine of the generating set shall meet the following requirements:

— hand controls shall be designed to withstand 1,2× the maximum actuating forces given in Table 1;

Table 1 — Clearance between controls

Operation by	Spacing (mm)	Maximum actuating (N)
Finger tip	10	10
Finger grasp		
— toggles	20	50
— knobs	20	50
Hand		
— upward	50	400
— fore-aft	50	300

— for handles, knobs, grips, levers and similar devices, requirements and tests shall be in accordance with IEC 60335-1:2013, 22.12;

— controls shall act positively and smoothly and without delay or unexpected action and be in accordance with ISO 2261;

— the surface temperature of the controls that shall be manually actuated while the engine is running shall be within the following limits in accordance with ISO 13732-1 for a contact time of 10 s,

  — 55 °C for metallic surfaces, and

— 70 °C for non metallic surfaces;

— sharp edges or corners on, or adjacent to manual controls shall be removed. Edges shall have a chamfer of at least 0,5 mm.

6.5.1.2 Verification

Control devices of the RIC engine shall be verified by inspection and testing.

Control devices of the generating sets shall be verified in accordance with IEC 60204-1:2009, 10.1 and 10.2.

For surface temperature measurement of the control devices (RIC engines and generating sets), the following method shall be conducted:

a) the generating set shall be operated at its rated power until the surface temperatures stabilize;

b) the test shall be conducted in a well-ventilated location not directly exposed to sunshine;

c) if the test is conducted at an ambient temperature outside of the nominal (20 ± 3) °C the reported temperatures shall be corrected by the Formula (1):

$$\text{Corrected temperature}\left(°C\right) = \text{reported temperature}\left(°C\right) - \text{ambient temperature}\left(°C\right) + 20°C \quad (1)$$

6.5.2 Identification

6.5.2.1 Requirements

The controls devices of the RIC engines shall be identified according to the function they perform or their function shall be explained in the operating manual. They shall be identified according to IEC 61310-2. Colour coding shall be according IEC 60073.

The marking on the engine controls shall be legible throughout the engine life.

Identification should preferably be by symbols according to ISO 7000 or ISO 8999 or, if there are no suitable symbols, by words placed on the control or adjacent to it. Design, location and marking principles shall be in accordance with IEC 61310-1.

Emergency shut-off control handles or buttons shall be prominently located and shaped as well as being coloured red, in order to be identified among the other controls.

The control devices on electrical equipment shall comply with the requirements of IEC 60204-1:2009, 10.1 and 10.2 with the exception as given in Table B.1.

6.5.2.2 Verification

Compliance with the requirements shall be verified by inspection.

6.5.3 Accessibility

6.5.3.1 Requirements

Controls should preferably be grouped.

Controls should be located within reach of the operator. Access shall be provided according to ISO 15534-2. The spacing between controls shall be sufficient to allow operation without unintentional actuation of adjacent controls. For the minimum clearances between controls recommended for the given maximum actuating force, see Table 1.

6.5.3.2 Verification

Compliance with the requirements shall be verified by inspection and measurement.

6.6 Monitoring devices

6.6.1 Requirements

6.6.1.1 Instrument identification

Monitoring instruments shall be identified on or adjacent to them, preferably by a symbol according to ISO 8999 or a descriptive wording for the system being monitored.

6.6.1.2 Instrument visibility

Monitoring instruments should be visible to the operator. They shall be illuminated for night time or indoor operation so that they are legible from the operator's position where the application requires it.

6.6.1.3 Instrument colour code

Monitoring instruments and monitoring systems should preferably be colour coded according to IEC 60073. Red is recommended for malfunction or unsafe situation; green for a satisfactory situation or to indicate a system is operating.

The instruments for the monitoring of the electrical equipment shall comply with IEC 60204-1:2009, 10.3.

6.6.2 Verification

Compliance with the requirements shall be verified by inspection.

6.7 Warning devices

6.7.1 Requirements

Warning devices, signs, markings and colours shall meet the requirements of ISO 11429.

6.7.2 Verification

Compliance with the requirements shall be verified by inspection.

6.8 Guarding

6.8.1 General

6.8.1.1 Requirements

The following clauses give the requirements for the common hazards related to guarding and any generating set or installation shall comply with these requirements.

Guards shall be designed in accordance with ISO 14120.

Fixing systems of fixed guards shall remain attached to the guards or to the generating set when the guards are removed. This requirement is limited to fixed guards that need to be removed during normal maintenance operations as described in instructions of use.

For fixed installed generating sets the need of guarding shall be agreed between generating set manufacturer and installer considering that persons shall be protected during operating and routine servicing.

Because it is not possible to envisage the layout of fixed installation, the overall requirements for this situation are not dealt with in this part of ISO 8528. Therefore, for fixed installations, the need for additional guarding to protect persons during operation and routine servicing shall be established after discussion between the generating set manufacturer, user and installer.

NOTE The provider of additional guarding for fixed installations that is outside the scope of this part of ISO 8528 is responsible for ensuring its suitability.

6.8.1.2 Verification

Compliance with the requirements shall be verified by inspection.

6.8.2 Guarding against mechanical hazards

6.8.2.1 Requirements

Moving parts of generating sets, e.g. fan, belt, chains, etc. shall be so arranged or enclosed as to prevent direct involuntary access during normal use, i.e. during maintenance, monitoring or control operations described in the manual of use.

If the guard is constructed of open-mesh material the openings shall be sized as follows:

a) Guards that are less than 100 mm from a hazard shall meet the requirements of IEC 60034-5:2006, Clause 8, with the 12 mm test probe.

b) Guards that are 100 mm or more from a hazard shall meet the opening requirements of ISO 13857:2008, Table 4.

6.8.2.2 Verification

Compliance with the requirements shall be verified by measurement and if necessary by using a 12 mm test probe.

6.8.3 Guarding against hot surfaces

6.8.3.1 General

The necessity to guard hot surfaces depends on its surface temperature, its location and if a person is likely to touch it.

The temperature of the guards shall not exceed the threshold temperature. If this cannot be avoided, then display a warning.

6.8.3.2 Requirements for generating sets except low power generating sets

A risk assessment shall be carried out by the generating sets manufacturer to determine the surfaces with a burn hazard and identify appropriate protective measures in order to prevent accidental contact in normal conditions of use, i.e. during control, monitoring and maintenance operations described in the manual of use.

At least the following areas shall be considered.

a) The surfaces which can be reached when probed by the cones in accordance with Figure 1 and Figure 2 shall not have a temperature higher than the following:

   1) 80 °C for metallic surfaces;

   2) 94 °C for non metallic surfaces.

b) The surfaces, except exhaust engine parts, which do not meet the requirements set in a) shall be guarded to meet a). When the guard does not permit the reduction of the temperature below the temperature limits, a warning marking shall be fixed on or near this guard to warn the generating sets user of the presence of a burn danger.

c) Any engine exhaust surface more than 10 cm^2 which can be reached when probed by the cones, shall be equipped with a guard to limit the most severe burn risks by direct contact. The guard shall meet the requirements specified in a). When the guard does not permit the reduction of the temperature below the limits threshold, a warning marking shall be fixed on or near this guard to warn the generating sets user of the presence of a burn danger.

d) An enclosure with access doors for maintenance or control operations shall not be considered as protection against contact with an engine exhaust.

6.8.3.3 Verification for generating sets except low power generating sets

a) The accessibility of the identified hot surfaces during control and monitoring operations shall be verified by applying the test cones in accordance with Figure 1 and Figure 2:

   1) when the distance between the identified hot area and the nearest control is in excess of 100 mm, cone A as shown in Figure 1 shall be used;

   2) for distances less than 100 mm between the identified hot area and the nearest control, cone B as shown in Figure 2 shall be used;

   3) for cone A with the axis of the cone anywhere 0° and 180° to the horizontal and with the point of the cone in a downward to horizontal direction, move the cone towards the hot surface. The cone shall not be moved in an upwards direction. When moving the cone, determine if contact is made with the hot surface area(s) with the cone tip or conical surface of the cone;

   4) Cone B shall be moved in any direction.

b) For maintenance operations, the hot surfaces to be considered are those more than 10 cm^2 located at less than 300 mm of a maintenance or control point and/or of access path for operators.

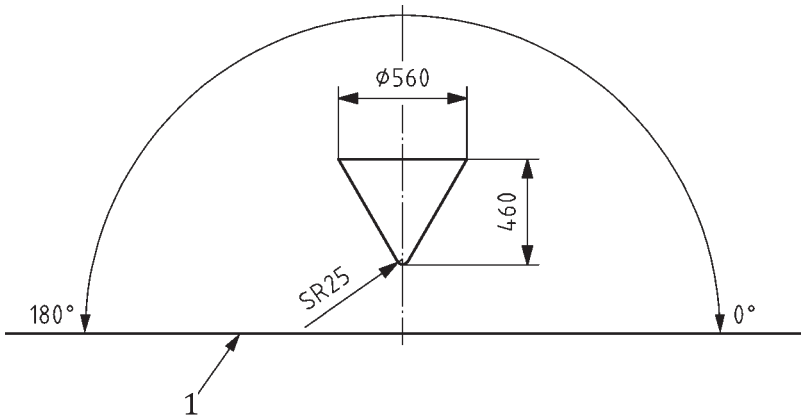
c) The generating set shall be operated at its rated power until the surface temperatures stabilize.

d) The test shall be conducted in a well-ventilated location not directly exposed to sunshine.

e) If the test is conducted at an ambient temperature outside of the nominal (20 ± 3) °C the reported temperatures shall be corrected by Formula (1):

$$\text{Corrected temperature}\,(°C) = \text{reported temperature}\,(°C) - \text{ambient temperature}\,(°C) + 20\,°C \quad (1)$$

Dimensions in millimetres

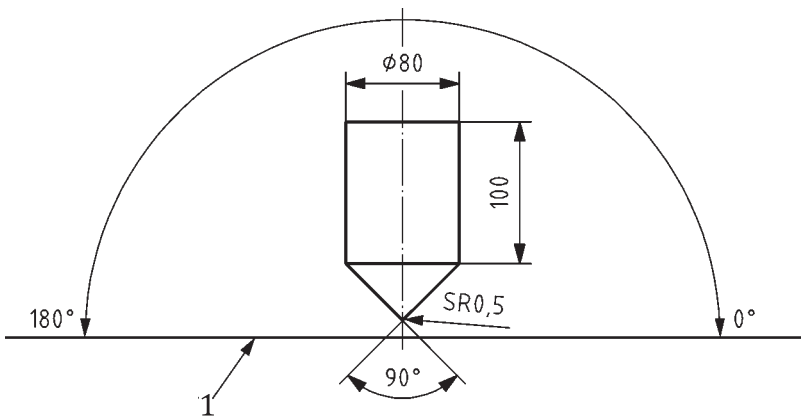


Key

1 horizontal plane

Figure 1 — Cone A

Dimensions in millimetres



Key

1 horizontal plane

Figure 2 — Cone B

6.8.3.4 Requirements for low power generating sets

a) The accessible surfaces in the close proximity of controls shall not have a temperature higher than the following:

   1) 80 °C for metallic surfaces;

   2) 94 °C for non metallic surfaces.

b) The carrying handles of generating sets and the accessible surfaces in their close proximity shall not have a temperature higher than the following:

   1) 50 °C for metallic surfaces;

   2) 70 °C for non metallic surfaces.

c) The engine exhaust, with potential burn hazards during the operating, but also during cooling period following a generating sets stopping, shall be equipped with a guard to limit the most severe

burn risks by accidental contact. The dimension of guard clearance shall ensure that such exhaust surface cannot be reached when being probed by test cones in accordance with Figure 1 and Figure 2. Any exhaust surface less than 10 cm^2 does not need to be equipped with protection.

Accessible engine exhaust components more than 10 cm^2 and their guards shall not have surface temperatures higher than 94 °C for non-metallic surfaces materials or 80 °C for metallic surfaces. When a guard does not permit the reduction of the temperature below the limits threshold, a warning marking shall be fixed, in addition, on or near this guard to warn the generating sets user of the presence of a burn danger.

d) Accessible hot surface parts more than 10 cm^2 except for these services described in a), b) or c) with a temperature higher than 94°C for non-metallic surfaces or 80 °C for metallic surfaces, shall be located inside the frame contour and a warning marking shall be fixed, in addition, on or near the parts to warn the low power generating sets user of the presence of a burn danger.

e) An enclosure with access doors for maintenance or control operations shall not be considered as protection against contact with an engine exhaust.

6.8.3.5 Verification for low power generating sets

a) The accessibility of the identified hot surfaces during control and monitoring operations shall be verified by applying the test cones in accordance with Figure 1 and Figure 2:

   1) when the distance between the identified hot area and the nearest control is in excess of 100 mm, cone A as shown in Figure 1 shall be used;

   2) for distances less than 100 mm between the identified hot area and the nearest control, cone B as shown in Figure 2 shall be used;

   3) for cone A with the axis of the cone anywhere 0° and 180° to the horizontal and with the point of the cone in a downward to horizontal direction, move the cone towards the hot surface. The cone shall not be moved in an upwards direction. When moving the cone, determine if contact is made with the hot surface area(s) with the cone tip or conical surface of the cone;

   4) Cone B shall be moved in any direction;

b) When the accessible hot surfaces are less than 10 cm^2 they shall be verified in accordance with 6.8.3.1.

   1) The surfaces temperatures shall be verified by measurement,

   2) The generating set shall be operated at its rated power until the surface temperatures stabilize,

   3) The test shall be conducted in a well-ventilated location not directly exposed to sunshine,

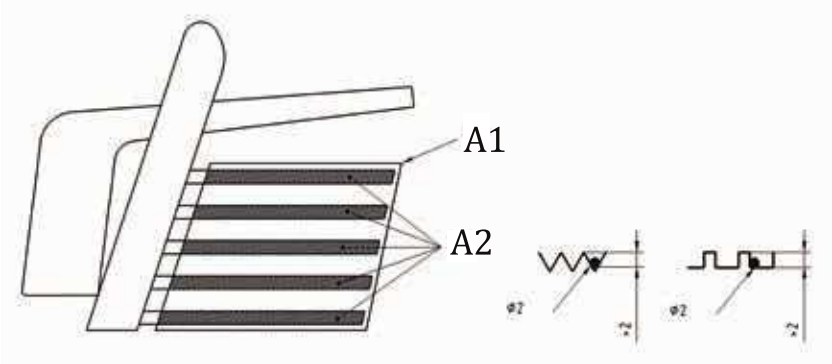
   4) If the test is conducted at an ambient temperature outside of the nominal (20 ± 3) °C the reported temperatures shall be corrected by Formula (1):

$$\text{Corrected temperature}\,(°C) = \text{reported temperature}\,(°C) - \text{ambient temperature}\,(°C) + 20\,°C \qquad (1)$$

A guard shall be provided to prevent accidental contact with any engine exhaust component during normal operation; any hot surface smaller than 10 cm^2 does not require guarding.

The determination of area for interrupted surfaces shall be made as follows.

If a marked surface (with area A1) consists of multiple separate surfaces of which the sum of the areas (A2) exceeds 80 % of A1, then A1 shall be considered as one uninterrupted area (see Figure 3). Surfaces whose structure does not allow a ball with 2 mm diameter to penetrate more than 2 mm below highest parts of the structure shall be considered as part of A1 (see Figure 3).



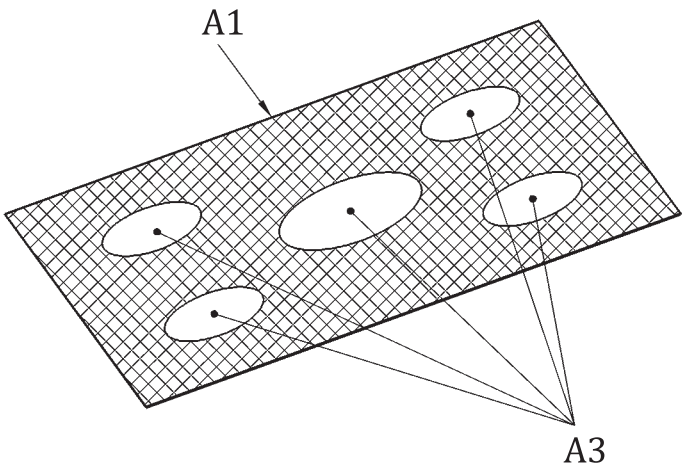
Key

A1 marked surface

A2 sum of area >80 % of A1

Figure 3 — Example of a surface consisting of multiple separate surfaces

If a marked surface (with area A1) includes holes of which the sum of the areas (A3) is less than 20 % of the area of marked surface (A1) it shall be considered as one uninterrupted area (see Figure 4).



Key

A1 marked surface

A3 sum of areas of the holes

Figure 4 — Example of a surface with holes

The recorded area of the marked surface(s) shall not be larger than 10 cm^2.

6.9 Stability for low power generating sets

6.9.1 Not in operation

6.9.1.1 Requirements

Generating sets shall exhibit proof of suitable stability when not in operation.

Test shall be conducted with fuel filled to the maximum capacity specified in the manufacturer's instructions.

6.9.1.2 Verification

Compliance shall be checked by placing the unit on a surface which is tilted 15° in all directions. The unit shall neither overturn nor spill fuel.

Units with flaps or doors are tested both with the flaps and doors closed and then with them open. The unit shall satisfy requirements under the worst of conditions.

6.9.2 In operation

6.9.2.1 Requirements

Generating sets shall be suitable for operation on mounting surfaces inclined up to 4°.

6.9.2.2 Verification

Compliance is checked by operating the unit in four positions set at 90° intervals around the vertical axis on a rough concrete surface inclined up to 4°. The unit shall not change its position by more than 10 mm even after 30 min of operation at no-load and at rated power.

6.10 Lighting

6.10.1 Requirements

Except for low generating sets and if installed, the lighting of a generating set shall illuminate the control levers, monitoring devices and corresponding walkways with an intensity of at least 20 lux.

6.10.2 Verification

Compliance with the requirements shall be verified by measurement or technical documentation.

6.11 Handling

6.11.1 Requirements

Generating sets above 140 kg shall have provisions for lifting attachments to attach lifting devices to lift the generating set or parts of it according to the manufacturers' instructions.

The lifting attachments shall be designed to withstand at least 1,5 times the mass lifted by lifting attachments. The lifting attachments shall be located to allow at least 20 mm clearance between lifting rope or chain or belt and any generating set components, unless the components are designed to withstand the contact during a lifting operation without permanent deformation or damage to the rope, chain or belt.

The access to the lifting attachments shall allow an easy attachment of the lifting hook or shackle.

Lifting attachments shall be so located that lifting ropes, chains or belts converge over the centre of gravity (if no cross beam is used) when the generating set or its lifted component is in the normal position specified by the manufacturer.

Generating sets below 140 kg intended for transportation by persons shall have carrying handles or an adequate frame design to transport it according to the manufacturers' manual.

The handles shall be designed to withstand at least 2,5 times the mass lifted divided by the number of carrying handles.

NOTE Typically, generating sets are either designed with handles or use the frame for carrying purposes. Therefore, it is not possible to prescribe the exact number or layout of handles. As a basis for providing means of carrying the generating set it is considered that a 140 kg set should be provided with the means of carrying by 4 persons.

6.11.2 Verification

Compliance with the requirements of 6.11.1 regarding the number and the location of the lifting attachments shall be verified by inspection.

The strength of the lifting attachments to withstand the mass to be lifted shall be verified by testing or calculation.

6.12 Mechanical strength

6.12.1 Requirements

Low-power generating sets shall be designed in such a way as to be able to withstand robust handling within the framework of normal operation. All parts, damage to which may impair safety, shall have sufficient mechanical strength.

The generating set shall satisfy the tests defined below.

a) Subjected to impact using an impact tester.

   Blows are applied to the generating set by means of the spring-operated impact tester according to IEC 60068-2-75.

   The spring is adjusted in such a way as to cause the hammer to strike with an impact energy of 1, 0 J ± 0,05 J.

   The release mechanism springs are adjusted in such a way as to exert just sufficient pressure to keep the release jaws in the engaged position.

   The apparatus is cocked by pulling the cocking knob until the release jaws engage with the groove in the hammer shaft.

   Blows are applied by pushing the release cone against the sample in a direction perpendicular to the surface of the sample at the point to be tested.

   Pressure is slowly increased so that the cone moves back until it is in contact with the release bars, which then move to operate the release mechanism and allow the hammer to strike.

   The entire sample, under no-running conditions, is rigidly held and three blows are applied to every point of the enclosure which is likely to be weak.

   Blows are also applied to protective devices, handles, levers, knobs, etc.

b) Free-fall test.

   Before testing the generating set shall be in the usual carrying/transporting condition. It is dropped from a height of 20 cm on to a concrete floor. This test is performed once.

6.12.2 Verification

After completing both tests, the sample shall exhibit no damage which would impair mechanical or electric safety.

6.13 Fire protection

6.13.1 General

The design shall consider hazards from flammable liquids or gases with regard to routing of pipes, location of reservoir, leakage, filling and draining. The possibility of contact with energy sources that could result in a hazard should be minimized.

6.13.2 Requirements

For the RIC engine, the basic requirements of ISO 6826 shall be met.

The orifices and the filling devices of the generating set shall meet the requirements of ISO 6826:1997, 6.2.

The piping for flammable liquids shall meet the requirements of ISO 6826:1997, 7.3 and the draining valves the requirements of ISO 6826:1997, 7.6.

For fuel tanks, the following additional requirements apply. Design requirements:

— fuel tanks shall be designed as to ensure that no leaks develop under normal operating conditions;

— filler necks in fuel tanks shall be arranged and designed in such a way as to ensure that fuel cans or other devices with spouts can be directly inserted and no fuel can come into contact with hot parts.

Strength requirements:

— the tank shall be secured to withstand normal handling;

— the tank shall be strong enough to withstand impact during normal handling or be protected from impact.

For low power generating sets, the following additional temperature requirement applies.

— Any parts of the generating set which are in direct contact with its supporting surface shall not exceed a temperature of 90 °C.

6.13.3 Verification

Compliance with the requirements shall be verified by inspection and examination of the engine manufacturer documentation.

For low power generating sets, compliance with the fuel tank strength requirements shall be satisfied by testing in accordance with 6.12.1 a).

For low power generating sets, the temperature measurement shall be done in the same operating conditions as specified in 6.8.3.5.

6.14 Hoses, pipes and electrical harnesses of the RIC engine

6.14.1 Requirements

Hoses, pipes and electric harnesses, as well as fittings and connectors, shall be designed and made of material to withstand expected pressure, voltage, temperature, abrasion, corrosion, etc. Excessive hose and electric cable length shall be avoided to prevent misuse and obstruction.

Hoses and electric harnesses shall be routed and retained so that it is unlikely they will be used as hand holds or footsteps.

Hoses and electric harnesses shall not interfere with the accessibility of service points.

Hoses and pipe assemblies that can leak flammable liquids or gases onto hot surfaces, shall either be guarded to prevent the liquid going onto the hot surface or be dimensioned to be able to contain twice the operating pressure. In case of fuel pipes, 1,2 times the maximum operating pressure is sufficient.

6.14.2 Verification

Compliance with requirements shall be verified by inspection and examination of the documentation provided by component manufacturers.

6.15 Electrical equipment

6.15.1 Generating sets

6.15.1.1 Degree of protection

These requirements do not apply to the safety extra low voltage circuits.

6.15.1.1.1 Protection against solid foreign objects and protection of persons against access to hazardous parts inside the enclosure

6.15.1.1.1.1 Requirements (minimum degree of protection)

a) For generating sets except low power generating sets

   — generating set : IP2X,

   — operator interface : IP3X,

   — live parts on the inside of doors : IP1X, and

   — switching and control devices : IP4X.

   NOTE If inside of doors: IP2X.

b) For low power generating sets

   — generating set : IP2X, and

   — operator interface : IP3X.

6.15.1.1.1.2 Verification

The degree of protection shall be verified on the generating set in accordance with the test method and acceptance criteria of IEC 60529.

6.15.1.1.2 Protection of the equipment inside the enclosure against harmful effects due to the ingress of water

6.15.1.1.2.1 Requirements (minimum degree of protection)

a) For generating sets except low power generating sets

   — generating set : IPX1M, and

   — operator interface : IPX3M.

b) For low power generating sets

   — generating set and operator interface : IPX3M.

6.15.1.1.2.2 Verification

The test method for each degree of protection shall be in accordance with IEC 60529 in operation condition with no load.

The test sample for the test shall be in a clean and new condition with all parts in place and mounted in the manner stated by the manufacturer. The degree of protection shall be verified in accordance with the acceptance criteria following a) or b).

a) Generating sets except low power generating sets shall comply with the acceptance criteria of IEC 60529.

b) For the lower power generating sets.

After the test against ingress of water,

— a dielectric test shall be performed in accordance with IEC 60335-1: 2013, 16.3, Table 7, and

— the creepage distance shall comply with IEC 60335-1:2013, 29.2, Table 17.

6.15.1.2 Insulation

6.15.1.2.1 Requirements

The insulation of output circuit shall comply with IEC 60204-1.

6.15.1.2.2 Verification

Insulation of output circuit shall be verified according to IEC 60204-1:2009, 18.3, 18.4.

In addition, for generators equipped with safety extra low-voltage circuits for the output that may be in direct contact of persons with its live parts during the operation, such as the output for battery charging outside the generating sets, or extra low- voltage circuits for control circuits inside generating sets, the generating set windings for these circuits shall be electrically isolated from other windings.

The voltage test according to IEC 60034-1:2010, 9.2 shall be performed between the main and/or excitation windings at:

$2U_N$ + 2000 V for generating set windings of safety extra low voltage circuit

2 U_N + 1000 V for generating set windings of extra low voltage circuit

where, U_N is the rated output voltage of the generating set.

6.15.1.3 Protective bonding circuit

6.15.1.3.1 Requirements

The protective bonding circuit shall comply with IEC 60204-1.

6.15.1.3.2 Verification

The function of the protective bonding circuit shall be verified according to IEC 60204-1:2009, 18.2.

6.15.1.4 Clearances, creepage distances and solid insulation

6.15.1.4.1 Requirements

Creepage distances and clearances shall not be less than the values, in mm, in IEC 60335-1:2013, Clause 29.

6.15.1.4.2 Verification

Compliance shall be checked by measurement of the clearances and verification on the basis of manufacturing documents.

6.15.2 Other electrical equipment

Electrical equipment used to operate the generating set shall meet the requirements of Annex B.

6.16 Noise

6.16.1 Requirements

When designing the generating set, the available information and technical measures to control noise at source shall be taken into account, see for example, ISO/TR 11688-1.

The main sources of airborne noise on generating sets include the following:

— the engine;

— the cooling system fan if provided;

— the exhaust system.

6.16.2 Verification

Airborne noise shall be measured as specified in ISO 8528-10:1998, Clause 9 at 75 % of rated power (PRP), except for low power generating sets to ISO 8528-8:2016, 3.3 (COP) and determined according to ISO 8528-10:1998, Clause 13 for the sound power level and according to ISO 8528-10:1998, Clause 14 for the emission sound pressure level.

6.17 Access systems

6.17.1 Requirements

Surfaces of all access system (e.g. walkways and platforms, etc.), if required, shall be slip resistant under the expected use to minimize the possibility of foot slippage.

Access systems shall be level and free from obstructions and protrusions to prevent injury.

The structure shall be sufficiently sturdy and stable to support any expected load without undue deformation or loss of integrity.

Access systems shall be designed according to ISO 14122-2:2001 and ISO 14122-2:2001/Amd1:2010.

6.17.2 Verification

Compliance with the requirements shall be verified by test or calculation.

6.18 Access to service points

6.18.1 Requirements

Openings intended for maintenance purposes shall comply with ISO 15534-2.

6.18.2 Verification

Compliance with the requirements shall be verified by inspection and measurement.

6.19 Gaseous and particulate exhaust emissions

6.19.1 Requirements

The exhaust shall be directed away from the generating set control panel.

For generating sets intended to be used indoors, the exhaust shall be directed outside.

NOTE This is the responsibility of the installer, see 7.1.

6.19.2 Verification

Compliance with the requirement shall be verified by inspection.

6.20 Drainage

6.20.1 Requirements

Provisions shall be made to allow drainage of fuel, coolant and lubrication oil without any spillage. This can be achieved by

— permanently installed pipework to a collection point, or

— providing access for collection containers to allow direct drainage, or

— access to drain plugs without the need to remove guards.

6.20.2 Verification

Compliance with the requirements shall be verified by inspection.

7 Operating and maintenance instructions

7.1 Requirements

Operating and maintenance instruction shall comply with ISO 12100:2010, 6.4.5 and shall provide adequate information to enable the generating set to be operated safely and give clear advice concerning its installation, use and maintenance.

Extensive use should be made of photographs and/or diagrams.

The operating and maintenance instructions shall include, but not be limited, to the following:

a) general description, in particular description of the generating set nameplate, and explanation of the adjustment points that shall not be modified;

b) general information concerning the toxicity of exhaust gases, fuel and oil;

c) information concerning the limitation of use at locations where the risk of fire may be high;

d) filling with fuel and oil;

e) starting and stopping;

f) correct use of batteries;

g) indications about the hot surfaces and their guards when provided;

h) routine maintenance instructions;

i) correct disposal of residual fluids;

j) indication that the installation and major repair work shall be carried out only by specifically trained personnel;

k) information on installation precautions, e.g. exhaust system, intake system, cooling system, drainage, fuelling, electrical connection, noise and access;

l) if necessary advice on the need of personal protection equipment;

m) in the case of generating sets provided for use by laymen the supplied instructions shall meet the requirements as defined in Annex C;

n) the operation manual shall contain information on sound power level from the generating set and the emission sound pressure level at the operator's position(s) as follows:

   1) A-weighted sound power level (*L*wA in accordance with ISO 8528-10:1998) emitted by the machine, together with uncertainty of stated values where the equivalent continuous A-weighted emission sound pressure level at the operator's station(s) exceeds 80 dB. The declaration of this value shall have the format of a single number declaration as defined in ISO 4871.

   2) A-weighted emission sound pressure level (*L*pA) at the operator's station (at a distance of 1 m where no operator station is existing) where this exceeds 70 dB, together with uncertainty of stated values; where this level does not exceed 70 dB, this fact shall be indicated. The declaration of this value shall have the format of a dual-number declaration as defined in ISO 4871.

   3) For indoor generating sets for which the ambient noise levels depend on the conditions of installation, it is not possible to specify these ambient noise levels in the operating and maintenance instructions. In this case, the operating and maintenance instructions shall include a warning about the dangers of airborne noise and on the need for performing, after the installation, acoustic measurements to determine the sound pressure level in the conditions specified in 6.16.2 and for implementing appropriate protective measures if necessary.

7.2 Verification

Compliance with the requirements shall be verified by examination of the operating and maintenance instructions and then by inspection of the generating set.

8 Safety labels

8.1 Requirements

The labels shall be clearly visible, legible and indelible.

The symbols shall be labelled according to ISO or IEC relevant standards.

Safety labels shall be present on a generating set to inform the user of potential danger if these risks have been identified by the manufacturer.

Low power generating sets shall be labelled with at least the following safety labels:

a) read the operator's instruction manual;

b) exhaust gas is poisonous; do not operate in an unventilated area [Carbon monoxide (CO) danger];

c) not to refuel when operating.

Safety labels shall be, for example, as shown below.

Caution	Read the operator's instruction manual before use
	
See ISO 7000-0434B	See ISO 7000-0790
Electrical hazard	Carbon monoxide (CO) danger
	
See ISO 7010-W012	See ISO 7010-W041 (under registration)

Fire hazard	Risk of being burnt
	
See ISO 7010-W021	See ISO 7010-W017

8.2 Verification

The conformity of the safety labels shall be verified by inspection.

9 Marking

9.1 Requirements

Generating sets shall be marked legibly and indelibly with the following minimum information:

— the name and address and trademark of the manufacturer and where applicable his authorized representative;

— the designation of the machinery "Generating set" or " Low-power generating set "

— the designation of series or type[1)]

— the serial number;

— the year of construction, that is the year in which the manufacturing process is completed;

— mass in kilograms;

— the rated power, in kilowatts, with the prefixes COP, PRP, LTP or ESP in accordance with ISO 8528-1:2005, Clause 13;

— the performance class in accordance with ISO 8528-1:2005;

— the rated power factor;

1) The designation of the series or type is to allow the technical identification of the product and this can be achieved a combination of letters and/or numbers and can be combined with the technical designation of the machinery.

— the rated frequency, in hertz;

— the rated voltage, in volts;

— the rated current, in amperes;

— for low power generating sets:

  — the quality class in accordance with ISO 8528-8:2016, 7.3.2;

  — the maximum power, in kilowatts, with the prefix MAX in accordance with ISO 8528-8:2016, 3.4;

  — the degree of protection provided by the generating set (at least IP23M).

NOTE Information related to the maximum side altitude above sea level (m) and the maximum site ambient temperature (C°) are not relevant for the rating plate but can be made available in a technical documentation.

9.2 Verification

The conformity of the markings shall be verified by inspection.

Annex A
(normative)

List of hazards

Table A.1 — List of hazards

Hazards		Relevant in
1	Mechanical hazards	
1.1	Crushing hazards	6.8.2
1.2	Shearing hazard	6.8.2
1.3	Cutting or severing hazard	6.8.2
1.4	Entanglement hazard	6.8.2
1.5	Drawing-in or trapping hazard	6.8.2
1.6	Impact hazard	6.8.2
1.7	Stabbing and puncture hazard	6.8.2
1.8	Friction or abrasion hazard	6.8.2
1.9	High pressure fluid ejection hazard	6.13, 6.14
1.10	Ejection of parts (e.g. broken belt)	6.8
1.11	Loss of stability (of machinery and machine parts)	6.9, 6.11
1.12	Slip, trip and fall hazards in relationship with machinery (because of their mechanical nature)	6.17
2	Electrical hazards	
2.1	Electrical contact (direct or indirect)	6.15
2.2	Electrostatic phenomens	non applicable
2.3	Thermal radiation or other phenomens, such as ejection of molten particles, and chemical effects from short circuits, overloads, etc.	6.15
2.4	External influences on electrical equipment, e.g. starter battery overcharge	6.15
2.5	Alternator automatic voltage regulator failure	6.3.1.2
3	Thermal hazards resulting in the following:	
3.1	Burns and scalds, by a possible contact of persons, by flames and also by the radiation of heat sources	6.8.3
3.2	Health damaging effects by hot or cold work environment	non applicable
4	Hazards generated by noise, resulting in:	
4.1	Hearing losses (deafness), other physiological disorders (e.g. loss of balance, loss of awareness)	6.16
4.2	Interferences with speech communication, acoustic signals, etc.	6.16
5	Hazards generated by vibration (resulting in a variety of neurological and vascular disorders)	non applicable
6	Hazards generated by radiation, especially by the following:	
6.1	Electrical arcs	6.15
6.2	Lasers	non applicable
6.3	Ionizing radiation sources	non applicable
6.4	Machines making use of high frequency electromagnetic fields	non applicable

Table A.1 *(continued)*

Hazards		Relevant in
7	Hazards generated by materials and substances processed, used or exhausted by machinery	
7.1	Hazards resulting from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts	6.13, 6.19, 7
7.2	Fire hazards	6.13
7.3	Biological and microbiological (viral or bacterial) hazards	non applicable
8	Hazards generated by neglecting ergonomic principles in machine design (mismatch of machinery with human characteristics and abilities)	
8.1	Unhealthy postures or excessive efforts	6.5.3, 6.11
8.2	Inadequate consideration of human hand-arm or foot-leg anatomy	6.5.3, 6.11
8.3	Misuse of personal protective equipment	6.15, 7
8.4	Inadequate area lighting	6.10
8.5	Mental overload, stress, etc.	non applicable
8.6	Human error	6.5.2, 6.6, 7
9	Hazard combinations	non applicable
10	Hazards caused by failure of energy supply, breaking down of machinery parts or other functional disorders	
10.1	Failure of energy supply (of energy and/or control circuits)	6.4
10.2	Unexpected ejection of machine parts or fluids	6.4, 6.8, 6.13, 6.14
10.3	Failure, malfunction of control systems (unexpected start up, unexpected overrun)	6.4
10.4	Errors of fitting	7
10.5	Overturn, unexpected loss of machine stability	6.9, 6.11
11	Hazards caused by (temporary) missing or incorrectly positioned safety related measures/means	
11.1	Guards	6.8, 7
11.2	Safety related protection devices	6.8, 7
11.3	Starting and stopping devices	6.2, 6.3, 6.4
11.4	Safety signs and signals	7, 8
11.5	Information or warning devices	6.5.2, 6.6, 6.7, 7, 8
11.6	Energy supply disconnecting devices	non applicable
11.7	Emergency devices	6.4
11.8	Feeding/removal of workpieces	non applicable
11.9	Essential equipment and accessories for safe adjustment and/or maintenance	7
11.10	Equipment evacuating gases	6.19

Annex B
(normative)

Application of IEC 60204-1:2009 for generating sets

B.1 General

In accordance with IEC 60204-1:2009, Annex F, this Annex specifies and completes the general requirements of IEC 60204-1 which are applicable to the electric equipment of the generating sets.

Table B.1 shall indicate the following:

— A: the articles or subclauses of IEC 60204-1 applicable to generating sets;

— R: the articles or subclauses of IEC 60204-1 for which a replacement is necessary so that these apply to generating sets and are indicated by the clauses or subclauses numbers in this Annex;

— N/A: the articles or subclauses of IEC 60204-1 that do not apply;

— whenever an article, clause or subclause is referenced, check in this table if it is "A", "R" or "N/A";

— the replacements of these clauses or subclauses are given in the continuation of this Annex.

Table B.1 — Table on the application of IEC 60204-1

IEC 60204-1:2009			ISO 8528-13:2016, Annex B Application for generating sets					
			A: applicable R: replacement N/A: not applicable					
			Generating sets except low-power generating sets			Low-power generating sets		
Clause	**Subclause**	**Title**	**A**	**R**	**N/A**	**A**	**R**	**N/A**
1		Scope		B.2			B.2	
2		Normative references	x			x		
3		Definitions	x			x		
4		General requirements		B.3			B.3	
	4.1	General considerations	x			x		
	4.2	Selection of equipment						
	4.2.1	General		B.3.1.1			B.3.1.1	
	4.2.2	Electrical equipment in compliance with the IEC 60439 series	x			x		
	4.3	Electrical supply		B.3.2			B.3.2	
	4.4	Physical environment and operating conditions						
	4.4.1	General	x			x		
	4.4.2	Electromagnetic compatibility (EMC)	x					x
	4.4.3	Ambient air temperature	x					x
NOTE Clauses applicable in totality are not detailed by subclauses.								

Table B.1 *(continued)*

IEC 60204-1:2009			ISO 8528-13:2016, Annex B Application for generating sets					
			A: applicable R: replacement N/A: not applicable					
			Generating sets except low-power generating sets			Low-power generating sets		
Clause	**Subclause**	**Title**	**A**	**R**	**N/A**	**A**	**R**	**N/A**
	4.4.4	Humidity		B.3.3.1			B.3.3.1	
	4.5	Altitude	x			x		
	4.4.6	Contaminants			x			x
	4.4.7	Ionizing and non-ionizing radiation			x			x
	4.4.8	Vibration, shock, and bump	x			x		
	4.5	Transportation and storage	x			x		
	4.6	Provisions for handling	x			x		
	4.7	Installation	x			x		
5		Incoming supply conductor terminations and devices for disconnecting and switching off						
	5.1	Incoming supply conductor terminations		B.4.1			B.4.1	
	5.2	Terminal for connection to the external protective earthing system		B.4.2			B.4.2	
	5.3	Supply disconnecting (isolating) device		B.4.3			B.4.3	
	5.4	Devices for switching off for prevention of unexpected start-up		B.4.4			B.4	
	5.5	Devices for disconnecting electrical equipment	x			x		
	5.6	Protection against unauthorized, inadvertent and/or mistaken connection	x			x		
6		Protection against electric shock						
	6.1	General	x			x		
NOTE Clauses applicable in totality are not detailed by subclauses.								

Table B.1 *(continued)*

IEC 60204-1:2009			ISO 8528-13:2016, Annex B Application for generating sets					
			A: applicable R: replacement N/A: not applicable					
			Generating sets except low-power generating sets			Low-power generating sets		
Clause	**Subclause**	**Title**	**A**	**R**	**N/A**	**A**	**R**	**N/A**
	6.2	Protection against direct contact						
	6.2.1	General		B.5.1.1			B.5.1.1	
	6.2.2	Protection by enclosures			x			x
	6.2.3	Protection by insulation of live parts	x			x		
	6.2.4	Protection against residual voltages	x			x		
	6.2.5	Protection by barriers	x			x		
	6.2.6	Protection by placing out of reach or protection by obstacles	x			x		
	6.3	Protection against indirect contact						
	6.3.1	General		B.5.2.1			B.5.2.1	
	6.3.2	Prevention of the occurrence of a touch voltage						
	6.3.2.1	General	x			x		
	6.3.2.2	Protection by provision of class II equipment or by equivalent insulation			x			x
	6.3.2.3	Protection by electrical separation		B.5.2.1.1			B.5.2.1.1	
	6.3.3	Protection by automatic disconnection of supply		B.5.2.1.2			B.5.2.1.2	
NOTE Clauses applicable in totality are not detailed by subclauses.								

Table B.1 *(continued)*

IEC 60204-1:2009			ISO 8528-13:2016, Annex B Application for generating sets A: applicable R: replacement N/A: not applicable					
			Generating sets except low-power generating sets			Low-power generating sets		
Clause	**Subclause**	**Title**	**A**	**R**	**N/A**	**A**	**R**	**N/A**
		Protection by automatic disconnection-for low power generating sets		B.5.2.1.3			B.5.2.1.3	
	6.4	Protection by the use of PELV	x			x		
7		Protection of equipment						
	7.1	General	x			x		
	7.2	Overcurrent protection			x			x
	7.3	Protection of motors against overheating	x			x		
	7.4	Abnormal temperature protection	x			x		
	7.5	Protection against supply interruption or voltage reduction and subsequent restoration			x			x
	7.6	Motor overspeed protection			x			x
	7.7	Earth fault/residual current protection	x			x		
	7.8	Phase sequence protection	x			x		
	7.9	Protection against over-voltages due to lightning and to switching surges	x			x		
8		Equipotential bonding						
	8.1	General	x			x		
	8.2	Protective bonding circuit						
	8.2.1	General		B.6.1.1			B.6.1.1	
	8.2.2	Protective conductors	x			x		
NOTE Clauses applicable in totality are not detailed by subclauses.								

Table B.1 *(continued)*

IEC 60204-1:2009			ISO 8528-13:2016, Annex B Application for generating sets					
			A: applicable R: replacement N/A: not applicable					
			Generating sets except low-power generating sets			Low-power generating sets		
Clause	**Subclause**	**Title**	**A**	**R**	**N/A**	**A**	**R**	**N/A**
	8.2.3	Continuity of the protective bonding circuit	x			x		
	8.2.4	Exclusion of switching devices from the protective bonding circuit	x			x		
	8.2.5	Parts that need not be connected to the protective bonding circuit	x			x		
	8.2.6	Protective conductor connecting points	x			x		
	8.2.7	Mobile machines	x			x		
	8.2.8	Additional protective bonding requirements for electrical equipment having earth leakage currents higher than 10 mA a.c or d.c	x			x		
	8.3	Functional bonding	x			x		
	8.4	Measures to limit the effects of high leakage current	x			x		
9		Control circuits and control functions						
	9.1	Control circuits			x			x
	9.2	Control functions			x			x
	9.3	Protective interlocks			x			x
	9.4	Control functions in the event of failure						
	9.4.1	General requirements			x			x
	9.4.2	Measures to minimize risk in the event of failure			x			x
	9.4.3	Protection against maloperation due to earth faults, voltage interruptions and loss of circuit continuity	x			x		
NOTE Clauses applicable in totality are not detailed by subclauses.								

Table B.1 *(continued)*

IEC 60204-1:2009			ISO 8528-13:2016, Annex B Application for generating sets					
			A: applicable R: replacement N/A: not applicable					
			Generating sets except low-power generating sets			Low-power generating sets		
Clause	**Subclause**	**Title**	**A**	**R**	**N/A**	**A**	**R**	**N/A**
10		Operator interface and machine-mounted control devices						
	10.1	General			x			x
	10.2	Push-buttons	x			x		
	10.3	Indicator lights and displays	x			x		
	10.4	Illuminated push-buttons	x			x		
	10.5	Rotary control devices	x			x		
	10.6	Start devices			x			x
	10.7	Emergency stop devices		B.7.1				x
	10.8	Emergency switching off devices			x			x
	10.9	Enabling control device	x			x		
11		Controlgear: location, mounting, and enclosures						
	11.1	General requirements	x			x		
	11.2	Location and mounting	x			x		
	11.3	Degrees of protection			x			x
	11.4	Enclosures, doors and openings	x			x		
	11.5	Access to controlgear	x			x		
12		Conductors and cables	x			x		
13		Wiring practices						
	13.1	Connections and routing	x			x		
	13.2	Identification of conductors	x			x		
	13.3	Wiring inside enclosures		B.8.1			B.8.1	
NOTE Clauses applicable in totality are not detailed by subclauses.								

Table B.1 *(continued)*

IEC 60204-1:2009			ISO 8528-13:2016, Annex B Application for generating sets					
			A: applicable R: replacement N/A: not applicable					
			Generating sets except low-power generating sets			Low-power generating sets		
Clause	**Subclause**	**Title**	**A**	**R**	**N/A**	**A**	**R**	**N/A**
	13.4	Wiring outside enclosures	x			x		
	13.5	Ducts, connection boxes and other boxes	x			x		
14		Electric motors and associated equipment	x			x		
15		Accessories and lighting			x			x
16		Marking, warning signs and reference designations			x			x
17		Technical documentation			x			x
18		Verification	x			x		
Annex	A (normative)	Protection against indirect contact in TN-systems	x			x		
	B (informative)	Enquiry form for the electrical equipment of machines	x			x		
	C (informative)	Examples of machines covered by this part of IEC 60204	x			x		
	D (informative)	Current-carrying capacity and overcurrent protection of conductors and cables in the electrical equipment of machines	x			x		
	E (informative)	Explanation of emergency operation functions	x			x		
	F (informative)	Guide for the use of this part of IEC 60204	x			x		
	G (informative)	Comparison of typical conductor cross-sectional areas	x			x		
NOTE Clauses applicable in totality are not detailed by subclauses.								

B.2 Scope

IEC 60204-1:2009, Clause 1 is replaced as follows.

This part of IEC 60204 is applicable to the electrical equipment or parts of the electrical equipment that operate with nominal supply voltages not exceeding 1 000 V for alternating current (a.c.) and not exceeding 1 500 V for direct current (d.c.), and with nominal supply frequencies not exceeding 200 Hz.

B.3 General requirements

IEC 60204-1:2009, Clause 4 is replaced as follows:

It is impracticable for manufacturers of generating sets to specify the type of system earthing on the load side. The following shows the types of system earthling (TN, TT, IT) and the corresponding types of system earthing for generating sets.

Types of system earthing (Generating sets & Load)	Types of system earthing (Generating sets only)
TN system	Neutral bonded
TT system	
IT system	Neutral unbonded/Neutral high-impedance bonded
NOTE Requirements for types of system earthing covered by this standard are applicable only to generating sets of the corresponding types of system earthling.	

B.3.1 Selection of equipment

B.3.1.1 General

IEC 60204-1:2009, 4.2.1is replaced as follows:

Electrical components and devices shall

— be suitable for their intended use, and

— electrical components important to safety (for example receptacle, circuit protector, conducting wire) shall comply with the safety requirements stipulated in the applicable ISO, IEC or national standards.

B.3.2 Electrical supply

IEC 60204-1:2009, 4.3 is replaced as follows:

Contrary to IEC 60204-1, the following requirements apply to generating sets.

Electrical equipment of generating sets, which is supplied by the generator of the generating sets itself, shall work without any failure under the rated conditions of the generating sets according to ISO 8528-1:2005, Clause 7 and ISO 8528-5:2013, Clause 16.

For low power generating sets, ISO 8528-8:2016, Clause 7 applies.

If not otherwise agreed, the electrical equipment which is not supplied by the generator of the generating set shall meet the requirements according IEC 60204-1:2009, 4.3.

In case the generator supplies electrical equipment of machinery, the supply requirements according to IEC 60204-1:2009, 4.3.1 apply. The requirements shall be agreed between user and manufacturer especially in view of the transient behaviour during load changes.

B.3.3 Physical environment and operating conditions

B.3.3.1 Humidity

IEC 60204-1:2009, 4.4.4 is replaced as follows:

Instead of the values given in IEC 60204-1:2009, generating sets shall meet the limit values according to ISO 8528-1:2005, Clauses 10 and 11.

Low power generating sets shall meet the limit values according ISO 8528-8:2016, Clause 7. Deviations from those values shall be agreed between manufacturer and user.

Deviations from those values shall be agreed between manufacturer and user.

B.4 Incoming supply conductor terminations and devices for disconnecting and switching off

B.4.1 Incoming supply conductor terminations

IEC 60204-1:2009, 5.1 is replaced as follows:

Contrary to IEC 60204-1 for generating sets, dependent from the demanded protection measure, a connection between neutral conductor and protective bonding circuit may be required.

If generating sets are used as standby-to-mains-units, an electrical and/or mechanical interlocking system is necessary to avoid parallel operation (see ISO 8528-4). If generating sets are operating parallel to the mains or other generating sets, additional equipment for synchronising and protection including any controls or instrumentation shall be provide if needed (see ISO 8528-4).

B.4.2 Terminal for connection to the external protective earthling system

IEC 60204-1:2009, 5.2 is replaced as follows:

The generating sets shall have a terminal for the connection of an external protective conductor and/or a functional grounding near the associated phase conductor terminal, or on a suitable place at the generating set frame. The requirements for this terminal shall be according to IEC 60204-1:2009, 5.2. If the use of this terminal at delivery of the generating sets is unknown, it shall be delivered and marked with the symbol 5019 of IEC 60417-DB-12M:2002.

B.4.3 Supply disconnecting (isolating) device

IEC 60204-1:2009, 5.3 is replaced as follows:

For generating sets in single operation, which provide power supply to various electrical equipment through a plug-type device, the electrical disconnection through the plug-type device up to 32 A or a protection switch above 32 A at the generating sets with manual operation is permitted. For generating sets in single operation, standby-to mains operation or parallel-to mains operation, which provides power to a consumer net, ISO 8528-4:2005, 5.2 applies.

Electrical equipment which is necessary for the operation of the generating set and which is not only supplied by the generator shall be equipped with a separate disconnecting device.

For generating sets used for stand-by operation a separate disconnecting device for secondary machines should be necessary.

B.4.4 Devices for switching off for prevention of unexpected start-up

IEC 60204-1:2009, 5.4 is replaced as follows:

Such devices are only necessary for generating sets with a remote starting device or an automatic starting device if there is any danger of an unexpected start. An emergency stop button should be used as such a device.

B.5 Protection against electric shock

B.5.1 Protection against direct contact

B.5.1.1 General

IEC 60204-1:2009, 6.2.1 is replaced as follows:

For each circuit or part of the electrical equipment, the measures of either 6.15.1.1 or 6.15.1.2 and, where applicable, IEC 60204-1:2009, 6.2.4 shall be applied.

Exception: where those measures are not appropriate, other measures for protection against direct contact (for example by using barriers, by placing out of reach, using obstacles, using construction or installation techniques that prevent access) as defined in IEC 60364-4-41 shall be applied (see IEC 60204-1:2009, 6.2.5 and 6.2.6).

B.5.2 Protection against indirect contact

B.5.2.1 General

IEC 60204-1:2009, 6.3.1 is replaced as follows:

For each circuit or part of the generating set, at least one of the measures as prescribed in B.5.2.1.1 and B.5.2.1.2 shall be applied.

— measures to prevent the occurrence of a touch voltage (B.5.2.1.1);

— automatic disconnection of the supply before the duration of contact with a touch voltage can become hazardous (B.5.2.1.2).

B.5.2.1.1 Protection by electrical separation

IEC 60204-1:2009, 6.3.2.3 is replaced as follows:

Electrical separation of an individual circuit is intended to prevent a touch voltage through contact with exposed conductive parts that can be energized by a fault in the basic insulation of the live parts of that circuit. For this type of protection, the requirement of IEC 60364-4-41:2005, 413 apply.

B.5.2.1.2 Protection by automatic disconnection of supply

IEC 60204-1:2009, 6.3.3 is replaced as follows:

This measure consists of the interruption of one or more of the line conductors by the automatic operation of a protective device in case of a fault. This interruption shall occur within a sufficiently short time to limit the duration of a touch voltage to a time within which the touch voltage is not hazardous. Interruption times are given in IEC 60204-1:2009, Annex A.

This measure necessitates co-ordination between the following:

— the type of supply and earthling system;

— the impedance values of the different elements of the protective bonding system;

— the characteristics of the protective devices that detect insulation fault(s).

Automatic disconnection of the supply of any circuit affected by an insulation fault is intended to prevent a hazardous situation resulting from a touch voltage.

This protective measure comprises both

— protective bonding of exposed conductive parts (see IEC 60204-1:2009, 8.2.3)

— and either: one of the following solutions (a or b).

a) for neutral bonded generating sets, residual current protective device and overcurrent protective devices for the automatic disconnection of the supply on detection of an insulation fault.

   In case the generating set is intended to use for TN-C system, the residual current protective devise is not required.

b) for neutral unbonded/neutral high-impedance bonded generating sets, insulation monitoring device and overcurrent protective devices for the automatic disconnection of the supply on detection of an insulation fault.

The insulation monitoring device shall, in the case where the supply is not interrupted in the event of the first earth fault, initiate an audible and/or visual signal which shall continue as long as the first earth fault persists.

Insulation monitoring devices are not required for generating sets not intended to be fixed installed for continuous use of the power supply.

NOTE In large machines, the provision of an earth fault location system can facilitate maintenance.

Residual current protective device and Insulation monitoring device shall correspond to ISO 8528-4:2005, 7.3.7.

Overcurrent protective devices, residual current protective devices and insulation monitoring devices may not be integrated by the manufacturer in generating sets provided, however, that information on characteristics of these devices and their installation by the user (grounding of neutral, connection distance to the generating set) shall be included in the use and instructions manual.

When a protection by differential current is needed or imposed as complementary protection, only residual differential devices not exceeding 30 mA shall be used.

Overcurrent protective devices to initiate automatic disconnection of the supply on detection of an insulation fault shall be those correctly sized taking into account the impedance of the generator and the short circuit behaviour of the generating sets; the fuses are not allowed.

The overcurrent protective device shall cause a reduction of voltage to a value lower or equal to 50 V in a time complying with values of IEC 60204-1:2009, Annex A or a disconnection of supply.

For polyphase generators, this requirement shall be verified in case of short-circuit between two phase conductors and between a phase conduct and an eventual neutral conductor.

For low power generating sets, this requirement shall be verified by a test of a short-circuiting with a resistance of 1,5 Ω behind the outputs of the generating set.

These requirements shall be verified by visual checking, operation test and control of use and instructions manual.

B.6 Equipotential bonding

B.6.1 Protective bonding circuit

B.6.1.1 General

IEC 60204-1:2009, 8.2.1 is replaced as follows:

The protective bonding circuit consists of the following:

— PE terminal(s) (see B.4.2);

— the protective conductors in the equipment of the machine including sliding contacts where they are part of the circuit;

— the exposed conductive parts and conductive structural parts of the electrical equipment;

— those extraneous conductive parts which form the structure of the machine.

All parts of the protective bonding circuit shall be so designed that they are capable of withstanding the highest thermal and mechanical stresses that can be caused by earth-fault currents that could flow in that part of the protective bonding circuit.

Where the conductance of structural parts of the electrical equipment or of the machine is less than that of the smallest protective conductor connected to the exposed conductive parts, a supplementary bonding conductor shall be provided. This supplementary bonding conductor shall have a cross-sectional area not less than half that of the corresponding protective conductor.

Except for low power generating sets, if an IT distribution system is used, the machine structure shall be part of the protective bonding circuit and insulation monitoring shall be provided. See B.5.2.1.2b).

Exposed conductive parts of equipment in accordance with B.5.2.1.1 shall not be connected to the protective bonding circuit.

B.7 Operator interface and machine mounted control devices

See IEC 60204-1:2009, Clause 10.

B.7.1 Emergency stop devices

See IEC 60204-1:2009, 10.7.

Only applicable if an emergency stopping is provided.

B.8 Wiring practices

B.8.1 Wiring inside enclosures

See IEC 60204-1:2009, 13.3.

Flame-retardant cable ducts are not required.

Annex C
(normative)

Instruction manual — Safety guide additional requirements for low-power generating sets for use by laymen

A generating set may cause hazards that are not recognized by the lay man and especially not recognized by children. Safe operation is possible with sufficient knowledge of the function of the generating set.

In the operation manual, the following information on safety, operation and maintenance requirements should be considered as a minimum practise.

a) General safety information

This shall include identification and explanation of warning labels that appear on the generating set. The following directives shall be mentioned.

1) Protect children by keeping them at a safe distance from the generating set.

2) Fuel is combustible and easily ignited. Do not refuel during operation. Do not refuel while smoking or near naked flames. Do not spill fuel.

3) Some parts of the internal combustion engine are hot and may cause burns. Pay attention to the warnings on the generating set.

4) Engine exhaust gases are toxic. Do not operate the generating set in unventilated rooms. When installed in ventilated rooms, additional requirements for fire and explosion protection shall be observed.

b) Electrical safety

The following directives shall be mentioned.

1) Before use, the generating set and its electrical equipment (including lines and plug connections) should be checked to ensure that they are not defective.

2) The generating set shall not be connected to other power sources, such as the power company supply mains. In special cases where stand-by connection to existing electrical systems is intended, it shall only be performed by a qualified electrician who has to consider the differences between operating equipment using the public electrical network and operating the generating set. In accordance with this part of ISO 8528, the differences shall be stated in the instruction manual.

3) Protection against electrical shock depends on circuit breakers specially matched to the generating set. If the circuit breakers require replacement, they should be replaced with a circuit breaker having identical ratings and performances characteristics.

4) Due to high mechanical stresses, only tough rubber-sheathed flexible cable (in accordance with IEC 60245-4) or the equivalent should be used.

5) If the generating set complies with the protection feature “protection by electrical separation” in accordance with Annex B, B.5.2.1.1, earthing of the generator is not required.

6) When using extension lines or mobile distribution networks the resistance value shall not exceed 1,5 Ω. For reference, the total length of lines for a cross section of 1,5 mm^2 should not exceed 60 m; for a cross section of 2,5 mm^2, this should not exceed 100 m (except the case

the generating set complies with the protection feature “protection by electrical separation” in accordance with Annex B, B.5.2.1.1).

7) The choice of protection arrangement to be carried out depending on characteristic of the generator, running conditions and scheme of grounded liaisons determined by the user, the instructions and operation and instructions manual shall contain all information needed to the user to carry out correctly these protective measures according to the user (information for grounded, allowable lengths of connection cables, devices of complementary protection, etc.).

— A warning reminding the user that he shall conform to regulations of electrical safety applicable to the place where the generating sets are used.

— A warning on the requirements and the precautions to be respected by the user in the case of re-supply by generating sets of an installation, depending on existing protective measures in this installation and applicable regulations.

c) Before start-up

Safe operation requires sufficient operator knowledge of the functions and positions of the controls and indicators or meters.

1) A description of the location, functions and positions of the controls and indicators or meters.

2) A pictorial representation of the labels on the generating set and further explanation of their meaning if necessary should be supplied.

3) Notes about necessary pre-operation checks, including the positioning of the generating set, shall be supplied.

d) Starting the RIC engine

1) Special guidance should be given regarding the use of readily evaporating fuels as starting aids if their use is appropriate.

2) Engines with manual starting equipment (e.g. handle starting equipment, recoil starter) should have notices warning against the dangers of injury caused by the sudden change of rotation direction of the engine.

e) Using the generating set

Generating sets should only be loaded up to their rated power under the rated ambient conditions. If generating set use is under conditions which do not conform to the reference conditions as stipulated in ISO 8528-8:2016, 7.1 and if cooling of the engine or alternator is impaired, e.g. as a result of operation in restricted areas, a reduction in power is necessary. Information should be provided to inform the user of the necessary reduction in power due to use in higher temperatures, altitude and humidity than those given in the reference conditions.

f) Maintenance

Prior to commencing maintenance work it shall be ensured that untimely start-up is not possible.

A schedule for routine and extended maintenance should be provided. The schedule should indicate which items can be performed by the layman and which items require the expertise of professional service personnel. Specifications should be given for the material necessary to perform maintenance that can be carried out by the layman.

g) Instructions for transporting and storage.

Bibliography

[1] ISO 3046-3:2006, *Reciprocating internal combustion engines — Performance — Part 3: Test measurements*

[2] ISO/TR 11688-1:1995, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning*

[3] IEC 364-3:1993, *Electrical installations of buildings — Part 3: Assessment of general characteristics*

[4] IEC 60417-DB-12M:2002, *Graphic symbols for use on equipment — 12-month subscription to online database comprising all graphical symbols published in IEC 60417*

[5] IEC 60439-1:2004, *Low-voltage switchgear and controlgear assemblies — Part 1: Requirements for type- tested and partially type-tested assemblies*

[6] IEC 60529-1:2001, *Degrees of protection provided by enclosures (IP Code)*

[7] IEC 60947-2:2009, *Low-voltage switchgear and controlgear — Part 2: Circuit breakers*

ICS 27.020; 29.160.40

Price based on 41 pages