Building & Industry
NOVENCO
SCHAKO Group

White Paper

NOVENCO® ClearChoice Pressure Differential Systems

for ultimate reliability and guaranteed smoke-free escape routes

1. Introduction

The NOVENCO ClearChoice Pressure Differential System (PDS) Kits are engineered to maintain smoke-free conditions within protected escape routes - safeguarding occupants, enabling efficient firefighting operations and supporting regulatory compliance. To guarantee the highest levels of operational integrity, the functionality and performance of our systems have been rigorously validated by the IFI Institute for Industrial Aerodynamics GmbH in Aachen, Germany.

Proven reliability through rigorous testing
Our comprehensive kit range was subjected to stringent testing procedures as defined by EN 12101-6:2022, focusing on three critical pillars: functionality, durability and reliability.

The tested configurations include:

- Active Supply & Active Exhaust: 4 specialised kits
- Active Supply & Passive Exhaust: 2 specialised kits.

Engineered for real-world deployment - beyond compliance requirements:

Space efficiency: Our configurable components are engineered with compact footprints to deliver maximum airflow and pressure control within the increasingly constrained technical spaces in buildings.

Modular architecture: Recognising that no two buildings are identical, our modular component system allows for seamless customisation and rapid integration, regardless of the project's complexity.

High-rise optimisation: To counteract stack effect, which can destabilise pressure balances in tall structures, our kits utilise dedicated dampers and precision controls to maintain a consistent safety barrier.

Ultra-fast response & door safety: Utilising a high-speed control logic, our systems react to pressure changes instantly. This not only maintains the smoke barrier but specifically prevents the "door slamming" effect. These response times have been empirically tested and recorded to ensure user safety during emergency egress.

2. New standards for pressure differential systems and kits

2.1 EN 12101-6:2022-11 and EN 12101-13:2022-11

Although the EN 12101-6:2005 remains mandated according to the European council, two new standards were published in 2022:

EN 12101-6:2022-11 defines differential pressure systems and their associated kits. It sets out detailed requirements for components, ensuring they meet defined performance and safety criteria and ensures that these components function reliably as part of an integrated system.

EN 12101-13:2022-11 covers the complete lifecycle of differential pressure systems, including planning, design, sizing, installation, commissioning, acceptance testing, routine functional testing and maintenance.

It provides clear procedures to ensure that systems operate effectively, comply with the applicable requirements and prevent smoke from spreading into protected areas. Together, these two standards form a comprehensive framework for the design, implementation and long-term operation of pressure differential systems.

CE Marking Note: EN 12101-6:2022-11 is not harmonised; systems defined therein cannot be CE marked. Compliance is demonstrated through a test certificate confirming the PDS kit(s) passed the EN 12101-6:2022-11 tests.
NOVENCO PDS kit test certificates are available on request.

EN 12101 and ISO 21927 Compliance							
EN 12101-2	EN 12101-3	EN 12101-6	EN 12101-7	EN 12101-8	EN 12101-9	EN 12101-10	EN 12101-13
✓	✓	✓	✓	✓	✓	✓	✓

2.2 The new EN12101-6: Integrated System Testing for Kit Validation

Part 6 introduces a structured testing procedure designed to verify the performance of kit assemblies under stringent laboratory operating conditions as described in the standard.
This method evaluates the kit as a fully integrated control system, ensuring that all components interact effectively to meet defined protection and performance objectives.

Depending on the features of the tested kit different configurations were tested.

The related components are connected to the test rig. All pressures, volume air flow rates and absorbed power of the fan are recorded during testing.

To pass the EN12101-6:2022-11 the system needs to perform the following tests in order:

- Initial functional test;
- Durability test (10.000 cycles);
- Second functional test;
- Ten subsets of oscillating tests.

Testing provides verified evidence of compatibility and functionality, delivering measurable assurance for stake holders, technical experts and end users, and forming a reliable basis for design validation, conformity assessment and quality assurance.

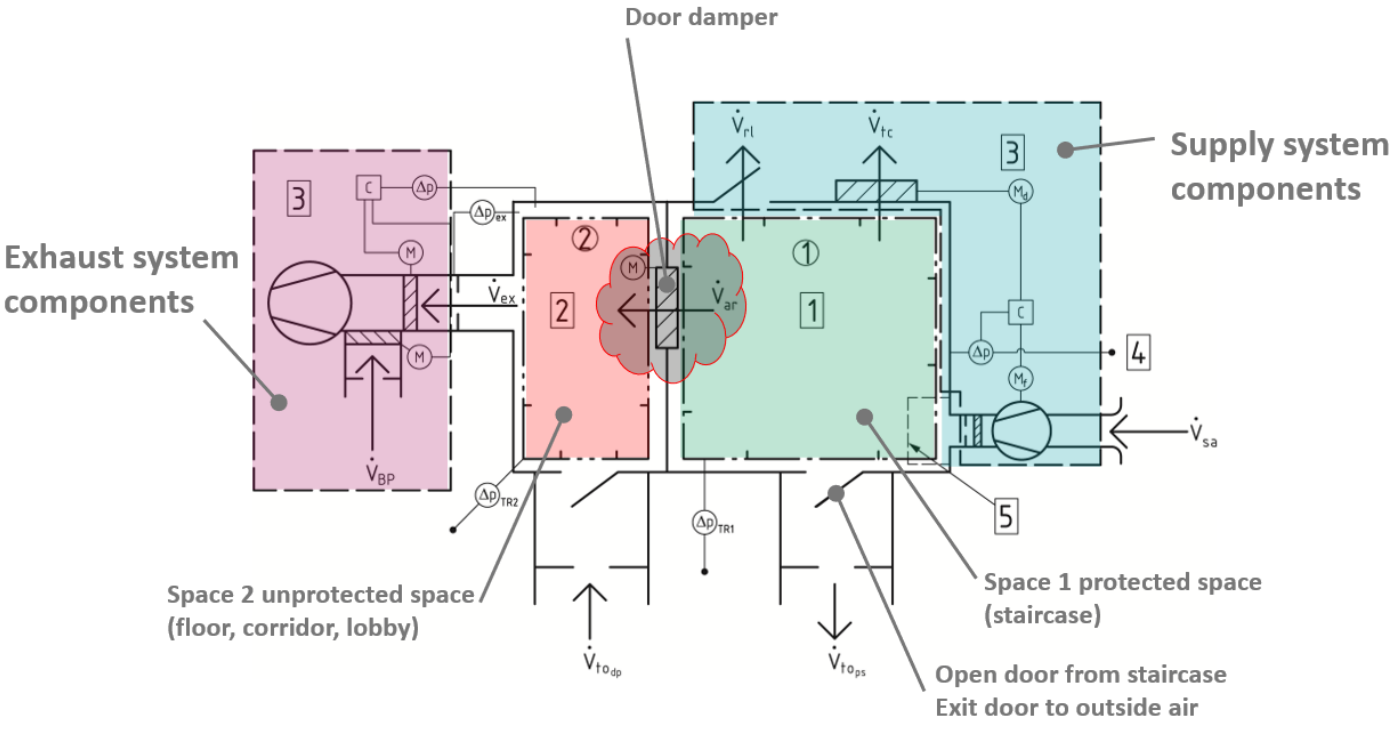


Figure 1 Schematic drawing of the test rig (pressurisation with powered air release)

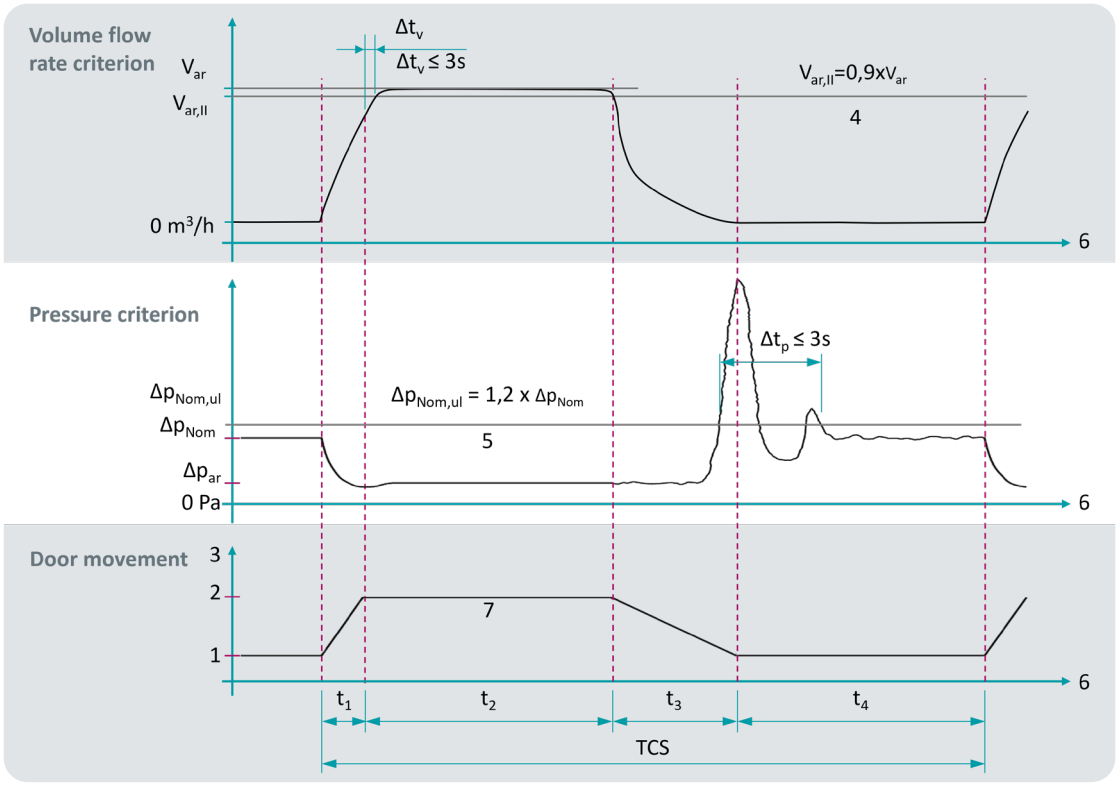
Functional test
The functional test consists of 20 cycles of opening and closing the door damper between room 1 and 2 in a predefined sequence as shown in Figure 2. The door starts in the closing position.

The functional test is successful when full 20 cycles meet the volume and pressure criteria.

The volume criterion is defined as 90% of the target volume flow is reached within 3 seconds after the door is in the fully open position.

The pressure criterion is defined as a the maximum period of 3 seconds where the pressure differential exceeds the nominal pressure +20%, as the door is closing.

Durability test and 2nd functional test
The kit needs to perform 10.000 uninterrupted cycles without malfunctioning. During the test cycles no values are measured. A subsequent functional test confirms continued compliance and highlights any deviation from initial performance.



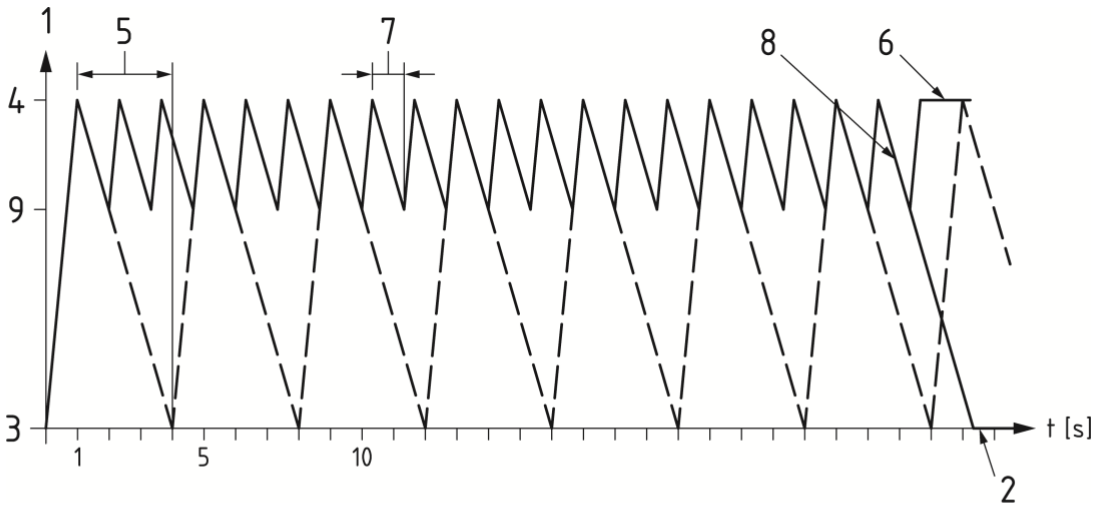
1. Door closed
2. Door open
3. Door angle
4. (Lower limit volume)
5. (Upper limit pressure)
6. Time
7. Door movement

Figure 2 Sequence of door movement for functional test

Oscillating test
Verifies the control system's ability to re-establish stable behavior during repeated door cycling - by opening and closing the door repeatedly without any waiting times as an oscillating cycle. This simulates a door which is passed by people on their escape with a small delay between each person, so that the door closes partly or in full.

The oscillating test consists of ten subtests (five airflow, five pressure), each running 20 oscillating cycles ending with a door open or closed to capture both criteria.

During the last cycle the performance of the volume airflow or pressure is recorded. For each subset the end position of the door angle is changed according to Table 1.



Key

1	angle of door opening (Y-axis)	6	door open test flow rate criterion
2	door closed test pressure criterion	7	part closing time t = 1 s
3	(door closed)	8	cycle 20
4	(door open)	9	60° (according to 1 s door closing time with even velocity for opening/closing to 3 s closing time)
5	closing time t = 3 s		

Figure 3 Example of Oscillating cycle with various part closing times

Door open	Door angle	Opening and closing time (s)
90°	60°	1,0
90°	45°	1,5
90°	30°	2,0
90°	15°	2,5
90°	0°	3,0

Table 1 Opening and closing times for varying subsets of oscillating tests

3. Introduction of the tested kits

The ClearChoice PDS kits are designed to accommodate use in a variety of building types, sizes and challenges, with an efficient, fast acting fan and controls designed to get the most out of the system within the smallest mechanical footprint.

3.1 Features and function of each performance class

Table 2 summarises the base function and performance class of each NOVENCO ClearChoice PDS kit.

Selection	Kit 1a	Kit 1b	Kit 2a	Kit 2b	Kit 3a	Kit 3b
How does exhaust takes place?						
Active exhaust	x	x	x	x		
Natural exhaust (not suitable for BH>60m)					x	x
What is building height?						
<60m	x	x			x	x
>60m [1]			x	x		
Where is purging required? [2]		x		x		
Additional components depending on project requirements	x	x	x	x	x	x
What class in accordance with EN 12101-13 is this system suitable for?						
Class 1 - for open area of door(s) on the fire floor up to:	5,5 m^2 (*5,5 m^2)				5 m^2 (*2,5 m^2)	
Class 2 - for open area of door(s) on the fire floor up to:	2,7 m^2 (*2,7 m^2)				2,5 m^2 (*N/A)	
*Suitable area when final exit route to the stair is open	Class 1 and 2				Class 1 only	

Table 2 Kit selection overview

[1] 60m limit is a guideline. Stack effect is depending on building height and summer/winter conditions which may vary per country. Above the 60m limit the stack effect becomes significant and extra measures are required to mitigate the effect.

[2] According national standards in some countries purging of the staircase is required.

Each active supply system and active air release system within the ClearChoice kits are managed through independent pressure control for their respective zone. This means that multiple adjacent supply and relief zones can be considered, allowing for the greatest scope in floor plan design.

3.1.1 Kit 1A & 1B

The NOVENCO Kit 1 (A&B) can be considered for buildings with total shaft heights of less than 60m, which are not significantly impacted by stack effect or wind conditions. This kit consists of active supply and air release systems, being:

- Active supply system (Zone 1, Figure 4 Overview of PDS kit 1A & 1B) consists of supply fan, pressure control damper and pressure sensor/control. Compared to kit 1A, kit 1B allows for a permanently open vent between the pressurised space and the exterior for purge ventilation throughout the operation of the PDS.
- Active air release system (Zone 2, Figure 4 Overview of PDS kit 1A & 1B) consists of smoke control fan, pressure control damper and pressure sensor/control.

Kit 1A & 1B are tested for Class 1 and Class 2, with the final exit door (d1, below) closed or open. The tested kit is applicable to door open areas between the supply Zone(s) 1 and relief Zone(s) 2 totalling 5.5m² for Class 1 systems and 2.7m² for Class 2 systems i.e. achieving 2m/s through a single door or 1m/s through two doors ~1.1mWx2.5mH.

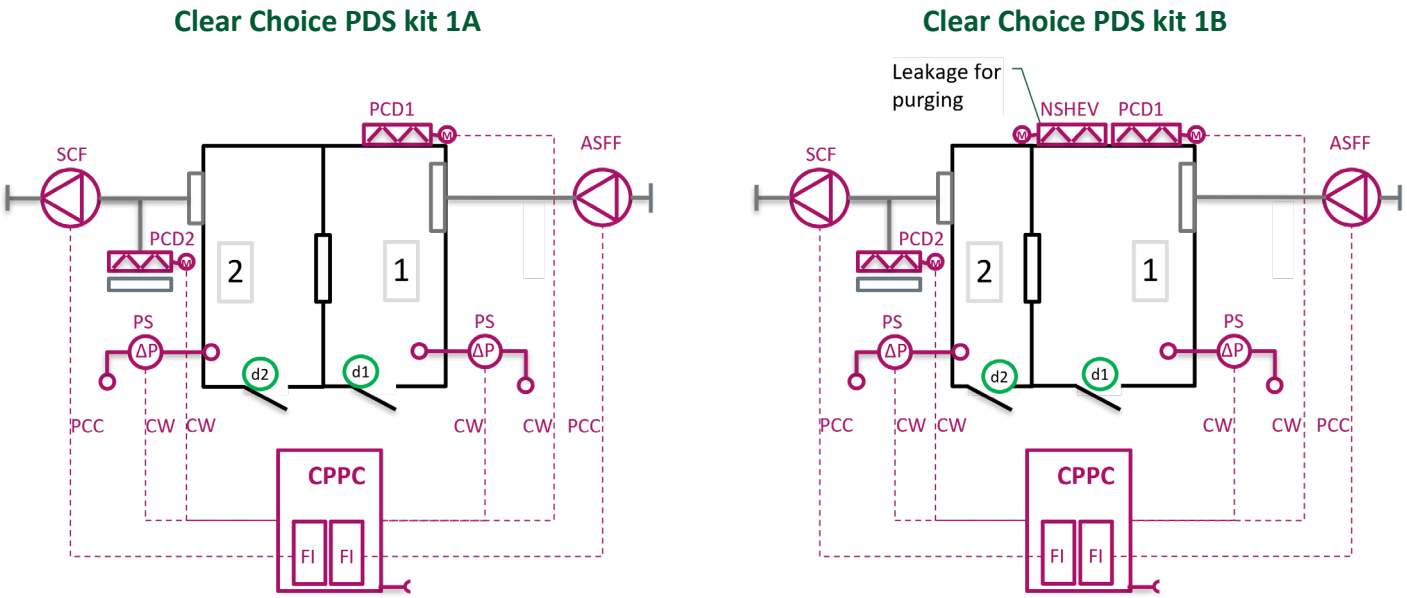


Figure 4 Overview of PDS kit 1A & 1B

Component	Description	Included	Function
ASFF	Supply fan	Yes	Positively pressurises protected zone
PCD-1	Pressure control damper (supply)	Yes	Relieves supply fan pressure to the exterior
NSHEV	Natural smoke and heat vent	B only	Provides purge ventilation of stairs
SCF	Smoke control fan	Yes	Provides air release and/or negative pressurisation of unprotected zone
PCD-2	Pressure control damper (relief)	Yes	Relieves exhaust fan pressure to the exterior
PCHGD	Pressure control hot gas damper	No	Acts as restriction between the relief fan and shaft to control pressures in the relief zone

Component	Description	Device	Description
PS	Pressure differential sensor	PCC / CW	Power / Control wire
CPPC	Control panel pressure control	FI	Frequency inverter

Key for Figure 4

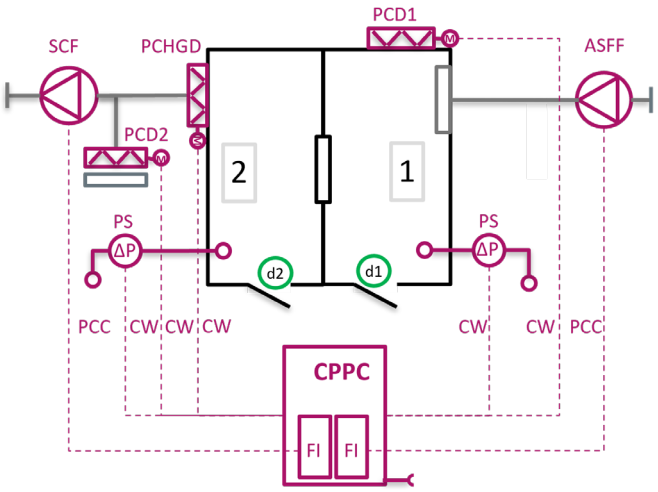
3.1.2 Kit 2A & 2B

The NOVENCO Kit 2 (A&B) can be considered for all buildings, but is targeted to buildings impacted by stack effect or wind conditions and buildings with total shaft heights of 60m or more. This kit is an extension of kit 1 with an additional hot gas damper consisting of:

- Active supply system (Zone 1, Figure 5 Overview of PDS kit 2A & 2B) consists of supply fan, pressure control damper and pressure sensor/ control. In addition to kit 1A, kit 1B allows for a permanently open vent between the pressurised space and the exterior for purge ventilation throughout the operation of the PDS.
- Active air release system (Zone 2, Figure 5 Overview of PDS kit 2A & 2B) consists of smoke control fan, pressure control damper and pressure sensor/ control. In addition, this kit includes a pressure control hot gas damper which acts to restrict the air release shaft for pressure control of the air release zone.

Kit 2A & 2B are tested for Class 1 and Class 2, with the final exit door (d1, below) closed or open. The tested kit is applicable to door open areas between the supply Zone(s) 1 and relief Zone(s) 2 totalling 5.5m² for Class 1 systems and 2.7m² for Class 2 systems i.e. achieving 2m/s through a single door or 1m/s through two doors ~1.1mWx2.5mH.

Clear Choice PDS kit 2A



Clear Choice PDS kit 2B

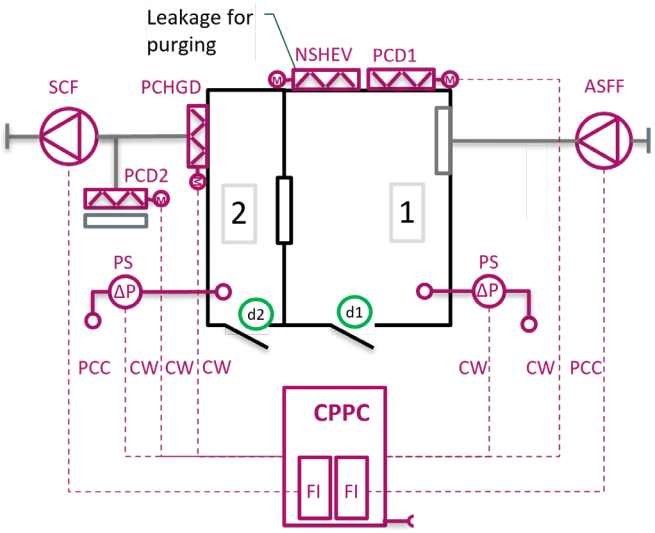


Figure 5 Overview of PDS kit 2A & 2B

Component	Description	Included	Function
ASFF	Supply fan	Yes	Positively pressurises protected zone
PCD-1	Pressure control damper (supply)	Yes	Relieves supply fan pressure to the exterior
NSHEV	Natural smoke and heat vent	B only	Provides purge ventilation of stairs
SCF	Smoke control fan	Yes	Provides air release and/or negative pressurisation of unprotected zone
PCD-2	Pressure control damper (relief)	Yes	Relieves exhaust fan pressure to the exterior
PCHGD	Pressure control hot gas damper	Yes	Acts as restriction between the relief fan and shaft to control pressures in the relief zone

Component	Description	Device	Description
PS	Pressure differential sensor	PCC / CW	Power / Control wire
CPPC	Control panel pressure control	FI	Frequency inverter

Key for Figure 5

3.1.3 Kit 3A & 3B

The NOVENCO Kit 3 (A&B) can be considered for buildings with total shaft heights of less than 60m, which are not significantly impacted by stack effect or wind conditions. The primary target buildings for this kit being passive air release vents or shafts are suitable i.e. low-rise buildings with open floorplans and/ or suitably large air release shafts. This kit consists of active supply systems and passive air release, being:

- Supply system (Zone 1, Figure 6 Overview of PDS kit 3A & 3B) consists of supply fan, pressure control damper and pressure sensor/ control. In addition to kit 3A, kit 3B allows for a permanently open vent between the pressurised space and the exterior for purge ventilation throughout the operation of the PDS.
- Passive air release (Zone 2, Figure 6 Overview of PDS kit 3A & 3B), with an air release path designed to limit pressure loss from the air release zone to exterior to less than the design pressure (nominally 30 Pa) – passive air release paths with pressure losses of less than 15 Pa are recommended for a 30 Pa design pressure.

Kit 3A & 3B are tested for Class 1 and Class 2, with the final exit door (d1, below) closed or open. The tested kit is applicable to door open areas between the supply Zone(s) 1 and relief Zone(s) 2 totalling 5.0m² for Class 1 systems and 2.5m² for Class 2 systems i.e. achieving 2m/s through a single door or 1m/s through two doors ~1.0mWx2.5mH, or 1m/s through one door when the final exit door is open.

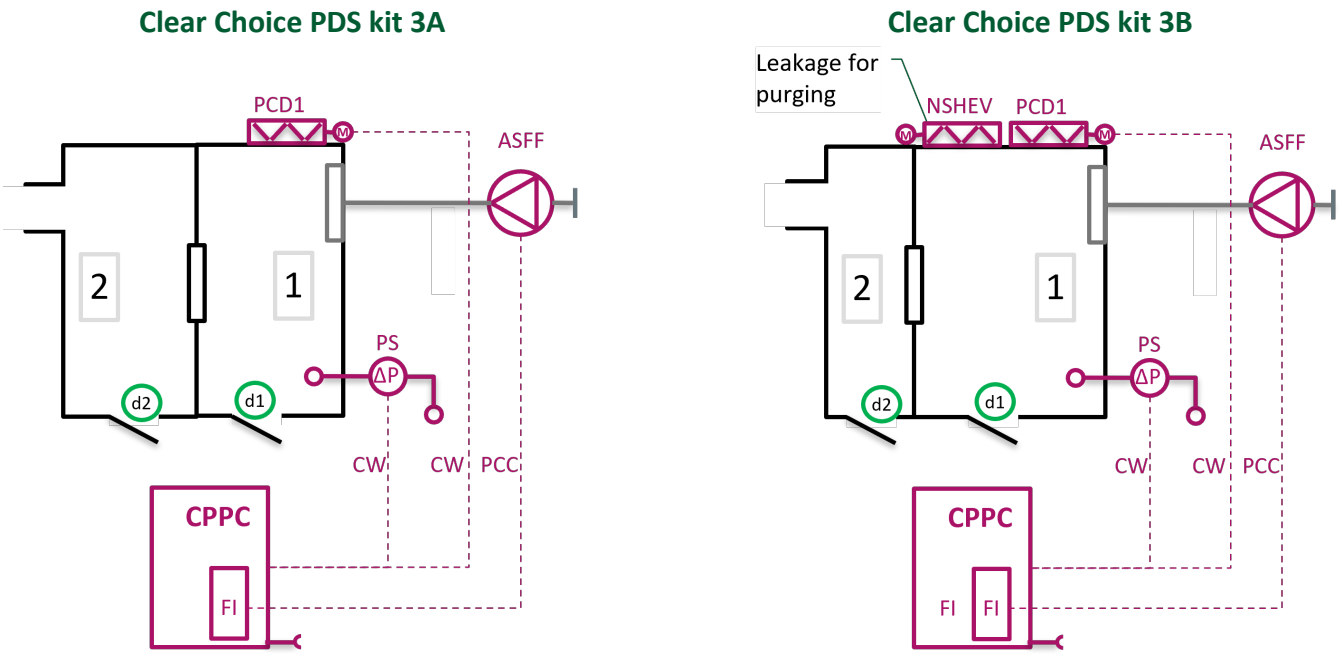


Figure 6 Overview of PDS kit 3A & 3B

Component	Description	Included	Function
ASFF	Supply fan	Yes	Positively pressurises protected zone
PCD-1	Pressure control damper (supply)	Yes	Relieves supply fan pressure to the exterior
NSHEV	Natural smoke and heat vent	B only	Provides purge ventilation of stairs
SCF	Smoke control fan	No	Provides air release and/or negative pressurisation of unprotected zone
PCD-2	Pressure control damper (relief)	No	Relieves exhaust fan pressure to the exterior
PCHGD	Pressure control hot gas damper	No	Acts as restriction between the relief fan and shaft to control pressures in the relief zone

Component	Description	Device	Description
PS	Pressure differential sensor	PCC / CW	Power / Control wire
CPPC	Control panel pressure control	FI	Frequency inverter

Key for Figure 6

3.2. Overview of the components included in the kits

Each kit uses NOVENCO ClearChoice inverter-driven supply and relief fans, pressure control dampers and sensors integrated with NOVENCO's fast-acting PDS control system to maintain precise pressure. This setup achieves reaction times under the 3-second test requirement across various scenarios. Table 3 provides an overview of the configuration of each kit.

Overview of main features	Kit 1a	Kit 1b	Kit 2a	Kit 2b	Kit 3a	Kit 3b
Mechanical Supply VFD control + Pressure control damper (PCD)	Yes	Yes	Yes	Yes	Yes	Yes
Mechanical Exhaust VFD control + Pressure control damper (PCD)	Yes	Yes	Yes	Yes		
Natural smoke and heat vent (NSHEV)		Yes		Yes		Yes
Pressure control hot gas damper (PCHGD)			Yes	Yes		

Table 3 Overview configuration of each kit

3.3 Definition of product families

Under EN 12101-6:2022-11, section 5.1.2 allows the creation of product “families”. A family includes different sizes of the same tested kit type. Any product that comes from the same kit family and meets or exceeds the tested fan conditions can be used in accordance with EN 12101-6:2022-11. This way it is possible to scale the kit components to other air volumes if required.

The results of the tested kits are summarised in a performance class.

Ratio parameters for family building according to EN 12101-6:2022-11 annex A4.4.1
Nominal motor power / inertia moment
Nominal motor power / shaft power
Nominal power of FI / nominal motor power
Nominal power of brake resistor / nominal power of FI

Table 4 Ration parameters

3.4 Significance of the classification

Transparency and compliance:
Each kit classification demonstrates full conformity with EN 12101-6 requirements, ensuring that all components meet standardised performance criteria for airflow, pressure control and system integrity. This compliance offers building owners verified assurance of tested safety and regulatory reliability.

Targeted selection and risk management:
Classification according to EN 12101-6 enables precise selection of suitable kits for specific pressure classes and operational scenarios. This supports robust risk assessment and consistent performance across varied building types and usage conditions.

Efficient planning and implementation:
Clear classification simplifies design and integration with other fire-safety measures, reducing installation risk and streamlining commissioning.

Long-term value:
Proven life-safety performance, lower maintenance costs and enhanced building resilience and operational continuity.

4. Example of use in building

The PDS kit is the heart of the control system and includes all components and devices that are responsible for maintaining the pressure difference between the protected and unprotected space.

As described in 3.2 which kit to select depends on:

1. Type of exhaust
2. Building height
3. Purging requirement

For example, for a building with active exhaust, under 60 meters in height and no purging requirements, PDS kit 1A is appropriate.
To complement the PDS kit additional components may be added in accordance with EN 12101-13:2022-11 as shown in Figure 7.

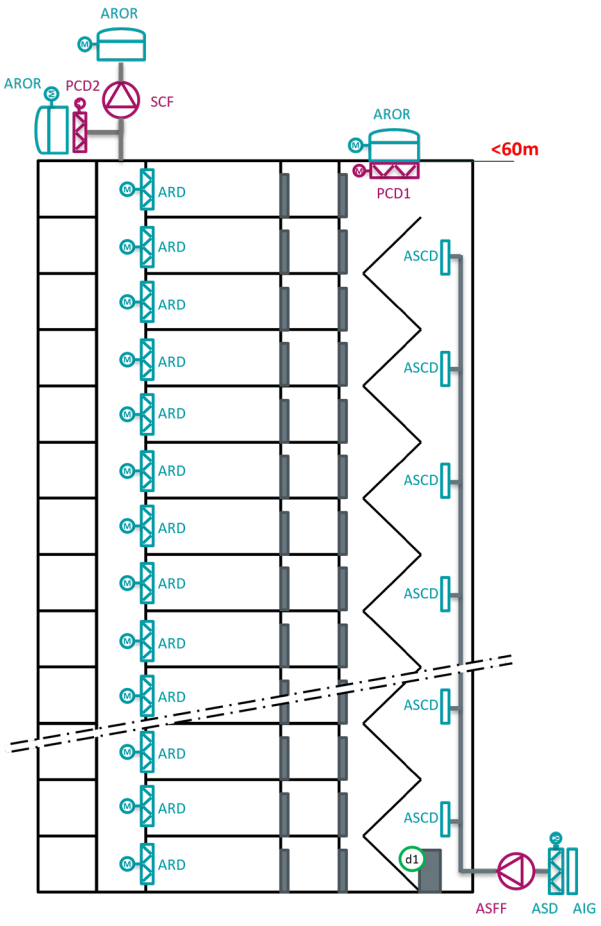


Figure 7 Principal scheme for use of PDS kit 1A

Component	Description	Part of PDS kit
ASFF	Supply fan	Yes
PCD	Pressure control damper	Yes
SCF	Smoke control fan	Yes
Controls	Control Panel, Pressure Sensor, Frequency Inverter	Yes
AROR	Air release opening roof (as required for project)	
ASD	Air supply damper	
ARD	Air release damper (smoke control damper EN 12101-8)	
ASCD	Air supply control damper (as required for project)	
AIG	Air Intake Grille	

Abbreviations used according to EN 12101-13:2022-11

5. Certification of components

Element	Description	CE certificate	Test certificate as part of EN 12101-6	Additional test certificate
ASFF	Supply fan Novax ACN		Yes	
PCD	Pressure control damper (Supply)		Yes	
NSHEV	Natural smoke and heat vent	EN 12101-2	Yes	
SCF	Smoke control fan Novax ACN	EN 12101-3	Yes	EN 12101-6:2022-11 Annex-C [3] 300°C/2h
PCHGD	Pressure control hot gas damper		Yes	EN 12101-6:2022-11 Annex-B B300 /2h
Controls	Control panel, Frequency inverter, Brake resistor, pressure differential sensor		Yes	

Table 5 Overview of available certificates for kit components regarding EN 12101 series

Annex C of EN 12101-6:2022-11 outlines the testing procedures for variable-speed exhaust fans operating under elevated temperature conditions. It extends the requirements of EN 12101-3 by evaluating how these fans perform when exposed to higher temperatures and alternating speeds. The use of variable-speed testing replicates realistic building scenarios, where occupant movement and the opening or closing of doors influence airflow and pressure dynamics.

Annex B of EN 12101-6:2022-11 describes the test method of the pressure control hot gas damper (PCHGD) at elevated temperature. Before the high temperature test is started the PCHGD is tested for leakage under ambient conditions. Also, the opening and closing time of the PCHGD is recorded under ambient conditions.

During the high temperature test the position of the blades are cycled every minute between fully open and fully closed; post-test open/close times must not differ by more than 20% from ambient values.

[3] The smoke fan was tested for high temperature in accordance with EN 12101-3 after a successful functional tests, durability test of at least 10,000 cycles and oscillating tests in accordance with the EN 12101-6 testing.

5. 1 Additional door slammer test

Going beyond regulatory compliance, NOVENCO partnered with IFI Aachen to conduct additional testing, demonstrating the superior performance of our PDS kits in preventing door slamming during operation.

For this purpose, a normal swing door with dimensions of 2x1 m (HxW) was installed with a door closer. Measurement devices where added to record the air velocity over the door opening, the door angle and the relative door closing speed.

The test was performed with PDS kit 1A and 2A. These kits are considered to be worst case because no permanent opening for purging is present in the test room.

Two door closers were tested; and it was proven that with the right selection and settings of the door closer the PDS kits 1A and 2A are fast enough to respond on the closing door to prevent the door slamming.

It should be noted that in real-world buildings, the effectiveness of preventing door slamming is subject to building design and national regulations (in regard to door size and opening force).

6. Conclusion

EN 12101-6:2022-11 establishes a robust foundation for next-generation pressurisation system kits.

NOVENCO ClearChoice PDS kits, designed with compact, flexible components, deliver fast-acting pressure control and advanced safety features such as door-slamming prevention.

By successfully passing the latest tests, NOVENCO once again demonstrates its commitment to excellence, innovation and safety. Our systems deliver reliable performance even in the most critical situations - protecting lives, preserving property and ensuring peace of mind when it matters most.

NOVENCO ClearChoice PDS Kits stand out
In summary, ClearChoice PDS Kits deliver safety, fast response and reliability where it matters most:

- Safe, smoke-free escape routes during evacuation
- Ultra fast system response may prevent door slamming
- Compact modular solutions for any building design
- Optimised performance in high-rise buildings can mitigate stack effect
- Reliability proven beyond standard requirements

ClearChoice PDS Kits are designed to ensure that escape routes remain free of smoke by maintaining a stable and controlled pressure differential during a fire. This is essential for protecting occupants and meeting strict fire safety regulations.

Thanks to advanced control logic, the system responds within seconds to pressure changes, which can prevent issues such as door slamming and supporting evacuation and fire fighting operations.

The compact, modular design makes ClearChoice ideal for buildings with limited space or complex layouts, allowing seamless integration without compromising performance.

For high-rise buildings, the system is specifically engineered to mitigate stack effect, ensuring consistent and dependable operation regardless of building height or seasonal conditions.

Finally, ClearChoice PDS Kits are tested beyond standard requirements - including additional door-slammer tests - to provide proven reliability and confidence that the system will perform when it is needed most.

Advantages for building owners and operators

In short, ClearChoice PDS Kits help building owners and operators achieve confidence, efficiency and long-term value:

- Regulatory confidence through full EN 12101 compliance
- Reduced installation and commissioning risk
- Lower lifecycle costs and maintenance needs
- Enhanced safety reputation with building owners, tenants and authorities
- Flexible, future-ready scalability

ClearChoice PDS Kits provide building owners and operators with peace of mind by fully complying with EN 12101 6 and EN 12101 13 standards, making approvals simpler and regulatory checks smoother.

The modular design and clear classification reduce installation risk, streamline planning, and simplify commissioning, saving time and effort on site.

Durable components and proven system reliability lower maintenance needs and extend the overall lifespan, helping to reduce lifecycle costs.

By demonstrating a strong commitment to occupant safety, owners enhance their building's reputation with, tenants, visitors, and regulatory bodies alike.

Finally, the product family concept allows for easy adaptation to different building sizes and airflow requirements, ensuring future scalability without compromising compliance or performance.

About NOVENCO

Since 1947, NOVENCO Building & Industry has been a global leader in high-performance air solutions. Its Life Safety Systems division specializes in Mechanical Smoke Ventilation Systems (MSVS) designed to protect lives and infrastructure by ensuring clear escape routes and heat removal during fire emergencies.

Commitment to International Standards

NOVENCO products are engineered for extreme reliability and carry comprehensive certifications to ensure global compliance:

- EN 12101-3 Certified: Smoke extract fans, including the high-efficiency ZerAx® and NovAx™ series, are tested and certified for high-temperature operation in classes F200, F300 and F400.
- System Integration: NOVENCO is a pioneer in certifying the complete drive package-ensuring fans and Frequency Converters (VSDs) function together seamlessly at high temperatures without emergency bypasses.
- Pressure Differential Systems: Solutions for stairwell and shaft protection comply with EN 12101-6 and EN 12101-13, providing precise air pressure control in escape routes.
- Quality & Sustainability: All systems are manufactured under ISO 9001, 14001 and 45001 standards, balancing critical safety with energy efficiency for LEED and BREEAM-certified buildings.

Through rigorous testing and international accreditation, NOVENCO provides guaranteed performance where safety is non-negotiable.

info@novenco-building.com

+45 70 77 88 99

novenco-building.com

MU 16373 0126