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Reciprocating internal combustion engine driven alternating current generating sets —

Part 4: Controlgear and switchgear

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

Partie 4: Appareillage de commande et de coupure

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

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

ISO 8528-4 was prepared by Technical Committee ISO/TC 70, *Internal combustion engines*.

This second edition cancels and replaces the first edition (ISO 8528-4:1993), which has been technically revised.

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 11: Rotary uninterruptible power systems — Performance requirements and test methods*[1)]

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

1) Part 11 will be published as ISO/IEC 88528-11.

Reciprocating internal combustion engine driven alternating current generating sets —

Part 4: Controlgear and switchgear

1 Scope

This part of ISO 8528 specifies the criteria for controlgear and switchgear for generating sets with reciprocating internal combustion engines.

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 (e.g. essential hospital supplies and high-rise buildings), supplementary requirements may be necessary. The provisions of this part of ISO 8528 should be regarded as a basis for establishing any supplementary requirements.

For generating sets driven by other prime movers (e.g. steam engines), this part of ISO 8528 should be regarded as a basis for establishing these requirements.

2 Normative references

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

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

ISO 8528-1[2)], *Reciprocating internal combustion engine driven alternating current generating sets — Part 1: Application, ratings and performance*

ISO 8528-5[2)], *Reciprocating internal combustion engine driven alternating current generating sets — Part 5: Generating sets*

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

IEC 62271-200, *A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

IEC 60439-1, *Low-voltage switchgear and controlgear assemblies — Part 1: Type-tested and partially type-tested assemblies*

IEC 60947-1, *Low-voltage switchgear and controlgear — Part 1: General rules*

2) ISO 8528-1 and ISO 8528-5 are under revision.

3 Other regulations and additional requirements

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 the order.

For a.c. generating sets operating in non-classified equipment, any additional requirements are subject to agreement between the manufacturer and customer.

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

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

4 General equipment requirements

4.1 Mounting

Switchgear, controlgear and monitoring equipment may be mounted on or off the generator set and in one or more cubicles.

4.2 Construction

The equipment shall be constructed in accordance with the following requirements:

a) for rated voltages up to 1 kV, IEC 60439-1 applies;

b) for rated voltages from 1 kV to 52 kV, IEC 62271-200 applies.

4.3 Operating voltage

The definition of operating voltage is given in IEC 60439-1 and IEC 62271-200.

4.4 Rated frequency

The operational frequency of the switchgear and controlgear shall be the same as the rated frequency of the generating set.

The frequency shall lie within the limits specified in the relevant IEC standards for the incorporated components. Unless otherwise stated, the acceptable operating limit values shall be assumed to comply with the requirements of Clause 16 of ISO 8528-5.

4.5 Rated current

The rated current of the switchgear assembly shall be stated, taking into account the ratings of all components of electrical equipment in the main circuit within the assembly, their disposition and application.

This current shall be carried without the temperature rise of any of its parts exceeding the limits specified in IEC 60439-1 and IEC 62271-200.

If the switchgear assembly consists of multiple main circuits, derating shall be carried out, taking into account the maximum sum of the actual currents at any one time.

The voltage variations during operation of the generator shall be taken into account when determining the rated current of the equipment (see 12.3 of IEC 60034-1).

4.6 Control circuit voltage

A voltage of less than 250 V shall be used. The following voltages are recommended:

a) for alternating current: 48 V, 110 V, 230 V, (250 V)[3];

b) for direct current: 12 V, 24 V, 36 V, 48 V, 110 V, 125 V.

NOTE Limits of control supply variation should be taken into account to ensure correct operation of control circuit devices.

4.7 Starter battery systems

If the engine is to be started electrically, heavy-duty starter batteries of adequate capacity for the duty considered shall be used and allowance made for the ambient temperature at which they are expected to operate.

Partial voltages shall not be taken from the battery unless the battery will be equalized.

If the control circuitry is also connected to the starter battery, then the battery shall have sufficient capacity for reliable operation of the control equipment under all conditions, even when cranking the engine (see 4.6).

For batteries which are always connected in parallel to the consumers, and which are discharged only in case of power failure or peak current demand, a static charger adapted for consumer feeding shall be used.

Such a charging device shall have sufficient output to provide the control system standing load current in addition to the necessary charging current for recharging the battery within an adequate time.

When the RIC engine is equipped with a mechanically driven battery-charging generator, recharging of the battery shall be executed within a reasonable engine running time. When such a battery-charging generator is provided, the static charger may supply the control system with only a standing load current and provide an adequate float charge current.

The charging equipment shall be selected so that no damage is caused to control relays and solenoids connected across the battery by occasional over-voltage during charging.

Starter motor cables shall be dimensioned for a total cable voltage drop, while cranking the engine, not exceeding 8 % of the nominal battery voltage.

4.8 Environmental conditions

Normal service conditions are specified in IEC 60439-1 and IEC 62271-200.

Where there are deviations from the normal service conditions, they shall be complied with or special agreements shall be made between the manufacturer and customer.

The customer shall inform the manufacturer if such exceptional service conditions exist.

In order to establish the ambient air temperature, the heat dissipation of other equipment installed in the same room shall be considered.

4.9 Enclosure and degree of protection

The enclosure shall be determined and may be selected from requirements specified in IEC 60947-1. Degrees of protection of persons against hazardous approach to live parts should be selected from IEC 62271-200.

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3) Value not specified in IEC 38:1983, IEC standard voltages.

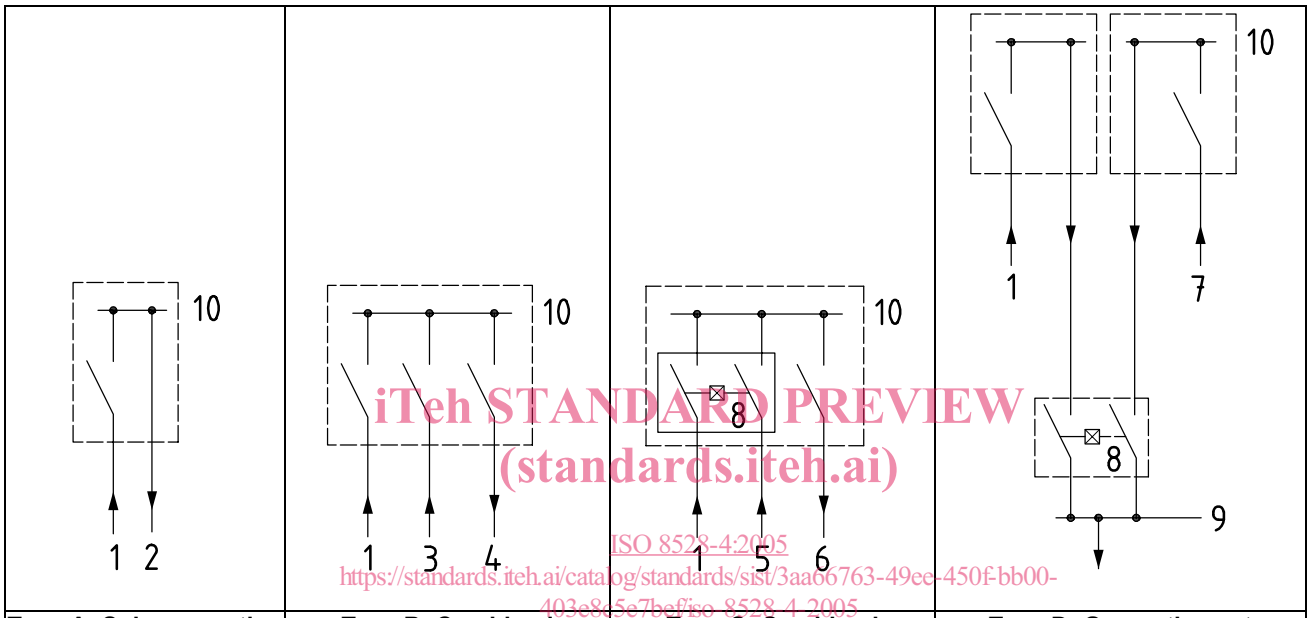
5 Generating set switchgear

5.1 General

Generating set switchgear includes all main circuit equipment of the generator incoming unit. If required, it may be extended by the mains incoming unit and the associated distribution.

Typical generating set switchgear schemes are shown in Figure 1.

All components incorporated in the switchgear shall be adequately rated to suit the generator set operation specified. They shall also be suitable, if required, for mains operation.



Type A: Sole generating set switchgear	Type B: Combined generating set/mains switchgear (preferably for parallel operation)	Type C: Combined generating set switchgear with incorporated COS (preferably for standby to mains duty)	Type D: Generating set switchgear with remote COS (preferably for standby to mains duty)

Key

1 generating set incoming
2 generating set outgoing
3 generating set and/or mains incoming
4 associated distribution
5 mains incoming
6 associated distribution
7 mains supply
8 change Over Switching (COS) device (electrically or mechanically interlocked)
9 load distribution
10 mains supply distribution

Figure 1 — Generating set switchgear schemes

5.2 Load-switching devices

The current rating of load-switching devices shall be selected for compatibility with the continuous rating of the generator, taking into account the corresponding utilization (service) category demanded (usually AC-1)[4].

If the AC-1 rating is likely to be exceeded in service, the manufacturer's specified making and/or breaking capacity for the load-switching device should be considered.

The customer shall specify the number of poles required according to the requirements of the local supply authority.

Where the ratings of the mains supply and generating set supply are dissimilar, then the change-over switching device shall be matched to the respective load requirements.

5.3 Fault current ratings

During a specified short time, the switchgear and cables shall be capable of withstanding the prospective fault current of the circuit in which they are located.

For a mains incoming unit incorporated in the switchgear, the customer shall give information about the short-circuit conditions at the point of installation (see IEC 60439-1).

Short-circuit protection by a current-limiting switching device (e.g. High Rupture Capacity (HRC) fuse back-up or current-limiting breaker) is permissible where appropriate. When such a current-limiting protection is used, all components and interconnections downstream need only be selected for the rated conditional short-circuit current.

5.4 Cables and interconnections

The temperature rise of cables and interconnections shall not exceed the maximum temperature limits of their insulation material. Cables shall not be situated in such a way that transmitted heat dissipation would have a detrimental effect on connected equipment, or on component parts in close proximity.

The voltage drop in interconnections shall meet the requirements for proper functioning for the intended use of the installation.

Terminals shall be so designed that conductors and cables corresponding to the appropriate rated currents can be connected.

Cables and busbars shall be adequately mechanically supported.

5.5 Generator protection

As far as possible, a standard protection arrangement should be used (see Table 1 and 7.2).

Consideration shall be given to the operational requirements of the generator when selecting the generator-protection equipment (see IEC 60034-1).

The following information shall be given by the generator manufacturer:

a) the generator sustained short-circuit current (if any) with the corresponding time limit;

b) the sub-transient and transient reactances, together with the appropriate time constants; and

c) the transient voltage performance resulting from any specified step load change.

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4) See IEC 60947-4-1:2000, *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor starters — Electromechanical contactors and motor starters*.

6 Control modes

6.1 General

Control modes are defined by the methods used for initiating the control sequence.

Table 1 gives guidelines on generating set protective and control devices.

6.2 Hand start/hand stop

The control of all functions is hand operated. This is used mainly on generating sets rated up to 20 kW and usually does not include protective control.

6.3 Local electric start/hand stop

This is an extension of 6.2 incorporating an electric start. This design of generating set is often supplied without protective control.

6.4 Local electric start/electric stop

This is an extension of 6.3 incorporating an electric stop. An electric stop is added primarily to facilitate the inclusion of automatic protective control.

6.5 Remote start/electric stop

This is essentially a local electric start/electric stop but arranged so that the manually initiated start and stop control is not located on or adjacent to the generating set. In cases where the manually derived signals are initiated from a location where the set is inaudible or signal feed-back is not practical, an automatic protective control shall be used.

6.6 Automatic start/automatic stop

With this type of control, starting or stopping the generating set is initiated by independently derived signals without manual intervention.

Typical applications include mains-failure control, load-level control, time-clock control, liquid-level control and thermostatic control.

Precautions shall be included to ensure adequately different switch-point values at ascending and descending levels, temperatures, etc., to minimize too frequent generating set operation.

6.7 Start on demand

This is usually applied to a domestic installation where the generating set is the only source of power supply.

When the agreed minimum load is switched on, the generating set starts automatically and continues to run until the connected load is switched off.

6.8 Standby-to-mains control

In the event of a complete mains failure or a voltage deviation outside defined limits, this type of control generates a mains failure detection signal which stops the generating set automatically. The system is similarly designed to stop the set and restore mains supply to the load after restoration of the mains to within defined voltage and frequency limits.

In order to achieve this, as a minimum the following facilities shall be incorporated:

a) mains-failure detection;

b) engine start/stop sequential control;

c) protection hold-off timer;

d) change-over switching device control; and

e) duty selection switch, MANUAL/AUTO.

The following additional facilities may be incorporated:

f) start delay;

g) engine start repeater;

h) engine warm-up timer;

i) switch closure delay timer;

j) mains restoration timer;

k) engine stop delay at no-load speed;

l) battery-charger failure detection;

m) starter pinion repeater;

n) preheating system;

o) hours-run counter;

p) monitoring equipment for special characteristics of the connected network.

6.9 Dual mutual standby control

This is related to the automatic duty cycling of two generating sets, one of which is the duty set and the other the standby to it. Duty change-over is controlled by a time clock, similar initiation or failure of the duty set itself.

The dual mutual standby arrangement is typically used for generating set continuously unattended operation.

6.10 Triple mutual standby control

This is where three generating sets operate in a similar mode to dual mutual standby control and the standby sequence is usually selectable.

6.11 Dual mutual standby-to-mains control

This is the same as dual mutual standby control except that the load is normally supplied by the mains, and the sequence described in 6.9 takes place in the event of a mains failure.

At satisfactory restoration of the mains supply, the load is normally, but not necessarily, returned to the mains and the selected standby sequence restored.

A variation of this arrangement is possible when the generating sets are used in sequence as the prime power supply in a dual mutual standby mode with the mains supply acting as standby.