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Sistemi za nadzor dima in toplote - 13. del: Sistemi za zagotovitev tlačnih razlik (PDS) - Načrtovanje in računske metode, vgradnja, preskušanje ustreznosti, rutinsko preskušanje in vzdrževanje

Smoke and heat control systems - Part 13: Pressure differential systems (PDS) - Design and calculation methods, installation, acceptance testing, routine testing and maintenance

Rauch- und Wärmefreihaltung - Teil 13: Differenzdrucksysteme — Rauchschutz-Druckanlagen (RDA) - Planung, Bemessung, Einbau, Abnahmeprüfung, Funktions-Tests, Betrieb und Instandhaltung

Systèmes pour le contrôle des fumées et de la chaleur - Partie 13 : Systèmes à différentiel de pression (SDP) - Méthodes de conception et de calcul, installation, essais de réception, essais périodiques et maintenance

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European foreword

This document (EN 12101-13:2022) has been prepared by Technical Committee CEN/TC 191 “Fixed fire-fighting systems”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2022, and conflicting national standards shall be withdrawn at the latest by October 2022.

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

This document together with EN 12101-6 supersedes EN 12101-6:2005 which will be withdrawn.

This document has the general title “Smoke and heat control systems” and consists of the following parts:

— 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 4: *Installed SHEVS systems for smoke and heat ventilation* (published as CEN/TR 12101-4)*;*

— Part 5: *Design and calculation for smoke and heat exhaust ventilation systems using a steady-state fire* (published as CEN/TR 12101-5)*;*

— Part 6: *Specification for pressure differential systems;*

— Part 7: *Smoke control duct sections;*

— Part 8: *Specification for smoke control dampers;*

— Part 10: *Power supplies;*

— Part 11: *Design, installation and commissioning requirements for enclosed car parks;*

— Part 12: *Design and calculation for smoke and heat exhaust ventilation systems using a time dependent fire;*

— Part 13: *Pressure differential systems (PDS) - Design and calculation methods, installation, acceptance testing, routine testing and maintenance.*

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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Introduction

This document covers information and requirements on the design and calculation methods, installation, acceptance testing, routine testing and maintenance of Pressure Differential Systems (PDS). PDSs are installed in buildings to prevent smoke in hazardous amounts from entering into protected spaces via leakage paths through physical barriers (e.g. cracks around closed doors) or open doors by using pressure differentials.

The requirements and test methods for kits used in PDS are published in EN 12101-6. For certain components as part of the kits, additional tests must be carried out in accordance with Part 6 prior to the kit test.

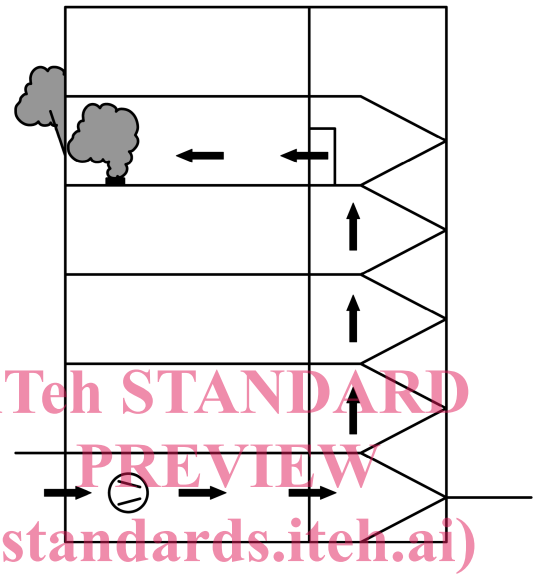


Figure 1 — Pressurization (General)

Pressure differential systems provide a means of maintaining tenable conditions in protected spaces, that are required to be kept free of smoke – e.g. escape routes, firefighting access routes, firefighting lift shafts, lobbies, staircases, and other spaces. It is necessary to determine where the fresh air supply for the PDS is to be introduced into a building as well as where that air and smoke will leave the building and what paths it will follow in the process, including during firefighting (e.g. with fire compartment door open) and in the event of likely events such as window failure.

By means of a PDS, a positive pressure difference is always achieved between the protected space and the unprotected space. This is achieved by pressurizing the protected space(s) (see Figure 1).

The aim therefore is to establish a pressure gradient from the protected space to the unprotected space while the doors are closed and an airflow from the protected space via the unprotected space to outside when specific doors are open.

The figures that accompany the text in this document are informative and are intended for clarification purposes only.

It is recommended that the designer should discuss the design and evacuation concept, including safety targets, with the authorities having jurisdiction, early in the building design process.

NOTE 1 From experience gained since EN 12101-6 was first published, this document now simply prescribes two systems only and these are specifically described in terms of the closed-door differential pressure and the open-door velocity only. Consequently the 10 Pa previously required in some scenarios is now withdrawn.

NOTE 2 It is recommended that an engineered solution for a PDS should adopt the functional requirements set out in this document where appropriate, inclusive of Table 1 as a minimum, in the absence of any national requirements.

1 Scope

This document gives calculation methods, guidance and requirements for the design, installation, acceptance testing, routine testing and maintenance for pressure differential systems (PDS).

PDSs are designed to hold back smoke at a leaky physical barrier in a building, such as a door (either open or closed) or other similarly restricted openings and to keep tenable conditions in escape and access routes depending on the application.

It covers systems intended to protect means of escape e.g. staircases, corridors, lobbies, as well as systems intended to provide a protected firefighting space (bridgehead) for the fire services.

It provides details on the critical features and relevant procedures for the installation.

It describes the commissioning procedures and acceptance testing criteria required to confirm that the calculated design is achieved in the building.

This document gives rules, requirements and procedures to design PDS for buildings up to 60 m.

For buildings taller than 60 m the same requirements are given (e.g. Table 1), but additional methods of calculation and verification are necessary. Requirements for such methods and verification are given in Annex D, but the methods fall outside the scope of this document [e.g. Additional mathematical analysis and/or Computational Fluid Dynamics (CFD)].

Routine testing and maintenance requirements are also defined in this document.

In the absence of national requirements and under expected ambient and outside conditions, the requirements in Table 1 are fulfilled by the PDS.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 12101-2, *Smoke and heat control systems - Part 2: Natural smoke and heat exhaust ventilators*

EN 12101-3, *Smoke and heat control systems - Part 3: Specification for powered smoke and heat control ventilators (Fans)*

EN 12101-6, *Smoke and heat control systems - Part 6: Specification for pressure differential systems - Kits*

EN 12101-7, *Smoke and heat control systems - Part 7: Smoke duct sections*

EN 12101-8, *Smoke and heat control systems - Part 8: Smoke control dampers*

EN 12101-10, *Smoke and heat control systems - Part 10: Power supplies*

EN 13501-4, *Fire classification of construction products and building elements - Part 4: Classification using data from fire resistance tests on components of smoke control systems*

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

EN 16763, *Services for fire safety systems and security systems*

EN 12259-1, F*ixed firefighting systems - Components for sprinkler and water spray systems - Part 1: Sprinklers*

EN 54 (all parts), *Fire detection and fire alarm systems*

EN 60770-1, *Transmitters for use in industrial-process control systems - Part 1: Methods for performance evaluation*

EN 60751, *Industrial platinum resistance thermometers and platinum temperature sensors*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 13943 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
accommodation
any part of the construction works which is not part of the protected escape route

3.2
air inlet
connection from the outside of the building to allow air entry

3.3
authorities
authorities having jurisdiction
AHJ
organizations, officers or individuals responsible for approving pressure differential systems, e.g. the local/national fire and building control authorities having jurisdiction, or other approved third parties

3.4
barometric relief damper
damper which opens at automatically without a controlled actuator at a specific pressure to allow pressure relief by providing flow of air to outside

3.5
control panel
multi-operational device to activate and/or control a PDS.

3.6
fire compartment
space (room or set of rooms) contained by boundaries with classified fire resistance

3.7
pressurized space
space (e.g. lift shaft, staircase, lobby, corridor, or other compartment) in which the air pressure is maintained at a higher level than that in the space where a fire is located

3.8
protected space
space where the design prevents smoke entry

3.9
smoke and heat exhaust ventilation system
SHEVS
system in which components are jointly selected to exhaust smoke and heat in order to establish a buoyant layer of warm gases above cooler, cleaner air

3.10
stack effect
movement of air into and out of buildings, resulting from air buoyancy

3.11
unpressurized space
space adjacent to or separate from the protected space where the pressure and airflow are not controlled by the PDS

4 Design objectives

4.1 General

The following design objectives are addressed in this document and can be selected to match the required application.

4.2 Protection of means of escape

It is essential that tenable conditions for life safety are maintained in protected spaces for as long as they are likely to be in use by the building occupants.

4.3 Protection of firefighting routes

To enable firefighting operations to proceed efficiently, protected firefighting access routes shall be maintained essentially free of smoke so that access to the fire-affected storey can be achieved without the use of breathing apparatus. The pressure differential system shall be designed so as to limit the spread of smoke into the dedicated firefighting route under normal firefighting conditions, but not compromising means of escape or firefighting objectives which remain the top priority.

4.4 Property protection

The spread of smoke shall be prevented from entering sensitive spaces such as those containing valuable equipment, data processing and other items that are particularly sensitive to smoke damage.

NOTE The purpose of a pressure differential system, whether used for the protection of means of escape, firefighting operations or property protection, has a significant influence on the system design and specification. It is therefore essential that the fire safety objectives are clearly established and agreed with the appropriate authorities having jurisdiction at an early stage in the design process.

4.5 Additional functions

If designed accordingly, the PDS may have a secondary function as a ventilation system, provided that it shall close the ventilation system down and switch to operation specifically as a PDS alone when a smoke alarm is received.

5 Requirements

5.1 General

For this document the PDS will only have to deal with one fire at any one time, following generally accepted practice. Designs and calculations will reflect this approach to fulfil the normative requirements of this document.

The PDS shall be designed in such a way, that the PDS can fulfil its function throughout the required operating time (e.g. 30, 60, 90 min) in accordance with national requirements.

If there is more than one PDS installed in a building, each PDS shall have its own control system. The failure of any one PDS control system shall not negatively affect any other PDS.

Therefore, in operation, pressure differential and airflow velocity criteria shall only be required to be met on the fire floor, but it shall be proven that the PDS can meet these requirements on all floors during acceptance testing, but not necessarily at the same time. It is not acceptable for the PDS to draw smoke into the protected space.

The PDS shall be triggered automatically by smoke detectors in accordance with EN 54 series. This may also be achieved by the PDS receiving smoke signals from a separate fire/smoke detection system. There shall be at least one single smoke detector on each floor installed on the unprotected side of the door to the protected space (e.g. in the corridor or lobby). The smoke detection system may be zoned to cover the whole building. Once the fire has been detected in a defined place by either smoke detection or a fire detection system, the PDS shall be activated. Any stray smoke, which may be detected in another place or in the protected space on another floor shall not change the operation of the PDS.

If there is a smoke detector or fire alarm activation within the protected space (e.g. staircase) before smoke has been detected on a specific floor, this shall not lead to activation of the PDS.

Any additional signals from smoke detectors or fire detection systems shall be ignored by the PDS.

NOTE 1 Early detection is given when smoke detectors are placed in spaces with fire load (e.g. accommodation), and not in the lobby or corridor, for example. However, if placing smoke detectors in accommodation or other areas, access for maintenance and testing shall be provided.

Each escape and rescue route, protected by PDS, shall be a stand-alone system (e.g. independent fan, ductwork, controls).

NOTE 2 PDSs for staircases and firefighters lift shafts, connected in one common lobby, are handled as one PDS, however consideration should be given to the use of separate fans for the staircase and for the firefighting lift shafts to give easier control and balancing of airflows.

Stack effect, convective airflow, airflow resistance, external wind etc. are amongst other influences which can adversely affect the function of a PDS and therefore shall be taken into account.

The following parameters are defined for the design and shall be met and confirmed by the acceptance test on site:

— Maximum door opening force (N);

— Minimum pressure differential (Pa);

— Minimum air flow velocity (m/s);

— Maximum response delay (s) – defined by initiation, operation and response times.

Table 1 — Design requirements of a PDS

Parameter	Class 1	Class 2
Door opening force	≤ 100 N	
Pressure differential	≥ 30 Pa	
Airflow velocity	≥ 1 m/s	≥ 2 m/s
Initiation time	≤ 60 s	
Operation time	≤ 120 s	
Response time	≤ 5 s	

NOTE Refer to Clause 8 when measuring the normative requirements given in Table 1.

5.2 Application of Class 1 and Class 2

5.2.1 Class 1

Class 1 will be required:

— in buildings with automatic water extinguishing systems using quick response sprinkler according to EN 12259-1 (with response time index (RTI)≤50) which operate in response to temperatures ≤ 72 °C; or

— in residential buildings up to 30 m or below the high-rise buildings limit (in accordance with national requirements); or

— in residential buildings, if there are at least two rooms without fire load between the protected space and the potential fire source and self-closing doors are present; or

— if accepted by authorities having jurisdiction.

5.2.2 Class 2

Class 2 will be required:

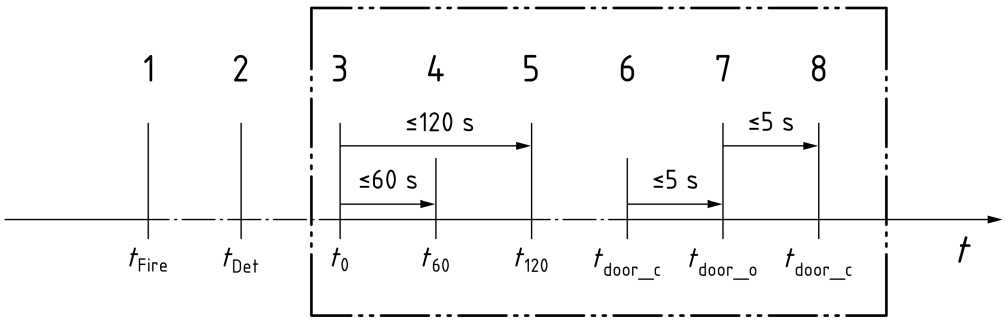
— where Class 1 is not applicable; or

— if required by authorities having jurisdiction.

5.3 Response delay – time period definitions

5.3.1 General

For the successful design and operation of the PDS, the initiation, operation and response times shall meet the requirements stated in Table 1, as further explained below and in Figure 2. The times for the start and detection of the fire are outside the scope of this document.



Key

1	t_{Fire}	start of a fire
2	t_{Det}	detection of the fire
3	t_0	activation of the Pressure Differential System (PDS)
4	t_{60}	initiation time
5	t_{120}	operation time
6	t_{Door_c}	time door closed
7	t_{Door_o}	time door open
8	t_{Door_c}	time door closed
t		time

NOTE The times within the scope of this document are shown in the key.

Figure 2 — PDS Response delay – time period definitions

5.3.2 The start of a fire (t_{Fire})

This is the point of the start of the fire (shown in Figure 2). It is outside the scope of this document and the results but is included to show the relationship to the other times specifically defined.

5.3.3 Detection of a fire (t_{Det})

This is the point of the detection of the fire (shown in Figure 2). It is outside the scope of this document and the results but is included to show the relationship to the other times specifically defined.

5.3.4 Activation of the PDS (t_0)

This is the point of the PDS activation and occurs as soon as the PDS receives an alarm signal from the detection system (Figure 2).

5.3.5 Initiation time (t_{60})

The initiation time is the time period which starts at the activation of the PDS (t_0) and ends after 60 s, by which time all the necessary components shall be in the correct operating position (e.g. damper, vents) - see Table 1 and Figure 2 - and the fan shall have started.

5.3.6 Operation time (t_{120})

The operation time is the time period which starts4 at the activation of the PDS (t_0) and ends after 120 s, by which time the PDS shall be in its fully operational status (see Table 1 and Figure 2).

5.3.7 Response times (t_{door_c}, t_{door_o})

The response time is the time period under which the PDS shall achieve the objective of either the pressure differential requirements (including maximum door opening force) or the air velocity requirements as the door is opened (5 s) and closed (5 s) (see Table 1 and Figure 2).

NOTE The requirement for the response time of 5 s in this document is with regard to site variances to allow a site tolerance on the test performed in EN 12101-6.

5.4 Door opening force

5.4.1 General

The PDS shall be designed so that the opening force at the door handle does not exceed 100 N. This requirement shall be met on all floors including the fire floor and for each door within the escape routes, when the PDS is in operation.

The characteristics of doors and their door closers (size, closing force and location of door handle) shall be taken into account when designing the PDS (see calculation information in Annex A).

All doors shall be kept closed while the PDS is in operation to maintain fire compartmentation except when manually or intentionally opened for escape or firefighting. All doors between pressurized and unpressurized spaces shall be fitted with automatic closing mechanisms including the final exit door (e.g. door closers with brake mechanism, to prevent accidents).

Door opening forces apply to all doors leading to protected spaces and to the outside as long as the PDS is in operation.

Door opening forces for doors along escape routes shall not exceed 100 N limit, if the PDS is in operation or not.

5.4.2 Doors (doors between pressurized and unpressurized spaces)

The opening force for these doors shall not exceed 100 N if the PDS is in operation or not.

All the requirements for the PDS in Table 1 shall be met on the fire floor despite the fact that, in some instances, the final exit door may not be completely closed.

NOTE 1 See also Annex A. Be aware that all combinations of door size and door closer cannot be acceptable as the 100 N value can be exceeded.

Where doors must open against pressure, the designer shall ensure that the door opening force does not exceed the requirements and that the door does not close with excessive force under the influence of the pressure (e.g. door closers with brake mechanism to prevent accidents).

If the door opening is aided by the pressurization (e.g. the final exit door), the designer shall ensure that either the door is kept closed, without causing excess door opening forces when the PDS is not in operation, or, if the door is not fully closed, the requirements of Table 1 are still met.

NOTE 2 As an option, door closers with dual functionality are available. If the PDS is not in operation, the door closer acts as a standard door closer. However, if the PDS is in operation, the door closer activates an additional, second door closer and increases the force used to close the door (e.g. the final exit door against the PDS).

5.5 Pressure differential systems

5.5.1 General

Pressure differential systems can be designed using overpressure (named pressurization).

The design of a PDS is influenced by the choice and definition of the protected and unprotected spaces together with the type and position of the air supply and air release routes.

The structure used in Clause 5 follows Figure 3.

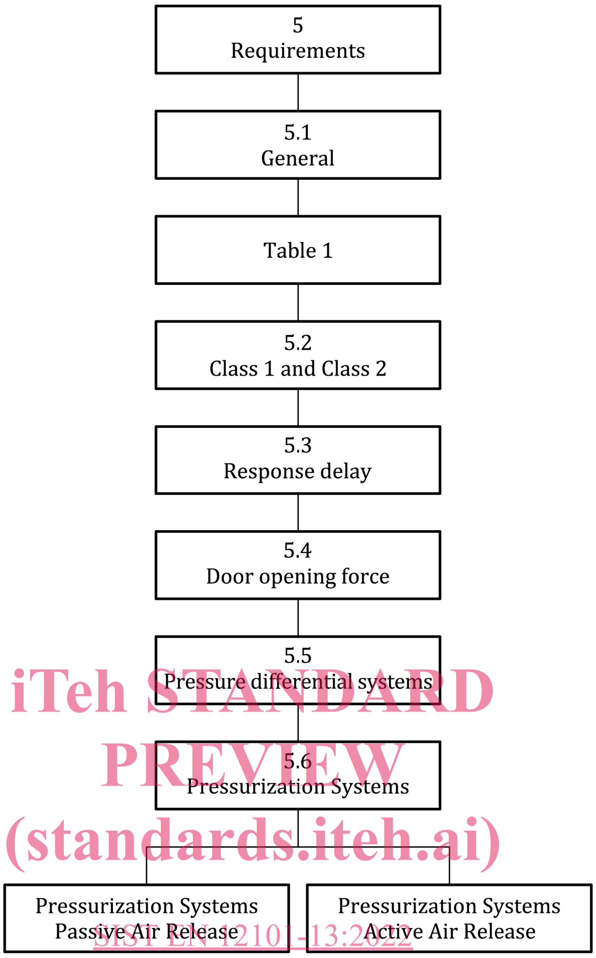


Figure 3 — Structure of the requirements depending on the system in use

5.5.2 PDS system types

5.5.2.1 General

Pressurization systems can be designed with passive (natural) or active (powered) air release;

NOTE See subclause 7.5 for component requirements.

5.5.2.2 Pressurization systems with passive air release

These systems have air supply fans which produce an overpressure within the protected space in reference to the unprotected space.

Air release is provided by means of controlled openings (e.g. natural vents to outside (in accordance with EN 12101-2), smoke control dampers (in accordance with EN 12101-8) to shafts).

Main feature of this system:

— controlled overpressure in the protected space (e.g. staircase).