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Smoke and heat control systems —

Part 10: Specification for power output devices

Systèmes pour le contrôle des fumées et de la chaleur —

Partie 10: Spécifications pour les sources d'alimentation

Reference number
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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 21927-10 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 11, *Smoke and heat control systems and components*.

ISO 21927 consists of the following parts, under the general title *Smoke and heat control systems*:

— *Part 1: Specification for smoke barriers*

— *Part 2: Specification for natural smoke and heat exhaust ventilators*

— *Part 3: Specification for powered smoke and heat exhaust ventilators*

— *Part 9: Specification for control equipment*[1)]

— *Part 10: Specification for power output devices*

1) To be published.

Introduction

Smoke and heat control systems (SHCS) create and maintain smoke-free areas in a construction works by controlling smoke flow and thus improve the conditions for the safe escape and/or rescue of people and animals and the protection of property. They also permit fighting a fire while it is still in its early stages. The use of smoke and heat exhaust ventilation systems (SHEVS) to create smoke-free areas beneath a buoyant smoke layer has become widespread. Their value in assisting in the evacuation of people from construction works, reducing fire damage and financial loss by preventing smoke logging, facilitating fire fighting, reducing roof temperatures and retarding the lateral spread of fire is firmly established. To obtain these benefits, it is essential that smoke and heat exhaust ventilators operate fully and reliably whenever called upon to do so during their installed life. A heat and smoke exhaust ventilation system is a composite of safety equipment intended to perform a positive role in a fire emergency.

It is expected that components for any smoke and heat control system will be installed as part of a properly designed system.

Smoke and heat control systems help to

— keep the escape and access routes free from smoke,

— facilitate fire fighting operations,

— delay and/or prevent flashover and, thus, full development of the fire,

— protect equipment and furnishings,

— reduce thermal effects on structural components during a fire,

— reduce damage caused by thermal decomposition products and hot gases.

Depending on the design of the system, natural or powered smoke and heat ventilators can be used in a smoke and heat control system.

Control equipment is required to control all components in an SHCS, such as

— natural ventilators,

— powered ventilators,

— smoke barriers,

— smoke dampers,

— air inlets.

Control equipment is dealt with in ISO 21927-9.

Pressure differential systems are used to either positively pressurize spaces separated from the fire or to depressurize the space containing the fire in order to limit or prevent the flow of smoke and heat into adjacent spaces. A typical use is to pressurize an escape stairwell in order to protect vertical means of escape.

Depending on the design of the system, natural or powered smoke and heat ventilation can be used in a smoke and heat control system.

Power output devices for a smoke and heat control system can be for pneumatic systems, low-voltage or extra-low-voltage electrical systems, or a combination of any of these.

Smoke and heat control system power output devices can also provide power for day-to-day ventilation and for other fire safety equipment under fire conditions.

Smoke and heat control systems —

Part 10:
Specification for power output devices

1 Scope

This part of ISO 21927 specifies requirements and gives test methods for primary and secondary electrical and pneumatic power output devices, designed for use in smoke and heat control systems in buildings.

NOTE A summary of functions is given in Annex A.

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 6988, *Metallic and other non organic coatings — Sulfur dioxide test with general condensation of moisture*

ISO 8528-1, *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, *Reciprocating internal combustion engine driven alternating current generating sets — Part 4: Controlgear and switchgear*

ISO 8528-5:2005, *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 8528-10, *Reciprocating internal combustion engine driven alternating current generating sets — Part 10: Measurement of airborne noise by the enveloping surface method*

ISO 8528-12:1997, *Reciprocating internal combustion engine driven alternating current generating sets — Part 12: Emergency power supply to safety devices*

ISO 8573-1, *Compressed air — Part 1: Contaminants and purity classes*

ISO 9809-1:2010, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 1: Quenched and tempered steel cylinders with tensile strength less than 1 100 MPa*

ISO 9809-2:2010, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 2: Quenched and tempered steel cylinders with tensile strength greater than or equal to 1 100 MPa*

ISO 9809-3:2010, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 3: Normalized steel cylinders*

ISO 12100-1, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

ISO 12100-2, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles*

ISO 21927-9[2)], *Smoke and heat control systems — Part 9: Specification for control equipment*

EN 286-1, *Simple unfired pressure vessels designed to contain air or nitrogen — Part 1: Pressure vessels for general purposes*

EN 1964-1, *Transportable gas cylinders — Specification for the design and construction of refillable transportable seamless steel gas cylinders of water capacities from 0,5 litre up to and including 150 litres — Part 1: Cylinders made of seamless steel with an R_m value of less than 1 100 MPa*

EN 13293, *Transportable gas cylinders — Specification for the design and construction of refillable transportable seamless normalized carbon manganese steel gas cylinders of water capacity up to 0,5 litre for compressed, liquefied and dissolved gases and up to 1 litre for carbon dioxide*

EN 50130-4, *Alarm systems — Part 4: Electromagnetic compatibility — Product family standard: Immunity requirements for components of fire, intruder and social alarm systems*

IEC 60068-1, *Environmental testing — Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing — Part 2-1: Tests — Test A: Cold*

IEC 60068-2-6, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-47, *Environmental testing — Part 2-47: Tests — Mounting of specimens for vibration, impact and similar dynamic tests*

IEC 60068-2-52:1996, *Environmental testing — Part 2-52 — Tests — Test Kb: Salt mist, cyclic (sodium chloride solution)*

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

IEC 60068-2-78, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*

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

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

Guideline 84/525/EWG *of the advice from 17 September 1984 for the adjustment of the legislation of the member states over smooth gas bottles from unalloyed aluminium and aluminium alloys*

2) To be published.

3 Terms and definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviations apply.

3.1 Terms and definitions

3.1.1
final voltage
lowest recommended voltage to which a battery should be discharged

NOTE The final voltage is specified by the battery manufacturer.

3.1.2
$I_{\text{max a}}$
maximum standby current

3.1.3
$I_{\text{max b}}$
maximum short duration current

3.1.4
multiple-use gas bottle
gas bottle that is held open to the system and can operate the system a number of times before it is necessary that it be replaced or refilled

3.1.5
power output device
source or store of power or a means of automatically switching between separate power sources

3.1.6
primary power source
power supply that is used whenever it is available

3.1.7
secondary power source
power supply that automatically replaces the primary power source in the event of its failure

3.1.8
single-use gas bottle
gas bottle that remains sealed until pierced for once-only emergency use

3.1.9
smoke and heat control system
arrangement of components installed in a building to limit the effects of smoke and heat from a fire

3.1.10
smoke and heat exhaust ventilation system
SHEVS
system comprised of components that together exhaust smoke and heat to establish a buoyant layer of warm gases above cooler, cleaner air

3.1.11
smoke and heat exhaust ventilator
SHEV
device specially designed to move smoke and hot gases out of the building under conditions of fire

3.2 Abbreviated terms

p.o.d.: power output device

c.p.: control panel

FPC: factory production control

4 General requirements — Electrical

4.1 General

If a smoke and heat control system fails to the “fire operational” position on loss of power, only one power source shall be required. For non-fail safe smoke and heat control systems, there shall be at least two power sources: the primary power source and the secondary power source. The primary power source shall be designed to operate from the public electricity supply or an equivalent system. The secondary power source, for example batteries or a generator, shall be permanently available, tested and maintained.

Each power source, on its own, shall be capable of operating those parts of the smoke and heat control system for which it is intended.

If the primary power source fails, then the p.o.d. shall be automatically switched over to a secondary power source. When the primary power source is restored, the p.o.d. shall be automatically switched back.

If the switching from one power source to the other causes an interruption in supply of power, the duration of the interruption shall be specified in the manufacturer's data (see Clause 9).

Where there are two or more power sources, failure of one of the power sources shall not cause the failure of any other power source or the failure of the supply of power to the system.

The p.o.d. shall be classified as either

— class A: suitable for use with all systems, or

— class B: suitable for use with fail safe systems only.

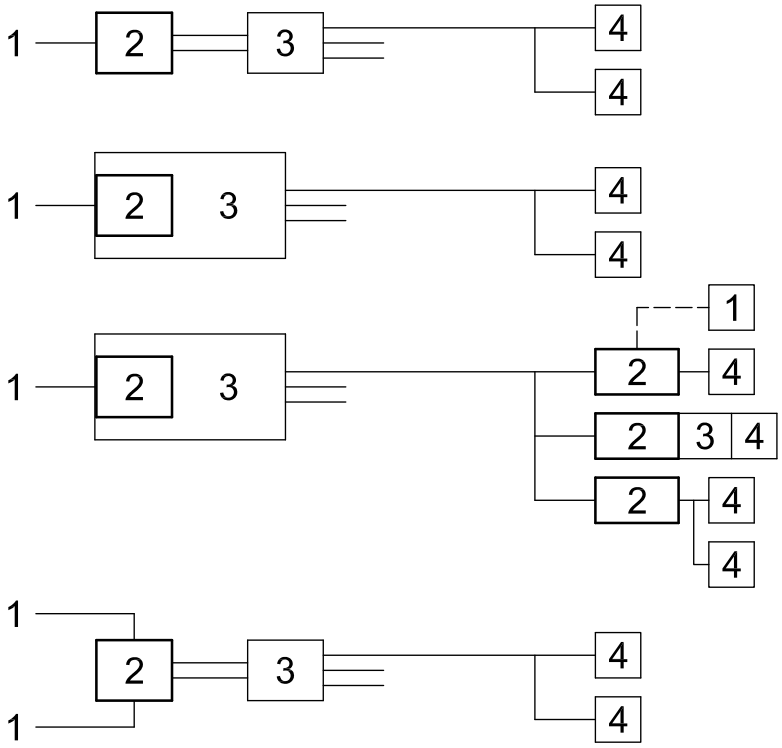
Monitoring of transmission paths, if required, shall be by the c.p., not the p.o.d.; see ISO 21927-9.

When subjected to the functional test in 12.1, the p.o.d. shall satisfy the requirements of 12.1.3.

The secondary power source may also be used for other functions, e.g. day-to-day comfort ventilation. When used in this way, the p.o.d. shall ensure that sufficient power is retained for emergency use as specified in Clause 6, e.g. by preventing further use for the other functions.

The compatibility of a separate p.o.d. with other equipment, for example the c.p., should be taken into account by the system designer.

NOTE The use of frequency converters for day-to-day ventilation within smoke control systems is dealt with in ISO 21927-9.



Key

1 mains in

2 power output devices (p.o.d.)

3 control panel (c.p.)

4 actuator or motor

Electrical requirement ————————

Electrical optional – – – – – – –

Figure 1 — Typical locations and interrelationships of electrical p.o.d. with other components of a smoke control system

4.2 Batteries

If a rechargeable battery is used as a power supply, the p.o.d. shall include equipment to charge and monitor the battery and maintain it in a fully charged state.

4.3 Generator sets

Generator sets used for the supply of power to a smoke and heat control system shall conform to ISO 8528, Parts 1 to 7, Part 10 and Part 12, and shall be diesel driven. Therefore, the test requirements in this part of ISO 21927 do not apply to generators; see 11.4.1. The generating set and the electrical arrangements for the supply from the generator shall be fully independent of the normal electrical supply for the smoke control system.

5 General requirements — Pneumatic

5.1 General

Pneumatic p.o.d. shall supply primary power, secondary power or both.

The p.o.d. shall be comprised of one of the following:

— compressor set and air receiver;

— air receiver set (fed from a separate non-specific air supply);

— gas bottle set (multiple use);

— gas bottle set (single-use).

When subjected to the functional test in 12.2, the p.o.d. shall satisfy the requirements of 12.2.1.4.

5.2 Power sources

5.2.1 General

If a smoke and heat control system fails to the “fire operational” position on loss of power, only one power source shall be required. For non-fail safe smoke and heat control systems, there shall be at least two power sources: the primary power source and the secondary power source, for example two compressors with a receiver or a compressor with a receiver plus a single-use CO_2 gas bottle. The secondary power source may be incorporated within the ventilator or other SHEVS component. Both power sources shall be readily available and maintained.

Each power source, on its own, shall be capable of operating those parts of the smoke and heat control system for which it is intended.

If the secondary power source is not independently initiated (e.g. a fusible bulb-operated single-use CO_2 bottle), and if the primary power source fails, then the p.o.d. shall automatically switch over to a secondary power source. When the primary power source is restored, the p.o.d. shall automatically switch back.

Where there are two or more power sources, failure of one of the power sources shall not cause the failure of any other power source or the failure of the supply of power to the system.

If the switching from one power source to the other causes an interruption in supply of power, the duration of the interruption shall be specified in the manufacturer's data (see Clause 9).

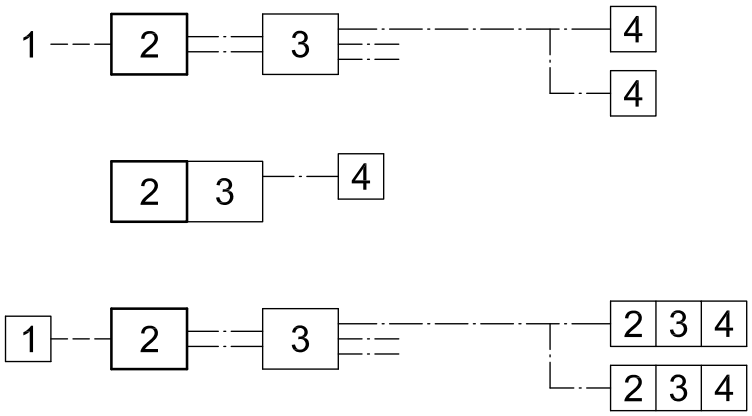
The p.o.d. shall be classified as either

— class A: suitable for use with all systems, or

— class B: suitable for use with fail safe systems only.

The secondary power source may also be used for other functions, e.g. day-to-day comfort ventilation. When used in this way, the p.o.d. shall ensure that sufficient power is retained for emergency use as specified in Clause 6, e.g. by preventing further use for the other functions.

The compatibility of a separate p.o.d. with other equipment, for example the c.p., should be taken into account by the system designer.



Key

1 mains in
2 power output devices (p.o.d.)
3 control panel (c.p.)
4 actuator

Pneumatic —·—·—·—

Electrical requirement ————————

Electrical optional — — — — — —

NOTE Pneumatic p.o.d. can be a compressor set, an air receiver or a gas bottle, as appropriate.

Figure 2 — Typical locations and interrelationships of pneumatic p.o.d. with other components of a smoke control system

5.2.2 Compressors

Compressors used for supply of power to a smoke and heat control system shall conform to IEC 60204-1, ISO 12100-1 and ISO 12100-2.

5.2.3 Air receivers

Air receivers used as a supply of power to a smoke and heat control system shall conform to EN 286-1.

5.2.4 Multiple-use gas bottles

5.2.4.1 General

Multiple-use gas bottles used for supply of power to a smoke and heat control system shall conform to EN 13293 or EN 1964-1 and Guideline 84/525/EWG.

Multiple-use gas bottles shall contain air, CO_2 or N_2.

5.2.4.2 Multiple-use CO_2 bottles

The filling factor for multiple-use CO_2 bottles shall be as follows, depending upon the maximum ambient temperature:

— filling factor equal to 0,75 kg/l at a maximum ambient temperature of 50 °C;

— filling factor equal to 0,71 kg/l at a maximum ambient temperature of 68 °C;

— filling factor equal to 0,58 kg/l at a maximum ambient temperature of 93 °C.

The maximum operating pressure when the bottle is filled with CO_2 shall not exceed the maximum rated pressure for the bottle.

The maximum filling shall not exceed 30 kg.

5.2.4.3 Construction

The valve shall be designed to empty the gas charge in the bottle completely. Back-pressure valves or valves allowing negative operating conditions are not permitted.

The bottle shall be equipped with a pressure relief valve or a burst cap. The relief pressure shall exceed 35 MPa (350 bar) and shall be less than the burst pressure of the bottle. The pressure relief device shall have sufficient capacity to prevent rupture of the bottle.

5.2.5 Single-use gas bottles

5.2.5.1 General

Refillable and non-refillable single-use gas bottles used for supply of power to a smoke and heat control system shall conform to the relevant part of ISO 9809.

Single-use gas bottles shall contain CO_2 or N_2.

5.2.5.2 Single-use CO_2 bottles

5.2.5.2.1 The filling factor for single-use CO_2 bottles shall be as follows, depending upon the maximum ambient temperature:

— filling factor equal to 0,75 kg/l at a maximum ambient temperature of 50 °C;

— filling factor equal to 0,71 kg/l at a maximum ambient temperature of 68 °C;

— filling factor equal to 0,58 kg/l at a maximum ambient temperature of 93 °C.

The maximum operating pressure when the bottle is filled with CO_2 shall not exceed the test pressure.

5.2.5.2.2 The maximum filling shall not exceed

— 500 g at 50 °C maximum ambient temperature,

— 150 g at 68 °C maximum ambient temperature,

— 120 g at 93 °C maximum ambient temperature.

5.2.5.3 Single-use N_2 bottles

5.2.5.3.1 The filling pressure at 15 °C shall be as follows, depending upon the maximum ambient temperature:

— 50 °C: 150 bar for a maximum ambient temperature of 50 °C;

— 68 °C: 135 bar for a maximum ambient temperature of 68 °C;

— 93 °C: 125 bar for a maximum ambient temperature of 93 °C.

The maximum operating pressure when the bottle is filled with N_2 shall not exceed 2/3 of the test pressure.

5.2.5.3.2 The maximum bottle volume shall be:

— 1,0 l at 50 °C nominal temperature;

— 0,3 l at 68 °C nominal temperature;

— 0,3 l at 93 °C nominal temperature.

5.2.5.4 Construction

The cap or disc shall be designed to serve as a pressure-relief device. The relief pressure shall exceed 35 MPa (350 bar) and shall be less than the burst pressure of the bottle. The pressure-relief device shall have sufficient capacity to prevent rupture of the bottle.

The bottle shall be protected from corrosion by zinc plating or grey paint.

6 Functions

6.1 Power supply from the primary power source — Electrical

When operated from the primary power source, the p.o.d.

a) shall be capable of operating in accordance with the specification given in the manufacturer's data, irrespective of the condition of the secondary power source, and

b) shall, if batteries are used as the secondary power source, be capable of continuously supplying the maximum standby current, $I_{\text{max a}}$, and simultaneously charging and monitoring a battery discharged to its final voltage.

NOTE When operated from the primary power source, the p.o.d. can allow battery charging to be limited or interrupted when the p.o.d. is delivering a short duration maximum output current, $I_{\text{max b}}$; see note to Table 5.

6.2 Power supply from the secondary power source — Battery

6.2.1 When operated from the secondary power source, the p.o.d. shall be capable of operating in accordance with the specification given in the manufacturer's data, irrespective of the condition of the primary power source.

6.2.2 At the end of the maximum standby period supplying the maximum standby current, $I_{\text{max a}}$, the battery shall be capable of supplying the maximum short duration current, $I_{\text{max b}}$, for a period of 180 s with the output voltage within the range specified by the manufacturer. To allow for possible failures of equipment or of the incoming mains supply, the secondary supply should be capable of maintaining the system in operation for at least 72 h, unless provision is made for immediate notification of failure, either by local or remote supervision of the system, and a repair contract is in force giving a maximum repair period of less than 24 h, in which case the minimum standby capacity may be reduced from 72 h to 30 h or may be further reduced to 4 h if spares, repair personnel and a standby generator are available on site at all times.

At the end of the maximum standby period, if deadlock is required, the residual power should be capable of operating the system (including deadlock) in accordance with the requirements of ISO 21927-9.

6.2.3 The battery shall be

a) rechargeable;

b) suitable for staying in a fully charged state;

c) constructed for stationary use;

d) marked with type designation and date of manufacture.

If the battery is mounted in a housing that houses other smoke and heat control system equipment, then the battery shall be of the sealed type and shall be mounted in accordance with the manufacturer's data.

6.2.4 The charger shall be designed and rated so that

a) the battery can be charged automatically,

b) a battery discharged to its final voltage can be recharged to at least 80 % of its rated capacity within 24 h and to its rated capacity within another 48 h,

c) the charging characteristics are within the battery manufacturer's specification over the ambient temperature range of the battery.

Except for currents associated with battery monitoring, the battery shall not discharge through the charger when the charging voltage is below the battery voltage.

6.3 Power supply from the secondary power source — Generators

6.3.1 The generator set shall automatically provide full output power within 15 s of failure of the primary power supply in accordance with ISO 8528-5:1993, Figure 6.

If the generator set is dedicated to the building life safety systems, starts only in case of fire signal and provides a fault indication to a permanently manned control room, the generator set should incorporate a fuel supply capable of supplying the generator set for a minimum of 4 h at full output. If the generator set operates whenever the primary power source fails and provides fault indication to a permanently manned control room, the generator set should incorporate a fuel supply capable of supplying the generator set for a minimum of 8 h at full output. Otherwise, it should have a 72 h supply at full output.

If the c.p. requires that an external power supply be maintained at all times, the generator should operate immediately on loss of the primary power supply, regardless of fire or standby condition.

6.3.2 Indication of the operational state of the generating set shall be provided. This shall include a visible indication of whether it is in standby condition (mains on), whether it is running (generator on) and any monitored fault condition. A voltmeter and ammeter indicating the total load on the generator shall also be provided.

6.3.4 The generator set shall have operating threshold values of at least class G2 in accordance with ISO 8528-5:1993, Table 3 and shall be at least class 1, 2 or 3 in accordance with ISO 8528-12:1997, Tables 1 and 2.

6.3.5 The control system of the generator set shall provide at least the following conditions:

— automatic operation;

— test condition for the testing of all automatic operations, which can be divided into test condition with load acceptance and test condition without load acceptance; in case of power failure during the test, the load acceptance shall take place automatically;

— full manual operation for

  — start,

  — stop,

  — generator ON-OFF;

— net ON-OFF;

— disablement of any generator condition, e.g. during maintenance services;

— emergency OFF.

6.4 Recognition and indication of faults — Electrical

6.4.1 Class A p.o.d. shall be capable of recognizing and signalling the following faults:

a) loss of the primary power source, within 30 min of the occurrence;

b) loss of the secondary power source, within 15 min of the occurrence

6.4.2 Class A battery systems, in addition, shall recognize:

a) reduction of the battery voltage to less than 90 % of the final voltage, within 30 min of the occurrence;

b) loss of the battery charger, within 30 min of the occurrence, except where the charger is switched off or limited as defined in the Note in 6.1.

6.4.3 Generator sets, in addition, shall recognize:

a) a battery voltage that is too low;

b) a start failure;

c) a motor temperature that is too high;

d) a lubricating oil pressure that is too low;

e) an overspeed;

f) a generator excess current;

g) a low fuel level (sufficient for less than 3 h operation).

6.4.4 For class B p.o.d., signalling is not required, but if provided it shall conform to the requirements given in 6.4.1 and 6.4.2.

If the p.o.d. is separately housed from the c.p., then at least a common fault output for the faults listed in 6.4.1 and 6.4.2 shall be provided.

If the p.o.d. is housed within the cabinet of the c.p., then the faults listed in 6.4.1 and 6.4.2 shall be indicated at least as a common fault in accordance with ISO 21927-9.

Where an indication of standby function is provided, the indication shall be green.

Where a SHEV contains an integrated p.o.d. and c.p., any indication provided solely for maintenance purposes, even if permanently lit when power is supplied, may be of any colour.

If a class A p.o.d. is designed for use with a c.p. contained in a separate cabinet, then an interface shall be provided for at least two transmission paths to the c.p., such that a short circuit or an interruption in one path does not prevent the supply of power to the c.p.

6.5 Power supply from compressed gases

6.5.1 General

If class A p.o.d. is designed for use with a c.p. contained in a separate cabinet, then an interface shall be suitable for connection of metallic tubing.

6.5.2 Compressors

The compressor shall provide compressed air to an air receiver, not directly to the c.p.

Each compressor shall be capable of filling the air receiver from atmospheric pressure to full rated pressure within a period of 60 min.

Capacity requirements for air receivers should be selected in accordance with the requirements valid in the place of use.

Operation of the compressor shall be controlled automatically from air receiver pressure.

Where two compressors provide primary and secondary supplies to an air receiver, the control system may be arranged so that under normal conditions the compressor in use alternates and/or both compressors operate together.

The air receiver shall be provided with

— a non-return valve to supply from compressor,

— an air pressure gauge,

— an adjustable air pressure switch for low-pressure alarm,

— an outlet shut-off valve, lockable open and closed.

Class A p.o.d. shall be capable of recognizing and signalling the following faults:

a) low pressure, at 10 % below compressor cut in pressure, within 15 min of the occurrence;

b) continuous compressor operation of more than 60 min.

For class B p.o.d., signalling is not required, but if it is provided, it shall conform to the requirements above.

The minimum quality of compressed air supply shall be as defined in Table 1.

Table 1 — Minimum air quality[a]

Contaminant	ISO class	Concentration max. mg/m^3	Size max. µm
Solid particles	7	10	40
Water	7	500	—
Oil	4	5	—

[a] In accordance with ISO 8573-1.

6.5.3 Air receivers (fed from a non-dedicated air supply)

Where air pressure is provided to a smoke and heat control system that does not fail to the operational position on loss of pressure from a non-dedicated air supply (e.g. a factory compressed air system), then air pressure for the smoke and heat control system shall be stored in a dedicated air receiver.

Capacity requirements for air receivers should be selected in accordance with the requirements valid in the place of use.

Use of an air receiver is recommended regardless of failure mode of the smoke and heat control system.

The air receiver shall be provided with

— a non-return valve to air supply;

— an air pressure gauge;

— an adjustable air pressure switch for low-pressure alarm;

— an outlet shut-off valve, lockable open and closed.

A class A p.o.d. shall be capable of recognizing and signalling low pressure within 15 min of the occurrence.

The air pressure switch should be set to operate at 10 % below the normal minimum supply air pressure.

Air receivers designed to operate only one SHEV and to be located within or adjacent to the SHEV do not require the gauge, pressure switch or shut-off valve.

6.5.4 Gas bottles

6.5.4.1 The power supply shall be provided from either

a) gas bottles permanently connected to the system and capable of providing multiple operations of the smoke and heat control system, or

b) single-use gas bottles, refillable or non-refillable, held disconnected and capable of operating the SHEV or smoke and heat control system once-only under fire conditions.

Capacity requirements for gas bottles should be selected in accordance with the requirements valid in the place of use.

6.5.4.2 Multiple-use gas bottles shall be provided with

— a gas pressure gauge,

— a gas pressure switch for low-pressure alarm or weighing device for low-gas-mass alarm,

— an outlet shut-off valve, lockable open and closed.

6.5.4.3 Single-use gas bottles shall be provided with

— a trigger mechanism in accordance with ISO 21927-9 to connect the gas bottle to the SHEV or smoke and heat control system upon failure of a fusible device or receipt of an actuation signal,

— visible indication of operation.

7 Materials, design and manufacture

7.1 Mechanical design

7.1.1 Housings for electrical components in the p.o.d. shall have a minimum IP rating in accordance with the environmental class as specified in Table 2.

7.1.2 The p.o.d. shall be housed either

a) in a separate housing, or

b) in housings associated with other smoke and heat control system equipment.

7.1.3 Manual controls, fuses, calibration elements, etc., for disconnection and adjustment of the power sources shall be accessible only by persons who are trained and authorized to

— re-configure the site-specific data held within the p.o.d. or controlled by them, and/or

— maintain the p.o.d. in accordance with the manufacturer's published instructions and data.

7.1.4 All manual controls, fuses, calibration elements and site connections (for example cable terminals and pneumatic fittings) shall be clearly labelled (e.g. to indicate their function, rating or reference to appropriate drawings).

7.2 Electrical design

All outputs shall have appropriate power limitations (e.g. fuses, electronic circuits) in order to ensure that, in case of external short circuits, no danger exists because of heat production.

8 Classification and testing

The p.o.d. shall be classified according to the intended in-use environmental conditions as shown in Table 2.

The p.o.d. shall be tested in accordance with Clauses 11 and 12. The tests shall be selected to match the classification in Table 2 in accordance with Tables 3 and 4.

Table 2 — Classification of p.o.d.

Environmental class	Environment	Temperature range °C	Minimum IP rating (electrical housings)
1	Internal, clean, low-temperature	–5 to +40	30
2	Internal, clean, high-temperature	–5 to +75	42
3	Internal — corrosive or humid or external	–5 to +75	54
4	external — corrosive	–25 to +75	65

9 Documentation

9.1 User's documentation

The manufacturer shall prepare installation and user documentation. This shall be comprised of at least the following:

a) general description of the equipment;

b) technical specifications of the inputs and outputs of the p.o.d., sufficient to permit an assessment of the mechanical, electrical and pneumatic compatibility with other components of the system (as described in other parts of ISO 21927), including the following:

   1) for electrical p.o.d.:

      — power requirements for recommended operation,

      — maximum and minimum electrical ratings for each input and output,

      — fuse ratings,

      — types and the maximum and minimum capacities of the batteries suitable for use with the p.o.d.,

      — maximum allowed current drawn from the battery when the primary power source is disconnected,

      — maximum interruption time during switching between power sources;

   2) for pneumatic p.o.d.:

      — maximum and minimum electrical ratings for any electrical input and output (if provided),

      — maximum output pressure,

      — storage capacity (by mass or volume);

      — fuse ratings (if applicable);

c) installation information, including

   1) suitability for use in various environments,

   2) mounting instructions,

   3) instructions for connecting inputs and outputs (e.g. cable diameter, pipe diameter and thread);

d) commissioning instructions;

e) operating instructions;

f) maintenance information.

9.2 Design documentation

The manufacturer shall prepare design documentation, which shall include drawings, parts lists, circuit diagrams, block diagrams and a functional description, to enable an assessment of compliance with the requirements of this part of ISO 21927 and to make a general assessment of the mechanical, pneumatic and electrical design.

10 Marking

10.1 General

The p.o.d. shall be clearly marked with the following information:

a) number of this part of ISO 21927, i.e. ISO 21927-10;

b) name or trademark of the manufacturer or supplier;

c) type number or other designation of the p.o.d.;

d) code or number identifying the production period, batch or unique reference of the p.o.d.;

e) classes to this part of ISO 21927;

f) technical data including

- interruption time,
- maximum capacity,
- input values,
- output values;

g) warnings, as appropriate.

If the p.o.d. is housed in its own cabinet, then at least a), b), c) and g) shall be marked on the outside of this cabinet.

If the p.o.d. is integrated with other equipment in a common cabinet, then at least a), b) and g) shall be marked on the outside of the common cabinet.

10.2 Gas bottles

Each cylinder shall be marked or labelled with at least

- the volume, type of gas, mass of filling or pressure, gross mass,
- the manufacturer or distributor, date, batch identification,
- the maximum nominal temperature, expressed in degrees Celsius.

The permitted orientation in use shall be clearly marked.

11 General test requirements

11.1 Standard atmospheric conditions for testing

Unless otherwise stated in a test procedure, the testing shall be carried out after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing in accordance with IEC 60068-1, as follows:

a) temperature: 15 °C to 35 °C;

b) relative humidity: 25 % to 75 %;

c) air pressure: 86 kPa to 106 kPa.

During any one test, the temperature and humidity shall be constant within a tolerance of ±15 % and shall not go outside the ranges given in a) and b) for each environmental test where the standard atmospheric conditions are applied.

11.2 Mounting and orientation

Unless otherwise stated in a test procedure, the specimen shall be mounted in its normal orientation by the normal means of mounting indicated by the manufacturer.

11.3 Electrical connection

If the test procedure requires that the specimen be operating, then, unless otherwise specified,

a) all inputs and outputs shall be connected to appropriate cables and equipment or to dummy loads corresponding to the maximum load, all as specified by the manufacturer, and

b) for battery systems, they shall be connected to the mains and to a battery of maximum capacity as rated by the manufacturer (tests with a maximum capacity battery are applicable to the p.o.d. with any smaller capacity battery).

11.4 Selection of tests

11.4.1 General

Generator sets are not covered by this test regime because they are covered by ISO 8528 (all parts).

Between one and three specimens shall be supplied for testing, as specified by the manufacturer.

If the p.o.d. is housed in the c.p., then the environmental and functional tests described in ISO 21927-9 shall be carried out in addition to the functional tests required by 12.1 or 12.2.

If the p.o.d. is housed separately from the c.p., then the tests shown in Table 3 or Table 4 shall be applied, except where a single-use gas bottle is part of the triggering mechanism, in which case it shall be tested in accordance with ISO 21927-9.

Where tests given in Table 3 or Table 4 are carried out, the choice of test shall depend on the class of p.o.d. (see Table 2 for details of the classification system).

Secondary power supplies shall be tested in accordance with 12.3.

Table 3 — Environmental tests for electrical p.o.d.

Test	Environmental class of p.o.d.				Operational or endurance	Subclause
	1	2	3	4		
Cold	Y	Y	Y	Y	Operational	12.4
Damp heat, steady state	Y	Y	Y	Y	Operational	12.5
Impact	Y	Y	Y	Y	Operational	12.6
Vibration, sinusoidal	Y	Y	Y	Y	Operational	12.7
Damp heat, steady state	X	Y	Y	Y	Endurance	12.8
Vibration, sinusoidal	Y	Y	Y	Y	Endurance	12.9
Dry heat	X	Y	Y	Y	Operational	12.10
SO_2 corrosion	X	X	Y	Y	Endurance	12.11
Salt spray testing	X	X	X	Y	Endurance	12.12
Protection against water, IP rating	X	Y	Y	Y	Operational	12.13
Protection against solid foreign objects, IP rating	X	Y	Y	Y	Operational	12.14
EMC immunity	Y	Y	Y	Y	Operational	12.15
"Y" indicates that the test is required.						
"X" indicates that the test is not required.						

11.4.2 Tests for one specimen

If a single specimen is supplied for environmental testing, the specimen shall be subjected to all of the required tests listed in Table 3 or Table 4, which may be carried out in any order. A functional test shall be carried out before and after the first environmental test and after each subsequent environmental test.

11.4.3 Tests for more than one specimen

If more than one specimen is supplied for environmental testing, then the tests may be divided among the specimens and carried out in any order. A functional test shall be carried out before and after each environmental test. For each specimen, the functional test after one environmental test may be taken as the functional test before the next environmental test.

11.4.4 Selection of functional tests

A functional test shall be carried out before, after and, when required, during the conditioning of each environmental test, as indicated in the test procedures. For each specimen, the initial functional test (before the conditioning of the first environmental test, on that specimen) and the final functional test (after the conditioning of the last environmental test, on that specimen) shall both be the full functional test; intermediate functional tests shall be the reduced functional test.

Table 4 — Environmental tests for pneumatic p.o.d.

Test	Environmental class of p.o.d.				Operational or Endurance	Subclause
	1	2	3	4		
Cold	Y	Y	Y	Y	Operational	12.4
Damp heat, steady state	Y	Y	Y	Y	Operational	12.5
Impact	C	C	C	C	Operational	12.6
Vibration, sinusoidal	Y	Y	Y	Y	Operational	12.7
Damp heat, steady state	X	Y	Y	Y	Endurance	12.8
Vibration, sinusoidal	Y	Y	Y	Y	Endurance	12.9
Dry heat	X	Y	Y	Y	Operational	12.10
SO_2 corrosion	X	X	Y	Y	Endurance	12.11
Salt spray testing	X	X	X	Y	Endurance	12.12
Protection against water, IP rating	X	C	C	C	Operational	12.13
Protection against solid foreign objects, IP rating	X	C	C	C	Operational	12.14
EMC immunity	C	C	C	C	Operational	12.15

"Y" indicates that the test is required.

"X" indicates that the test is not required.

"C" indicates that the test is applicable for electrical components of compressor sets only.

12 Tests

12.1 Electrical functional test

12.1.1 Full functional test

The test consists of all nine tests with voltage combinations and output currents as given in Table 5. The output voltages and the test results shall be measured and recorded.

12.1.2 Reduced functional test

The test consists of tests 7 and 8 as given in Table 5. The output voltages and the test results shall be measured and recorded.

12.1.3 Requirements

In the tests of 12.1.1 and 12.1.2, the output voltages and test results recorded shall not fall outside the range specified by the p.o.d. manufacturer and the requirements in this part of ISO 21927.

Table 5 — Functional tests for battery p.o.d.

Test	Mains supply voltage	Condition of battery	Output current load	Purpose of test	Duration of test
1	V_n[a] + 10 %	$V_{b\ min}$[b]	$I_{max\ a}$[c]	No overheating	4 h
			$I_{max\ b}$[d]		≥180 s
2	V_n − 10 %	$V_{b\ min}$	$I_{max\ a}$[c]	Performance within specification and no overheating	4 h
			$I_{max\ b}$[d]		≥180 s
3	Disconnected	$V_{b\ min}$	$I_{max\ b}$[d]	Output voltage within specification	—
4	V_n[a] − 0 %	V_b = 0 [e]	$I_{max\ b}$	Output voltage within specification	—
5	V_n + 10 %	≥$V_{b\ min}$[b] and ≤$V_{b\ max}$[f] charging capability disconnected	I_{min}[g]	Output voltage within specification	—
6	V_n + 10 %	Disconnected	$I_{max\ b}$	Ripple within specification	—
7	V_n − 10 %	Disconnected	$I_{max\ b}$	Ripple within specification	—
8	V_n + 10 %	$V_{b\ max}$	I_{min}	Output voltage within specification	—
9	V_n	≤0,9 × $V_{b\ min}$	I_{min}	Fault signal	—

NOTE The manufacturer specifies by $I_{max\ a}$ that current which is necessary for continuous monitoring, current load for the battery and indications. $I_{max\ b}$ specifies the current that is necessary for opening the smoke and heat control system.

[a] V_n is the nominal voltage of the public supply or equivalent.

[b] $V_{b\ min}$ is the final voltage of the battery at the test temperature, as specified by the manufacturer.

[c] Output current load, $I_{max\ a}$, is the maximum standby load.

[d] Output current load, $I_{max\ b}$, is the maximum short-duration load (if $I_{max\ ab}$ is not specified by the manufacturer, then $I_{max\ a}$ shall be applied).

[e] $V_b = 0$ means a short circuit across the battery connection.

[f] $V_{b\ max}$ is the float voltage of the battery.

[g] Output current load, I_{min}, is the minimum current load specified by the p.o.d. manufacturer.

12.2 Pneumatic functional test

12.2.1 Compressor sets

12.2.1.1 Discharge the air receiver to atmospheric pressure then close the outlet shut-off valve. Operate the compressor with a supply voltage of V_n − 0 %. Measure the time taken to charge the air receiver to the rated maximum pressure.

12.2.1.2 Repeat within 15 min with a supply voltage of V_n + 0 %.

12.2.1.3 Leave the receiver charged for 72 h with the compressor switched off.

12.2.1.4 In the tests of 12.2.1.1 and 12.2.1.2, the time taken to charge the receiver shall be no more than 60 min. In the test of 12.2.1.3, the air pressure in the receiver shall not drop by more than 5 % of the initial value after correction for any change in environmental temperature or pressure.

12.2.2 Multi-use gas bottles

Discharge the bottle until the alarm operates. The mass or pressure shall be within 10 % of the manufacturer's nominal setting.

12.2.3 Single-use gas bottles

No test is required by this part of ISO 21927 since the functional test for these bottles is carried out with the triggering device or c.p. in accordance with ISO 21927-9.

12.3 Test of the charger and the secondary power source

12.3.1 Electrical charger

12.3.1.1 Discharge the battery to its final voltage at a discharge current of $I_d = C/20$, expressed in amperes, for lead acid type batteries, or $I_d = C/10$, expressed in amperes for nickel-cadmium type batteries, where C is the rated ampere-hour capacity of the battery, given by the manufacturer.

NOTE Other types of batteries can require different discharge currents.

12.3.1.2 Charge the battery for 72 h with the appropriate charger connected to the nominal mains voltage (V_n) while the p.o.d. output is loaded by $I_{max\ a}$.

12.3.1.3 Repeat the procedure as in 12.3.1.1 and measure the discharge time, T1, expressed in hours.

12.3.1.4 Charge the battery again for 24 h at V_n – 15 % while the p.o.d. output is loaded by $I_{max\ a}$.

12.3.1.5 Repeat the procedure as in 12.3.1.1 and measure the discharge time, T2, expressed in hours.

12.3.1.6 In the test of 12.3.1.3, the product of the discharge time, T1, and the discharge current, I_d, shall be not less than the rated capacity, C, of the battery.

12.3.1.7 In the test of 12.3.1.5, the product of the discharge time, T2, and the discharge current, I_d, shall be not less than 0,8 times the rated capacity, C, of the battery.

12.3.2 Replenishing pneumatic systems

For pneumatic p.o.d., monitor the specimen during the conditioning period to check that the available pressure is within the manufacturer's specified limits. During the last hour of the conditioning period, for a compressor set only, discharge the air receiver and check that the receiver is refilled to operating pressure within 60 min.

12.4 Cold (operational)

12.4.1 Object of the test

The object of the test is to demonstrate the ability of the equipment to function correctly at low ambient temperatures appropriate to the anticipated service environment.

12.4.2 Test procedure

12.4.2.1 General

Testing shall be carried out in accordance with the test procedures with gradual changes in temperature in IEC 60068-2-1 with the modifications and additions given in 12.4.2. Test Ad shall be used for heat-dissipating specimens and test Ab shall be used for non-heat-dissipating specimens.

12.4.2.2 Initial examination

Before conditioning, subject the specimen to the functional test.

12.4.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2, connected in accordance with 11.3 and shall be operating.

12.4.2.4 Conditioning

Apply the severity of conditioning in accordance with Table 6.

Table 6 — Conditioning for cold (operational) test

Environmental class	1	2	3	4
Temperature, °C	–5	–5	–5	–25
Duration, h	16	16	16	16

12.4.2.5 Measurements during conditioning

For electrical p.o.d., monitor the specimen during the conditioning period to check that the output voltage is within the manufacturer's specified limits. During the last hour of the conditioning period, subject the specimen to the reduced functional test.

For pneumatic p.o.d., monitor the specimen during the conditioning period to check that the available pressure is within the manufacturer's specified limits. During the last hour of the conditioning period, for a compressor set only, discharge the air receiver and check that the receiver is refilled to operating pressure within 60 min.

12.4.2.6 Final measurements

Within 30 min after the end of the recovery period, subject the specimen to the functional test in accordance with 12.1 or 12.2 and inspect it visually for mechanical damage both externally and internally.

12.5 Damp heat, steady state (operational)

12.5.1 Object of the test

The object of the test is to demonstrate the ability of the equipment to function correctly at high relative humidities (without condensation) that can occur for short periods in the service environment.

12.5.2 Procedure

12.5.2.1 General

Testing shall be carried out in accordance with the procedures in IEC 60068-2-78 with the modifications and additions given in 12.5.2.

12.5.2.2 Initial examination

Before conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2.

12.5.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2, connected in accordance with 11.3 and shall be operating.

12.5.2.4 Conditioning

Apply the following severity of conditioning:

— temperature: 40 °C ± 2 °C;

— relative humidity: $(93\ ^{+2}_{-3})$ %;

— duration: 4 d.

Precondition the specimen by raising the temperature slowly from ambient to the conditioning temperature 40 °C ± 2 °C and holding it until temperature stability has been reached before raising the relative humidity, to prevent the formation of water droplets on the specimen.

12.5.2.5 Measurements during conditioning

For electrical p.o.d., monitor the specimen during the conditioning period to check that the output voltage is within the manufacturer's specified limits. During the last hour of the conditioning period, subject the specimen to the reduced functional test.

For pneumatic p.o.d., monitor the specimen during the conditioning period to check that the available pressure is within the manufacturer's specified limits. During the last hour of the conditioning period, for a compressor set only, discharge the air receiver and check that the receiver is refilled to operating pressure within 60 min.

12.5.2.6 Final measurements

Within 30 min after the end of the recovery period, subject the specimen to the functional test and inspect it visually for mechanical damage both externally and internally.

12.6 Impact (operational)

12.6.1 Object of the test

The object of the test is to demonstrate the immunity of the equipment to mechanical impacts upon the surface, which it can sustain in the normal service environment and which it can reasonably be expected to withstand.

12.6.2 Test procedure

12.6.2.1 General

Testing shall be carried out using test apparatus and procedure in accordance with IEC 60068-2-75, Test Ehb, with the modifications and additions given in 12.6.2.4.

12.6.2.2 Initial examination

Before conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2.

12.6.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2, connected in accordance with 11.3 and shall be operating.

12.6.2.4 Conditioning

Apply impacts to all external surfaces of the specimen.

For all such surfaces, three blows shall be applied to any point(s) considered likely to cause damage to or impair the operation of the specimen.

Care shall be taken to ensure that the results from a series of three blows do not influence subsequent series.

Apply the following severity of conditioning:

— impact energy: $(0{,}5 \pm 0{,}04)$ J;

— number of impacts per point: 3.

12.6.2.5 Measurements during conditioning

Monitor the specimen during the conditioning period to check that the outputs are within the manufacturer's specified limits and ensure that the results of the three blows do not influence subsequent series.

12.6.2.6 Final measurements

Within 30 min after the end of the recovery period, subject the specimen to the functional test in accordance with 12.1 or 12.2 and inspect it visually for mechanical damage externally and internally.

12.7 Vibration, sinusoidal (operational)

12.7.1 Object of the test

The object of the test is to demonstrate the immunity of the equipment to vibrations at levels appropriate to the service environment.

12.7.2 Test procedure

12.7.2.1 General

Testing shall be carried out in accordance with the procedure in IEC 60068-2-6 with the modifications and additions given in 12.7.2.4.

The vibration operational test may be combined with the vibration endurance test so that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in each axis.

12.7.2.2 Initial examination

Before conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2.

12.7.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2 and IEC 60068-2-47, connected in accordance with 11.3 and shall be operating.

12.7.2.4 Conditioning

Subject the specimen to vibration in each of the three mutually perpendicular axes in turn, one of which is perpendicular to the plane of mounting of the specimen.

Apply the following severity of conditioning:

a) frequency range: 10 Hz to 150 Hz;

b) acceleration amplitude: 0,981 $m \cdot s^{-2}$ (0,1 g_n);

c) number of axes: 3;

d) number of sweep cycles per axis: 1 for each functional condition.

12.7.2.5 Measurements during conditioning

Monitor the specimen during the conditioning period to check that the output voltage or pressure is within the manufacturer's specified limits.

12.7.2.6 Final measurements

Within 30 min after the end of the recovery period, subject the specimen to the functional test in accordance with 12.1 or 12.2 and inspect it visually for mechanical damage externally and internally.

12.8 Damp heat, steady state (endurance)

12.8.1 Object of the test

The object of the test is to demonstrate the ability of the equipment to withstand the long-term effects of humidity in the service environment (e.g. changes in electrical properties due to absorption, chemical reactions involving moisture or galvanic corrosion).

12.8.2 Test procedure

12.8.2.1 General

Testing shall be carried out in accordance with the test procedure in IEC 60068-2-78 with the modifications and additions given in 12.8.2.4.

12.8.2.2 Initial examination

Before conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2.

12.8.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2. The specimen shall not be supplied with power during the conditioning.

12.8.2.4 Conditioning

Apply the following severity of conditioning:

— temperature: 40 °C ± 2 °C;

— relative humidity: $(93\ ^{+2}_{-3})$ %;

— duration: 21 d.

Precondition the specimen by raising the temperature slowly from ambient to the conditioning temperature of 40 °C ± 2 °C and holding it until temperature stability has been reached before raising the relative humidity, to prevent the formation of water droplets on the specimen.

12.8.2.5 Final measurements

After conditioning, subject the specimen to the functional test required by 12.1 or 12.2 and inspect it visually for mechanical damage both externally and internally.

12.9 Vibration, sinusoidal (endurance)

12.9.1 Object of the test

The object of the test is to demonstrate the ability of the equipment to withstand the long-term effects of vibration at levels appropriate to the environment.

12.9.2 Test procedure

12.9.2.1 General

Testing shall be carried out in accordance with the test procedure in IEC 60068-2-6 with the modifications and additions given in 12.9.2.4.

The vibration endurance test may be combined with the vibration operational test, so that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in each axis in turn.

12.9.2.2 Initial examination

Before conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2.

12.9.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2 and IEC 60068-2-47, connected in accordance with 11.3 and shall be operating. The specimen shall not be supplied with power during the conditioning.

12.9.2.4 Conditioning

Subject the specimen to vibration in each of the three mutually perpendicular axes in turn, one of which shall be perpendicular to the plane of the specimen.

Apply the following severity of conditioning:

a) frequency range: 10 Hz to 150 Hz;

b) acceleration amplitude: 4,905 $m \cdot s^{-2}$ (0,5 g_n);

c) number of axes: 3;

d) number of sweep cycles: 20 per axis.

12.9.2.5 Final measurements

After conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2 and inspect it visually for mechanical damage both externally and internally.

12.10 Dry heat (operational)

12.10.1 Object of the test

The object of the test is to demonstrate the ability of the equipment to function correctly at high ambient temperatures appropriate to the anticipated service environment.

12.10.2 Test procedure

12.10.2.1 General

Testing shall be carried out in accordance with the test procedures with gradual changes in temperature in accordance with IEC 60068-2-1 with the modifications and additions given in 12.10.2.4. Test Bd shall be used for heat-dissipating specimens (in accordance with IEC 60068-2-1) and test Bb shall be used for non-heat-dissipating specimens.

12.10.2.2 Initial examination

Before conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2.

12.10.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2, connected in accordance with 11.3 and shall be operating.

12.10.2.4 Conditioning

The specimen shall be conditioned in accordance with Table 7.

Table 7 — Dry heat conditioning

Environmental class	**1**	**2**	**3**	**4**
Temperature, °C	No test	+75	+75	+75
Duration, h		2	2	2

12.10.2.5 Measurements during conditioning

For electrical p.s.e., monitor the specimen during the conditioning period to check that the output voltage is within the manufacturer's specified limits. During the last hour of the conditioning period, subject the specimen to a reduced functional test.

For pneumatic p.s.e., monitor the specimen during the conditioning period to check that the available pressure is within the manufacturer's specified limits. During the last hour of the conditioning period, for a compressor set only, discharge the air receiver and check that the receiver is refilled to operating pressure within 60 min.

12.10.2.6 Final measurements

Within 30 min after the end of the recovery period, subject the specimen to the functional test in accordance with 12.1 or 12.2 and inspect it visually for mechanical damage both externally and internally.

12.11 SO_2 corrosion

12.11.1 Object of the test

The object of the test is to demonstrate the ability of the equipment to withstand corrosive effects, caused by air pollution.

12.11.2 Test procedure

12.11.2.1 General

Testing shall be carried out in accordance with the procedures described in ISO 6988 with the modifications and additions given in 12.11.2.4.

12.11.2.2 Initial examination

Before conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2.

12.11.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2, connected in accordance with 11.3 and shall not be operating.

12.11.2.4 Conditioning

The specimen shall be conditioned in accordance with Table 8.

Table 8 — Conditioning for SO_2 corrosion test

Environmental class		**1**	**2**	**3**	**4**
Theoretical SO_2 concentration at the beginning of a cycle		No test	No test	0,67 % by volume	0,67 % by volume
Cycle	**1. Test section**	No test	No test	8 h	8 h
	2. Test section			16 h	16 h
Test cycles		No test	No test	20	20
Climate	**1. Test section**	No test	No test	(40 ± 3) °C at 100 % relative humidity	(40 ± 3) °C at 100 % relative humidity
	2. Test section			18 °C to 28 °C relative humidity ≤ 75 %	18 °C to 28 °C relative humidity ≤ 75 %
Soil water in the test chamber[a]		No test	No test	0,67 % by volume	0,67 % by volume

[a] Distilled water is added to the base of the chamber until it fills the specified percentage volume of the chamber.

12.11.2.5 Measurements during conditioning

No measurements are required during this period.

12.11.2.6 Final measurements

Within 30 min after the end of the recovery period (24 h at laboratory temperature), subject the specimen to the functional test required by 12.1 or 12.2 and inspect it visually for mechanical damage both externally and internally.

12.12 Salt spray testing

12.12.1 Object of the test

The object of the test is to demonstrate the ability of the equipment to withstand a saliferous atmosphere.

12.12.2 Test procedure

12.12.2.1 General

Testing shall be carried out in accordance with the procedures in IEC 60068-2-52 with the modifications and additions given in 12.12.2.4.

12.12.2.2 Initial examination

Before conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2.

12.12.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2, connected in accordance with 11.3 and shall not be operating. Connection to the p.o.d. shall be by untinned stranded copper wire.

12.12.2.4 Conditioning

The specimen shall be conditioned in accordance with Table 9.

Table 9 — Conditioning for salt spray test

Environmental class		1	2	3	4
Total duration		No test			28 d
Number of cycles					4
Saline solution	Salt concentration				5 % by volume
	pH-value of the saline solution				6,2 to 7,2
	Temperature				15 °C to 35 °C
	Duration per cycle				2 h
Damp heat	Temperature				40 °C
	Relative humidity				93 %
	Duration per cycle				166 h

12.12.2.5 Measurements during conditioning

No measurements are required during this period.

12.12.2.6 Final measurements

After the test procedure, the specimen shall be handled in accordance with IEC 60068-2-52:1996, Clause 10. After the test procedure, subject the specimen to the functional test in accordance with 12.1 or 12.2 and inspect it visually for mechanical damage both externally and internally.

12.13 Protection against water

12.13.1 Object of the test

The object of the test is to demonstrate the protection against water of the equipment.

12.13.2 Test procedure

12.13.2.1 General

Testing shall be carried out in accordance with the procedures described in IEC 60529 with the modifications and additions given in 12.13.2.4.

12.13.2.2 Initial examination

Before conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2.

12.13.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2 and connected in accordance with 11.3.

12.13.2.4 Conditioning

The specimen shall be conditioned in accordance with IEC 60529 for protection against water.

12.13.2.5 Measurements during conditioning

Monitor the specimen during the conditioning period to check that the output voltage is within the manufacturer's specified limits. No change in the status of the equipment is allowed.

12.13.2.6 Final measurements

After the recovery period, subject the specimen to the functional test in accordance with 12.1 or 12.2 and inspect it visually for mechanical damage both externally and internally.

12.14 Protection against solid foreign objects

12.14.1 Object of the test

The object of the test is to demonstrate the protection against solid foreign objects of the equipment.

12.14.2 Test procedure

12.14.2.1 General

Testing shall be carried out in accordance with the procedures described in IEC 60529 with the modifications and additions given in 12.14.2.

12.14.2.2 Initial examination

Before conditioning, subject the specimen to the functional test in accordance with 12.1 or 12.2.

12.14.2.3 State of the specimen during conditioning

The specimen shall be mounted in accordance with 11.2 and connected in accordance with 11.3.

12.14.2.4 Conditioning

The specimen shall be conditioned in accordance with IEC 60529 for protection against solid foreign objects.

12.14.2.5 Measurements during conditioning

Monitor the specimen during the conditioning period to check that the output voltage is within the manufacturer's specified limits. No change in the status of the equipment is allowed.

12.14.2.6 Final measurements

Within 30 min after the end of the recovery period, subject the specimen to the functional test in accordance with 12.1 or 12.2 and inspect it visually for mechanical damage both externally and internally.

12.15 EMC immunity tests (operational)

The following EMC immunity tests shall be carried out on any p.o.d. that it is intended to be provided with mains electrical power in accordance with EN 50130-4:

a) mains voltage variations;

b) mains supply voltage dips and interruptions;

c) electrostatic discharge;

d) radiated electromagnetic fields;

e) conducted disturbances induced by electromagnetic fields;

f) fast transient bursts;

g) slow high-energy voltage surges.

The functional test, called for in the initial and final measurements, shall be the reduced functional test as described in 12.1.3.

The connections to the various inputs should be made with unscreened cables unless the manufacturer's installation data specify that only screened cables should be used.

13 Evaluation of conformity

13.1 General

Compliance of p.o.d.s with the requirements of this part of ISO 21927 shall be demonstrated by

— type testing,

— factory production control by the manufacturer.

The p.o.d. shall be type tested in accordance with this part of ISO 21927.

The power output device shall continuously conform to the type testing samples for which compliance with this part of ISO 21927 has been verified.

However, where the manufacturer uses power output devices already shown to conform to those requirements relevant for that power output device (e.g. by CE marking), it is not necessary to repeat the evaluation that led to such conformity.

13.2 Type testing

13.2.1 Type testing shall be performed to demonstrate conformity with this part of ISO 21927. All characteristics given in this part of ISO 21927 shall be subject to this type testing.

This testing applies whether the product is a one-off design, a product based on a standard design range or series production.

In the case of modification of the power output device or of the method of production (where these can affect the stated properties), type testing shall be performed. All characteristics given in this part of ISO 21927 that can be changed by the modification shall be subject to this type testing.

13.2.3 Tests previously performed in accordance with the provisions of this part of ISO 21927 may be taken into account, providing that they were made according to the same or a more rigorous test method on the same p.o.d. or p.o.d. of similar design, construction and functionality, such that the results are applicable to the p.o.d. in question.

13.2.4 P.o.d. may be grouped into families where one or more characteristics are the same for all p.o.d. within that family or where the test results are representative of all p.o.d. within that family. In this case, it is not necessary to test all the items of p.o.d. of the family for the purposes of the type testing.

13.2.5 Test samples shall be representative of the normal production. If the test samples are prototypes, they shall be representative of the intended future production.

All type testing and its results shall be documented in a test report.

13.2.6 Successful completion of testing shall be taken as representative of all p.o.d.s built by the manufacturer to conform to this part of ISO 21927 using the ranges of components declared.

13.3 Factory production control

13.3.1 General

A factory production control (FPC) system shall be established, documented and maintained to ensure that the p.o.d.s placed on the market conform to the documented performance characteristics.

FPC is the permanent internal control of production exercised by the manufacturer.

All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures.

This production control system documentation should ensure a common understanding of conformity evaluation and enable the achievement of the required product characteristics and the effective operation of the production control system being checked.

Factory production control, therefore, brings together operational techniques and all measures enabling maintenance and control of the conformity of the control equipment with technical specifications. Its implementation may be achieved by controls and tests on measuring equipment, raw materials and constituents, processes, machines and manufacturing equipment and finished products, including material properties in products, and by making use of the results thus obtained.

13.3.2 General requirements

The FPC system shall be part of a quality management system, for example ISO 9001.

13.3.3 Specific requirements for p.o.d.s

13.3.3.1 The FPC system shall

— address this part of ISO 21927, and

— ensure that the p.o.d. placed on the market conform with the documented performance characteristics.

Records shall be established and maintained that provide evidence that the production has been sampled and tested. These records shall show clearly whether production conforms to the FPC acceptance criteria.

Where the p.o.d. fails to meet the acceptance criteria, the FPC provisions for non-conforming products shall apply. The necessary corrective action shall immediately be taken and the p.o.d. or batches not conforming shall be isolated and properly identified. Once the fault has been corrected, the test or verification in question shall be repeated.

The results of controls and tests shall be properly recorded. The product description, date of manufacture, test method adopted, test results and acceptance criteria shall be entered in the records. With regard to any control result not conforming to the requirements of this part of ISO 21927, the corrective measures taken to rectify the situation (e.g. a further test performed, modification of manufacturing process, throwing away or putting right of product) shall be recorded.

13.3.3.2 Individual p.o.d. or batches of p.o.d. and the related manufacturing details shall be completely identifiable and retraceable.

Annex A
(informative)

Summary of functions

Table A.1 below provides a summary of the functions covered by this part of ISO 21927, whether they are required or optional, and the relevant subclauses where requirements can be found.

Table A.1 — Summary of functions

Function (subclause)	Type and number of power sources					
	ELV[a] Class A	**LV[b] Class A**	**ELV Class B**	**LV Class B**	**Pneumatic Class A**	**Pneumatic Class B**
Primary power source[c] (6.1, 6.5)	Mains[d] or batteries	Mains	Mains[d] or batteries	Mains	Mains[e] or gas bottle	Mains[e] or gas bottle
Secondary power source[cg] (6.2, 6.5)	Batteries	Mains/ generators/ batteries	X	X	Gas bottle or air receiver	X
Fault output (6.4)	R	R	O	O	R	O
Standby function (6.1, 6.2)	O	O	O	O	O	O
Dual output transmission path (6.4, 6.5)	R[f]	R[f]	X	X	O	X
Charger equipment (if batteries used) (6.2.4)	R	R	R	X	X	X
Minimum number of power sources (4.1, 5.2.1)	2	2	1	1	2	1

[a] Extra-low voltage, ELV, up to 75 VDC or 50 VAC.

[b] Low voltage, LV, up to 1 500 VDC or 1 000 VAC.

[c] These rows show typical examples.

[d] Mains via, for example, transformer and rectifier.

[e] Mains to operate compressor.

[f] Only where the p.o.d. is in a separate cabinet from the c.p.

[g] The secondary power source may be incorporated within the ventilator or other SHEVS component.

"X" indicates not required.

"R" indicates required.

"O" indicates option (with requirements).

Bibliography

[1] ISO 9001:2000, *Quality management systems — Requirements*

[2] ADR, *The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)*

[3] ISO 21927-9, *Smoke and heat control systems — Part 9: Specification for control equipment*

[4] EN 12205, *Transportable gas cylinders — Non-refillable metallic gas cylinders*

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