

Design Note No. DMS-DN01

Project Basement Stair Lobby Ventilation



Subject Application of PPV for Basement Stair Lobby Ventilation

Date 03 Feb 2021

1.0 DOCUMENT CONTROL

Issue	Date	Description	Author	Reviewed
0	14/11/16	Design note issue	HB	DS
A	03/02/21	Design Note Updated	GS	HB

2.0 INTRODUCTION

The purpose of this Design Note is to document the application of the PPV Concept within residential developments and how it can be utilised as part of a Building Regulations Application.

This note also outlines the requirements and considerations which should be applied in the application of a PPV unit.

Prior to ordering or installing a PPV Unit, the PPV concept should be agreed with the design team and signed off by the Approving Authorities.

3.0 GUIDANCE DOCUMENTS

Schedule 1 of the Building Regulations identifies the legal requirement to be met in the design and construction of buildings.

The Approved Document B (ADB) issued by the Secretary of State provides practical guidance to meet the above Schedule and where followed, allows compliance with the Building Regulations. The Approved Document makes references to other guidance documents where further guidance can be followed.

In the case of smoke ventilation principles to the basement stair lobby, this is covered in Approved Document B (ADB) V1 2019., Section 3.75. The guidance is in B1 for means of escape and is not intended for fire fighting operations nor post-fire smoke clearance. The section identifies natural ventilation or mechanical smoke control as the two possible design provisions to achieve lobby ventilation as shown in Figure 1 below.

3.75 Where a stair serves an enclosed car park or **place of special fire hazard**, the lobby or corridor should have a minimum 0.4m² of permanent ventilation or be protected from the ingress of smoke by a mechanical smoke control system.

Figure 1 - (ADB) Extract

The Construction and Approval Bodies identified there was little guidance on meeting mechanical smoke control systems. The Smoke Control Association (SCA), through HVAC set up a working group to develop guidance along with other acceptable solutions.

The SCA Guidance document on Residential Buildings – 2015 identifies the two possible methods to meeting the above mechanical smoke control requirement (positive or negative pressurisation) as shown in Figure 2 below. This SCA guide is a referenced document for smoke control systems design within the British Standards BS9991:2015.

7.6 Ventilation of lobbies to ancillary accommodation

The prescriptive codes recommend for means of escape that ancillary accommodation (e.g. car park or places of special fire hazard) is separated from the staircase by means of a natural ventilated lobby (e.g. where ADB recommends for a small single staircase building a 0.4 m² vent). This is normally achieved by a fire rated plenum linking the lobby to the outside of the building allowing any smoke in the lobby to be ventilated.

The natural ventilation cannot always be achieved. An alternative approach may be to use one of the following mechanical ventilation systems.

- 1) Mechanical extraction from the lobby at a rate equivalent to the natural vent and a pressure not exceeding 20 Pa across the lobby doors. The fan discharge should be ducted to the outside.
- 2) Positive pressurisation of the lobby above the surrounding space.

In developing the above system, the replacement air should be taken from the sterile area ensuring smoke is not actively drawn into the lobby. This could be from the staircase or riser and where dedicated active openings are provided, they should be controlled by a local smoke detector.

Duty and standby fans should be provided to ensure the system operates in the event of component failure.

All testing during commissioning should be carried out with the doors closed.

Figure 2 - Smoke Control to Common Escape Routes in Apartment Buildings

As can be seen from the above, option 2) allows the lobby space to be pressurised to a higher pressure than the surrounding space when the doors are closed. Replacement air is to be taken from the stair or risers. Onward leakage is required from the risk area so the pressure difference can be maintained. Further guidance in the BSEN12101:Part 6 suggests a pressure difference of 50pa for a closed door condition which has become the industrial standard.

This SCA document was prepared by a working Committee from Approving Authorities, Fire Services, Fire Consultants and Manufacturers, similar to British Standard's so a workable solution could be developed that met the requirements of all interested parties. During the drafting stage, the document was circulated to external Fire Services, Building Control & Approved Inspector representative bodies who commented on the draft which was then incorporated within the final document. This process, as with any standard, is intended to allow the concepts to become acceptable and allow easy approval where the guidance is followed.

The Committee who prepared the SCA document were made up of representatives from a cross spectrum of the industry as identified in Figure 3 below. This Code has now become a recognised standard in the design of smoke control systems.

Acknowledgements	
Contributions to this guide are gratefully acknowledged from the following people:	
Conor Logan	Colt International Ltd
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Figure 3 – Contributors to the SCA Guidance Documents

The SCA guidance document has gone through revisions with the current 2020 Rev 03 edition providing the same guidance.

4.0 CONCEPT OF POSITIVE PRESSURISATION VENTILATION

As discussed above, PPV involves pressurising the basement lobby to a higher pressure to the car park or places of special fire hazard. The inlet air needs to come from the sterile stair side of the lobby with door leakage into the car park or special fire hazard. This is achieved by locating a PPV unit on the stair wall side which would inject the air into the lobby raising the space to a higher pressure with onward leakage of air into the car park or place of special fire hazard as shown in Figure 4 below. Leakage is required from the risk space such as the car park or stores to the external to ensure the pressure difference is maintained. In order to ensure the pressurised air is kept in the protected lobby, it is always recommended the doors open into the protected pressurised lobby ensuring they remain closed when the PPV unit is running as shown below.

The general principals of pressurisation are outlined in BS EN 12101: Part 6, although basement stair lobbies with closed door requirements only are not addressed in this document. To meet the means of escape requirements of ADB for the closed door condition, the basement lobby would need to be raised to 50pa above that of the car park or places of special fire hazard with the door closed. This 50pa across a closed door has become an acceptable industrial standard and will be utilised with the PPV concept.

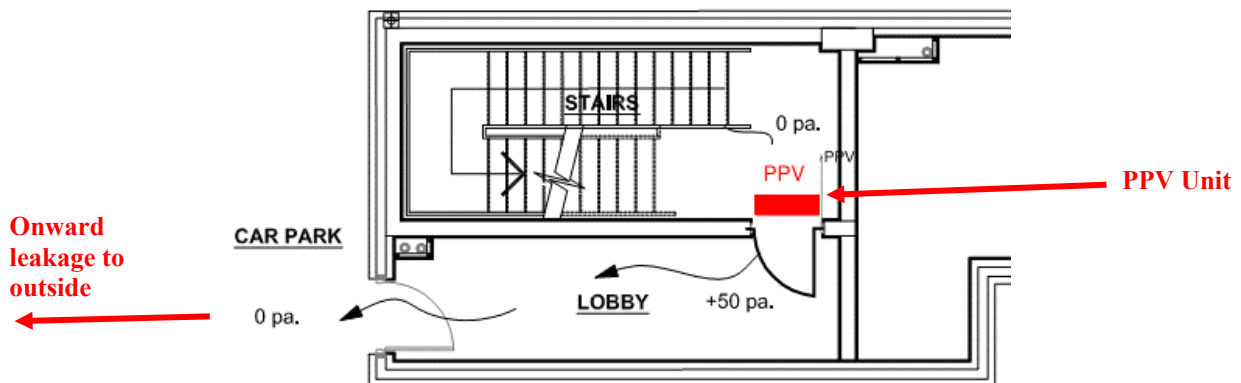


Figure 4 – Lobby Pressurisation Concept

The unit incorporates duty and standby fans, duty and standby fire dampers, fire detector interface, single phase automatic electrical change over switch, controls, status LED and a volt free contact for 3rd party monitoring duty conditions. All the above is located within the decorative PPV enclosure box.

The PPV concept involves a fire detector located in the car park/place of special fire hazard outside the lobby door. On detection of fire in the car park/place of special fire hazard side of the lobby door, the duty fire damper and duty fan operate to achieve 50pa across the closed lobby/car park door. On duty fan failing, the duty fire damper will close, and the standby fan and standby damper will open to maintain the 50pa across the closed lobby/car park door.

On duty power failure, the unit will switch over to the standby power supply. In the unlikely event of standby power or standby fan failure, the fire damper will close. returning the lobby compartmentation.

All the components are duplicated thus the PPV system is considered to be a 'Life Safety' system. The system incorporates no complicated electronics or inverters.

The PPV unit is a fixed volume system which is commissioned with all the doors closed to achieve 50pa across the closed door between the lobby and car park/storerooms depending on application. This involves setting the fan to the necessary fan speed at which the system will then run, following activation of the fire detection system.

The system will continue to run until the fire detector is reset.

5.0 SYSTEM CAPABILITY

The Daisy PPV unit incorporate one small duty and one standby supply low temperature fan housed within the enclosure. Each of the fans is capable of delivering 0.5m³/s at an operating pressure of 50pa. This will provide a pressure difference of 50 pa across a total leakage area of 0.08m² assuming an airtight fire compartment.

It is critical the Client is advised of the importance of an **airtight compartment** with the only leakage through the access fire doors. The pressure difference will not be achieved from a leaky enclosure as the fan is developing a volume to overcome the leakage across a British Standard fitted fire door.

Table 1 below shows the typical leakage areas for British Standard tested and fitted fire and lift doors and is an extract from BS EN 12101: Part 6 (Table A.3).

Element	Leakage area (m ²)	Volume to achieve 50pa (m ³ /s)
PPV unit capability	0.08	0.500
Single leaf door in rebated frame opening into a pressurised space (2m high, 0.8m wide)	0.01	0.060
Single leaf door in rebated frame opening outwards from a pressurised space (2m high, 0.8m wide)	0.02	0.120
Double leaf door (2m high, 1.6m wide)	0.03	0.180
Lift landing doors (2m high, 1.6m wide)	0.06	0.350

Table 1 – Leakage Areas for BS Doors

When all the doors opening onto the pressurised lobby are added together, the leakage area cannot exceed 0.08m².

In addition to the above the swing of the door also needs to be considered. Where the fire door opens into the pressurised space, the doorstops will prevent the door being pushed out as the pressure builds up. This is the recommended door swing.

On lobbies with the doors opening out of the space, door closures of a heavy duty may be required to keep the door closed against the pressures. These needs to be considered by the Design Team and Approving Authorities. Door closer can only be selected after the PPV unit is commissioned.

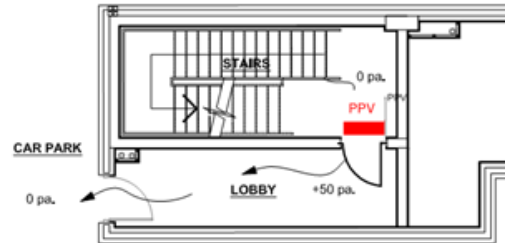
The following section looks at the leakage due to fire doors both for circulation and lifts.

Case 1

PPV unit fitted on stair wall side of stair/lobby door injecting air from the stair into the lobby to raise the lobby to 50pa above the surrounding spaces.

Two single fire doors ($0.01\text{m}^2 + 0.01\text{m}^2$) =
0.02m² leakage area

Pressurised lobby acceptable as less than 0.08m² leakage from lobby



Case 2

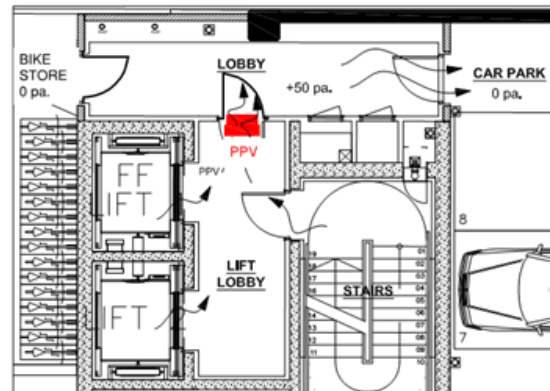
PPV unit fitted on lift lobby side of lift lobby/lobby door injecting air from the lift lobby into the lobby to raise the lobby to 50pa above the surrounding spaces. This includes the car park and the bin store.

Three single fire doors ($0.01\text{m}^2 \times 3$) =
0.03m² leakage area

The two small cupboards to right of lift lobby/lobby door are horizontally fire stopped at ground level, thus no leakage.

The bin store needs to have onward leakage to the outside to avoid the store reaching equal pressure to lobby.

Pressurised lobby acceptable as less than 0.08m² leakage from lobby



Case 3

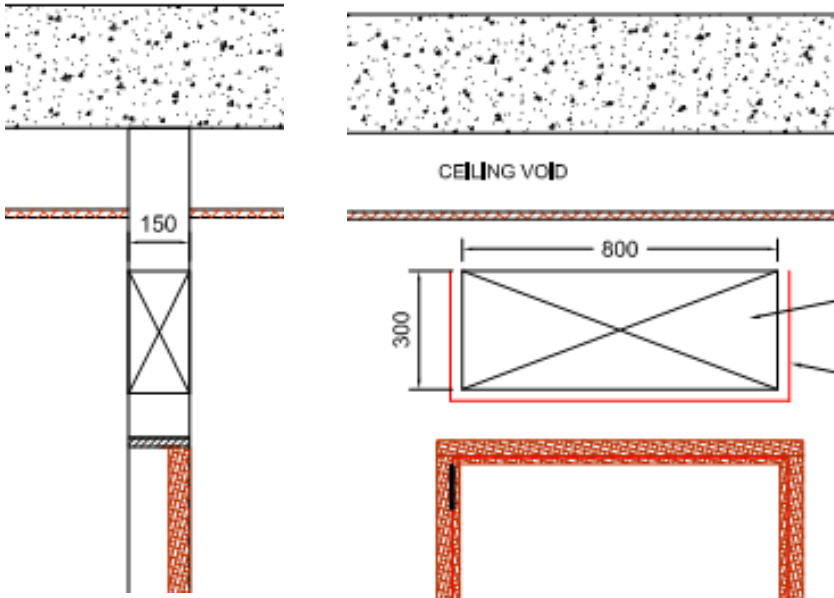
If we look at Case 2 but try to pressurise the lift lobby, we will have 2 lift doors and one single door to consider in the leakage calculation. This would be as follows:

Two lift doors ($0.06\text{m}^2 \times 2$) + lobby door (0.02m^2)
0.14m² leakage area

Pressurised lift lobby would not be acceptable as leakage area exceeds 0.08m² leakage from the lift lobby. This demonstrates why we cannot have a lift within the pressurised lobby.

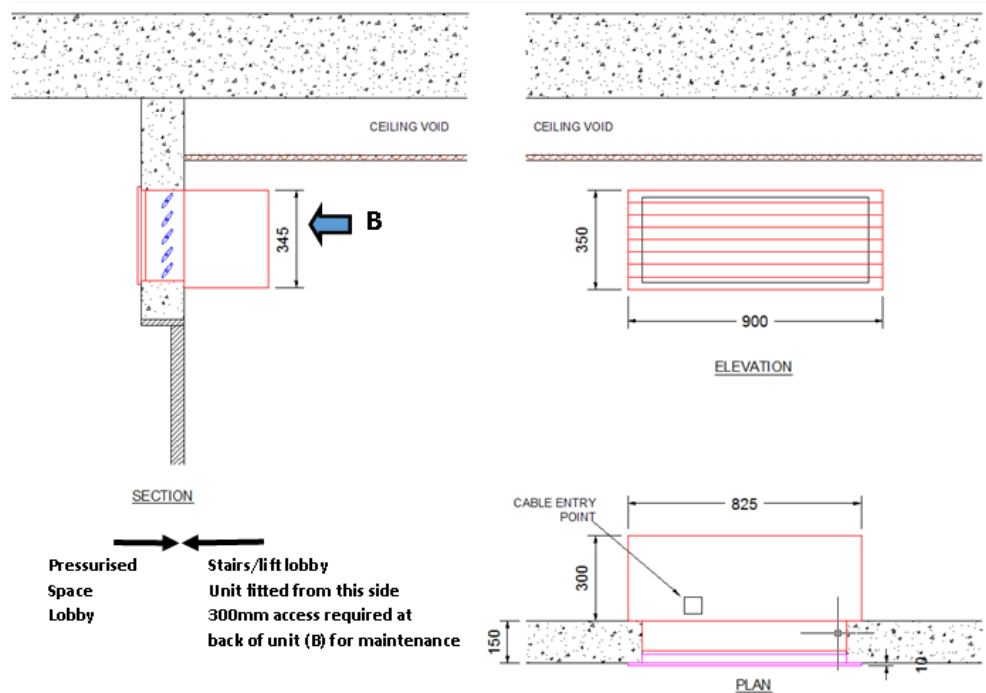
6.0 INSTALLATION

The PPV unit slides into a structural compartment wall opening 800mm x 300mm as shown below. The opening can be in the horizontal or vertical orientation.



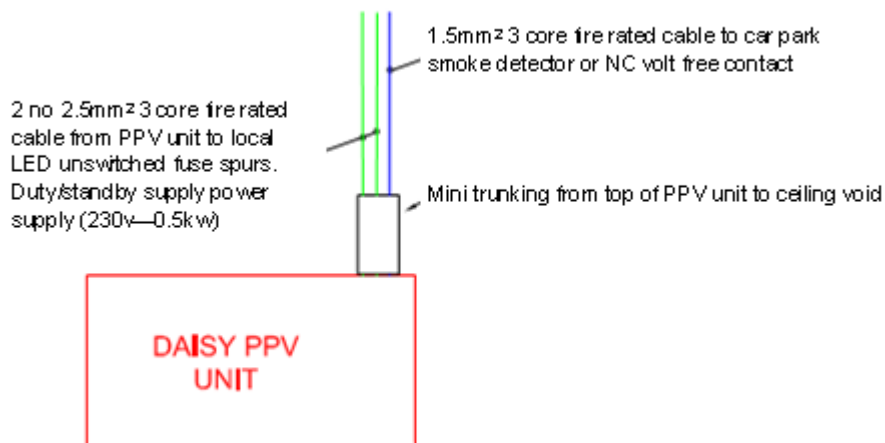
800mm x 300mm airtight structural opening with solid infills on the vertical sides to support the PPV fixing weight of 47kg.
Clear 60mm zone around hole on 3 sides

The PPV unit slides into the structural opening from the sterile side with the PPV fire damper sitting in the structural opening to provide the necessary compartmentation. The PPV dimensions are shown below.



Access is required to the back of the unit at position 'B'. This is where commissioning and maintenance is carried out.

The diagram below shows the cable requirements to the PPV unit.



PPV WIRING REQUIREMENTS

7.0 IMPORTANT CONSIDERATIONS

- 1) Pressurised lobby enclosure needs to be of airtight construction with the only leakage between circulation doors and the frames. No other leakage paths are allowed from the pressurised lobby.
- 2) The PPV unit should be positioned on the non-risk wall side of the pressurised space as shown in Figure 4 so the sterile clean air is injected into the pressurised space. This will also protect the PPV unit from the hot gases impinging on the PPV casing.
- 3) Sufficient makeup air should be available to the PPV unit fan inlet.
- 4) To allow the pressure difference to be maintained, it is necessary to have leakage from the risk area outside the pressurised space to outside the building. In the case of car parks, this is normally achieved by the car ramp or ventilation. In the case of stores, dedicated natural ventilation should be provided.
- 5) The PPV unit can be positioned in the vertical or horizontal position.
- 6) Lift doors should be avoided in the pressurised lobby as they create a large leakage area. It is our recommendation not to pressurise a lobby containing a lift door.
- 7) Fire doors should be fitted to the British Standard tested criteria.
- 8) Leakage consideration should be made to all fire doors, lift doors, cupboard doors and any openings within the pressurised lobby.
- 9) Vertical riser compartments should be made airtight at floor and ceiling level.
- 10) The leakage area across all openings should not exceed 0.08m².
- 11) Double doors add an additional 50% leakage area.
- 12) Where any ventilation grills are provided, they will need to be of an airtight standard during fire mode.
- 13) We recommend doors should open into the pressurised space to ensure they remain closed when the PPV unit is running. Where the Client chooses not to follow this recommendation, they need to discuss implications with the design team and Approval Authorities.
- 14) We recommend the power supplies are monitored by 3rd party controls which will allow power supply failure to be identified.
- 15) Prior to ordering or installing a PPV Unit, the PPV concept should be agreed and signed off by the Approving Authorities.

8.0 DOCUMENTATION

Further documentation of the concept is provided by a 3rd party Fire Consultancy, in their report titled 'Positive Pressurisation Ventilation Review, Generic Application to Stair Lobbies & Place of Special Fire Hazard'. This includes documentation on the research carried out.

Information on the Installation & maintenance is provided in the document titled 'Daisy PPV Unit, Installation & Maintenance Manual'.

9.0 CONCLUSION

Approved Document B identifies natural ventilation or mechanical smoke control as the two possible solutions to protect basement stair lobbies.

The Smoke Control Association Guidance document on Residential Buildings – 2015 identifies pressurisation of the basement stair lobbies with the doors closed as a method to meeting the above mechanical smoke control requirement.

The SCA Guide is an accepted document for the design of smoke control systems and is referenced in the British Standard BS9991:2015.

The Organisations identified in Figure 3, along with consultation with other Approval Organisations produced the SCA guidance document which is intended to allow designs of systems to be approved as they have followed the simple guidance.

The PPV unit develops a 50pa pressure difference across a closed door which is intended to prevent smoke entering the protected lobby in accordance with the SCA guidance document.

The PPV Concept is outlined in this Design Note including design criteria, leakage, documentation, and Important Considerations prior to the installation of the PPV Unit.

Prior to ordering or installing a PPV system, the PPV concept should be agreed with the design team and signed off by the Approving Authorities.