AS/NZS 1668.1:1998

Australian/New Zealand Standard™

The use of ventilation and airconditioning in buildings

Part 1: Fire and smoke control in multi-compartment buildings

Building Code of Australia
primary referenced Standard

ABCB
Australian Building Codes Board

STANDARDS AUSTRALIA
STANDARDS NEW ZEALAND

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee ME/62, Ventilation and Airconditioning. It was approved on behalf of the Council of Standards Australia on 12 June 1998 and on behalf of the Council of Standards New Zealand on 9 June 1998. It was published on 5 November 1998.

The following interests are represented on Committee ME/62:

Air Conditioning and Mechanical Contractors Association of Australia
Air Conditioning and Refrigeration Equipment Manufacturers Association of Australia
Australasian Fire Authorities Council
Australian Building Codes Board
Australian Institute of Building Surveyors
Australian Institute of Environmental Health
Australian Institute of Refrigeration, Air Conditioning and Heating
Chartered Institution of Building Services Engineers
Department of Contract and Management Services, W.A.
FPA Australia
Institution of Refrigeration Heating and Airconditioning Engineers, New Zealand
Insurance Council of Australia
Metal Trades Industry Association of Australia
Plastics and Chemicals Industry Association
Property Council of Australia
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Australian/New Zealand Standard™

The use of ventilation and airconditioning in buildings

Part 1: Fire and smoke control in multi-compartment buildings

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee ME/62, Ventilation and Airconditioning, to supersede AS 1668.1—1991, *The use of mechanical ventilation and air-conditioning in buildings*, Part 1: *Fire and smoke control*.

There is a considerable body of fire research which indicates that when a fire occurs in a multi-compartment building, the smoke from the fire is a far greater hazard to occupant safety than the fire itself, i.e.

(a) Smoke obscures vision, preventing occupants from finding safe escape routes.

(b) Smoke hinders the fire brigade in its search and rescue operations.

(c) Smoke can kill by asphyxiation or by poisoning people well before the temperature of the fire or smoke causes injury.

The fundamental purpose of this document is, therefore, life safety. Its objective is to provide standardized minimum requirements for mechanical air-handling and mechanical smoke control systems for use by designers, installers, inspectors and regulators of these systems. The Standard does not identify those buildings in which smoke control systems or pressurization systems are required. This is covered in the Building Code of Australia (BCA) or the New Zealand Building Code Handbook and approved documents, as applicable.

The first edition of AS 1668.1, published in 1974, prescribed a smoke control system intended to restrict the movement of smoke by way of airconditioning and ventilation ducting within a multistorey office building. This philosophy did not address smoke movement in a building by way of paths other than the air-handling system. Since the original publication, the Standard has changed, the zone pressurization system was added and the Standard has been applied (correctly and incorrectly) to buildings other than multistorey offices.

The objective of the Standard has also been expanded to limit smoke spread in a building by way of paths other than simply the ductwork. This revision looks deeper into the application of the Standard within buildings with varied uses, offers designers more options to find solutions for particular building types and further clarifies the intended application of the Standard.

The main technical changes made in this edition can be summarized as follows:

(i) Five particular methods of active smoke control have been included, with a table indicating which one (or more) of these methods is recommended according to the risk presented by the building type.

(ii) The Standard has been linked to AS 1670.1.

(iii) More comprehensive testing clauses have been included.

(iv) Requirements for power and indication wiring and smoke detection for system control have been revised.

(v) Requirements for non-electrical control systems have been added.

(vi) Recommendations on reliability have been included because of concerns over the long-term operational capabilities of highly complex systems.

(vii) Protection of small exhaust duct penetrations in fire compartmentalization walls may now be by subduct rather than by fire dampers due to damper maintenance problems.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard. Figures provided in this Standard are informative.

This Standard incorporates a Commentary on some of the clauses. The Commentary directly follows the relevant Clause, is designated by ‘C’ preceding the clause number and is printed in italics in a panel. The Commentary is for information only and does not need to be followed for compliance with the Standard.

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The use of ventilation and airconditioning in buildings

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SECTION 1 GENERAL

1.1 SCOPE This Standard sets out the minimum requirements for the design, construction, installation and commissioning of mechanical ventilation and airconditioning systems for fire and smoke control in multi-compartment buildings. This Standard also includes provisions that are applicable to single compartment buildings. Five specific methods of smoke control are defined and the appropriate requirements specified for each.

The Standard does not include requirements for smoke control systems utilizing exhaust from above the hot layer. Requirements for the maintenance of smoke control systems are also not included.

NOTE: AS 1851.6 outlines management procedures for maintaining the fire and smoke control features of air-handling systems.

1.2 SYSTEM OBJECTIVES Systems designed in accordance with this Standard are intended to restrict smoke spread into areas within a building, via the following:

(a) Fire-isolated exits, ramps and passageways.

(b) Principal evacuation routes (e.g. public corridors) leading to a safe place (where practicable).

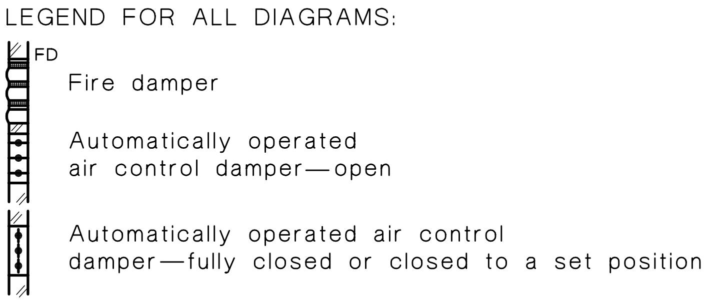
(c) Adjacent fire/smoke compartments via principal connecting paths such as stairs, lift and service shafts, airconditioning ducts, ventilation ducts and ceiling plenums.

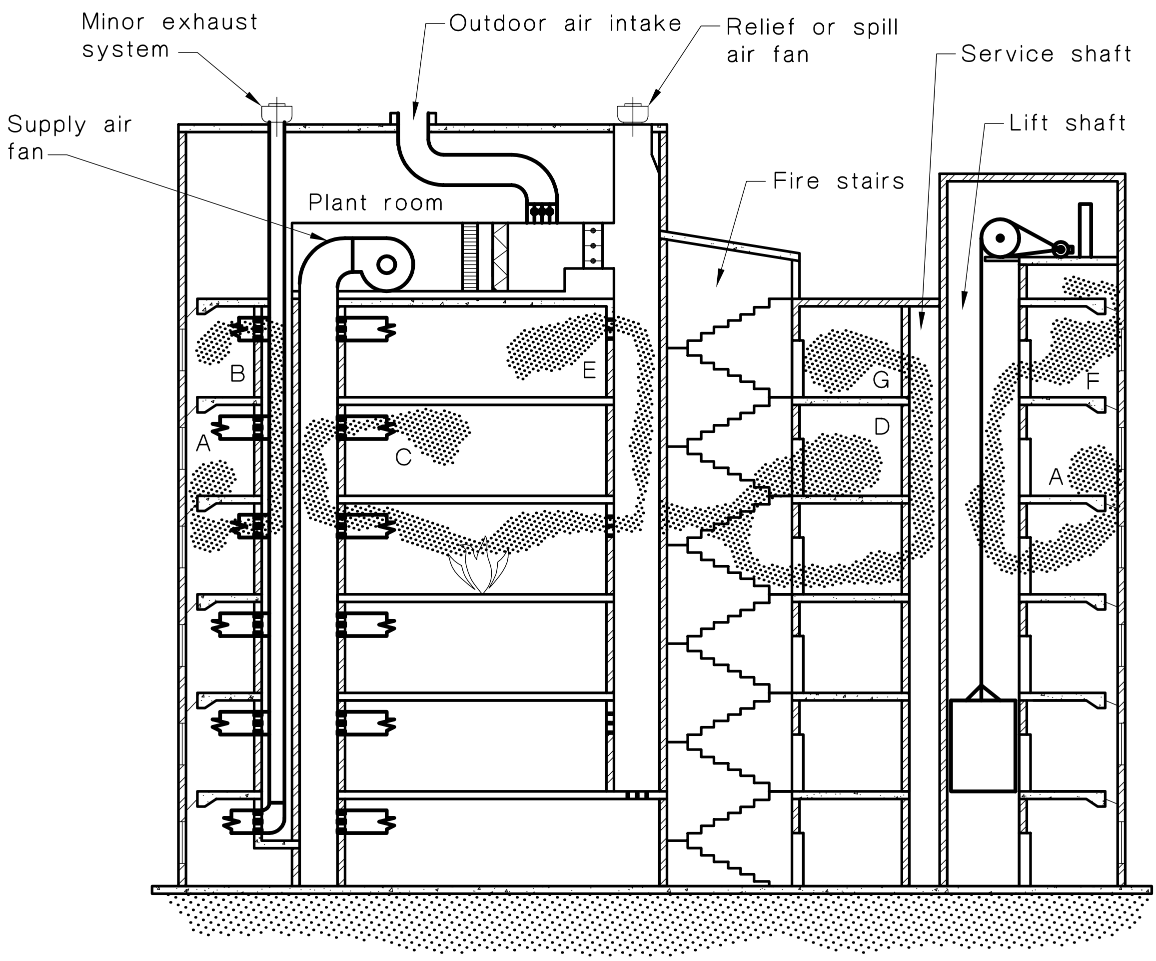
(d) Throughout the building via minor paths such as structural joints, gaps, cracks and building services penetrations.

For the specified airflows and pressure differentials, systems are required to cope with a single fire event. Some systems are required to incorporate controls that will respond to more than one fire event. Systems that achieve the specified air velocities or pressure differentials for more than one fire event are considered to exceed the minimum requirements of this Standard.

C1.2 *This Standard sets out requirements for using an air-handling system to reduce smoke spread from a fire-affected compartment to other areas. Possible leakage paths are shown in Figure 1.1. Systems designed in accordance with this Standard are expected to maintain a tenable atmosphere within fire-isolated exits to enable occupant evacuation and fire brigade search and rescue operations, not specifically to clear smoke from the fire-affected compartment. Smoke control systems should not adversely affect the normal usage of the building or create discomfort in the internal environment.*

While systems are required to handle a single fire event, they should be designed to respond to a spreading fire. Provided the fire has not damaged the system, it should respond appropriately; however, it is recognized that the performance of the system is likely to be reduced. Performance pressure differentials would not be mandatory in this instance.





LEAKAGE PATHS SHOWN ABOVE:

A Leakage between floors via poorly sealed spandrel
B Leakage between floors via ductwork of minor exhaust e.g. toilet exhaust
C Leakage between floors via supply air ductwork
D Leakage into fire stairs and then on to typical floors from fire stairs
E Leakage between floors via relief or return air path
F Leakage between floors via lift shaft
G Leakage between floors via service duct or riser shaft

FIGURE 1.1 TYPICAL MULTISTOREY BUILDING, SHOWING POSSIBLE SMOKE LEAKAGE PATHS (CENTRAL AIRCONDITIONING—NOT RUNNING)

1.3 APPLICATION

1.3.1 General This Standard applies to buildings incorporating mechanical ventilation or airconditioning systems. Smoke control systems as detailed in Sections 6, 7 and 8 only apply to multi-compartment buildings where fire or smoke may spread from one compartment to another. This Standard is not intended to apply to Class 1 and Class 10 buildings or large single compartments in any type of building utilizing smoke exhaust from above the hot layer.

NOTES:

1 For a description of building class refer to the Building Code of Australia. Classes of building are functionally equivalent to purpose groups in the New Zealand Building Code Handbook and approved documents.

2 The Building Code of Australia specifies minimum requirements for the application of smoke control systems in buildings in Australia. Where building regulations do not specify minimum requirements, guidance on the application of smoke control systems to buildings is provided in Appendices A, B and C.

C1.3.1 *Typical classes of buildings (or parts of buildings) include but are not limited to multistorey, multi-compartment, high or low rise buildings such as the following:*

(a) Offices and educational. (See Appendix A, other multi-compartment buildings.)

(b) Residential—high rise units and hotels. (See Appendix A.)

(c) Health care—hospitals. (See Appendices A and B.)

(d) Laboratories, correctional facilities and industrial premises. (See Appendix C.)

(e) Fire-isolated exits. (See Section 9.)

(f) Lift shafts. (See Section 10.)

(g) Commercial kitchen. (See Section 11.)

Recommendations for the application of smoke control systems to various classes and categories of buildings are given in Appendix A. Classes of buildings are functionally equivalent to purpose groups as defined in the New Zealand Building Regulations. Where the functional requirements of buildings conflict with the requirements for smoke control, the principles and objectives of this Standard may be applied; however, the detail requirements may be varied. Due consideration should be given to fire engineering solutions utilizing some or all of the following tools: passive fire compartmentalization, smoke channelling methods and building design, fire and smoke detection and alarm systems, and automatic fire suppression systems.

It is intended that this Standard be applied to new buildings. Its application to some existing buildings may be inappropriate and in such instances alternative designs and solutions may be necessary.

1.3.2 Building Code of Australia This Standard will be referenced in the Building Code of Australia by way of BCA Amendment 4 to be published by 1 January 1999, thereby superseding the previous edition, AS 1668.1—1991, which will be withdrawn 12 months from the date of the publication of this edition.

1.4 NEW DESIGNS AND INNOVATIONS Any alternative materials, design, methods of assembly, and procedures that do not comply with specific requirements of this Standard, or are not mentioned in it, but give equivalent results to those specified, are not necessarily prohibited.

1.5 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS	
1324	Air filters for use in ventilation and airconditioning
1324.1	Part 1: Application, performance and construction
1530	Methods for fire tests on building materials, components and structures
1530.1	Part 1: Combustibility test for materials
1530.3	Part 3: Simultaneous determination of ignitability, flame propagation, heat release and smoke release
1530.4	Part 4: Fire-resistance test of elements of building construction
1603	Automatic fire detection and alarm systems
1603.1	Part 1: Heat detectors
1603.2	Part 2: Point type smoke detectors
1603.8	Part 8: Multi-point aspirated smoke detectors
1603.13	Part 13: Duct Sampling units
1668	The use of mechanical ventilation and airconditioning in buildings
1668.2	Part 2: Mechanical ventilation for acceptable indoor-air quality
1670	Fire detection, warning, control and intercom systems—System design, installation and commissioning
1670.1	Part 1: Fire
1682	Fire dampers
1682.1	Part 1: Specification
1682.2	Part 2: Installation
1735	Lifts, escalators and moving walks
1735.2	Part 2: Passenger and goods lifts—Electric
1851	Maintenance of fire protection equipment
1851.6	Part 6: Management procedures for maintaining the fire and smoke control features of air-handling systems
2106	Methods for the determination of the flashpoint of flammable liquids (closed cup)
2118	Automatic fire sprinkler systems
2118.1	Part 1: Standard
2484	Fire—Glossary of terms
2484.1	Part 1: Fire tests
3102	Approval and test specification for electric duct heaters
3960	Guide to reliability and maintainability program management
4072	Components for the protection of openings in fire-resistant separating elements
4072.1	Part 1: Service penetrations and control joints
4254	Ductwork for air-handling systems in buildings
4260	High efficiency particulate air (HEPA) filters—Classification, construction and performance
4428	Fire detection, warning, control and intercom systems—Control and indicating equipment
4428.1	Part 1: Fire
4428.7	Part 7: Air-handling fire mode control panel
4429(Int)	Methods of test and rating requirements for smoke-spill fans

AS/NZS
1905 Components for the protection of openings in fire-resistant walls
1905.1 Part 1: Fire-resistant doorsets

3013 Electrical installations—Classification of the fire and mechanical performance of wiring systems

3103 Approval and test specification—Electric room heaters

3179 Approval and test specification—Refrigerated room air-conditioners

4391(Int) Smoke management systems—Hot smoke test

NZS
2139 Specification for heat actuated fire detector

4512 Fire alarm systems in buildings

ABCB
BCA Building Code of Australia

NZBIA
New Zealand Building Code Handbook and approved documents

ASHRAE
Handbook—Applications 1995
Handbook—Fundamentals 1997
Design of smoke management systems

1.6 DEFINITIONS For the purpose of this Standard, the definitions given in the Building Code of Australia or the New Zealand Building Code Handbook as applicable, AS 2484.1 and those below apply.

1.6.1 Air

1.6.1.1 *Exhaust air*—air, other than return air, removed from an enclosure by mechanical means and discharged to atmosphere.

1.6.1.2 *Outdoor air*—air outside the building.

1.6.1.3 *Recycle air*—that portion of air removed from enclosures as return air and returned as part of the supply air, by mechanical means.

1.6.1.4 *Relief air*—that portion of return air that is not recycled including air leakage through a facade or discharge through specific relief paths.

1.6.1.5 *Return air*—air removed from an enclosure by mechanical means. All of the return air may be expelled as relief air, or all or part of it may be recycled.

1.6.1.6 *Smoke-spill air*—air drawn into the smoke-spill system during operation in the smoke-control mode.

1.6.1.7 *Supply air*—air introduced into an enclosure by mechanical means.

1.6.2 Air-handling plant—a component part of an air-handling system that includes equipment providing air movement, as well as equipment for the purpose of controlling the direction, rate of airflow, division of airflow or condition of air (i.e. concentration level of contaminants, temperature and humidity).

1.6.3 Air-handling system—a system for the purpose of directing air in a positive and controlled manner to or from specific enclosures by means of air-handling plant, ducts, plenums, air-distribution devices or automatic controls.

1.6.4 Air-pressurization system—an air-handling system designed to establish a pressure differential in accordance with this Standard.

1.6.5 Central air-handling system—an air-handling system that is capable of recycling air from one or more compartments to another one or more compartments.

1.6.6 Combustible—deemed combustible when tested in accordance with AS 1530.1.

1.6.7 Downstream—in the direction of airflow.

1.6.8 Duct—a component part of an air-handling system, intended for the passage of air from one part of an air-handling system to another (see also the definition of 'plenum').

1.6.9 Economy cycle—the automatic operation of an air-handling system whereby outdoor air is used to provide cooling when ambient conditions are suitable.

1.6.10 Equipment plenum—an air chamber, directly attached to air-handling equipment, intended for the collection and passage of air, to which one or more ducting systems may be connected to form part of an air-handling installation within a building.

1.6.11 Failure position—the position the device reverts to upon loss of operating power which results in the least adverse effect on occupants.

1.6.12 Fire-affected compartment—a single area within a building required by building regulation for the control of fire or smoke, where a fire event has occurred. This area may be either a fire or smoke compartment.

1.6.13 Fire alarm—a device which may be operated manually or automatically and which is intended to provide warning of the existence of a fire event.

1.6.14 Fire-isolated—separated by fire-resistant construction.

1.6.15 Fire-isolated exit—a fire-isolated stairway, a fire-isolated ramp or a fire-isolated horizontal passageway, whether used individually or in combination, which provides egress from a storey or enclosed space to a road or open space.

1.6.16 Flexible connection—a section of flexible duct used at junctions between ductwork and items of plant that are subject to vibration or for seismic isolation.

1.6.17 Individual air-handling system—an air-handling system that is only capable of recycling return air to the compartment from which it was drawn.

1.6.18 Kitchen exhaust hood—a component part of a kitchen exhaust system intended for collecting the heat, fumes and other aerosols arising from cooking appliances, and whose installation is required by AS 1668.2.

1.6.19 Major exhaust system—an exhaust system installed as a stand-alone system or in conjunction with a recycle or supply system and having openings exceeding 0.1 m^2 from a fire compartment into a separate shaft or duct within a shaft.

1.6.20 Major supply system—a supply system installed as a stand-alone system or in conjunction with recycle or exhaust systems and having inlet openings exceeding 0.1 m^2 into a fire compartment from a separate shaft or duct within a shaft.

1.6.21 Masonry—concrete, stone, brick, terracotta block, concrete block, or other similar building unit or material, or a combination thereof, assembled unit-by-unit to form a wall, pier, shaft, chimney or other part of a building.

1.6.22 May—indicates the existence of an option.

1.6.23 Minor exhaust system—an exhaust system installed to exhaust air having openings from a fire compartment not exceeding 0.1 m^2 into a separate shaft or duct within a shaft.

1.6.24 Minor supply system—a system delivering air from a separate shaft or duct within a shaft via openings into a fire compartment not exceeding 0.1 m^2.

1.6.25 Multiple compartment building—a building containing two or more compartments required to have fire- or smoke-resisting separation.

NOTE: A fire-separated exit, ramp or passageway is considered to be a separate compartment.

1.6.26 Non-fire-affected compartment(s)—those areas within a building required by building regulation for the control of fire or smoke, where no fire (or smoke) has been detected, after the detection of fire (or smoke) in another compartment of the building (for fire-affected compartment, see Clause 1.6.12).

1.6.27 Plantroom—a room within a building dedicated for the housing of plant or equipment.

1.6.28 Plenum—an air compartment or chamber remote from the air-handling equipment, intended for the passage of air, to which one or more ducts may be connected and which forms part of an air-handling system (e.g. ceiling void).

1.6.29 Required—required by this Standard or by building regulation.

NOTE: Building owners and managers, fire insurance underwriters and other bodies may have requirements in addition to those of this Standard.

1.6.30 Shaft—the walls or other parts of a building bounding a well or a vertical chute, duct or similar passage. Shafts may be required to carry hot products of combustion under conditions of smoke-spill operation.

1.6.31 Shall—indicates that a statement is mandatory.

1.6.32 Smoke—a generally visible suspension in air of solid or liquid particles or gases resulting from combustion or pyrolysis and entrained air.

1.6.33 Smoke compartment—a part of a building, which has subdividing walls, floors or other smoke barriers within it, required to contain smoke.

1.6.34 Smoke spill—the action of an air-handling system in exhausting smoke from the building to the outside in the event of fire.

1.6.35 Smoke-spill system—a special configuration of those elements of an air-handling system which are required to conduct smoke-spill air. This configuration extends from the most upstream smoke or fire-resistant barrier that is being penetrated to the point of discharge outside the building.

1.6.36 Sprinkler system—an automatic fire sprinkler system designed and installed in compliance with the appropriate building regulations.

1.6.37 Subduct—an entry piece intended to prevent backflow of air or products of combustion.

1.6.38 Upstream—against the direction of airflow.

1.6.39 Zone smoke control dampers—all dampers, associated with a particular fire or smoke compartment or zone, which form part of a zone pressurization smoke control system.

1.7 ACRONYMS The acronyms below are used in this Standard.

1.7.1 AZF Alarm zone facility.

1.7.2 AVF Alarm verification facility.

1.7.3 FFCP Fire fan control panel.

1.7.4 FIP Fire indicator panel.

1.7.5 FRL Fire resistance level (Australian equivalent to FRR).

1.7.6 FRR Fire resistance rating (New Zealand equivalent to FRL).

1.7.7 MIMS Mineral insulated metal sheathed.

1.7.8 VAV Variable air volume.

SECTION 2 AIR-HANDLING SYSTEMS— GENERAL REQUIREMENTS

2.1 SCOPE OF SECTION This Section sets out general requirements applicable to air-handling systems and pressurization systems defined in this Standard.

2.2 DUCTWORK

2.2.1 Early fire-hazard properties The material, or any composite material, employed in the construction of ductwork shall comply with the fire performance requirements of AS 4254.

2.2.2 Combustibility and temperature of fusion Where required by Clauses 3.4(b), 3.7.2 and 11.2.3, the materials employed in ductwork shall have the following performance characteristics:

(a) *Combustibility* The materials shall be deemed to be not combustible.

(b) *Temperature of fusion* The materials shall have a temperature of fusion not less than 1000°C.

(c) *Insulation* Insulation materials shall have a temperature of fusion not less than 500°C and, if internal, shall be faced with perforated metal complying with Item (b). Fittings (acoustic attenuators, seals, or similar) having an aggregate length of not more than 2 m, along any duct path from fan to outlet, need not comply with the requirements of this Clause. Fibreglass and rockwool internal insulation systems, faced with perforated metal complying with Item (b), are deemed to comply with this requirement.

(d) *Flexible connections* Flexible connections shall have a temperature of fusion of no less than 500°C.

> ***C2.2.2(d)*** *Materials of a lesser temperature may be considered where the integrity of the system cannot be lost due to failure of the flexible connection.*

NOTE: Ductwork required to comply with these combustibility requirements include smoke-spill ducts, subducts and kitchen exhaust ductwork.

2.2.3 Fire resistance Where required by Clause 3.7.2 of this Standard, the form of construction shall be equivalent to that of a test specimen tested in accordance with AS 1530.4 and proved to comply with the fire resistance requirements specified in the relevant clause of this Standard. Unless otherwise indicated, the FRL shall be not less than that required for the construction separating different fire compartments.

NOTE: This requirement may be waived provided that the duct is enclosed in construction having the required fire resistance.

2.2.4 Duct installation Ducts and components associated with systems required to operate in the fire mode shall be installed in accordance with AS 4254 and Clause 3.6 and shall not reduce the fire resistance of the construction through which the duct passes.

2.3 PLENUMS AND CASINGS The exposed face of any insulation in equipment plenums, built-up air-handling and proprietary air-handling plant casings shall have indices not greater than the following as determined in accordance with AS 1530.3:

(a) A spread of flame index 0.

(b) A smoke-developed index 3.

Masonry, concrete, metal or metal-faced sandwich construction are deemed-to-comply materials for the purpose of this requirement. Where casings are of metal-faced sandwich construction, all raw edges shall be covered effectively to ensure that the insulation core is not exposed, inside or outside the casing. Where necessary, raw edges shall be fitted with edge strips. When located on the airstream side of the casing, edge strips or gaskets between panels shall comply with the early fire hazard indices nominated above for exposed insulation.

Where not exposed to the airstream, but otherwise exposed within the building, materials used for edge strips or gaskets between panels shall have fire hazard properties in accordance with the requirements of the relevant building regulations.

All gaskets thicker than 3 mm between metal faces and all non-metallic edge strips that project over the metal face of the sandwich panel on the airstream side of the casing, shall be completely covered with metal strips.

2.4 AIR DAMPERS

2.4.1 Mechanical fire dampers Fire dampers of the thermally released or motorized type shall be manufactured and installed in accordance with AS 1682.1 and AS 1682.2. Motorized dampers shall fail to the closed position by a thermally operated device located in the airstream. Damper closure retaining devices shall be incorporated.

> ***C2.4.1*** *A motorized fire damper should be tested as a complete assembly as it requires a drive motor that is compatible with the characteristics of the damper in respect of construction, type and weight. Failure of the drive motor when subjected to fire should ensure that the damper's ability to close (or remain closed if already motorized to that position as a result of a fire alarm) is not impaired.*

2.4.2 Intumescent fire dampers Fire dampers of the intumescent type shall be manufactured to close under fire conditions as a result of swelling of the intumescent material. Intumescent fire dampers shall be tested for FRL requirements in accordance with AS 1530.4 with an extended fully closed-off period of 120 s. Dampers shall also comply with the air leakage test of AS 1682.1. Dampers shall be installed in accordance with the relevant requirements of AS 1682.2.

2.4.3 Smoke dampers Smoke dampers shall be constructed and installed as for fire dampers in accordance with AS 1682.1 and AS 1682.2 except for the following:

(a) The damper shall be provided with a means to allow automatic closure from a fire alarm signal. The thermally activated device may be omitted.

(b) Damper tip seals shall be incorporated for sealing against smoke.

(c) Where motorized, the damper closure retaining clip shall be omitted to allow automatic resetting to the open position upon resetting of the smoke control system.

2.4.4 Air control dampers An air control damper not designated as a smoke damper shall be a motorized damper that opens or closes to control air as part of a smoke control system.

Where utilized in smoke-spill systems, air control dampers shall resist high temperatures such that they operate in a smoke-spill mode at temperatures in accordance with the requirements of Clause 4.8.

C2.4.4 A high temperature construction for a smoke-spill air control damper is necessary to ensure that any failure (due to buckling or distortion) does not cause an obstruction to the passage of hot smoke through the damper. Such a construction is not required where an air control damper is installed in the supply air for pressurization, as any failure resulting from excessive heat within the fire-affected compartment is considered to be remedied by closure of the fire damper. For this purpose, it is desirable that any air control damper be installed as close as possible to the fire damper in the fire-resistant wall.

While damper tip seals are not a requirement for effective sealing of air control dampers, their installation should be considered, particularly where multiple compartments are served from a central plant system and excessive leakage may be detrimental to fan capacity or system performance.

2.4.5 Combined damper arrangements Where it is a requirement to install a fire damper and a smoke damper or a fire damper and an air control damper in the same location they may be combined into that of a single fire-rated damper installation.

2.4.6 Motorized operation Where dampers are motorized they shall operate to their required position within a time period not exceeding 60 s from receipt of a fire alarm signal. (See also Clause 9.3.1(c).)

2.4.7 Non-return discharge dampers Non-return discharge gravity dampers, installed on smoke-spill systems, shall mechanically latch open or be arranged to fail open during system operation. Where all compartments served by the smoke-spill system are protected by a sprinkler system mechanical latching is not required.

C2.4.7 During a fire the smoke-spill fan may fail due to the high temperatures. It is important that the smoke-spill path remain open so that the smoke may be naturally ventilated through the smoke-spill system. Non-return discharge dampers may require provisions for access or for remote resetting. In a sprinklered building smoke temperatures are likely to be lower and smoke-spill system failure due to high temperature is considered to be unlikely.

2.5 AIR FILTERS

2.5.1 Fabric filters Fabric filters shall be constructed in accordance with AS 1324.1 or AS 4260 as appropriate.

2.5.2 Location of air filters in relation to openings Air filters shall be located in relation to outdoor air intakes so that entering ignition sources, such as burning embers, cannot be deposited on the filters.

2.5.3 Liquid adhesive coatings Liquid adhesive coatings for air filters shall have a flashpoint of not less than 160°C when measured in accordance with the Pensky-Martens method set out in AS 2106. Provision shall be made for regular removal of sludge from the liquid adhesive reservoir of air filters of the automatic viscous-impingement type.

2.5.4 Screens for filters Electrostatic precipitation air filters, which are not preceded by fabric filters or viscous-impingement filters, or which do not incorporate or are not followed by a viscous-impingement or fabric after-filters, shall be provided with lint screens—

(a) located downstream of the electrostatic filters;

(b) readily accessible or removable for cleaning; and

(c) not coarser than 1.6 mm mesh.

2.6 ELECTRIC HEATERS

2.6.1 General All electric heaters installed in ducts and air-handling plant shall comply with the requirements of AS 3102 and Clause 2.6.2 and 2.6.3 as appropriate.

2.6.2 Casing The thermally insulated case required by AS 3102 shall have a coefficient of heat transfer not greater than 30 W/m^2K at 100°C.

> ***C2.6.2*** *AS 3102 describes manufacturing type tests applicable to electric duct heaters and allows a maximum rating of 50 kW per unit.*

2.6.3 Small heaters Small heaters integral with factory-built air-handling plant shall comply with AS/NZS 3103 or AS/NZS 3179. These shall be fully type tested with a safety clearance certificate and shall have a maximum rating of 2.4 kW for single phase, or 2 kW per phase, unless full compliance with AS 3102 can be demonstrated.

2.7 ELECTRICAL INSTALLATION The installation of electrical components of air-handling systems shall comply with relevant regulations.

SECTION 3 FIRE PROTECTION OF OPENINGS

3.1 SCOPE OF SECTION This Section sets out requirements intended to maintain the fire integrity of building elements which may otherwise be compromised by mechanical ventilation or airconditioning ducts or plant.

> ***C3.1*** *Building regulations require certain building elements to be fire-resisting. Openings in these elements to accommodate air-handling systems should be treated in a manner such that the fire-resisting performance of the element is not unduly impaired. Where openings cannot be appropriately treated, then the air-handling systems themselves should be designed to maintain fire-resisting performance. Typical arrangements for protection of openings are shown in Figures 3.1 and 3.2.*

3.2 GENERAL

3.2.1 General requirements Openings in fire-resisting construction shall be protected such that the required FRL of the construction is not impaired.

3.2.2 Packing Service penetrations and control joints shall be protected in accordance with the requirements of AS 4072.1.

3.3 OPENINGS IN WALLS Openings in walls, required to have an FRL, shall be protected with fire dampers except where they are—

(a) associated with a smoke-spill or minor exhaust system which are protected with subducts in accordance with Clauses 3.6 and 3.7.4;

> ***C3.3(a)*** *Minor exhaust systems may be protected with subducts in lieu of fire dampers. Subducts can take up more shaft space but require less access for maintenance. System operational requirements are different depending on the type of protection employed.*

(b) associated with a duct forming part of a kitchen exhaust system;

(c) part of a lift vent;

(d) located in an external wall where an unprotected opening is permitted by building regulations; or

(e) located in a load-bearing wall required to have an FRL with respect to structural adequacy only.

> ***C3.3*** *The openings listed in this Clause are primarily associated with smoke exhaust systems required to operate in the fire mode where closure of fire dampers during a fire would negate the system function. The build-up of grease on a fire damper in a kitchen exhaust duct could inhibit the action of the damper.*

3.4 OPENINGS IN FLOORS Openings in floors, required to have an FRL, shall be protected in accordance with Items (a) or (b) as follows:

(a) *Shafts* Openings in two or more floors, required to be fire-resisting, and separating fire compartments shall be contained in a shaft such that the required level of fire separation is maintained (see Figure 3.1). Shafts need not extend into the highest fire compartment served (except as required by Clause 3.7 for smoke-spill) or alternatively into the lowest fire compartment served. Shafts are not permitted to form part of the highest and lowest fire compartment simultaneously. Ducts associated with stairwell pressurization systems may be installed within the stair shaft being served.

(b) *Fire dampers* Fire dampers may be installed (see Figures 3.1 and 3.2) where—

(i) the damper has attained the required FRL with respect to structural adequacy, integrity and insulation when tested to AS 1530.4; or

(ii) the damper is at the bottom of a shaft; or

(iii) the damper is at the top of a shaft, and, to minimize the risk of mechanical damage and ignition of any combustible material from heat transfer through the damper and duct, there is an internally insulated 2 m long duct with 50 mm of insulation complying with Clause 2.2.2 or a masonry shaft of minimum length 2 m, connected above the fire damper; or

(iv) a duct passes through one floor only and the duct above the fire damper is protected in accordance with Item (iii).

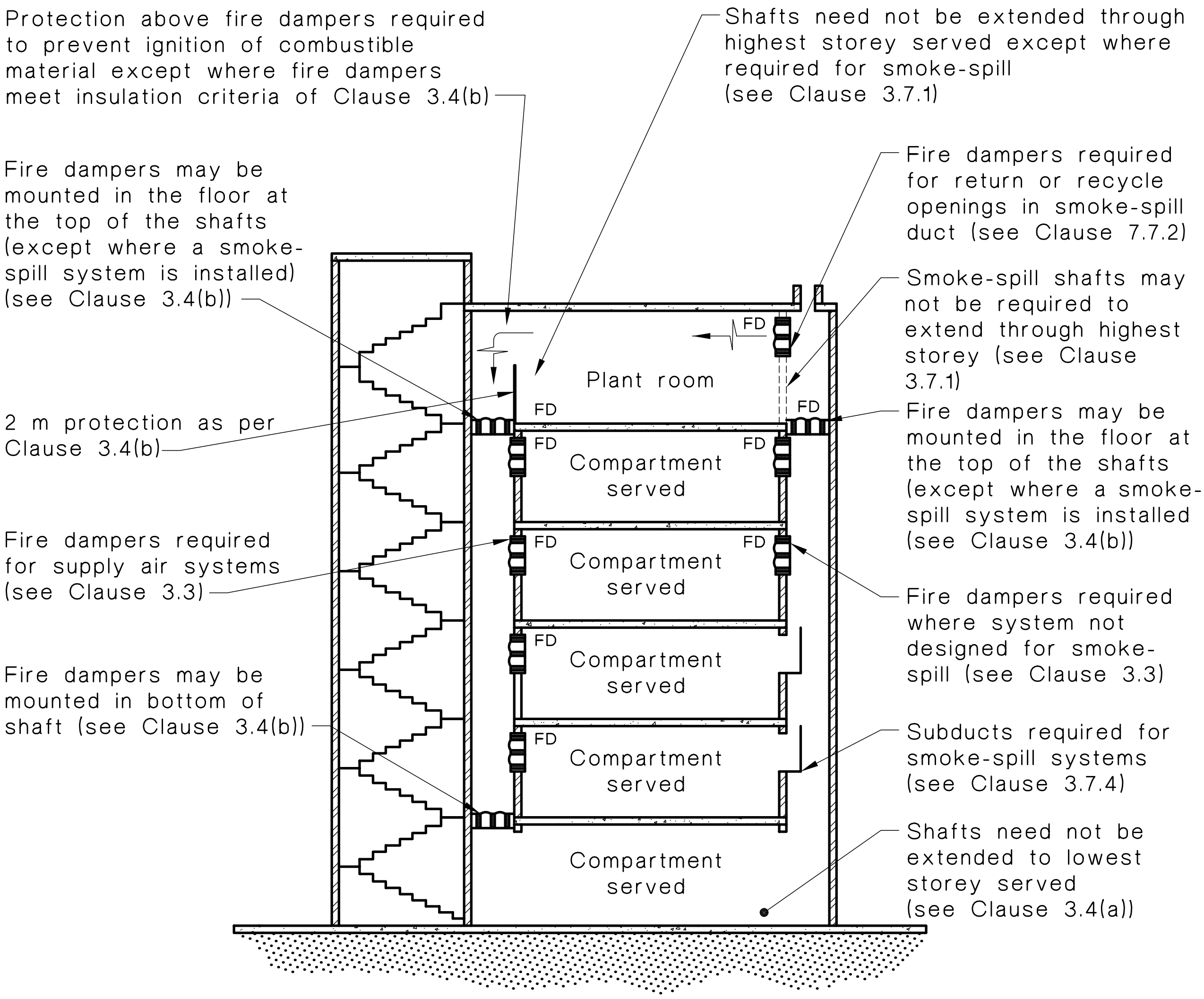
Fire dampers shall not be installed to protect openings in floors where such openings are associated with a smoke-spill system, a kitchen exhaust system or form part of a lift vent. Such openings may only be protected by shafts in accordance with Clause 3.4(a).

Fire dampers and shafts may be omitted where they are located in a floor required to have an FRL with respect to structural adequacy only.

C3.4 *Fire-resisting shafts are required where ducts pass through two or more floors having an FRL to maintain the integrity of the compartments. Shafts are not required where fire dampers having the required fire resistance level with respect to integrity and insulation are installed at each floor level. In practice the most likely use of such dampers would be associated with supply or exhaust systems not forming part of a smoke control system. In these instances, ducts between floors need not have any special protection.*

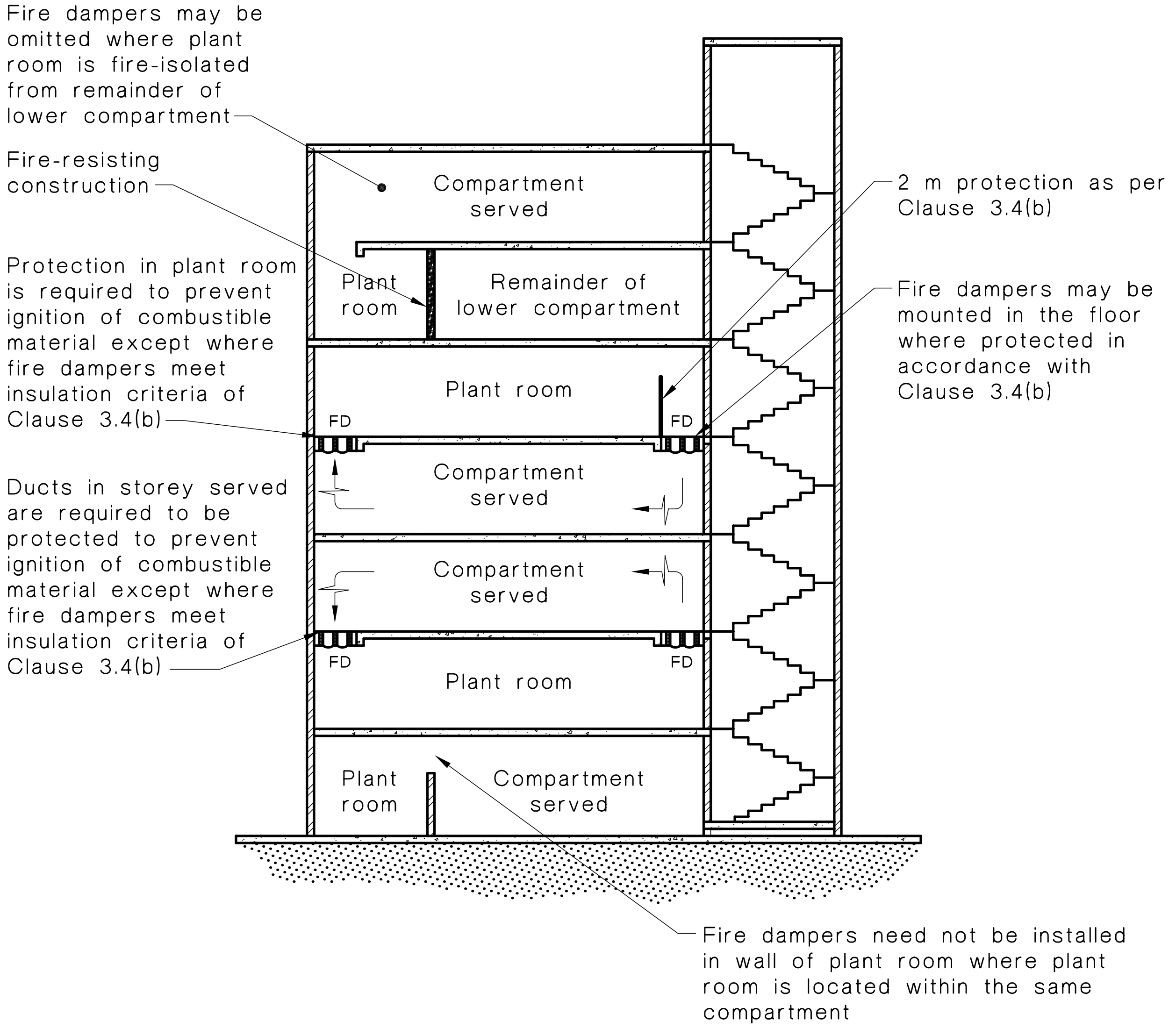
Fire dampers are an acceptable method of protecting openings but do not usually meet the FRL insulation criterion. Installation is therefore restricted in most instances to the vertical plane. Horizontal mounting is permitted where the damper is designed to provide a barrier to heat transfer and has achieved the required fire resistance level with respect to both integrity and insulation. Conventional dampers are permitted in floors where protection is provided above the damper to prevent ignition of combustibles. Such protection could take the form of a physical barrier to prevent combustibles coming in contact with the duct, fire-resistant ducts or the application of thermal insulation. Designers need to consider the extent of direct exposure a damper could have to a fire below, the likely fire size and flame and gas temperatures.

Openings associated with smoke-spill are not permitted to have fire dampers installed; such openings are detailed in Clause 3.3. Subducts are required to protect these openings and are considered to maintain the integrity of fire separation between compartments.



NOTE: Fire dampers at the top or bottom of a shaft may be omitted where the shaft is permitted to form a common compartment with a plant room or connected compartment.

FIGURE 3.1 TYPICAL ARRANGEMENT FOR PROTECTION OF OPENINGS FOR AIR-HANDLING SYSTEMS SERVING MORE THAN ONE COMPARTMENT



NOTE: Fire dampers may be omitted where the plant room and compartment served are permitted to form a common compartment.

FIGURE 3.2 TYPICAL ARRANGEMENT FOR PROTECTION OF OPENINGS FOR AIR-HANDLING SYSTEMS SERVING ONE COMPARTMENT WHERE FLOORS ARE REQUIRED TO BE FIRE-RESISTANT

3.5 FIRE-RESISTANT LIGHTWEIGHT STRUCTURES Openings in non-masonry wall, floor/ceiling or roof/ceiling construction required to have an FRL, including ceilings required to have a resistance to the incipient spread of fire, shall be protected by means identical with those used in the prototype test specimen that achieved the required FRL. Ducts or openings shall not be incorporated into a construction unless they are protected by construction equivalent to the prototype test specimen that achieved the required FRL.

3.6 SUBDUCTS

3.6.1 Outlet projection Within the return air shaft or fire-resisting duct, each subduct shall have an outlet projection facing downstream to the direction of smoke-spill airflow not less than 500 mm long (see Figures 3.3 to 3.10). Where the normal direction of airflow is upwards, the subduct shall discharge the smoke-spill air vertically upwards;

where the normal direction of airflow is downwards or horizontal, the subduct shall discharge the smoke-spill air horizontally.

3.6.2 Packing For all types of subducts, any space between the subduct and the fire-resisting structure shall be effectively sealed with material that—

(a) complies with Clause 3.2.2; and

(b) has a fusion temperature not less than 1000°C; and

(c) prevents excessive leakage of combustion products; and

> ***C3.6.2(c)*** *In zone pressurization systems particularly, the space between a subduct and the surrounding fire-resisting structure should be reasonably well sealed, to avoid loss of fan capacity due to uncontrolled leakage of air from non-fire-affected compartments into the smoke-spill shaft. It should be noted, however, that minor gaps between subduct and the surrounding fire-resisting shaft structure will not seriously impact on the objective of restricting the spread of smoke into adjacent compartments, provided the smoke-spill fan has been selected to handle the resulting leakage airflows.*
>
> *Gross leakage between the subduct and the surrounding fire-resisting structure is to be avoided, because in the event of smoke exhaust fan failure, the subduct's upstand is the only thing preventing leakage of combustion products from the smoke exhaust shaft into non-fire-affected compartments. Excessive clearance around a subduct will allow gross leakage and hence bypassing of the upstand.*

(d) will accommodate the expansion of the subduct (up to 1000°C) without imposing forces that will distort the subduct or adversely affect the FRL of the fire-resisting structure.

> ***C3.6.2(d)*** *The packing material between the subduct and the fire-resisting structure should be sufficiently compliant to accommodate the likely expansion of the subduct during a fire. If non-compressible packing prevents subduct expansion, the subduct may buckle, leading to gross leakage. In the case of lightweight fire-resistant shaft construction, expansion of the subduct without sufficient clearance may rupture the wall. (See Clause 3.6.3.2.)*

Fibreglass insulation (wrapped in reinforced aluminium foil if necessary), and contained by steel flanges is deemed to comply with the requirements of Item (b) above.

3.6.3 Smoke-spill systems

3.6.3.1 *Manufacture* Subducts shall be manufactured from steel of 2 mm min. thickness or be otherwise constructed to achieve an FRL not less than that required for the shaft.

NOTE: An example of an acceptable alternative material is reinforced concrete integral with the reinforced concrete shaft.

Subducts manufactured from steel shall have all joints welded and the whole of the subduct shall be suitably protected against corrosion after manufacture. Where other materials are used, joints shall be made in a manner providing similar integrity to continuous welding when subjected to fire. Alternatively, to facilitate erection, subducts may be made in sections, provided that a flanged connection in accordance with Clause 3.6.3.2 and a gasket made of a material deemed not combustible are used to join the sections.

> ***C3.6.3.1*** *Steel used for subducts should be either painted with a zinc-rich paint, galvanized, stainless or otherwise protected against the corrosive effects of the subduct's environment.*

3.6.3.2 *Installation* Subducts shall be fixed directly to the fire-resisting structure by means of a continuously welded steel angle forming a mounting flange of minimum thickness 2.5 mm. Attachment of the flange shall be by means of grouted steel bolts or by steel bolts that engage in expanding anchors of material having a temperature of fusion not less than 1000°C. Alternatively, subducts may be installed by clamping between flanges, one of which has been welded to the casing with the other bolted through slotted holes to the outside of the wall.

Where the subduct penetrates the fire-resisting structure, the clearance between the subduct and the penetration shall be sufficient to allow expansion without imposing forces that will distort the subduct or adversely affect the FRL of the fire-resisting structure. In any case, the overall size of the penetration shall be not less than 1% +10 mm larger than each dimension (W × H) of the associated subduct. The space between the subduct and the fire-resisting structure shall be sealed in compliance with Clause 3.6.2.

C3.6.3.2 *In order that subducts continue to function, minimum material thickness and outlet projection dimension are specified. Sideways discharge, where return air is downwards, is intended to optimize the efficiency of the return airflow whilst maintaining the upward projection for smoke-spill operation. Typical arrangements of subducts with air-handling systems and construction details are shown in Figures 3.3 to 3.10.*

3.6.3.3 *Attachment of ductwork* If ductwork in the compartment is attached to a subduct, the method of attachment shall be such that any deformation or collapse of the ductwork in a fire does not dislodge the subduct or adversely affect the fire-resisting structure in which the subduct is mounted.

C3.6.3.3 *This Clause is aimed a protecting the integrity of lightweight fire-resisting wall structures, which could be substantially damaged by collapse of a large or long duct connected rigidly to the subduct. Where ductwork larger than 500 × 500 mm and longer than 3 m is connected to a subduct in a lightweight fire-resisting wall, consideration should be given to breakaway joints as described in AS 1682.2 for duct/fire damper connection. Alternatively, the subduct may be separately supported on the building's fire-resisting structure, independently of the lightweight fire-resisting wall. In all such cases, where proprietary fire-resisting systems are employed, the manufacturer's recommendations regarding protection of penetrations should be followed.*

3.6.4 Minor exhaust systems

3.6.4.1 *Manufacture* Subducts used in minor exhaust systems shall be manufactured from galvanized steel in accordance with the duct construction and installation requirements of AS 4254 from the same material as the sheet metal riser (see Figure 3.6).

3.6.4.2 *Installation* Subducts shall be installed directly into a sheet metal riser constructed in accordance with AS 4254 and fixed to the riser with a mounting flange not less than 30 × 30 × 1.6 mm steel utilizing fastenings of material having a temperature of fusion not less than 500°C. The sheet metal riser shall be enclosed in a shaft which may contain water supply, soil and waste services.

3.7 SMOKE-SPILL SYSTEMS

3.7.1 System enclosure Smoke-spill air-handling plant and ductwork located within a fire compartment, other than the compartment being served, shall be enclosed with fire-resisting construction having an FRL not less than that needed to maintain the required integrity between compartments.

Where located in a plantroom, smoke-spill plant and associated ductwork need not be enclosed in a fire-resisting construction unless the plantroom contains other unenclosed essential services e.g. essential switchboards, supply air systems, air pressurization systems, hydrant pumps and emergency batteries.

> ***C3.7.1*** *The smoke-spill system is required to maintain its integrity when handling smoke-spill air to ensure the supply air system remains operative and the supply air uncontaminated. Where smoke-spill plant and ductwork are located within a plantroom, fire isolation of such equipment is not required unless essential services are also contained therein in which case plant isolation will be necessary. A typical example where fire isolation may not be required would be a rooftop enclosure containing smoke-spill plant, general ventilation plant and general pumps, or similar.*

3.7.2 Ductwork Ductwork, plenums and equipment plenums used in smoke-spill systems shall comply with Clause 2.2.2. Ductwork, plenums and equipment plenums, forming part of a smoke-spill system and connecting more than one fire compartment and outside any fire-resisting enclosure, shall comply with Clause 2.2.3 and, for this purpose, the FRL shall be assessed—

(a) with respect to a fire outside the duct, in terms of structural adequacy and integrity; and

(b) with respect to a fire inside the duct, in terms of structural adequacy, integrity and insulation.

> ***C3.7.2*** *Ducts forming part of smoke-spill systems may traverse other fire compartments provided the integrity of the fire compartments is maintained. Smoke-spill ducts need not have fire resistance with respect to insulation when exposed to an external fire. For satisfactory performance of the smoke-spill system, it is recommended that the prototype duct, tested in accordance with AS 1530.4, should not have deformed to the extent of reducing its cross-sectional area by more than 15%.*
>
> *Figure 3.10 illustrates a central air-handling system designed for smoke control and serving compartments within the same storey. Integrity of the compartments is maintained by fire dampers in the supply air system and by a combination of fire-resisting ducts and subducts for the return/smoke-spill air system.*

3.7.3 Shafts Smoke-spill air within a fire-resisting shaft need not be ducted but where ducts are provided, they shall comply with Clause 3.7.2. Smoke-spill shafts shall not contain any other building service.

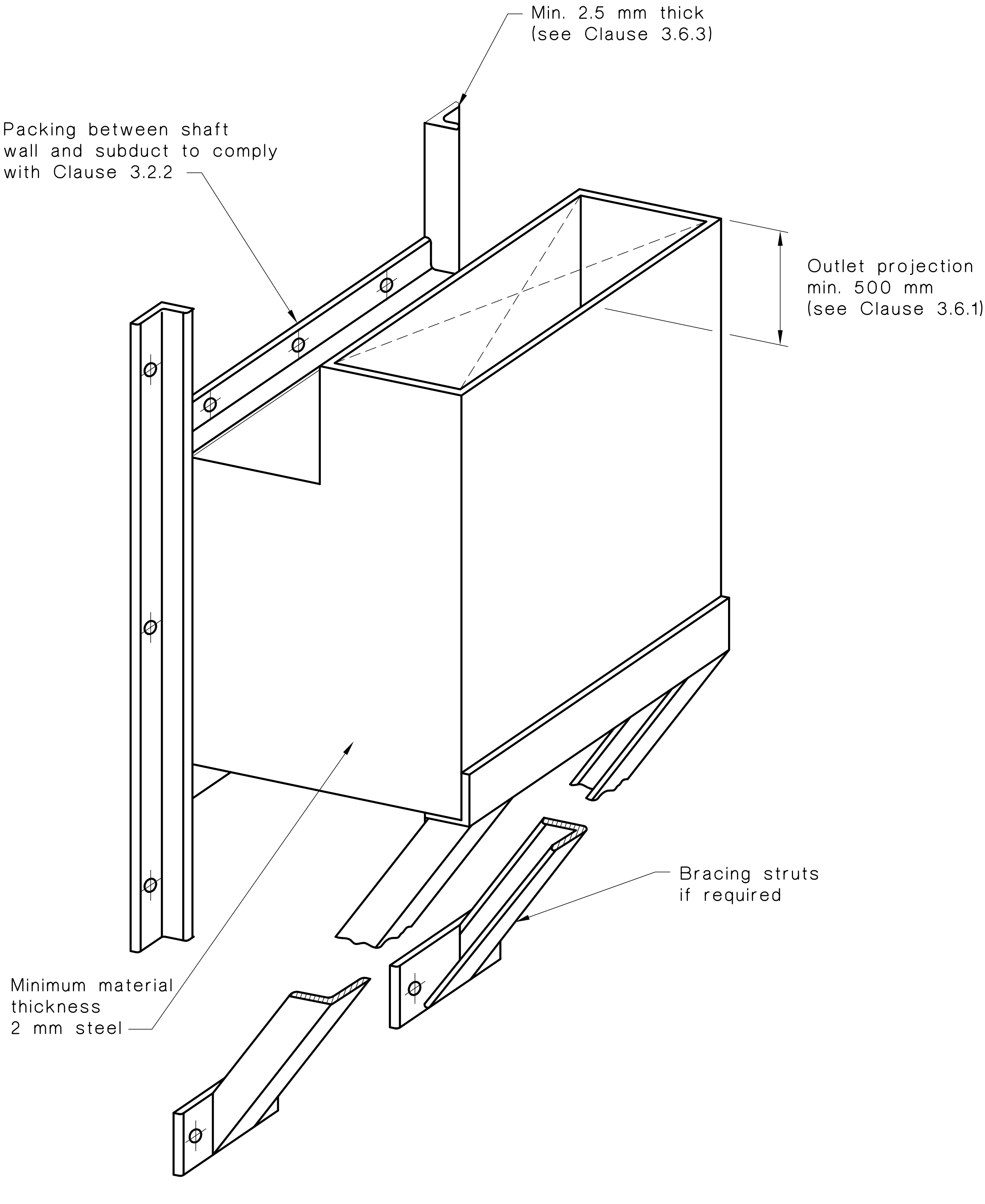
> ***C3.7.3*** *The use of ducts within a smoke-spill shaft will usually be determined by the air-handling system design. Such ducts should retain their cross-section area during fire. (See Clause 3.7.2.) Other services, including supply air systems, are not permitted within the same shaft to prevent spread of fire to, or adverse effect on, those services during a fire.*

3.7.4 Entry of smoke Where smoke or air enters a smoke-spill system, a subduct complying with Clause 3.6 shall be fitted at each point of entry to the shaft or fire-resisting duct, except that a subduct is not required at any entry point from the most upstream compartment, i.e. farthest from the smoke discharge point when operating in the fire mode.

> ***C3.7.4*** *To prevent smoke from infiltrating into other compartments, subducts are required at each entry point into the shaft such that the smoke has to flow downwards before it can enter the other compartment. (See Clause 3.6.1.)*

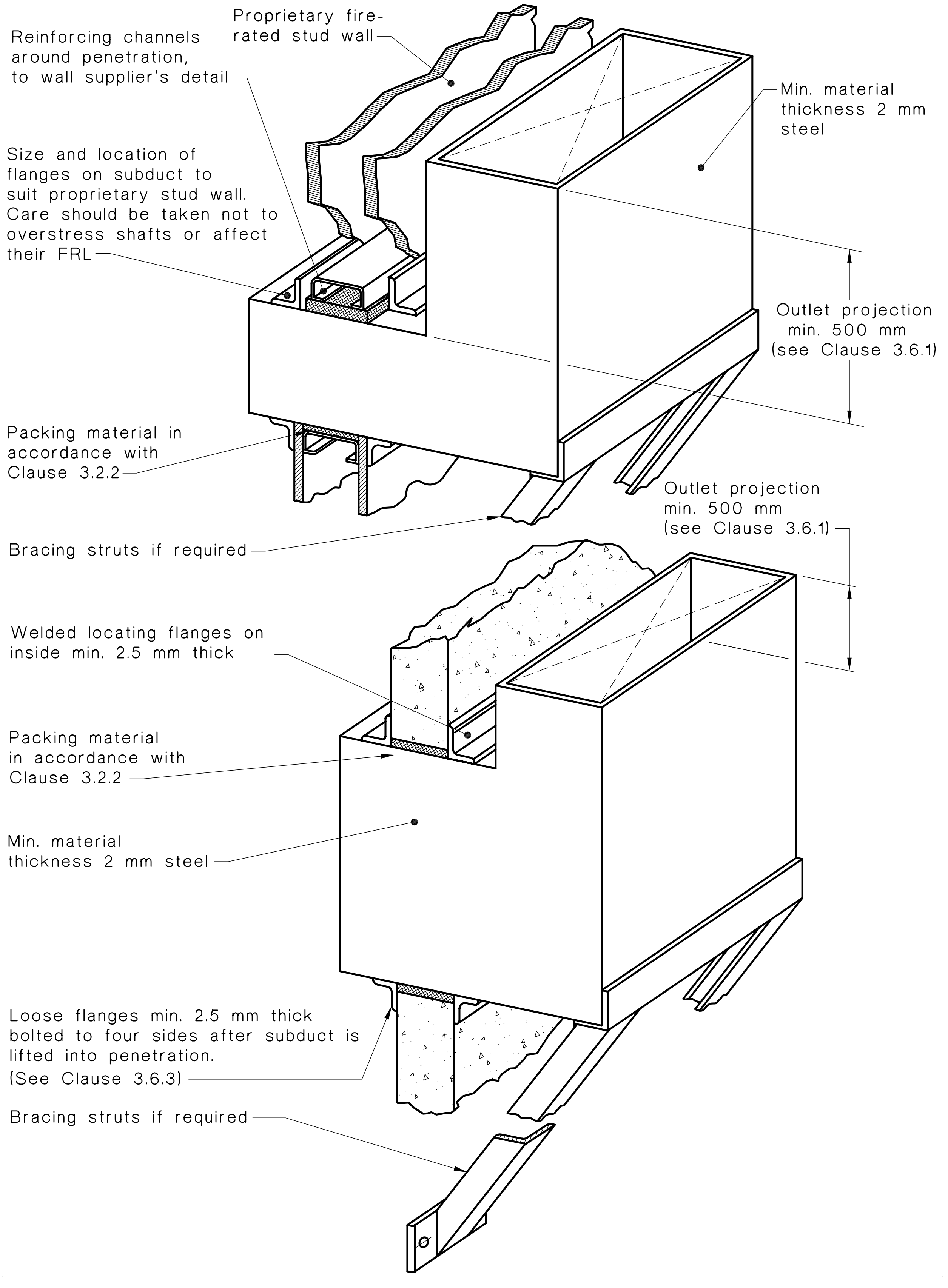
3.8 INDIVIDUAL AIR-HANDLING SYSTEMS Mechanical components of an individual air-handling system, which forms part of a smoke control system located in areas outside the fire compartment it served, shall be isolated from all such areas with construction to maintain the required FRL.

> ***C3.8*** *Individual air-handling plants need not be fire-separated from the compartment they serve. However, where components are located within or pass through a compartment which they do not serve, they should be fire isolated to maintain the integrity of each compartment.*



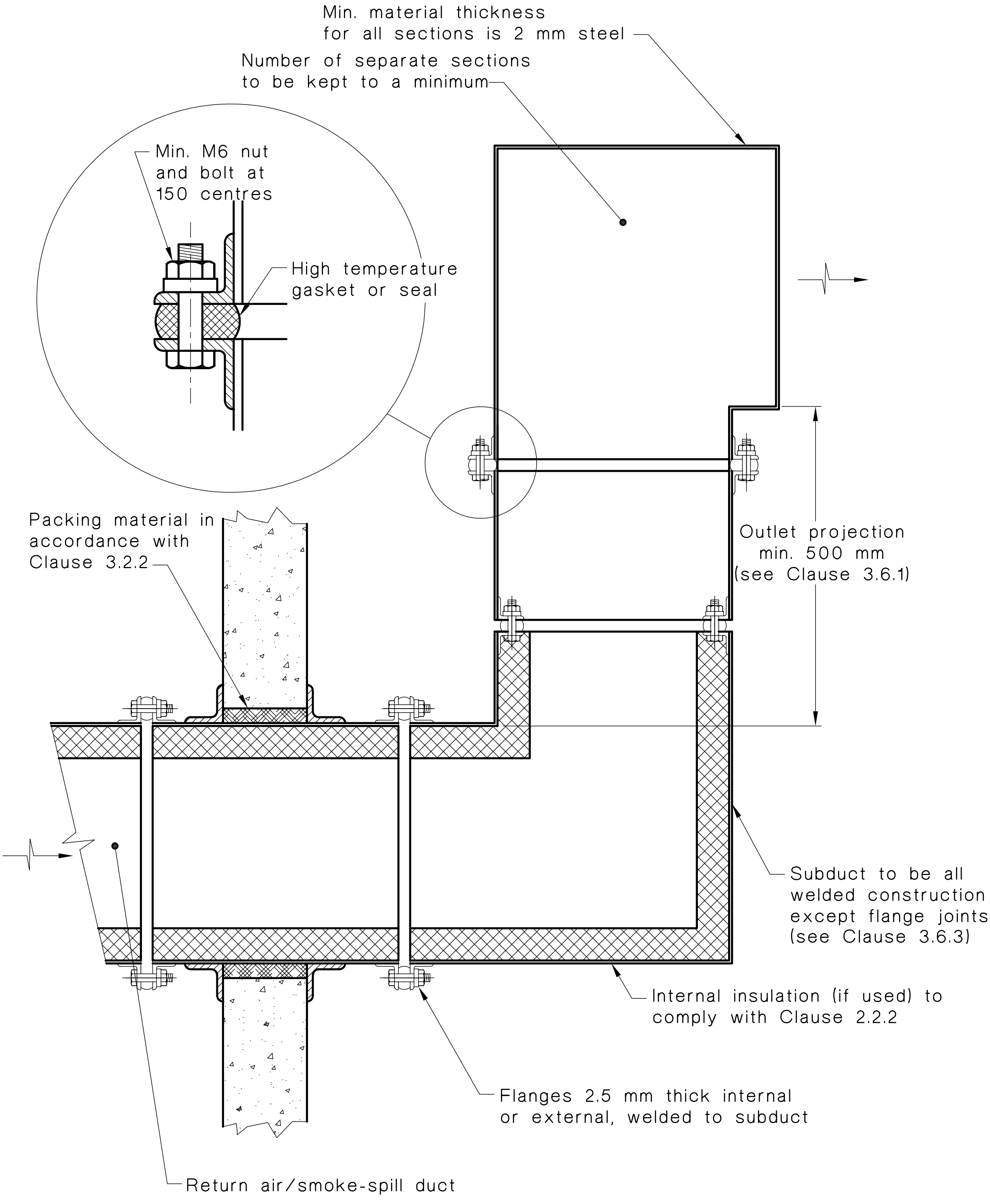
DIMENSIONS IN MILLIMETRES

FIGURE 3.3 DIAGRAMMATIC ILLUSTRATION OF A TYPICAL SMOKE-SPILL SUBDUCT ATTACHED TO THE INSIDE OF A SHAFT



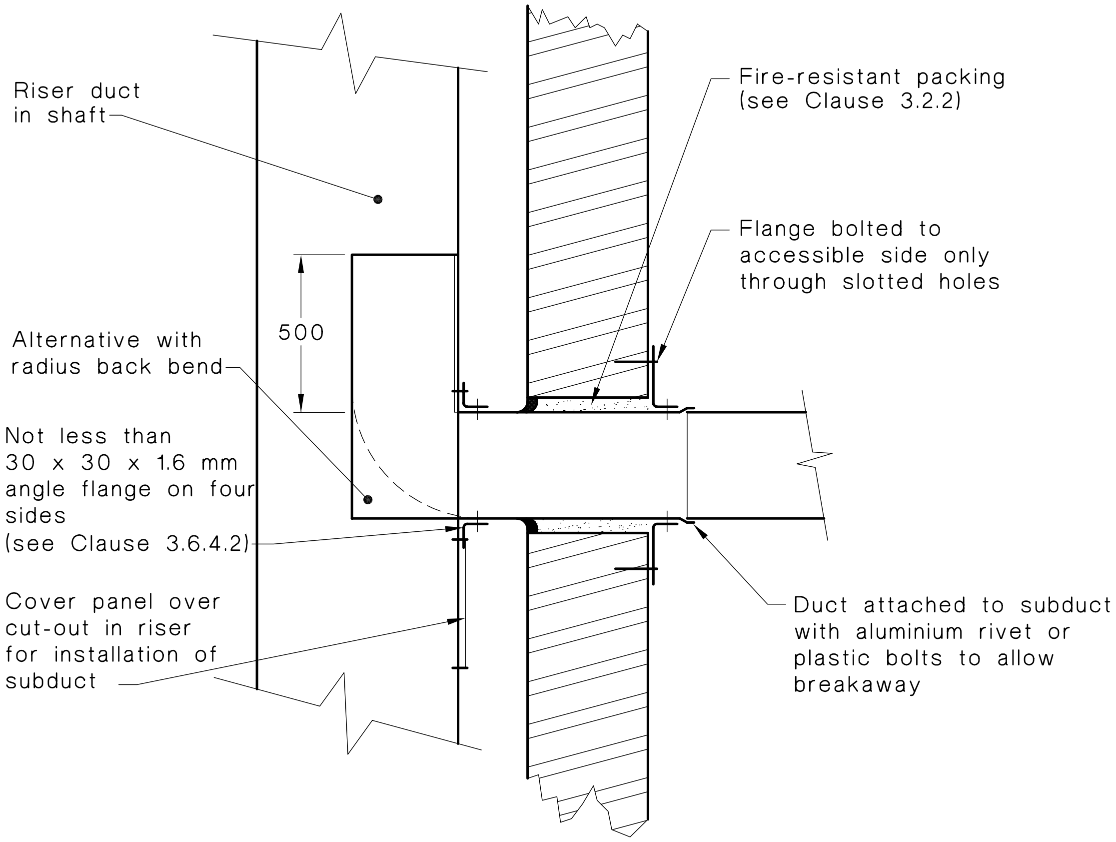
DIMENSIONS IN MILLIMETRES

FIGURE 3.4 DIAGRAMMATIC ILLUSTRATION OF A TYPICAL SUBDUCT ATTACHED THROUGH WALL OF SHAFT

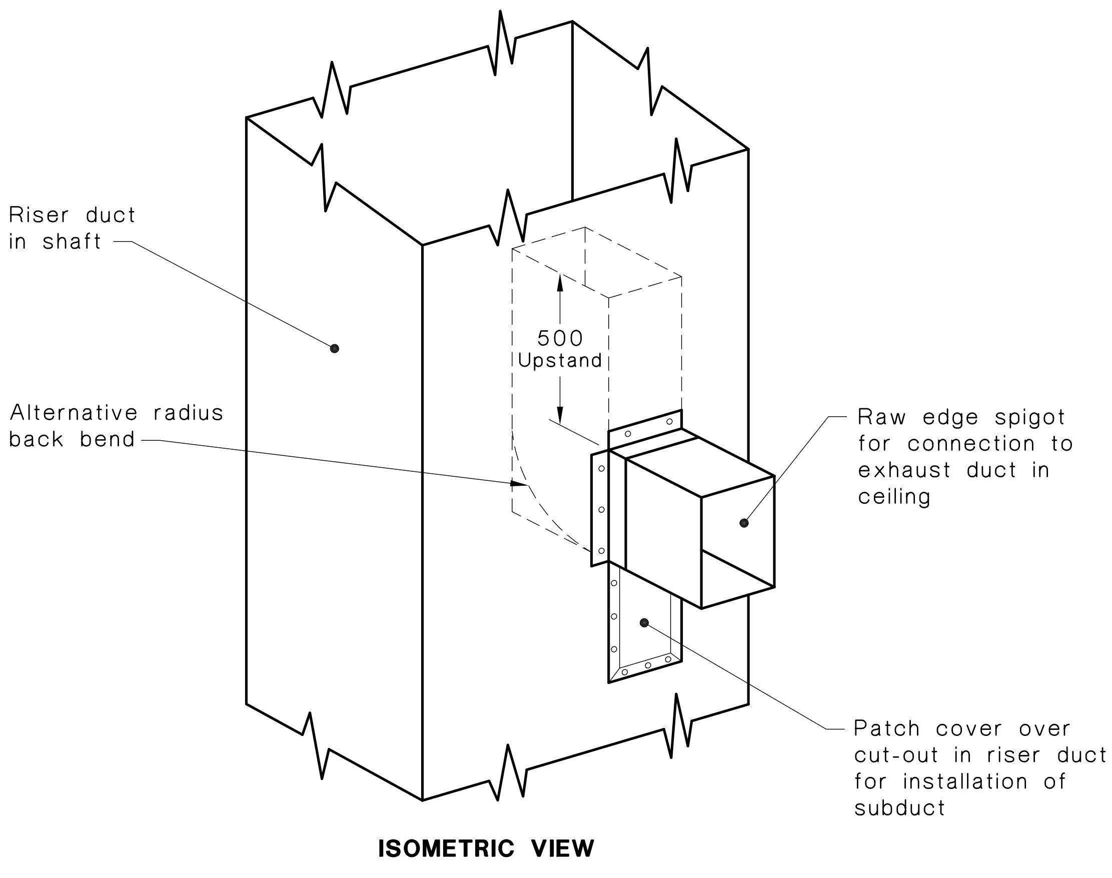


DIMENSIONS IN MILLIMETRES

FIGURE 3.5 TYPICAL CONSTRUCTION OF SECTIONAL SMOKE-SPILL SUBDUCT



SECTIONAL ELEVATION



ISOMETRIC VIEW

DIMENSIONS IN MILLIMETRES

FIGURE 3.6 TYPICAL CONSTRUCTION OF MINOR EXHAUST SUBDUCT

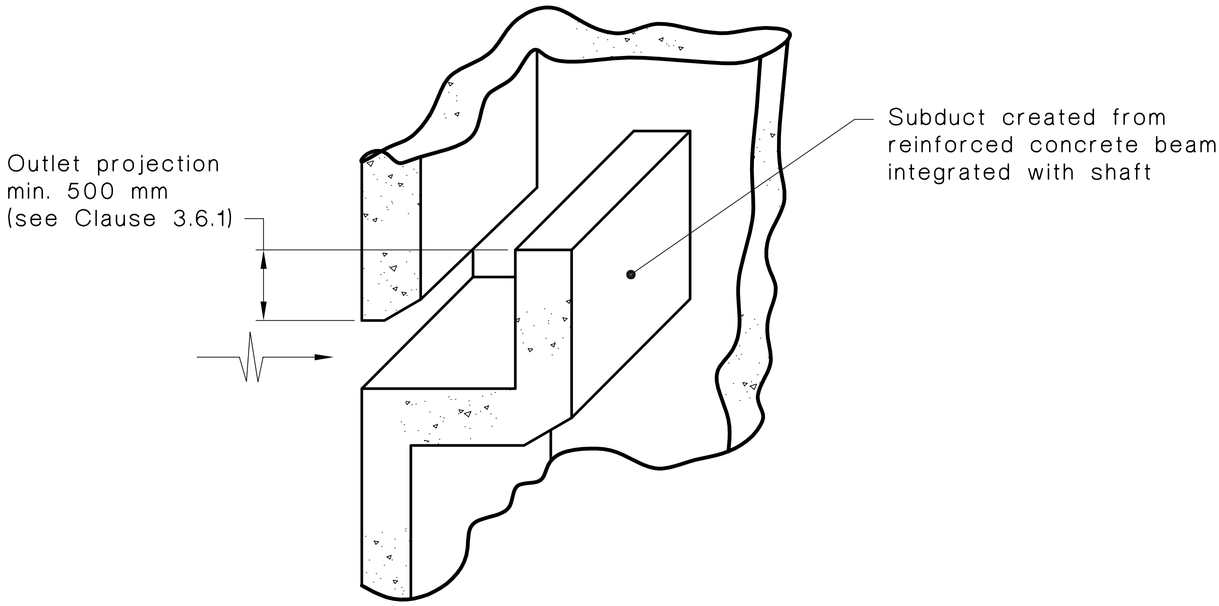


FIGURE 3.7 TYPICAL 'ALTERNATIVE MATERIAL' SUBDUCT USING REINFORCED CONCRETE

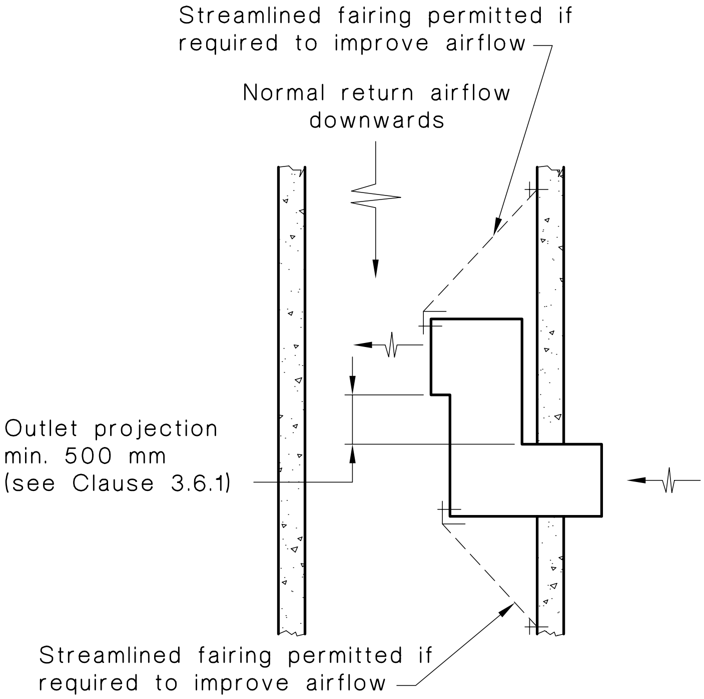


FIGURE 3.8 NORMAL DIRECTION OF AIRFLOW DOWNWARDS

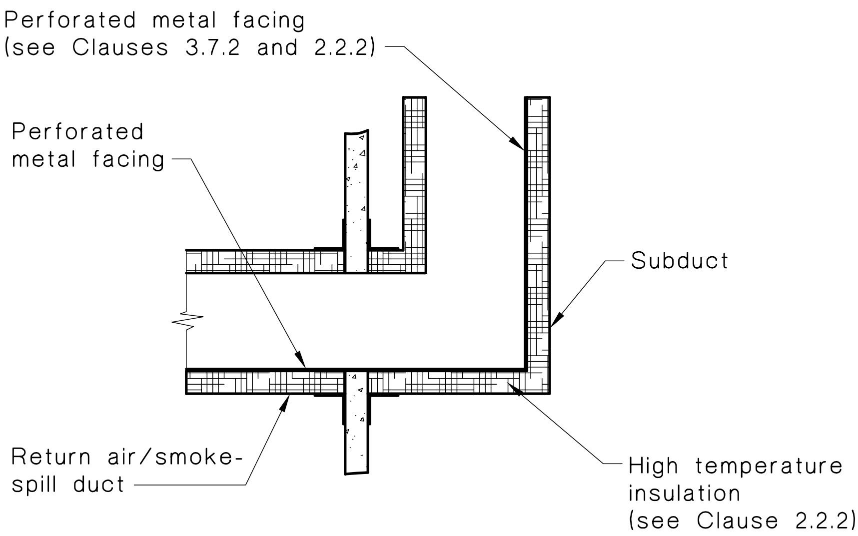


FIGURE 3.9 TYPICAL INTERNALLY INSULATED SMOKE-SPILL DUCTWORK

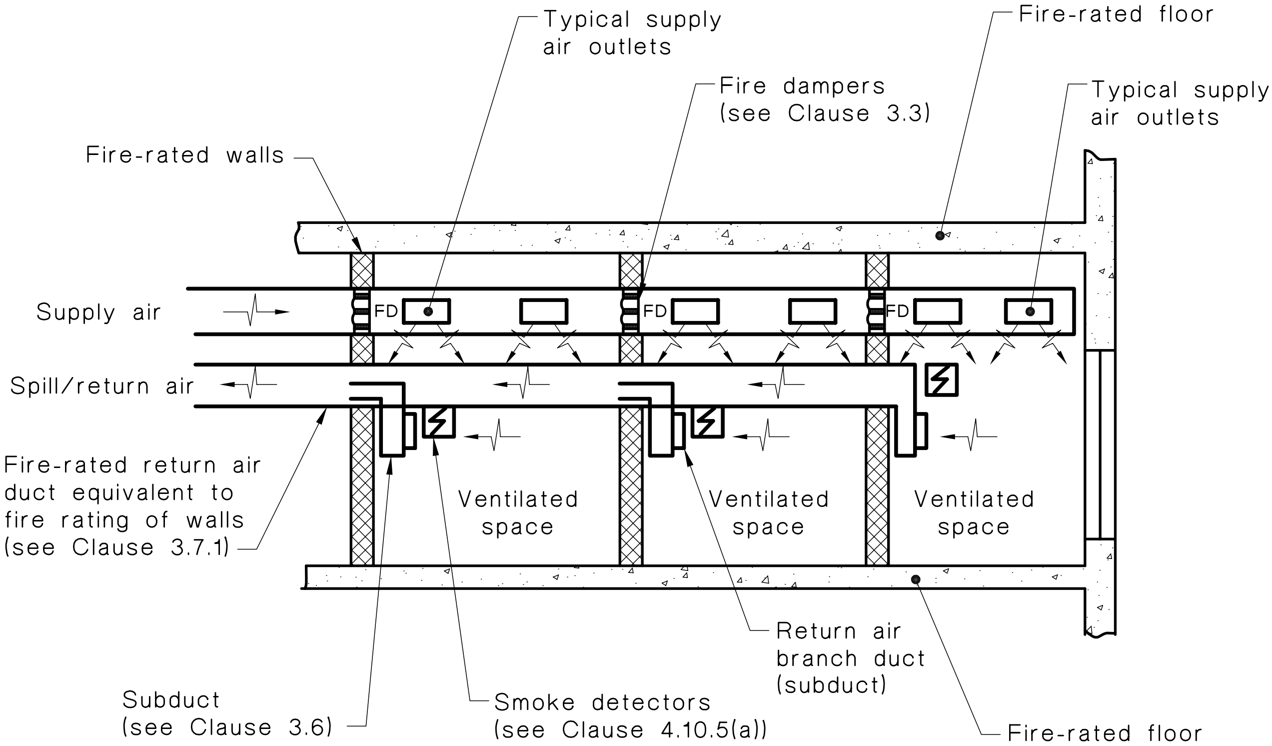


FIGURE 3.10 AIR PURGE SYSTEM—TYPICAL INSTALLATION WHERE INDIVIDUAL STOREYS ARE SUBDIVIDED INTO SEPARATE COMPARTMENTS

SECTION 4 SMOKE CONTROL SYSTEMS — GENERAL REQUIREMENTS

4.1 SCOPE OF SECTION This Section sets out the general requirements for air-handling systems used for smoke control. The requirements of this Section shall be applied to all mechanical air-handling systems required to incorporate smoke control provisions in conjunction with the specific requirements of Sections 6, 7, 8, 9 and 10, as appropriate.

C4.1 *There are various air-handling system arrangements which can be used to achieve the objectives of smoke control required by Clause 1.2. This Section sets out requirements for those components and aspects common to such air-handling systems.*

4.2 LOCATION OF EXTERNAL OPENINGS Outdoor air intakes and discharge openings for smoke-spill air shall be appropriately located to minimize the possibility of smoke contamination of the intake air.

NOTE: See requirements for air-intake and air-discharge locations in AS 1668.2.

C4.2 *This Standard does not seek to lay down firm rules for the location of openings in the exterior walls of buildings as each opening for each building requires individual consideration. Factors to be taken into account include the purpose of the opening, its proximity to other openings and to external hazards, the effect of wind and the effect of surrounding buildings on airflow.*

Ideally, smoke-spill discharge openings should be located on the leeward side of the building. Intake openings for supply air and for the pressurizing of stair or lift shafts should be located on the windward side at a level below that of the smoke-spill opening. It may be desirable to carry out model studies of the building and its environs to select the optimum locations of openings.

To further assist designers, the following guidelines are provided:

(a) Outdoor air intakes should not be located beneath any awning, colonnade or other building projection, or set back where smoke may be trapped under the overhang or recess.

(b) Discharge openings above the roof of the building should be designed to discharge the smoke-spill air vertically upwards or upwards at an angle not less than 45° above the horizontal and in a direction away from any outdoor air intake opening, natural ventilation opening or boundary of an adjacent allotment.

Discharge openings above the roof of the building should be located as follows:

(i) At a level higher than the top of any outdoor air intake opening that is within a horizontal distance of 8 m.

(ii) At a horizontal distance of not less than 6 m from any outdoor air intake opening, natural ventilation opening or boundary of an adjacent allotment.

(c) Discharge openings through any wall of the building should be designed to discharge the smoke-spill air at a velocity of not less than 5 m/s horizontally and in a direction away from any outdoor air intake opening, natural ventilation opening or boundary of an adjacent allotment.

Discharge openings through any wall of the building should be located as follows:

(i) At a level higher than the top of any outdoor air intake opening that is within a horizontal distance of 12 m, and separated vertically or directed such that smoke contamination of intake air is minimized.

(ii) At a horizontal distance of not less than 8 m from any outdoor air intake opening or natural ventilation opening, situated in a different wall face.

(iii) At a horizontal distance of not less than 12 m from any outdoor air intake opening in the same wall face, natural ventilation opening in the same wall, or boundary of an adjacent allotment.

Chapter 15 of the 1997 ASHRAE Fundamentals Handbook contains comprehensive information on airflow around buildings, dispersion of building exhaust gases and designs to minimize re-entry. Particularly critical cases may warrant wind tunnel testing of models.

4.3 DIRECTION OF SMOKE-SPILL AIRFLOW UNDER SMOKE-CONTROL CONDITIONS Wherever possible the direction of assisted airflow in the smoke-spill system shall be such that the natural convection flow of smoke is assisted. Where the direction of airflow is downwards it shall be demonstrated that the performance of the system is not compromised in respect to the objectives of this Standard.

C4.3 *This Clause emphasizes that regardless of whether the direction of return airflow is upwards or downwards under normal operating conditions, it is recommended that the flow of smoke-spill air is always upwards (except between compartments on the same level). Where return airflow is downwards, subducts, as illustrated in Figure 3.8, should be used. It is considered that only in the most unusual of circumstances would smoke-spill air be designed to flow downwards.*

4.4 LOCATION OF SMOKE-SPILL SYSTEM INLETS Air inlets for the collection of smoke shall be located so as not to assist the movement of smoke towards a required exit.

C4.4 *Smoke spread in the vicinity of a fire is predominantly governed by the buoyancy and expansion forces of the smoke and hot gases. However, the location of smoke-spill air inlets in mechanically assisted systems can have a significant effect on the movement of cooled smoke in regions away from the immediate vicinity of a fire. It is, therefore, important to ensure that such inlets are not located so as to assist the movement of smoke to principal evacuation routes leading to required exits (e.g. public corridors). The use of return air ceiling plenums as the smoke-spill paths meets this requirement and is encouraged.*

4.5 HEAT EXCHANGE EQUIPMENT Air-to-air heat exchange equipment located in the smoke-spill path forming part of the supply air system shall not be exposed to the smoke-spill stream when operating in the fire mode.

4.6 NOISE The noise level during operation of the smoke control systems (including smoke-spill fans and air pressurization fans) shall not exceed 65 dB(A) in occupied spaces or 5 dB(A) above the ambient noise levels to a maximum level of 80 dB(A). Noise levels in fire-isolated exits shall not exceed 80 dB(A).

C4.6 During emergency egress situations, system noise levels may interfere with command conversation, which may represent a threat to safe occupant evacuation or may contribute to occupant distress in the event of a fire. For this reason, the maximum sound pressure level generated by smoke control systems should not exceed 65 dB(A) and never exceed 80 dB(A) in the occupied space. On reaching the safety of a fire- isolated exit, occupants can egress with considerably less verbal direction and, as such, can safely sustain higher sound levels. To this end, the maximum sound pressure level in the fire-isolated exits should not exceed 80 dB(A). The designer should select mechanical equipment that will not increase noise to above these levels. Certainly, the noise generated by the supply air fan to pressurize a stair shaft should not deter people from entering the stair shaft.

4.7 FIRE DOORS' PRESSURE DIFFERENTIALS Pressure differentials across fire doors providing access to fire-isolated exits shall be such that—

(a) the force to open any door against the combined effect of the air pressure differential and any self-closing mechanism does not exceed 110 N at the door handle; and

(b) doors are not prevented from closing and latching, i.e. the force due to air pressure on the door leaf does not exceed the force of the self-closing or automatic-closing device and latching device (where provided).

NOTE: Reference should be made to AS/NZS 1905.1 for automatic-closing force.

C4.7 To ensure exits are available at all times, it is critical that the maximum force required to open doors does not exceed 110 N. This limit is applicable to all smoke control systems irrespective of whether exits are pressurized or not. Calculations need to be made for the 'worst case' situation. In zone pressurization systems, pressurization of non-fire-affected compartments could prevent the doors from closing. Whilst this is unlikely to cause pollution of the exit, it may affect the pressure differential between the compartments. The principle of requiring doors to close and latch in a fire situation should be retained.

4.8 SMOKE-SPILL FAN

4.8.1 General Each smoke-spill fan, complete with its drive, flexible connections (where required), control gear and wiring shall be constructed and installed so that it is capable of continuous operation at its rated capacity as follows:

(a) In sprinklered buildings the fan shall operate for a period of not less than 2 h with a smoke-spill air temperature of 200°C.

(b) In unsprinklered buildings, the fan shall operate for a period of not less than 30 min with a smoke-spill air temperature of 300°C.

The smoke-spill fan shall be type-tested for these rating requirements in accordance with AS 4429(Int).

Apart from fuses and circuit-breakers used for protection of circuits, all safety devices intended for the protection of smoke-spill fans and their ancillaries shall be automatically overridden during the fire mode to ensure continued operation.

C4.8.1 *Calculation of expected smoke-spill air temperatures at the smoke-spill fan is a complex process and depends on many variables including—*

(a) expected fire size, which will vary from compartment to compartment;

(b) size and configuration of the affected compartment;

(c) materials of construction, volume of materials and their thermal inertia;

(d) ventilation (including leakage) rates;

(e) air-handling system arrangement including distance of the smoke-spill fan from the actual fire or smoke reservoir;

(f) cooling effect from water sprinkler systems;

(g) cooling effect from return air from non-fire-affected compartments; and

(h) proximity of smoke-spill fan to fire source.

4.8.2 Selection criteria Smoke-spill fans shall be selected to handle the design volumetric airflow rate (calculated at the smoke-spill air temperature) at the installed system resistance under ambient temperature conditions. The fan motor shall be selected such that it will not overload during testing at ambient conditions.

C4.8.2 *Fan manufacturers should be informed that fans will be required to operate at ambient and fire-mode conditions, otherwise the motor may have insufficient power and may overload.*

4.9 INITIATION OF SMOKE CONTROL SYSTEMS Smoke control systems shall be initiated by smoke detectors in accordance with Clause 4.10. Other fire safety systems may be utilized to provide smoke control system initiation in accordance with Clause 4.11.

C4.9 *Smoke detection systems are required to provide timely operation of the smoke control system, ideally before the fire has developed to sufficient intensity to operate a thermal detector or sprinkler system. The early detection of smoke is considered an essential element of the smoke control system.*

4.10 AUTOMATIC SMOKE DETECTION FOR SYSTEM CONTROL

4.10.1 Type Point type smoke detectors shall be of the photoelectric or ionization type in accordance with AS 1603.2. Duct sampling units shall be in accordance with AS 1603.13. Multi-point-aspirated smoke detectors shall be in accordance with AS 1603.8. Where heat detectors are required, they shall comply with AS 1603.1.

NOTE: In some applications smoke detectors are inappropriate (e.g. kitchen exhaust) and heat detectors are required.

Detection of smoke in a duct or chamber shall be accomplished with a duct sampling unit or multi-point-aspirated smoke detector based on the photoelectric principle. Point type ionization detectors shall not be used at exit doors.

4.10.2 Sensitivity of detectors Detectors shall comply with the following:

4.10.2.1 *General*

(a) Occupied space detectors—

   (i) photoelectric—nominal response threshold of not more than 8% Obs/m (AS 1603.2); or

(ii) ionization—nominal response threshold of not more then 0.4 MIC X (AS 1603.2); or

(iii) multi-point-aspirated smoke detectors—nominal response threshold determined for each sampling point shall not be more than 4% Obs/m (AS 1603.8).

NOTE: Incorporation of AVF or equivalent within a detector to minimize false alarms is acceptable.

(b) Supply or outdoor air detectors—

(i) photoelectric duct sampling unit—nominal response threshold of not more than 8% Obs/m (AS 1603.13); or

(ii) multi-point-aspirated smoke detectors—nominal response threshold determined for each sampling point shall not be more than 4% Obs/m (AS 1603.8). There shall be a minimum of two sampling points per source of air.

AVF or equivalent delays shall not be applied.

(c) Exhaust duct heat detectors—sealed type detector marked for 200°C (AS 1603.1 or NZS 2139).

NOTE: Care should be taken to prevent duct detection devices from being exposed to temperatures colder than the air being sampled, as moist air can condense and build-up of water on or within the assembly can cause false alarms.

Equivalent sensitivities shall be applied in New Zealand in accordance with NZS 4512.

4.10.2.2 *Relative sensitivity of detectors* In zone pressurization systems all smoke detectors shall have the same nominal sensitivity where providing an alarm from—

(a) the occupied space and any air inlet to a shaft, duct or plant; or

(b) adjacent fire or smoke compartments.

C4.10.2.2 *A mix of detector sensitivities (including point/multi-point type) in different locations or compartments could result in the air-handling plant serving a non-fire-affected compartment, operating as if it was the fire-affected compartment. Where in-duct or air-handling plant enclosure sensing (as compared to the occupied space) is unavoidable, a mix in detector sensitivity is not considered to be a problem as shutdown of the air-handling plant will still occur although full building zone pressurization mode has not been initiated. In this case one of the devices specified in Clause 4.10.2(b) should be used.*

4.10.3 Control and indicating equipment Automatic smoke detectors shall be connected to control and indicating equipment complying with AS 4428.1 Grade I or II. This equipment may be combined with any building automatic detection/suppression system or be dedicated to the smoke control system.

4.10.4 Alarm zones Except as required by Clause 4.10.5(b), (c) and (d), occupied space detectors associated with zone pressurization systems shall be connected to form a separate alarm zone for each fire compartment subject to the maximum number of devices permitted per circuit under AS 1670.1.

C4.10.4 *Designers should be aware that correct initiating actions from the detectors in the respective compartments is critical for the correct operation of zone pressurization systems.*

4.10.5 Location Except where detectors can be located to provide multiple coverage, automatic smoke detectors shall be located to sample air as follows:

(a) *Occupied space* In the absence of a smoke detection system in accordance with AS 1670.1 or NZS 4512 as applicable, smoke detectors shall be located on an ‘extended’ spacing basis of a maximum 20.4 m grid layout.

Where a system using heat detectors complying with AS 1670.1 is installed, the smoke detectors shall be interspersed accordingly to the existing spacing criteria which may extend to 21.6 m, in place of heat detectors.

Smoke detectors and sampling points shall be located adjacent to each return/relief/economy air inlet to a shaft, duct or plant as applicable.

Such detectors and sampling points shall be ceiling-mounted in accordance with AS 1670.1 and arranged at natural collection points for hot smoke having due regard to the ceiling geometry and its effect on the smoke migratory path via corridors within partitioned areas.

A detector or sampling point shall be located adjacent to each required exit and lift landing door, set back horizontally from the door opening by a distance not less than 1.5 m or no greater than 3.0 m. Where a corridor leading to exits is formed by floor to ceiling height partitions and access doors from rooms leading into such corridors are within 1.5 m of the required exit, then the detector shall be set back to not less than 0.3 m from the exit. (See Figure 4.1(b).)

Where tenancy fitouts using floor to ceiling height partitions occur, smoke detectors shall be located to cover all smoke migratory paths where thus formed, in compliance with the extended spacing criteria (see Figure 4.1(a)). Additional detectors may be necessary in these cases to cover all smoke migratory paths.

C4.10.5(a) *Smoke detection usually provides an earlier warning than heat detection or fire sprinklers and, therefore, should be incorporated throughout the occupied space. An extended spacing in accordance with BCA provisions is considered appropriate. Where an AS 1670.1 or NZS 4512 fire detection system is proposed, such detectors may be interspersed within the normal required grid spacing. Two separate systems are not required.*

Where smoke detection is required for smoke control, then smoke detectors should be incorporated in the occupied space and at air inlets to shafts, ducts or plant to cover normal air movement patterns. Such air patterns should be assessed in alternative directions if multiple return air or separate relief air shafts are utilized. In this case separate detectors for return and relief air would be required. Where return/relief air is conveyed through ceiling voids, those smoke detectors only required at air inlets to shafts, ducts or plant should be contained within the ceiling void.

The use of ionization and photoelectric smoke detectors located on an alternate basis throughout the occupied space is desirable. For health care buildings, the alternate basis (within corridors) has been a traditional method that is still recommended unless a very sensitive multi-point-aspirated detection system is utilized.

Smoke detectors are located near fire-isolated exits to ensure that smoke control systems operate prior to smoke entering the stairwells. Whilst activation of the smoke control system also occurs from the occupant space detection, the entries to fire-isolated exits are usually via corridors where smoke may migrate. The range for smoke detector location provides flexibility in design with the intention that smoke in any corridor leading to the fire-isolated exit, which has a room accessible from that corridor, is detected within 0.3 to 1.5 m of exit entry. Otherwise, the maximum 3.0 m distance applies where such a detector may form part of the occupant space system.

(b) *Supply or outdoor air-handling systems* In the supply airstream to obtain a representative sample of supply air in those systems required or allowed to operate in the fire mode using any supply air fan to deliver outdoor air to a single or multi-compartment during fire mode.

The detector shall be located downstream of the air filter and supply air fan of each air-handling plant and upstream of the first branch take-off or, where this is not possible, within the outdoor/return air mixing chamber upstream of the supply air fan. (See Figure 4.1(C)).

The detector shall indicate on the FIP but shall not raise a fire alarm and shall only provide control of the supply air fan operation. The fan shall stop on detection of smoke.

The AZF monitoring the supply or outdoor air detector shall initiate a control signal to restart the supply air fan (where activated to operate in the fire pressurization mode) after the detector has been in the non-alarm state for a continuous period of not less than 60 s nor more than 75 s. The AVF shall not apply to this alarm zone.

Detectors installed in air-handling systems shall be provided with permanent indelible labels, stating fire alarm zone designation and detector number, affixed adjacent to the detectors. All visual alarm indicators on smoke detectors located in air-handling systems shall be clearly visible. Where this condition cannot be met, appropriately labelled remote indicating devices shall be provided.

C4.10.5(b) *Induct or air-handling plant enclosure smoke sensing should be avoided for general smoke alarm as this is adequately covered by the occupant space and air inlet to shaft, duct or plant detectors considered to be at the fire source. However, for supply air, outdoor/return air mixing or where outdoor air is necessary and contamination of this source is to be detected, induct or air-handling plant enclosure smoke sensing may be inevitable.*

The most efficient method of sensing within the ductwork or mixing chamber of air-handling units is currently by use of the aspirated smoke detector system. A duct sampling unit (AS 1603.13) can also be regarded as a sampling system. However, this is not the same as an aspirated detection system which would typically consist of a device drawing air from one or more locations by means of pipe(s) having sampling points along the length of the pipe. The sampled air is passed through the sensing portion of a very sensitive smoke detector sensing head, which initiates an alarm signal at a level selected to suit the particular environmental conditions associated with the protected areas.

(c) *Exhaust ducts* Ducts that are used for exhausting cooking fumes, flammable vapours, lint material and the like shall have at least one fully sealed heat detector (AS 1670.1) or monitored sprinkler head (AS 2118.1) at the furthest practicable downstream point of the duct.

NOTE: Detectors for this application should be carefully selected to suit the temperature, humidity and contaminant levels of the environment so that spurious alarms are minimized.

(d) *Lift shaft zone* Lift shafts that are required to be pressurized in accordance with Section 8 or Section 10 of this Standard shall incorporate smoke detectors as follows:

(i) One detector located at the top of the shaft or group of shafts within the overrun area.

(ii) One detector located at the bottom of the shaft or group of shafts within the pit area.

(iii) One detector located in the lift motor room if that motor room forms part of the pressurization system.

Detectors shall indicate as separate alarm zones.

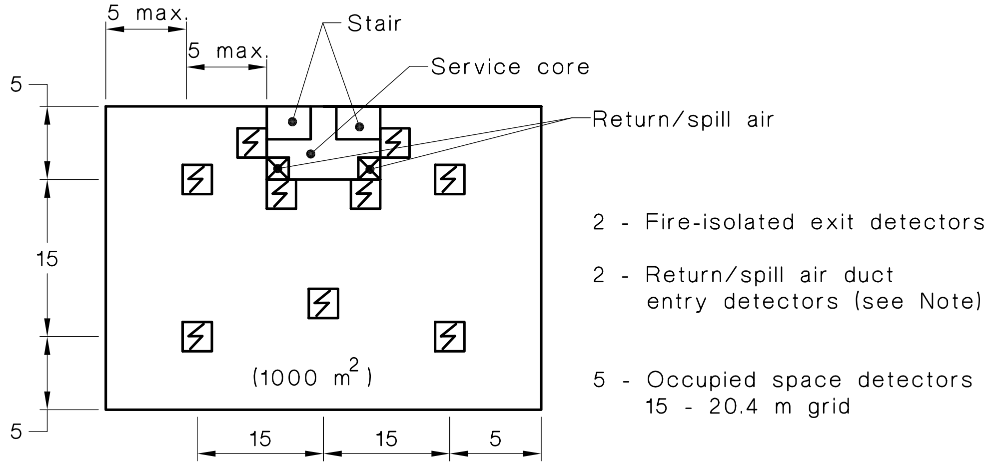
NOTE: Mechanical protection of detectors in pit areas should be considered.

4.10.6 Installation Automatic smoke detectors located in accordance with Clause 4.10.5 shall be installed in accordance with the relevant requirements of AS 1670.1 or NZS 4512, as applicable.

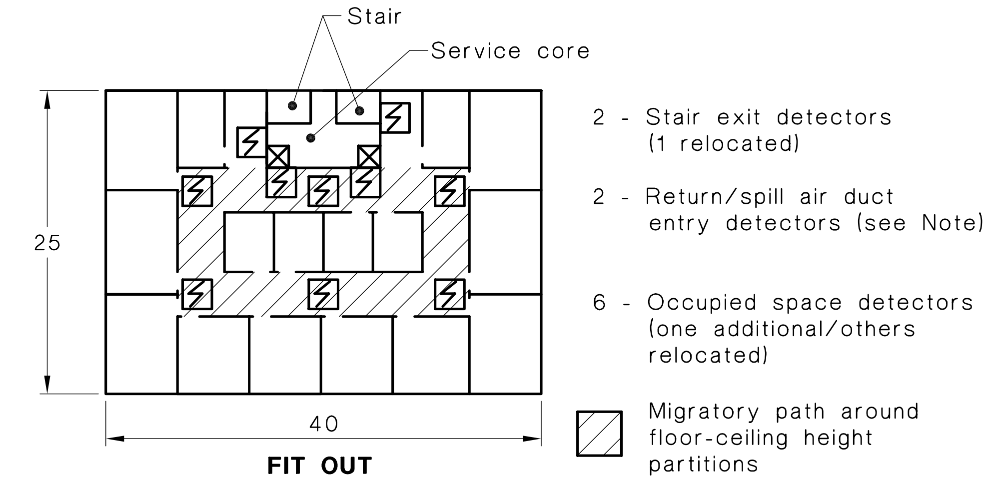
4.11 OTHER FIRE SAFETY SYSTEMS AND SYSTEM CONTROL Activation of fire sprinkler systems and manual call points shall only activate common building smoke control systems such as system shutdown, air purge, lift shaft pressurization and fire-isolated exit pressurization.

Fire sprinkler systems shall not provide activation for zone pressurization systems unless the sprinkler system is zoned identically to the smoke control system zoning. Manual call points shall not activate zone pressurization systems.

C4.11 *If fire sprinklers inadvertently activate zone pressurization systems outside of the area affected by the fire event, then the system may act to spread smoke throughout the building and not contain or restrict it. The proper operation of zone pressurization systems relies on accurate identification of the fire location. Manual call points could be activated by persons not in the fire-affected compartment, thus sending false signals to the smoke control system. (See Clause C8.2).)*

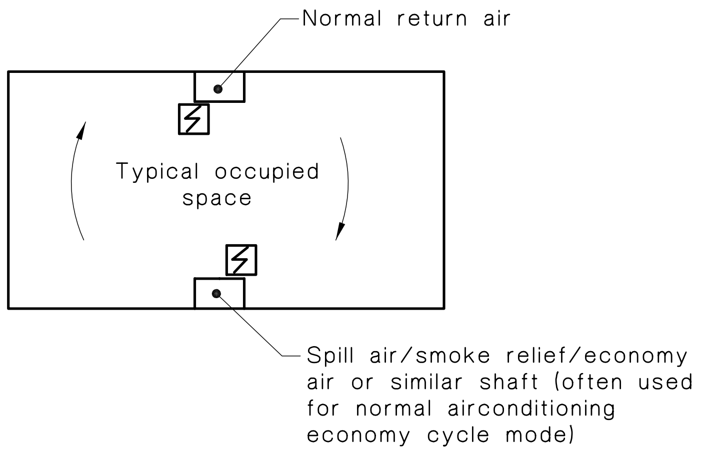


OPEN PLAN



FIT OUT

NOTE: Where return/relief air path is via the ceiling void, the return/relief air duct entry smoke detectors should be within the ceiling void.



NOTE: Where the return air/spill air, under normal airconditioning mode, can take two (or more) alternative paths, location of the return/spill detectors should cover all possible paths.

DIMENSIONS IN METRES

FIGURE 4.1(A) DETECTOR LOCATION

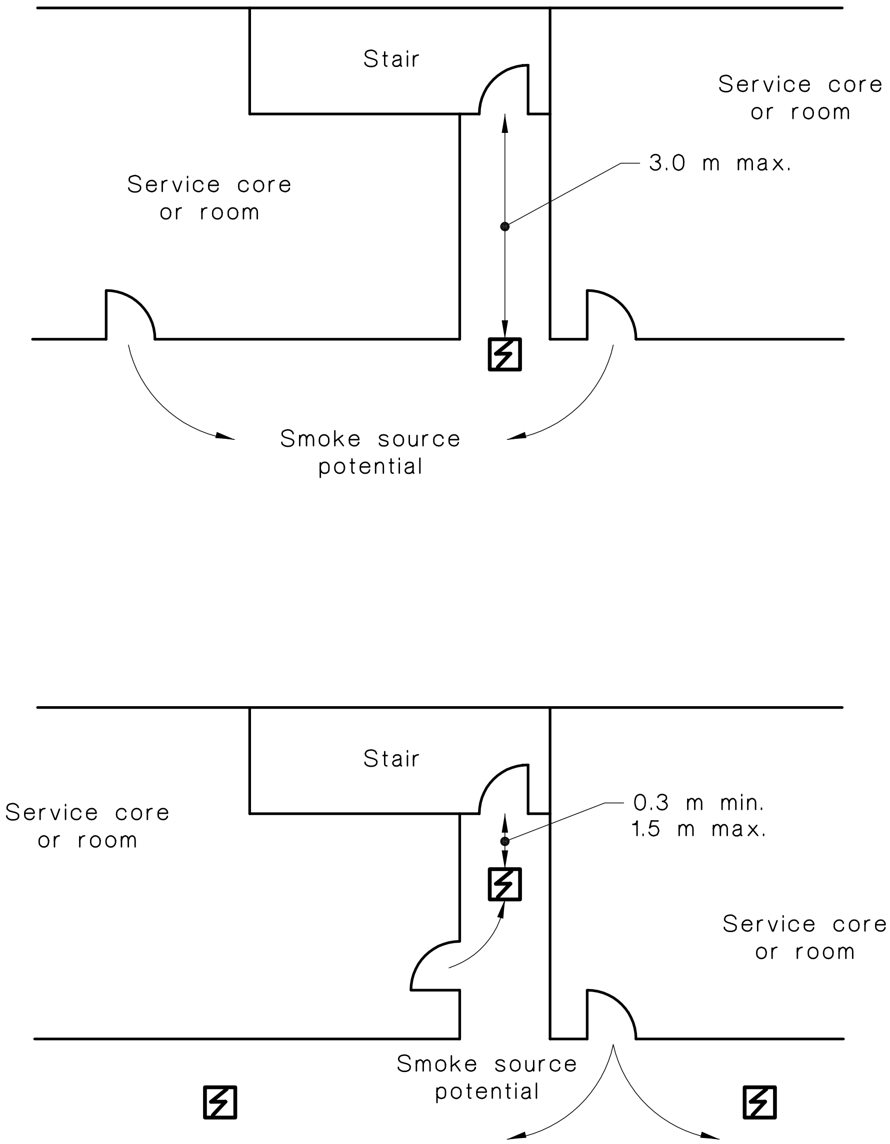
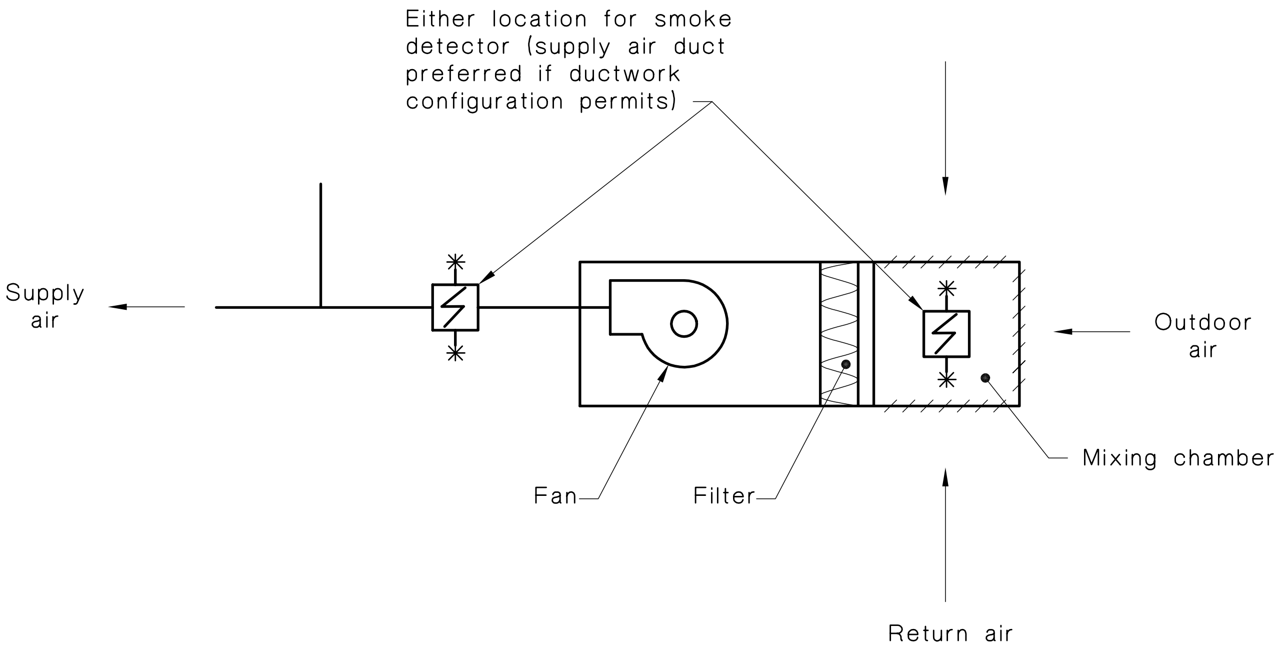
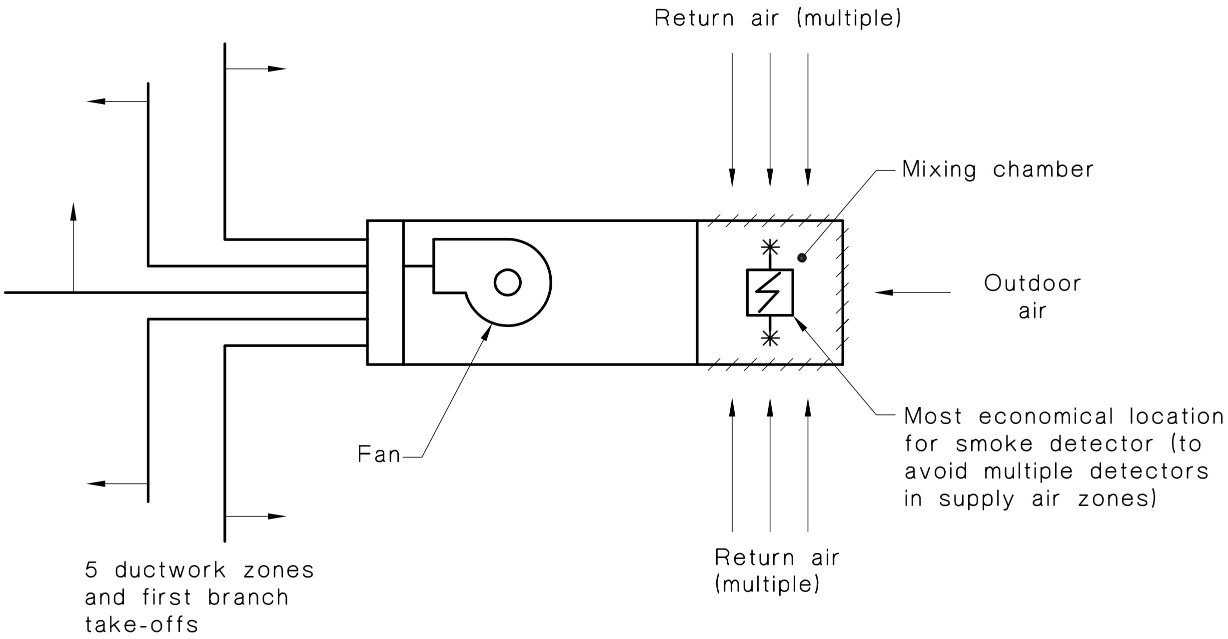


FIGURE 4.1(B) DETECTOR LOCATION



(a) AHU single duct discharge



(b) AHU multiple duct discharge

NOTE: The choice for location of the smoke detector is available to assist with the ease of access according to configuration of air-handling plant ducting arrangements.

FIGURE 4.1(C) DETECTOR LOCATION

4.12 ELECTRICAL INSTALLATION

4.12.1 Equipment Electrical equipment required to operate in the smoke-control mode, including motors, starters and speed controllers, shall be selected to meet any specific requirements of this Standard and to generally provide a high degree of reliability under likely fire conditions. Overload safety devices of variable frequency inverters in equipment shall be automatically overridden when operating in the fire mode.

NOTE: Appendix D provides guidance on the reliability of a system.

> ***C4.12.1*** *Selection of electrical equipment can have a significant effect on the reliability of the smoke control system. For example, variable frequency inverters used in variable air volume systems and stair pressurization systems could shut down if ambient temperatures exceed 40–50°C or if the power supply is disturbed, both of which are likely scenarios during a fire.*

4.12.2 Wiring Wiring systems required to function in the fire mode shall comply with AS/NZS 3013 and Appendix E. Any wiring installed within a lift shaft shall comply with AS 1735.2. Where MIMS cable is used, the final connections to equipment may be made using a flexible wiring system having a classification not less than WS52W in accordance with AS/NZS 3013.

Equipment to be wired in this manner includes—

(a) power, control and indicating circuits associated with supply air fans, smoke-control fans, and motorized dampers, except where loss of voltage cannot adversely affect the operation of the smoke-control system;

> ***C4.12.2(a)*** *It is not intended to require a fire-rated power supply or actuator system to each VAV damper; however, the VAV damper power supply should be protected in such a manner that a failure in one compartment does not render the whole system inoperative and, hence, prevent the necessary opening of VAV dampers.*

(b) supply air detector circuits; and

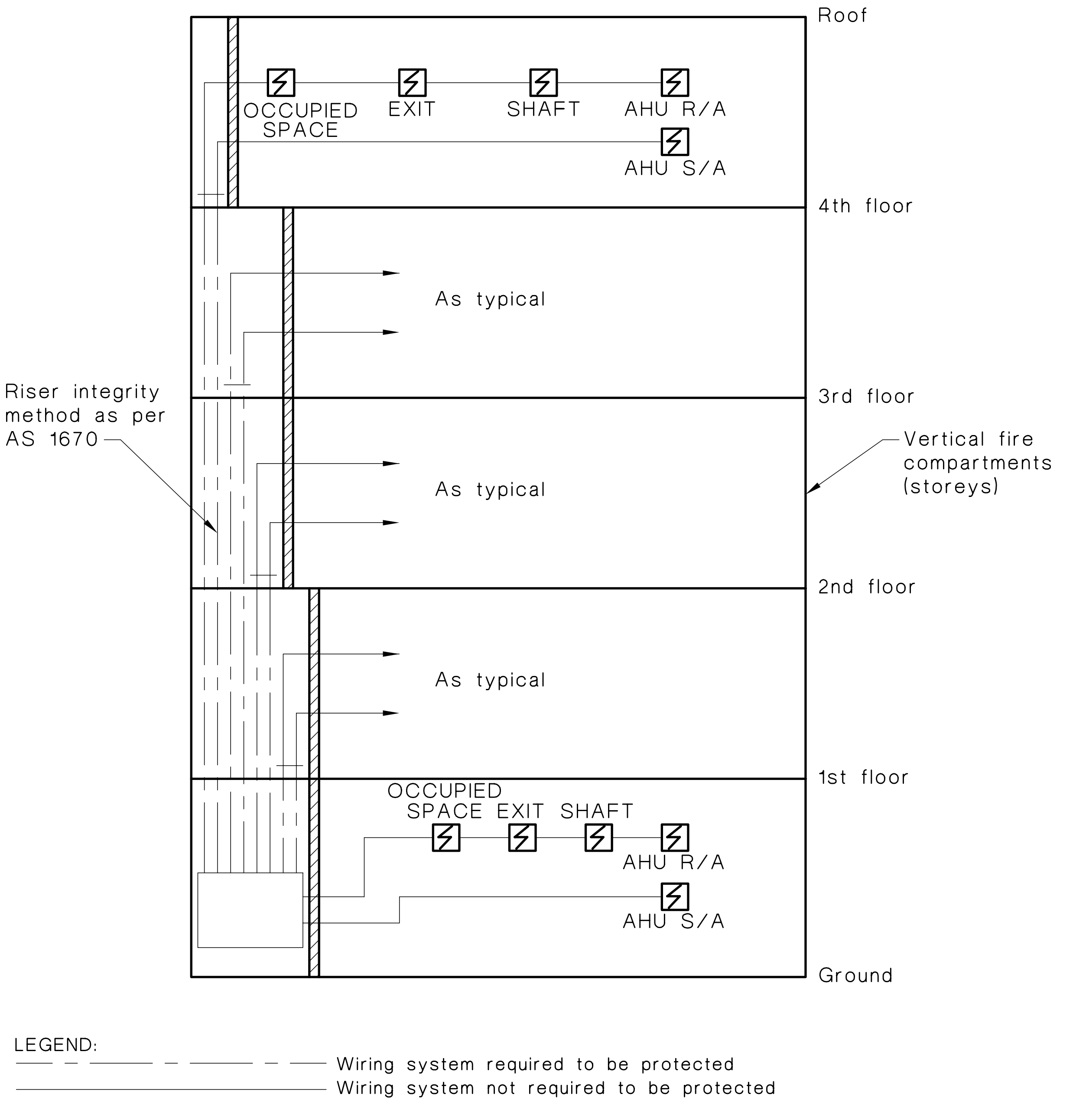
(c) return air detectors, exit detectors and other detector wiring which run through more than one fire compartment and which are used to initiate zone pressurization smoke control systems.

Wiring which runs within a single fire compartment need not be wired in this manner. (See Figure 4.2.)

NOTE: It is not intended that the requirements of this Clause apply to supply fans serving a single compartment where the wiring is contained within this compartment.

> ***C4.12.2*** *These provisions are intended to reduce the likelihood of damage to the central distribution power and control circuits of systems required to function and provide ongoing control during a fire.*

4.12.3 Equipment enclosure Any power, control or indicating panel associated with zone pressurization, fire-isolated exit pressurization, smoke-spill, or supply air fan required to operate in fire mode shall be housed in an enclosure that is fire-isolated from the occupied spaces. Separate fire-rated enclosures are not required where such boards or panels are installed in fire-isolated plantrooms or are within or adjacent to the FIP.



NOTES:

1 This Figure is applicable to addressable or conventional detection systems.

2 For control circuits, similar integrity should apply.

3 Integrity method for detection systems to be in accordance with AS 1670.1.

4 Wiring can be individual cables or multi-core as required to suit system type.

FIGURE 4.2 FIRE INTEGRITY OF DETECTION SYSTEMS

4.12.4 Isolation switches Any isolating switches located on a switchboard or adjacent to supply air or smoke-spill air fan motors shall be lockable and shall be fitted with a prominent warning label as follows:

> **WARNING: THIS ISOLATING SWITCH MUST BE LOCKED IN THE 'ON' POSITION AS THE FAN IS REQUIRED TO OPERATE DURING A FIRE.**

4.12.5 Power supply Smoke control systems shall be supplied from the essential electrical power supply.

NOTE: Where adequate emergency supplies to essential services are available, it is recommended that smoke-control and air pressurization systems be supplied with emergency power.

4.13 CONTROL AND INDICATION

4.13.1 Functions A fire fan control and indication panel (FFCP) shall be provided to perform the following functions:

(a) Control the automatic operation of the air-handling equipment (fans and zone smoke control dampers) during fire mode, in accordance with the requirements of this Standard.

(b) Except for systems incorporating system shutdown for smoke control, provide manual controls to override the automatic operation of the air-handling equipment in accordance with the requirements of this Standard.

(c) Except for systems incorporating system shutdown for smoke control, indicate the status of the air-handling equipment.

The FFCP shall be constructed in accordance with the requirements of AS 4428.7 or NZS 4512 as applicable.

The FFCP shall provide manual control of the functions of each supply air fan, exhaust fan, smoke-spill fan and zone smoke control dampers required or allowed to operate in the fire mode (except for systems covered by Clause 5.2.3). Automatic control functions shall be in accordance with the requirements of Sections 4, 5, 6, 7, 8, 9, 10 and 11 (as appropriate) of this Standard. Controls, indicators and labelling shall be in accordance with Clauses 4.13.4, 4.13.5 and 4.13.6.

The FFCP shall be incorporated in the FIP and segregated from other equipment in accordance with AS 1670.1 or located adjacent to the FIP (see Figure 4.3). Where there is no FIP the FFCP shall be in a location accessible to the fire brigade.

C4.13.1 *The FFCP provides the firefighters with the means to manually override the automatic operation of the smoke control system. It is unlikely that the firefighters will need to override the automatic operation, unless the smoke control system has been compromised by fire damage, smoke leakage or faulty operation.*

Typical uses of the FFCP would be the following:

(a) To stop a supply fan that is introducing smoke-laden air into a non-fire zone.

(b) To control a zone pressurization system by manipulation of zone smoke control dampers.

(c) To start a stair pressurization fan which has shut down due to false detection of smoke at air intake.

(d) To control a smoke-spill fan.

(e) To stop an exhaust fan that is drawing smoke-laden air into a non-fire area.

(f) To assist in clearing smoke after a fire.

4.13.2 Controls Each fan or set of zone smoke control dampers required to be controlled by the FFCP shall be served by a three position ON-AUTO-OFF switch on the FFCP for use by the fire brigade. Switches serving fans (with or without interlocked dampers) shall be labelled ON-AUTO-OFF. To avoid electrical overloads or surges during manual activation, the 'ON' position of these three position switches shall not be located between 'AUTO' and 'OFF' positions.

Switches serving zone smoke control dampers only, shall be labelled FIRE-AUTO-NON-FIRE, to indicate the status of the damper zone.

Where multiple dampers are interlocked to provide smoke control to a single compartment, then one FIRE-AUTO-NON-FIRE switch may be employed for control of the dampers. Where fan and dampers are interlocked to serve one compartment, then a single switch may provide control, labelled either ON-AUTO-OFF or FIRE-AUTO-NON-FIRE in a consistent manner throughout the FFCP.

Where multiple fans are installed in a location in order to accommodate structural geometry, i.e. they operate as if they were a single fan, then one ON-AUTO-OFF switch may be employed for control of the bank of fans provided that each fan has a dedicated contactor.

A separate smoke control system reset switch shall be installed in the FFCP or the FIP to permit independent re-setting of the smoke control system including any motorized dampers by the firefighters. Resetting by use of FIP detector circuit reset/isolation switches is not acceptable.

Where a system incorporates motorized dampers required to direct supply air or limit smoke exhaust to a certain area, it is essential that the design incorporates any necessary fan start delays, which may be necessary whilst motorized dampers drive to their set position.

Controls shall be operable at all times, i.e. whether the system is in fire mode or normal mode.

NOTE: This Standard recognizes that controls will not be operable at times of maintenance or repair.

C4.13.2 *A smoke control system in compliance with this Standard will operate automatically in the event of a fire, to restrict the spread of smoke into areas within the building, in accordance with Clause 1.2. If, however, the automatic control functions have been compromised by fire damage, smoke leakage or faulty operation, it is the intention of this Clause that the fire brigade can take manual control of the smoke control system.*

On-off override controls are specified for each supply air and each smoke-spill fan to permit manual control by authorized fire brigade personnel.

Manual controls are also specified for those sets of dampers serving each smoke control zone of a zone pressurization system (i.e. the supply air dampers and the return air dampers in each compartment). In essence, the manual override 'FIRE' or 'NON-FIRE' for these dampers carries out the same function as an 'alarm' or 'non-alarm' from the smoke detectors serving that zone, except that the manual override does not raise a fire alarm. In the case of a zone pressurization system using individual air-handling systems, manual override of the fans, with the usual damper interlocks, will usually provide adequate override control of zone pressurization or exhaust, without separate control of the dampers.

While each fan (or set of fans operating as a single fan) and each set of zone smoke control dampers are to be provided with manual override controls, the normal mode air-handling plant dampers (outdoor air dampers, relief air dampers or recycle air dampers), the shut-off system dampers and lift shaft pressurization dampers are not required to be provided with direct manual override controls. Indirect control of these latter groupings of dampers may occur as a secondary benefit of interlocks and fan start delays. In the interests of keeping the FFCP as simple as possible, as befits any emergency control system, it is recommended that the number of separate damper override switches is kept to a minimum, except where the characteristics of a project requires greater control to overcome perceived special risks.

The requirement for a separate smoke control reset switch allows the firefighters to reset detector circuits and cancel audible alarms, whilst still retaining all the functions of the smoke control system. This requirement may dictate the use of electronic memory devices or latching relays to ensure that the smoke control fans and dampers remain in their fire mode status after the FIP is reset.

Problems have been experienced where fan start and damper initiation from a closed position have been concurrent. The resultant no flow pressure differential developed by the fan required an impracticably high motor torque to open the damper, i.e. the damper did not open because the installed motor had insufficient torque. Apart from this problem, excessive negative or positive air pressure can damage distribution ductwork or building structure and should be avoided.

4.13.3 Indicators Each fan required to be equipped with a three position ON-AUTO-OFF switch shall also be provided with positive indication on the FFCP of fan operating status. Fan status shall be monitored by a pressure differential switch arranged to sense airflow or a current monitoring relay sensing fan motor current, arranged to sense a change in motor load resulting from a loss of airflow or equivalent.

The sensing device shall be selected so that a difference between design and low airflow can be indicated. These devices shall be integrated with the smoke control system control logic, to illuminate indicators on the FFCP. Indicator colours and status conditions shall be as follows:

(a) Red—indicating fan running.

(b) Green—indicating fan stopped.

(c) Amber—indicating fan fault.

For (a) and (b) a single multicolour indicator may be used. Indicators are not required for damper controls.

NOTE: A fault should be indicated where the operation (e.g. airflow) does not correspond to the actuating control signal.

In the case of multiple fans being controlled by one ON-AUTO-OFF switch as allowed under Clause 4.13.2, there shall be one red (fan running) indicator and one green (fan stopped) indicator for each fan. A minimum of one amber (fault) indicator for the bank of fans is permitted. The system designer shall in this case assess the number of fans whose incorrect operation constitutes a fault condition.

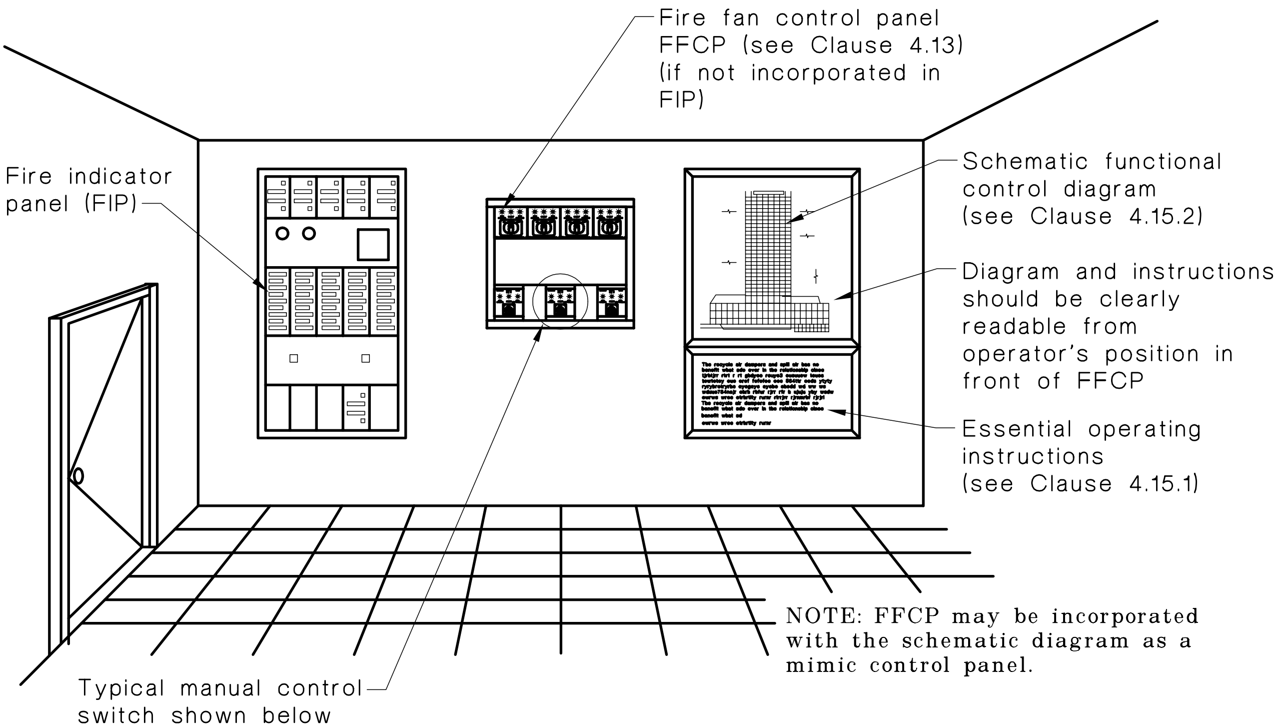
Indicators shall be logically grouped adjacent to each ON-AUTO-OFF or FIRE-AUTO-NON-FIRE control switch with an appropriate label identifying the fan or zone smoke control damper set being monitored. Indicators shall be operable at all times. An indicator test circuit shall be provided.

C4.13.3 *Current monitoring relays selected for monitoring airflow need to be capable of discriminating between the current drawn by the fan motor when operating under design conditions, and the current drawn by the fan motor when airflow has ceased, i.e. fan belt broken, fan blades detached, shaft or keyway sheared, fan discharge damper closed, main fire damper closed, and similar. Pressure differential switches selected need to be capable of discriminating between design airflow, and no airflow or low airflow.*

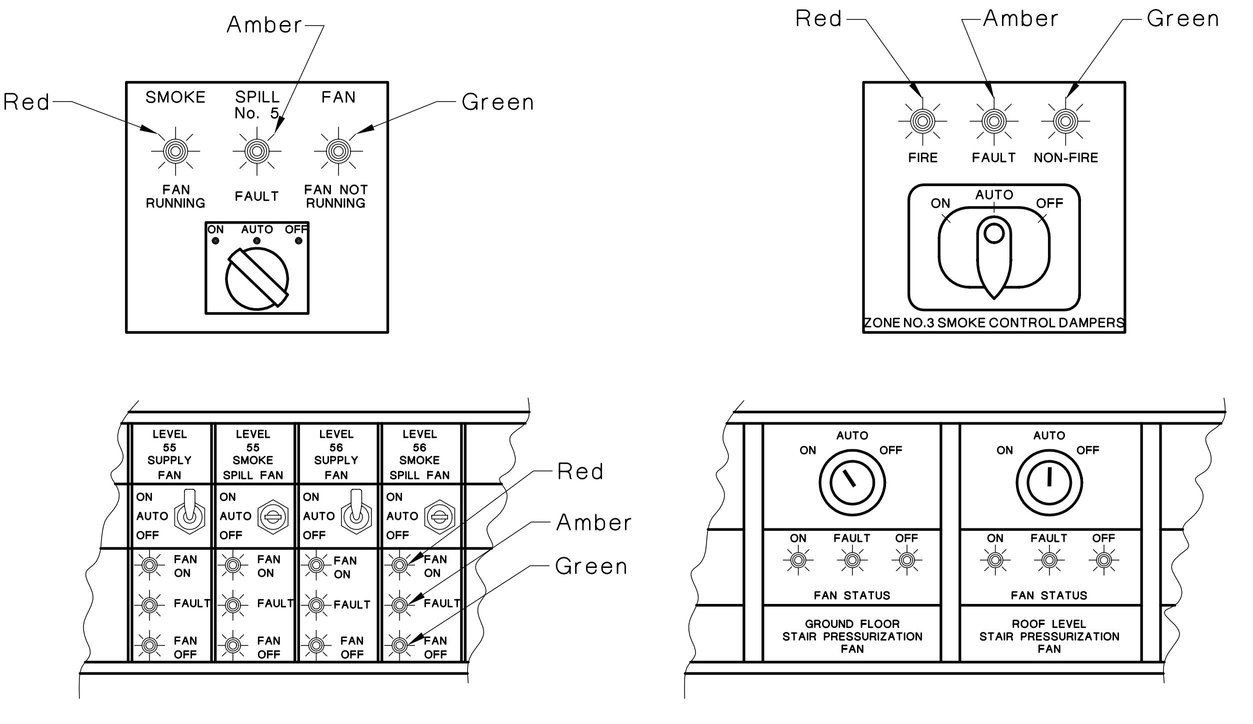
Current monitoring relays should not be used when there is very little difference between normal operating motor current and no-load motor current. In these situations, current monitoring relays cannot discriminate between design airflow and no airflow. Relays should be tested during commissioning to ensure that they repeatably indicate 'normal airflow' and 'failed airflow'.

4.13.4 Notices and labels The function and operation of each switch and indicator shall be clearly described with labels having durable and indelible letters not less then 5 mm high in a colour directly contrasting to that of the background. The labels shall be permanently and firmly secured below each component. In addition to the above, the following label shall be provided:

THESE CONTROLS SHALL BE OPERATED BY AUTHORIZED PERSONNEL ONLY.



(a) Typical wall elevation showing FIP, FFCP and schematic functional control diagram



(b) Typical variation of manual control switches for use by the attending fire brigade (see Clause 4.13.2)

FIGURE 4.3 TYPICAL LAYOUT—FIRE FAN CONTROL PANEL AND SCHEMATIC FUNCTIONAL CONTROL DIAGRAM

4.14 NON-ELECTRICAL CONTROL SYSTEMS Where non-electrical control systems are used for indication or operation of dampers, relief devices or other equipment required to operate in the fire mode, then those entire control systems including the central energy source, piping, tubing, cabling and field terminal equipment shall be protected against mechanical damage and shall be required to maintain integrity of operation for not less than 120 min under fire conditions.

Integrity can be demonstrated by a fire resistance test to AS 1530.4.

C4.14 *The most commonly used non-electrical systems are pneumatic controls or remote cable-operated systems. To maintain integrity during a fire, equivalent to that required for electrical controls, such systems should be constructed from materials that do not melt or otherwise break down during a fire. The following is a useful guide for designers and installers:*

(a) Essential tubing or cables should be constructed in steel or copper.

(b) Central pneumatic air system (compressors, pressure reducing sets, dryers and receivers) should be considered essential services which are supplied from the essential electrical power supply and which are protected to maintain integrity in the event of—

(i) inadvertent isolation during normal operation or in fire mode; or

(ii) fire in a remote compartment.

(c) Actuators whose failure would not affect the operation of the smoke control system need not maintain the specified integrity under fire conditions.

(d) Tubing or cables whose failure would not affect the operation of the smoke control system need not maintain integrity under fire conditions.

(e) Pneumatic tubing serving non-essential or fail-safe components may be polyethylene (or other plastic material) provided that loss of the non-essential part of the system does not cause the whole system to fail, through loss of pneumatic pressure.

(f) Where added security of pneumatic systems requires stand-by, remote compressed air bottles may be a design option worthy of consideration.

4.15 OPERATING INSTRUCTIONS

4.15.1 Instructions A set of essential instructions for starting, operating and stopping each air-handling system shall be permanently displayed in a convenient and conspicuous location near the FFCP.

4.15.2 Diagram A schematic diagram showing the functional air-side operating arrangement for each air-handling plant shall be permanently displayed adjacent to the operating instructions in a readily accessible position for viewing.

C4.15 *Adequate operating instructions and a complete functional air-handling schematic for air-handling system are essential aids for normal operating personnel. They assume even greater importance as an accurate guide for fire service personnel who may be called upon to make quick decisions in an emergency situation.*

4.16 TESTING

4.16.1 General Each air-handling system incorporating smoke control provisions shall be tested.

NOTE: Guidance on appropriate test procedures is given in Appendix F.

> ***C4.16.1*** *Testing requirements form a very important part of any smoke control system to ensure that it will function as intended during a fire. As system designs vary to match building configurations, test procedures need to be developed to encompass the specifics of individual systems. Typical examples of commissioning procedures are given in Appendix F.*

4.16.2 Objective The objective of testing smoke control systems is to verify that they operate and perform in accordance with the design specification and performance criteria of this Standard.

4.16.3 Component testing Each component of the smoke control system shall be tested to verify that it functions in accordance with the design specification and meets the performance criteria of this Standard.

4.16.4 System integrity testing Testing shall be conducted after the construction of the building (or relevant portion) is essentially completed and the completeness of the building structure has been checked. Checks shall include the integrity of shafts, that glazing and ceiling are in place and that doors operate correctly.

All other systems that impact on the smoke control system of the building (e.g. air-handling, fire alarm, lifts and essential services) shall be operable and incorporated into the test procedure, as applicable.

4.16.5 Measurement

4.16.5.1 *Fire doors* Force-to-open (and close) fire doors shall be measured under building fire mode conditions to determine compliance with Clause 4.7.

4.16.5.2 *Purging system* The capacity of the supply air and the smoke-spill fans shall be measured to determine compliance with Section 7.

4.16.5.3 *Zone pressurization systems* Pressure differentials between the fire-affected compartments and non-fire-affected compartments shall be measured to determine compliance with Section 8.

The pressure differential measurements shall be taken for each compartment in turn being designated the fire-affected compartment.

4.16.5.4 *Fire-isolated exit pressurization systems* The velocity and direction of airflow shall be measured to determine compliance with Clause 9.3.

4.16.5.5 *Lift shaft pressurization systems* Pressure differentials between the lift shaft and the occupied space shall be measured to determine compliance with Clause 10.3.

4.17 NOISE

The noise level of smoke-control systems shall be measured to determine compliance with Clause 4.6. The stairway noise level shall be measured in the doorway and fire-isolated exit landing, with the door open. The occupied space level shall be measured in the common paths of travel leading to the doorway with the door closed.

4.18 TEST SCHEDULE

A schedule setting out the testing procedure shall be prepared.

4.19 TEST RESULTS

Results from testing shall be recorded and certified.

SECTION 5 MISCELLANEOUS SYSTEMS

5.1 SCOPE OF SECTION This Section sets out the requirements for miscellaneous air-handling systems that do not form part of a smoke control system. This Section shall be read in conjunction with Sections 2 and 3.

5.2 APPLICATION

5.2.1 General Except as indicated in Clauses 5.2.2, 5.2.3, 5.3 and 5.4, air-handling systems not designed to operate in the fire mode shall shut down in accordance with Section 6, on activation of any automatic fire detection or sprinkler system installed in the building.

Where systems are designed or required to shut down in fire mode, smoke detectors (in accordance with Clause 4.10.5(b)) are not required to be installed.

> ***C5.2.1*** *Where a system is designed to shut down in fire mode supply, smoke detectors are not required. If the system is allowed to operate in fire mode, then supply air smoke detectors are required to be installed.*

5.2.2 Special purpose systems Special purpose air-handling systems, such as those serving computers or operating theatres, need not be systems incorporating shutdown.

5.2.3 Small systems Individual air-handling systems having a total aggregate supply airflow rate of not more than 1000 L/s, located in and serving a single fire compartment, may continue to operate.

5.3 EXHAUST SYSTEMS

5.3.1 Minor exhaust systems Minor exhaust systems protected with fire dampers, in accordance with Clause 3.3, may operate in the fire mode. Minor exhaust systems protected with subducts in accordance with Clause 3.6 shall operate in the fire mode. Minor exhaust systems required to operate during a fire are not required to comply with Section 4. (See Figure 5.1.)

> ***C5.3.1*** *Minor exhaust systems are those systems that exhaust a relatively small quantity of air from each compartment including those required by AS 1668.2, e.g. toilet exhaust, battery charging, document copying, incinerette and domestic range hoods. Minor systems constitute a leakage path between fire compartments. There is no limit to the number of systems that may serve a fire compartment; however, a designer has to consider this leakage in the overall design of the smoke control systems with particular regard to the minimum 20 Pa pressure differential requirement. Fire dampers or subducts are installed to maintain the integrity of each fire compartment.*

5.3.2 Major exhaust systems Where they do not form part of a smoke control system, major exhaust systems shall be treated as a central air-handling system in accordance with Sections 7 or 8, or be a system incorporating shutdown in accordance with Section 6.

> ***C5.3.2*** *Major exhaust systems cover those systems not classified as minor. In most instances it is likely that these systems will be designed for smoke control. Where not so designed, they have the capacity to allow an unacceptable quantity of smoke to spread between compartments, and smoke dampers are, therefore, required to maintain the integrity of compartmentalization and close off the openings on detection of smoke.*

5.4 SUPPLY AIR SYSTEMS

5.4.1 Minor supply air systems Such systems may operate in the event of fire. (See Figure 5.2.)

> ***C5.4.1*** *Minor supply systems are those systems that supply a relatively small quantity of air to each compartment. Minor supply systems may constitute a leakage path between fire compartments. There is no limit to the number of minor supply air systems that may serve a compartment. A designer should consider this leakage in the overall design of the smoke control systems with particular regard to the 20 Pa pressure differential requirement.*

5.4.2 Major supply air systems

5.4.2.1 *Smoke detectors* Smoke detectors, where required by Clause 4.10.1, shall be installed in the supply air system in accordance with Clause 4.10.5(b).

5.4.2.2 *Operation* Where they do not form part of a smoke control system, major supply systems shall be treated as central air-handling systems in accordance with Section 7 or 8, or be systems incorporating shutdown in accordance with Section 6.

The systems shall be shut down in the event of a supply air smoke detector signal.

> ***C5.4.2.2*** *In most instances major supply air systems will be designed for smoke control. Where not so designed, they have the capacity to allow an unacceptable quantity of smoke to spread between compartments and smoke dampers are, therefore, required to maintain the integrity of compartmentalization and close off the smoke leakage path.*

5.5 CAR PARK VENTILATION SYSTEMS

5.5.1 General Notwithstanding the provisions of Clause 5.3, mechanical car park ventilation systems installed to comply with AS 1668.2 shall incorporate fire safety provisions for smoke control or smoke extraction as detailed in Clause 5.5.2 to 5.5.5.

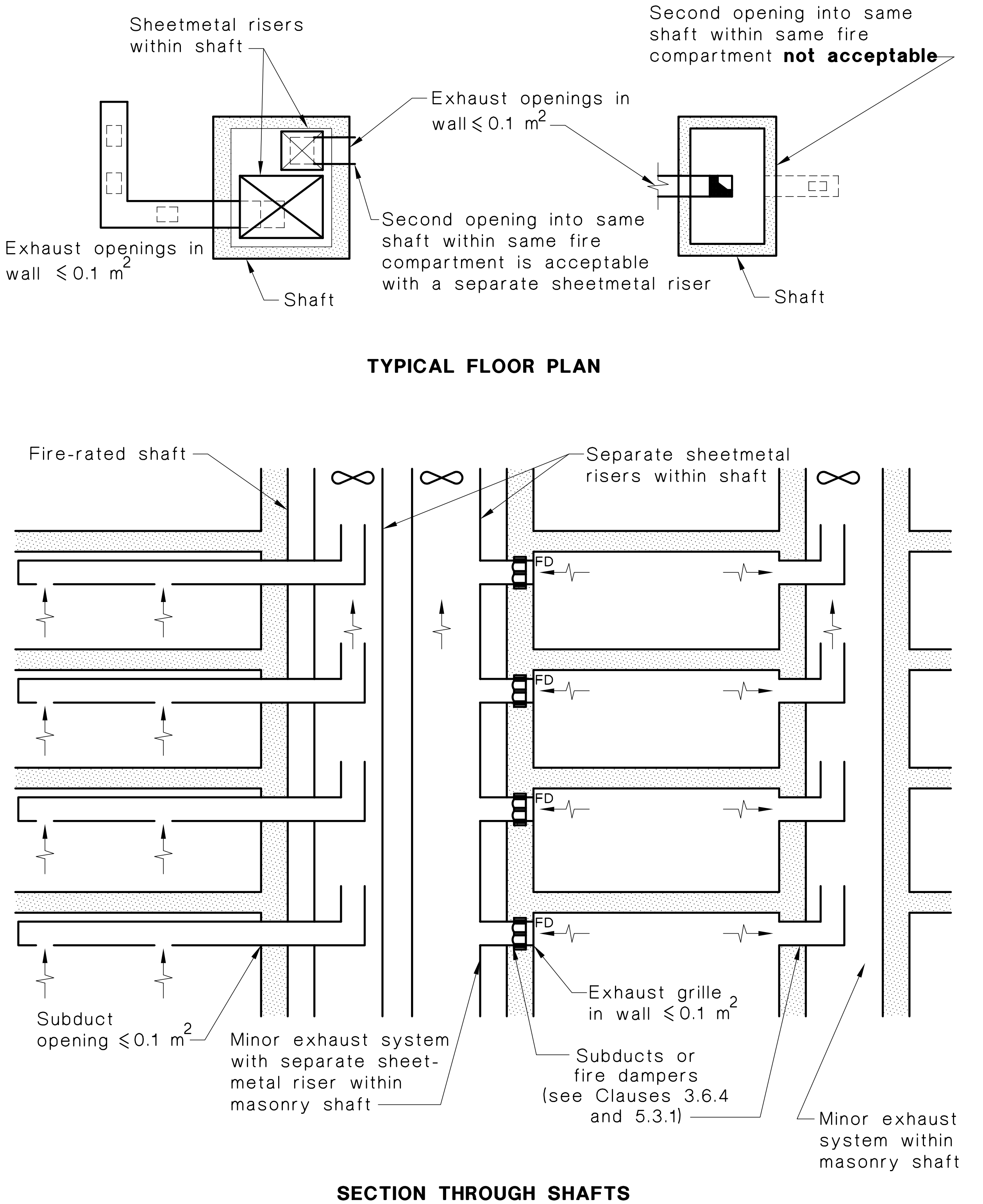
5.5.2 Fire isolation Any mechanical components of the ventilation system located outside the car park fire compartment and within another fire compartment shall be isolated from that fire compartment with construction to maintain the required FRL.

5.5.3 Control To enable manual control by authorized fire personnel, each fan shall be provided with an ON-AUTO-OFF control device installed in the FFCP in compliance with Clause 4.13.2.

5.5.4 Smoke detectors Smoke detectors in accordance with Clause 4.10.1 shall be installed in the supply air system in accordance with Clause 4.10.5(b).

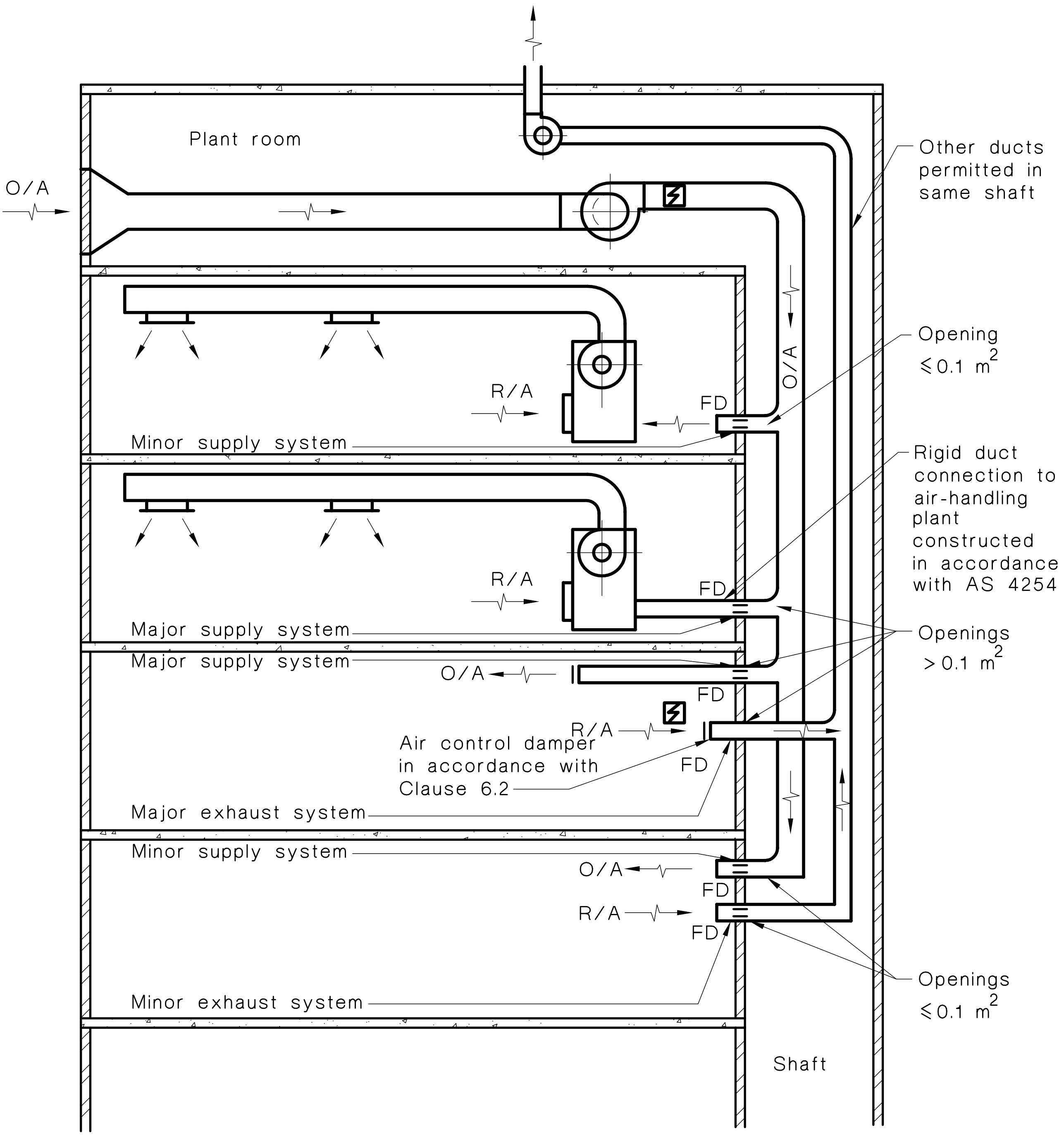
5.5.5 Operation Exhaust air systems shall continue to operate in the event of fire in the car park. Where the system incorporates variable airflow rates, it shall automatically switch to its full capacity on activation of any fire alarm or sprinkler system in the car park. Supply air systems shall shut down upon the receipt of a fire alarm signal from the supply air detector.

> ***C5.5*** *Car park ventilation systems are not required as smoke control systems and the requirements of Section 4 are not applicable. It is the intention of this Standard that any installed ventilation system incorporates provisions to enable manual control by attending firefighters.*



NOTE: Fire dampers or subducts are acceptable alternatives.

FIGURE 5.1 EXAMPLES OF MINOR EXHAUST SYSTEM ARRANGEMENTS



NOTES:

1 This is a composite diagram for explanatory purposes only and is not intended to indicate that major and minor classifications would apply to the one air-handling system.

2 For minor exhaust systems see Clauses 1.6.23 and 5.3.1; for major exhaust systems see Clauses 1.6.19 and 5.3.2. For minor supply systems see Clauses 1.6.24 and 5.4.1; for major supply systems see Clauses 1.6.20 and 5.4.2.

FIGURE 5.2 MINOR AND MAJOR SUPPLY AND EXHAUST AIR SYSTEMS

SECTION 6 SYSTEM SHUTDOWN

6.1 SCOPE OF SECTION This Section sets out the requirements for the shutdown of systems to aid in smoke control. The requirements of this Section shall be read in conjunction with Sections 2 and 3.

6.2 SHUTDOWN SYSTEM ARRANGEMENT The main features of this arrangement are the following:

(a) The mechanical air-handling plant shall automatically stop on receipt of a fire alarm.

(b) In addition to the requirement to maintain the FRL between fire compartments, air-control dampers installed between all fire compartments served shall automatically close on receipt of a fire alarm.

(c) Smoke dampers installed between all smoke compartments in health care buildings shall automatically close on receipt of a fire alarm.

C6.2 *The primary effect of the system shutdown arrangement is to restrict the spread of smoke from a fire-affected compartment to a non-fire-affected compartment via the air-handling system ducts and shafts. System shutdown will not, by itself, prevent the spread of smoke via lift shafts, exits, service shafts, structural joints or gaps and cracks in the building structure.*

6.3 GENERAL REQUIREMENTS

6.3.1 System operation Except as required by Section 5, all air-handling systems not required to operate in the fire mode shall automatically shut down on receipt of a fire alarm.

6.3.2 Dampers Air-control dampers shall be installed at all fire compartment penetrations. Smoke dampers shall be installed in all smoke compartment penetrations. Dampers shall automatically close on receipt of a fire alarm and may be combined with required fire dampers (see Clause 2.4).

6.3.3 Smoke detectors Smoke detectors for system shutdown shall be located and installed in accordance with Clause 4.10.

SECTION 7 AIR PURGE SYSTEMS

7.1 SCOPE OF SECTION This Section sets out the requirements for air purge systems that are required to provide smoke control. The requirements of this Section shall be read in conjunction with the relevant requirements of Sections 2, 3 and 4.

This Section applies to central plant systems serving multiple compartments. Where individual systems serve single compartments they shall comply with Section 6 or 8.

NOTE: Typical layouts of air purge systems are given in Figures 7.1 to 7.4.

7.2 AIR PURGE SYSTEM ARRANGEMENT The main features of the air purge arrangement are the following:

(a) Smoke-spill air is discharged directly to atmosphere via ducts or via dampers in each compartment, at a flow rate no less than the maximum rate for return air (or relief air where no return) under normal operating conditions.

(b) Outdoor air is supplied to all compartments via the supply air ducts at a rate less than the smoke-spill air.

C7.2 *The primary effects of the air purge system arrangement are—*

(a) to restrict the spread of smoke from a fire-affected compartment to a non-fire-affected compartment via the air-handling system ducts and shafts; and

(b) to aid the removal of smoke from the fire-affected compartment.

The first aim of the air purge system arrangement is, therefore, to prevent recycling of the contaminated return air. This is achieved by diverting and discharging it direct to atmosphere by way of the smoke-spill system. The most critical aspect of this function is to prevent smoke-spill air being drawn past the recycle air damper into the supply air system. Consideration should be given to installing a smoke damper in lieu of the fire damper required under Clause 7.7.2 and arranging for it to be automatically closed at the same time as the recycle air damper. Purge systems will not, by themselves, prevent the spread of smoke via lift shafts, exits, service shafts, structural joints or gaps and cracks in the building structure.

7.3 PERFORMANCE CRITERIA When the system is in the fire mode, the force to open the doors to all required exits shall not exceed the requirements of Clause 4.7.

7.4 SMOKE-SPILL FAN A smoke-spill fan, where provided, shall comply with Clause 4.8 and discharge smoke-spill air direct to atmosphere. The design capacity shall be such as to achieve the requirements of Clause 7.2(a) and 7.3.

C7.4 *No recommended capacity has been nominated for the smoke-spill fan. It is intended that designers be able to maximize the use of components of air-handling systems installed for normal ventilation and airconditioning purposes. It is important to ensure that whatever the capacity of the smoke-spill fan, the maximum force permitted to open exit doors should not be exceeded. It is important to remember that in the fire mode the exhaust rate of each floor may need to cope with open exit doors which require a velocity of 1 m/s. For a typical two-exit compartment this equates to an exhaust capacity of approximately 3000 L/s plus an allowance for lift doors and other leakage paths.*

7.5 RETURN AIR FAN The return air fan may operate as the smoke-spill fan provided it complies with all requirements of Clause 7.4.

7.6 SUPPLY AIR FAN The total supply air quantity shall be less than the volumetric capacity of the smoke-spill fan. The capacity shall be determined such that pressure differentials across exit doors comply with Clause 4.7.

C7.6 *To maintain a reasonable pressure balance between supply and exhaust rates, outdoor air is supplied to all compartments through the supply air system at a lower rate than that of the exhaust. In determining this supply air rate it is important to ensure that the force required to open any exit door is not excessive.*

7.7 DAMPERS

7.7.1 Air-control damper An air-control damper complying with Clause 2.4.4 shall be installed—

(a) in the recycle airstream such that when operating in smoke control mode recycle air is kept to a minimum; and

(b) in the outdoor airstream to control outdoor air intake.

NOTE: Air-control dampers may be controllable fire dampers.

7.7.2 Fire damper A fire damper shall be installed upstream of the recycle air-control damper required under Clause 7.7.1 except where smoke-spill air is not drawn past that damper.

7.7.3 Failure position The failure position of dampers during loss of power or control shall be in accordance with Table 7.1.

7.8 OPERATION UNDER FIRE MODE Under fire mode, components of the air-handling system shall be controlled in accordance with Table 7.2.

TABLE 7.1

FAILURE POSITION OF AIR-CONTROL DAMPERS

No.	Damper	Damper use	Failure position
1	Recycle	Serving the main return air path to the air-handling unit(s)	Closed
2	Outdoor	Serving air entry to the air-handling unit(s) and supply system(s)	Open
3	Smoke-spill	Serving the smoke-spill fan for discharge	Open
4	Supply	Serving supply ducts from central riser (all compartments if installed)	Open

NOTE: The normal shutdown of the air-handling systems need not provide the nominated failure positions. Failure positions are nominated for the event of fire originating from that compartment. However, due regard for the possibility of dampers being in a different position under normal shutdown should not be disregarded, as the time taken to activate to the required fire mode position may have allowed smoke spread.

Table 7.1 *The failure positions of airduct dampers reflect the least adverse effects on occupants, e.g. the fully open position of the outdoor air intake damper is less likely to cause problems opening doors even though contaminated air may be drawn into non-fire-affected compartments under certain circumstances.*

The recycle air damper is recommended to take up its failure position during system downtime, e.g. non-working hours, to reduce the risk of smoke from a fire occurring during that time (especially from a slowly developing fire) spreading via the return air system to the supply air system before fire mode is initiated.

TABLE 7.2

OPERATIONAL REQUIREMENTS FOR SYSTEMS DESIGNED AS AIR PURGE SYSTEMS IN FIRE MODE

Conditions	System control						
	Recycle air damper	**Smoke-spill air damper (see Note 2)**	**Outdoor air damper**	**Smoke-spill fan**	**Return air fan (if not used for smoke spill)**	**Supply air fan**	**Supply air damper (if installed)**
Initiating conditions (see Note 1)	Specified below						
Actuation of— (a) any detector required by Clause 4.10.5(a); or (b) building automatic fire sprinkler, smoke detection system or manual call point	Close	Open	Open	Start	Stop	Start	Open
Override conditions (see Note 1)	Specified below						
(c) Actuation of supply air smoke detector as required by Clause 4.10.5(b)	—	—	—	—	—	Stop	—
(d) Reset of supply air smoke detector	—	—	—	—	—	Start	—

NOTES:

1 Initiating conditions (a) and (b) and override conditions (c) and (d) represent the transmission of a signal from the detector-monitoring equipment to the air-handling system control panel. Time delays required by Clause 4.10 shall have elapsed prior to signal transmission. The delay between receipt of the signal and component change in operation will include inherent delays of the control equipment and any specific delays necessary for reliable operation. Within these limitations such delays should be minimized but should not exceed 60 s.

2 The smoke-spill air damper will, in many instances, also function as a relief damper under normal operating conditions. Where they are physically separated and the relief air damper is not used for smoke-spill, it shall close under initiating conditions (a) and (b).

3 Where a component of the air-handling system is in the mode required by the initiating conditions at the time of signal transmission, the status of the component shall remain unchanged.

4 Where a variable air volume system is used with an air purge system, the system shall be designed so that on a fire alarm, the variable air volume terminals shall take up an open position, or by some other means, the supply airflow rate to each compartment can be maintained. (See Commentary C4.12.2(a).)

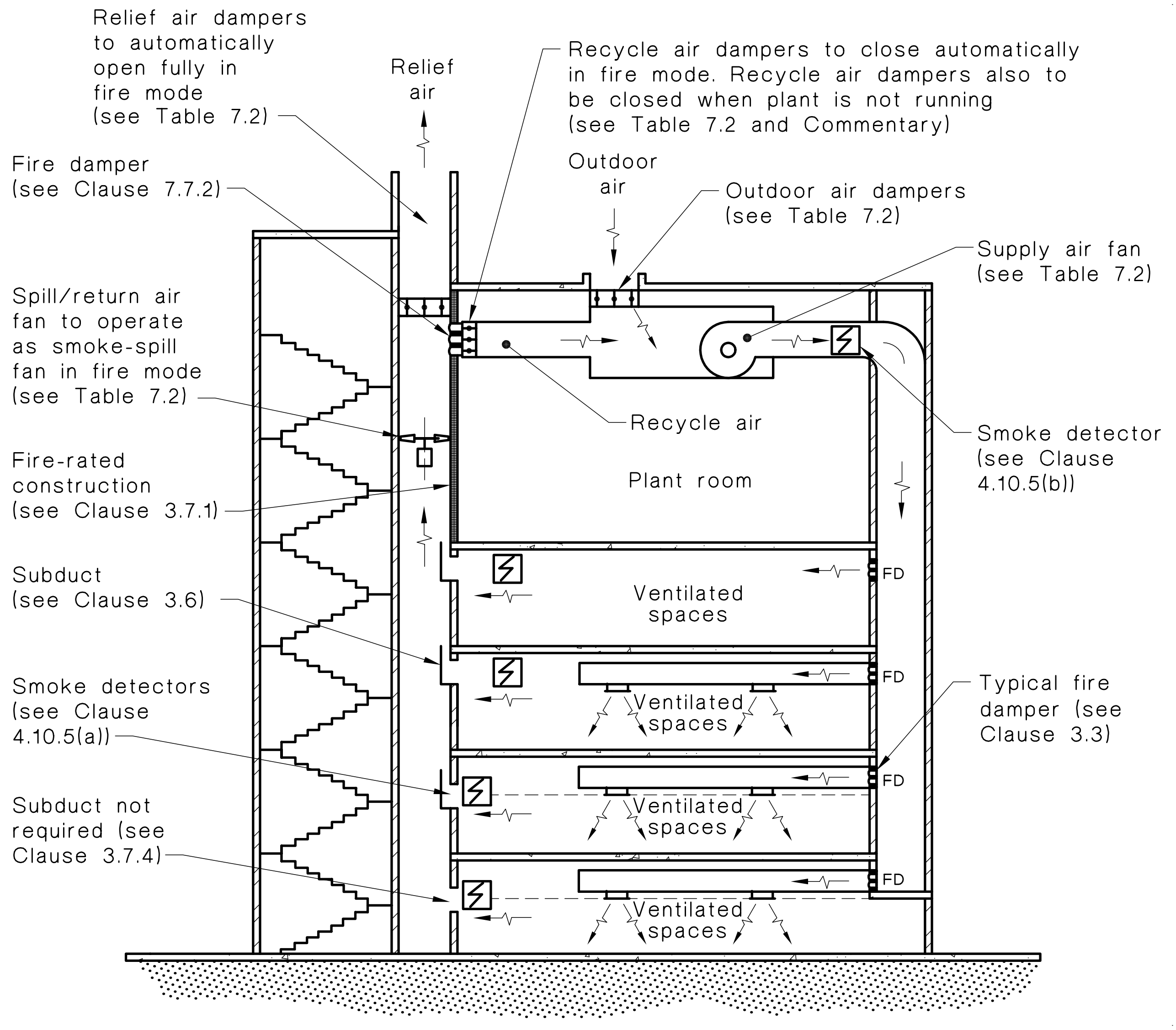


FIGURE 7.1 AIR PURGE SYSTEM—TYPICAL INSTALLATION WITH PLANT ROOM ABOVE SPACES BEING SERVED

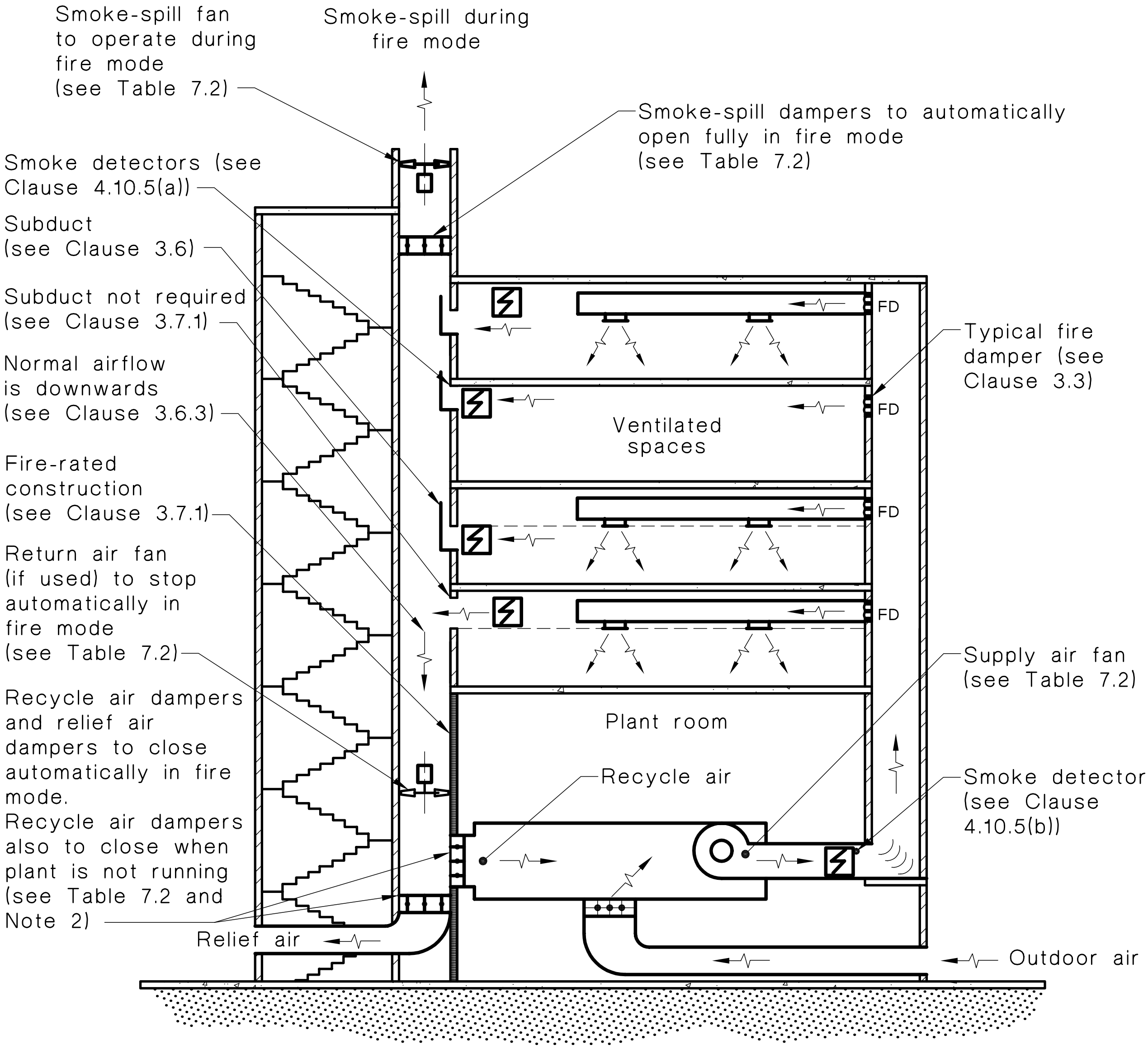


FIGURE 7.2 AIR PURGE SYSTEM—TYPICAL INSTALLATION WITH PLANT ROOM BELOW SPACE BEING SERVED

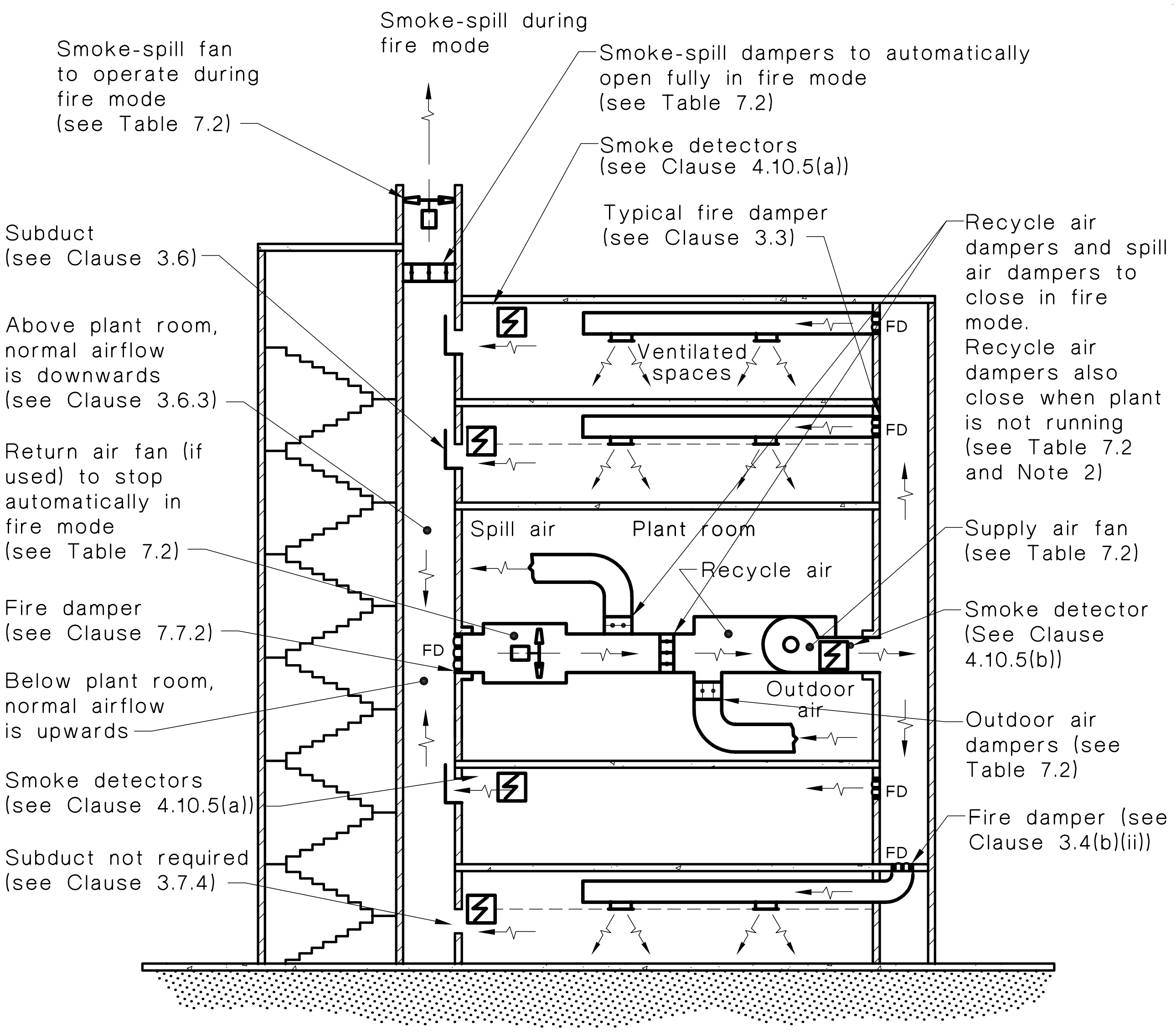


FIGURE 7.3 AIR PURGE SYSTEM—TYPICAL INSTALLATION WITH PLANT ROOM BETWEEN SPACES BEING SERVED

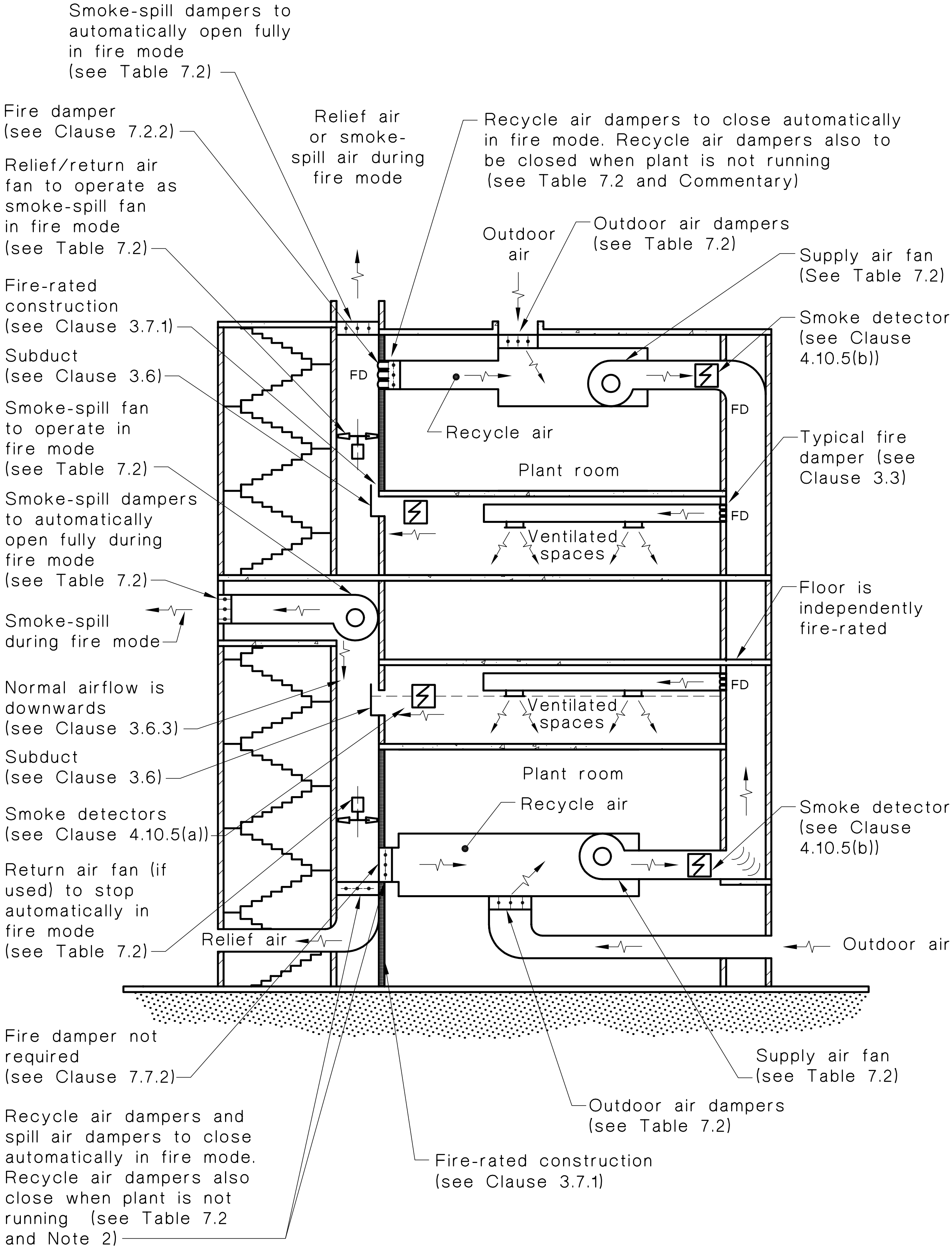


FIGURE 7.4 AIR PURGE SYSTEM—TYPICAL INSTALLATION OF SEPARATE SYSTEMS WITH PLANT ROOMS ABOVE AND BELOW SPACES BEING SERVED

SECTION 8 ZONE PRESSURIZATION SYSTEMS

8.1 SCOPE OF SECTION This Section sets out the requirements for systems that are required to provide smoke control with a zone pressurization system. The requirements of this Section shall be read in conjunction with the relevant requirements of Sections 2, 3 and 4.

This Section includes requirements for central plant and individual plant air-handling systems. Specific clauses refer to both system configurations unless indicated otherwise.

NOTE: Typical layouts of zone pressurization systems are given in Figures 8.1 to 8.5.

8.2 ZONE PRESSURIZATION SYSTEM ARRANGEMENT The main features of this arrangement are the following:

(a) Smoke-spill air from the fire-affected compartment is discharged direct to atmosphere.

(b) Return air/relief air from non-fire-affected compartments is controlled.

(c) Uncontaminated outdoor air is supplied or made up to all non-fire-affected compartments at a rate such that a positive pressure is maintained in non-fire-affected compartments with respect to the fire-affected compartment.

(d) Pressurization of fire-isolated exits may be achieved subject to the requirements of Section 9.

C8.2 *The primary effects of the zone pressurization arrangement are—*

(a) to restrict the spread of smoke from a fire-affected compartment to a non-fire-affected compartment via the air-handling system ducts and shafts;

(b) to restrict the spread of smoke from a fire-affected compartment to a non-fire-affected compartment by minor paths;

(c) to aid the removal of smoke from the fire-affected compartment;

(d) to restrict the spread of smoke into lift shafts: and

(e) to restrict the spread of smoke into fire-isolated exits.

With zone pressurization systems, the exits may be fully pressurized utilizing air leakage from the pressurized non-fire-affected compartments via gaps around the doors. This arrangement is likely to achieve the performance criteria where there are 10 or more storeys involved. Below this number, special relief openings into the fire-isolated exit or a combination system may be needed.

Incorrect identification of the compartment or incorrect signalling to dampers could result in the fire-affected compartment becoming pressurized. This possibly would result in smoke being forced into other compartments and fire-isolated exits (especially when not separately pressurized) with potentially disastrous consequences.

8.3 PERFORMANCE CRITERIA A positive pressure not less than 20 Pa and not greater than 100 Pa shall be developed in all non-fire-affected compartments above the pressure in the fire-affected compartment, measured with all required exit doors closed. Expansion pressures due to the fire itself shall be ignored.

> ***C8.3*** *Although research into smoke control systems is continuing in various parts of the world, it is generally accepted that for most applications a positive pressure of around 20 Pa in non-fire-affected compartments with respect to the fire-affected compartment will minimize the spread of smoke. A higher pressure should be designed for where ceiling heights exceed 3 m; 40 Pa is suggested for 6 m high ceilings. The system should be designed to maintain the appropriate pressure differential under likely conditions of stack and wind effect. (See Clause 4.2.)*
>
> *The 100 Pa upper limit is necessary to avoid problems with lift door operation. In practice, higher pressure differentials may be acceptable on a project-specific basis subject to confirmation that the lift doors will not be adversely affected by the pressure differential.*

8.4 SMOKE-SPILL SYSTEM

8.4.1 Smoke-spill fans Except where relief air provisions are incorporated in accordance with Clause 8.4.4, each compartment shall be provided with a smoke-spill provision to mechanically exhaust smoke-spill air from the fire-affected compartment direct to atmosphere.

8.4.2 Smoke-spill fan capacity Smoke-spill fans required to remove smoke from the fire-affected compartment shall comply with Clause 4.8. The exhaust capacity shall be based on outdoor ambient temperature and pressure (non-fire) conditions and the quantity needed to achieve the performance requirements of Clauses 8.3 and 4.7.

> ***C8.4.2*** *The fan capacity should be the sum of—*
>
> *(a) the volume of make-up air entering the largest compartment when all required exit doors serving that compartment are open;*
>
> *(b) for central plant systems that serve multiple compartments, the volume of leakage air associated with closed air-control dampers which interconnect from other non-fire-affected compartments; and*
>
> *(c) leakage air through minor supply and exhaust systems, lift shafts, service penetrations, building gaps and similar.*
>
> *Make-up air may not be available through exit doors if leakage paths are excessive. Leakage paths, including losses via lift shafts, should be assessed, particularly where lift openings exceed three per compartment.*
>
> *The exhaust quantity from the fire-affected compartment is difficult to assess accurately. The air in the compartment expands due to temperature increase, air filters into the compartment via leakage paths such as lift shafts, exhaust ducts, curtain wall construction, cracks, openings, minor penetrations and open doors to pressurized stairs.*
>
> *In practice, door velocities appear to be in the vicinity of 2 m/s requiring about 6500 L/s exhaust from a typical two-exit compartment plus leakage from other compartments plus two lift openings. Further guidance on fan capacity and building leakage is given in Chapter 48 of the 1995 ASHRAE Applications Handbook and in the ASHRAE publication, Design of Smoke Management Systems.*

8.4.3 Return air fans and relief air fans Return air fans and relief air fans used for economy cycle operations may operate as smoke-spill fans, provided they comply with Clause 4.8.

8.4.4 Spill air relief Provision to relieve smoke-spill air directly to atmosphere may be provided in lieu of smoke-spill fans, provided any fire-isolated exits are pressurized in accordance with Section 9.

C8.4.4 *Where building facade configuration permits, it is possible to incorporate air-relief devices that open the fire-affected compartment to atmosphere, thus relieving any pressure build-up in that compartment due to the fire or infiltration from leakage paths and open fire-isolated exit doors.*

Location of smoke relief openings in relation to outdoor air inlets serving pressurization systems to other non-fire-affected compartments is an important facet of design. Such relief openings should be as evenly distributed as possible along the external faces of the building and, because of external wind conditions, will not work satisfactorily unless located on at least two faces, which should preferably be on opposite sides of the building.

8.5 SUPPLY AIR

8.5.1 Central plant systems

8.5.1.1 *Supply air fan* The rated capacity of any required supply air fan(s) shall be not less than that required to achieve the performance requirements of Clauses 8.3 and 4.7.

8.5.1.2 *Individual compartment dampers* Air-control dampers in accordance with Clause 2.4 shall be provided at the supply air and smoke-spill/relief air openings of each compartment.

NOTE: Air-control dampers may be controllable fire dampers.

8.5.1.3 *Air-control dampers* An air-control damper complying the Clause 2.4.4 shall be installed—

(a) in the recycle airstream such that when operating in smoke control mode recycle air is kept to a minimum; and

(b) in the outdoor airstream to control outdoor air intake.

NOTE: Air-control dampers may be controllable fire dampers.

8.5.1.4 *Fire dampers* A fire damper shall be installed upstream of the recycle air-control damper required under Clause 8.5.1.3 except where smoke-spill air is not drawn past that damper.

8.5.1.5 *Failure position* The failure position of airduct dampers shall be in accordance with Table 8.1.

8.5.2 Individual plant systems

8.5.2.1 *Supply air fan* Supply air fans, where used, shall have a capacity sufficient to achieve the differential pressure required by Clause 8.3 when delivering outdoor air only.

C8.5.2.1 *It would be expected that a supply air fan in non-fire-affected compartments would be arranged to operate in the normal economy cycle under fire conditions. The air pressure within these compartments should not prevent the fire door to a fire-isolated exit from closing (see Commentary C4.7). Where an economy cycle is not incorporated, the supply air fan should deliver sufficient air to meet the performance criteria of 20 Pa.*

8.5.2.2 *Air-control dampers* Air-control dampers in accordance with Clause 2.4 shall be provided to control outdoor air and relief air for each compartment.

The failure position of dampers during loss of power or control shall be in accordance with Table 8.2.

NOTE: Air-control dampers may be controllable fire dampers. Additional air-control dampers may also be necessary, depending on system arrangement, to meet the requirements of Clause 8.3.

TABLE 8.1

FAILURE POSITION OF AIR-CONTROL DAMPERS (CENTRAL AIR-HANDLING SYSTEMS)

Item No.	Damper	Damper use—Smoke control	Failure position
1	Supply	Compartment supply duct from central riser	Closed
2	Return/recycle	Return air to central riser from compartment and/or main return air path to air-handling unit	Closed
3	Relief	Relief to separate central riser utilized only to control overpressurization for normal economy cycle operation Refer also Item No. 4	Closed
4	Smoke-spill or relief	Serving entry to dedicated smoke spill shaft or directly to outside the building with or without smoke-spill fan Refer also Item No. 3	Open
5	Outdoor	Serving air entry to air-handling unit and supply system	As required
6	Return/smoke-spill	Serving entry to combined return/smoke-spill central riser shaft from each compartment	Open

NOTE: The normal shutdown of the air-handling systems need not provide the nominated failure positions. Failure positions are nominated for the event of a fire originating from that compartment resulting in loss of power or control to the dampers. However, due regard for the possibility of dampers being in a different position under normal shutdown should not be disregarded, as the time taken to activate to the required fire mode position may have allowed smoke spread.

8.6 AIR RELIEF AND MAKE-UP Where the air leakage rates to or from compartments is inadequate to achieve the required airflows and pressure differentials, provision shall be made for the appropriate relief or make-up.

Normal air-control damper leakage or setting of supply air, return air and relief air-control dampers to prevent full closing is an acceptable method of controlling leakage rates.

C8.6 *By controlling the supply and return air in the manner described, it is expected that the 20 Pa pressure differential will be readily achieved in most instances. The extent of building leakage can have a significant effect on performance. Air-control dampers are, therefore, permitted to be adjusted (to set positions) to control pressures developed. It is recommended that air-control dampers be set to fully close or open, as applicable, in the first instance, and only adjusted away from these positions as found necessary during commissioning. Special attention is required to ensure make-up provisions do not short-circuit the extraction/relief of smoke.*

TABLE 8.2

FAILURE MODE OF AIR-CONTROL DAMPERS (INDIVIDUAL AIR-HANDLING SYSTEMS)

Item No.	Damper	Damper use—Smoke control	Failure position
1	Return/recycle	Return/recycle provision to the air-handling unit specifically	Closed
2	Relief	Relief path to control overpressurization for normal economy cycle operations Refer also to Item 3	Closed
3	Smoke-spill or relief	Serving entry to dedicated smoke-spill shaft or discharge to outside the building with or without smoke-spill fan Refer also to Item 2	Open
4	Outdoor	Serving air entry to air-handling unit	As required
5	Return/smoke-spill	Serving entry to combined return/smoke-spill riser shaft from the compartment	Open
6	Outdoor	Serving an entry to air-handling unit from a common shaft	Closed

NOTE: The normal shutdown of the air-handling systems need not provide the nominated failure positions. Failure positions are nominated for the event of a fire originating from that compartment resulting in loss of power or control to the dampers. However, due regard for the possibility of dampers being in a different position under normal shutdown should not be disregarded, as the time taken to activate to the required fire mode position may have allowed smoke spread.

8.7 OPERATION UNDER FIRE CONDITIONS

8.7.1 Central plant systems Under fire mode, components of the air-handling system shall be controlled in accordance with Table 8.3.

8.7.2 Individual plant systems Under fire mode, components of the air-handling system shall be controlled in accordance with Table 8.4.

8.8 INDIVIDUAL PLANTS INCORPORATING COMMON SHAFTS Where a shaft is used in conjunction with individual air-handling plants, for supply of outdoor air or discharge of smoke-spill air associated with smoke control operation, the requirements of Clauses 8.1 to 8.7 shall apply. (See Table 8.2.)

This Clause does not apply to common shafts used for the supply of make-up, outdoor and relief air associated with normal recycle operation of the individual plants. Such shafts may be considered as minor or major exhaust or supply systems as applicable. (See Section 5.)

C8.8.1 *Where a shaft is common to a number of individual air-handling plants for the supply of outdoor air or for the discharge of smoke-spill air, the smoke control system is required to be arranged as for zone pressurization. To achieve the objectives, the individual air-handling plants should comply with the provisions for the individual air-handling plants without shafts, and the shafts and any common components should comply with the relative requirements for a central air-handling system.*

8.9 LIFT SHAFT AIR RELIEF Where a zone pressurization system is installed, each lift shaft enclosure, irrespective of the number of lifts installed, shall incorporate a 0.1 m^2 minimum free area opening at the highest practicable location within the shaft. The opening shall vent to atmosphere directly or via a duct that maintains any required compartmentation FRL. Fire dampers shall not be installed on relief ducts. Air-control dampers may be installed on the vents which shall open in the fire or failure mode.

For multi-rise shaft enclosures, air-relief openings may be interconnected between shafts but shall be increased in size proportionately per shaft up to the point of discharge. (See Figure 8.6.) Where lift shafts are required to be fire isolated from other lift shafts, interconnection or cross-ventilation shall not be permitted.

C8.9 *The opening required for each lift shaft enclosure is necessary to provide some minor relief to atmosphere. While not required for this purpose, vents will also provide the relief of smoke from within the shaft to atmosphere. Air-relief openings should not be provided where indirect or direct lift shaft pressurization systems are required to be installed. The size of the vent required for lift shaft air relief is considerably smaller than has traditionally been required and should not cause problems with lift doors and ride quality from external wind forces that may have previously been encountered.*

TABLE 8.3

OPERATIONAL REQUIREMENTS FOR CENTRAL AIR-HANDLING SYSTEMS DESIGNED FOR ZONE PRESSURIZATION IN FIRE MODE

Initiation conditions (see Note 1)	System control									
	Recycle air damper	**Smoke-spill air damper (see Note 2)**	**Outdoor air damper**	**Smoke-spill fan**	**Return air fan (if not used for smoke spill)**	**Supply air fan**	**Supply air damper fire-affected compartment**	**Supply air damper non-fire-affected compartment**	**Return air damper fire-affected compartment**	**Return air damper non-fire-affected compartment**
Actuation of— (a) any detector required by Clause 4.10.5(a); or (b) building automatic fire sprinkler or smoke detection system (Clause 4.11)	Close	Open	Open	Start	Stop	Start	Close to set position (see Note 3)	Open to set position (see Note 3)	Open fully or to set position (see Note 3)	Close to set position (see Note 3)
Override conditions (see Note 1)	As specified below									
(c) Actuation of supply air smoke detector as required by Clause 4.10.5(b); or			Close			Stop				
(d) Reset of supply air smoke detector; or			Open			Start				
(e) Actuation of lift shaft smoke detector or lift motor room smoke detector (see Note 7)	Close	Close	Open	Stop	Stop	Start	Refer to non-fire-affected compartment	Open to set position (see Note 3)	Refer to non-fire-affected compartment	Close to set position (see Note 3)

NOTES:

1 Initiating conditions (a) and (b) and override conditions (c) and (d) represent the transmission of a signal from the detector-monitoring equipment to the air-handling system control panel. Time delays required by Clause 4.10 shall have elapsed prior to signal transmission. The delay between receipt of the signal and component change in operation will include inherent delays of the control equipment and any specific delays necessary for reliable operation. Within these limitations such delays should be minimized but should not exceed 60 s.

2 The smoke-spill air damper will, in many instances, also function as a relief air damper under normal operating conditions. Where they are physically separated and the relief air damper is not used for smoke-spill, it shall close under initiating conditions (a) and (b).

3 The set position for these dampers shall be in accordance with Clause 8.6.

4 Where a component of the air-handling system is in the mode required by the initiating conditions at the time of signal transmission, the status of the component shall remain unchanged.

5 Where a variable air volume system is used with a zone pressurization system, the system shall be designed so that on a fire alarm, the variable air volume terminals, if not designed to be air-control dampers in accordance with Clause 2.4, shall take up an open position so that they do not prevent the system from achieving the required pressure differential between a fire-affected compartment and a non-fire-affected compartment.

6 Subsequent fire alarms from other compartments shall initiate operation of the smoke control system as a fire-affected compartment. This shall override the non-fire-affected pressurization control arrangement initially instigated.

7 Where the lift motor room has an airconditioning or supply air ventilation system this shall shut down. Where an exhaust air ventilation system is installed this should preferably start up or continue to run.

TABLE 8.4

OPERATIONAL REQUIREMENTS FOR INDIVIDUAL AIR-HANDLING SYSTEMS DESIGNED FOR ZONE PRESSURIZATION IN FIRE MODE

Initiating conditions (see Note 1)	**System control**											
	Fire-affected compartment						**Non-fire-affected compartment**					
	Recycle air damper	**Smoke-spill air damper**	**Outdoor air damper**	**Relief air/ smoke-spill fan**	**Return air fan (where fitted and not used for smoke spill)**	**Supply air fan**	**Recycle air damper**	**Smoke-spill air damper**	**Outdoor air damper**	**Spill air/ smoke-spill fan**	**Return air fan (where fitted)**	**Supply air fan**
Actuation of— (a) any detector required by Clause 4.10.5(a); (b) building automatic fire sprinkler or smoke detection system (Clause 4.11); or	Close	Open	Open fully or to set position (see Note 2)	Start	Stop	Stop	Close	Close fully or to set position (see Note 2)	Open fully or to set position (see Note 2)	Stop	Stop	Start
(c) lift shaft smoke detectors or lift motor room smoke detector (see Note 7)	See non-fire-affected compartment						Close	Close fully or to set position (see Note 2)	Open fully or to set position (see Note 2)	Stop	Stop	Start

NOTES:

1 Initiating conditions (a) and (b) represent the transmission of a signal from the detector-monitoring equipment to the air-handling system control panel. Time delays required by Clause 4.10 shall have elapsed prior to signal transmission. The delay between receipt of the signal and component change in operation will include inherent delays of the control equipment and any specific delays necessary for reliable operation. Within these limitations such delays should be minimized but should not exceed 60 s.

2 The set position for these dampers shall be as determined in accordance with Clause 8.6.

3 Where a component of the air-handling system is in the mode required by the initiating conditions at the time of signal transmission, the status of the component shall remain unchanged.

4 Where a variable air volume system is used with a zone pressurization system, the system shall be designed so that on fire alarm, the variable air volume terminals, if not designed to be air-control dampers in accordance with Clause 2.4, shall take up an open position so that they do not prevent the system from achieving the required pressure differential between fire-affected compartment and non-fire-affected compartment.

5 Where a recycle damper is fitted or any other air-control dampers are installed they shall operate to assist smoke control.

6 Subsequent fire alarms from other compartments shall initiate operation of the smoke control system as a fire-affected compartment. This shall override the non-fire-affected pressurization control arrangement initially instigated.

7 Where the lift motor room has an airconditioning or supply air ventilation system this shall shut down. Where an exhaust air ventilation system is installed this should preferably start up or continue to run.

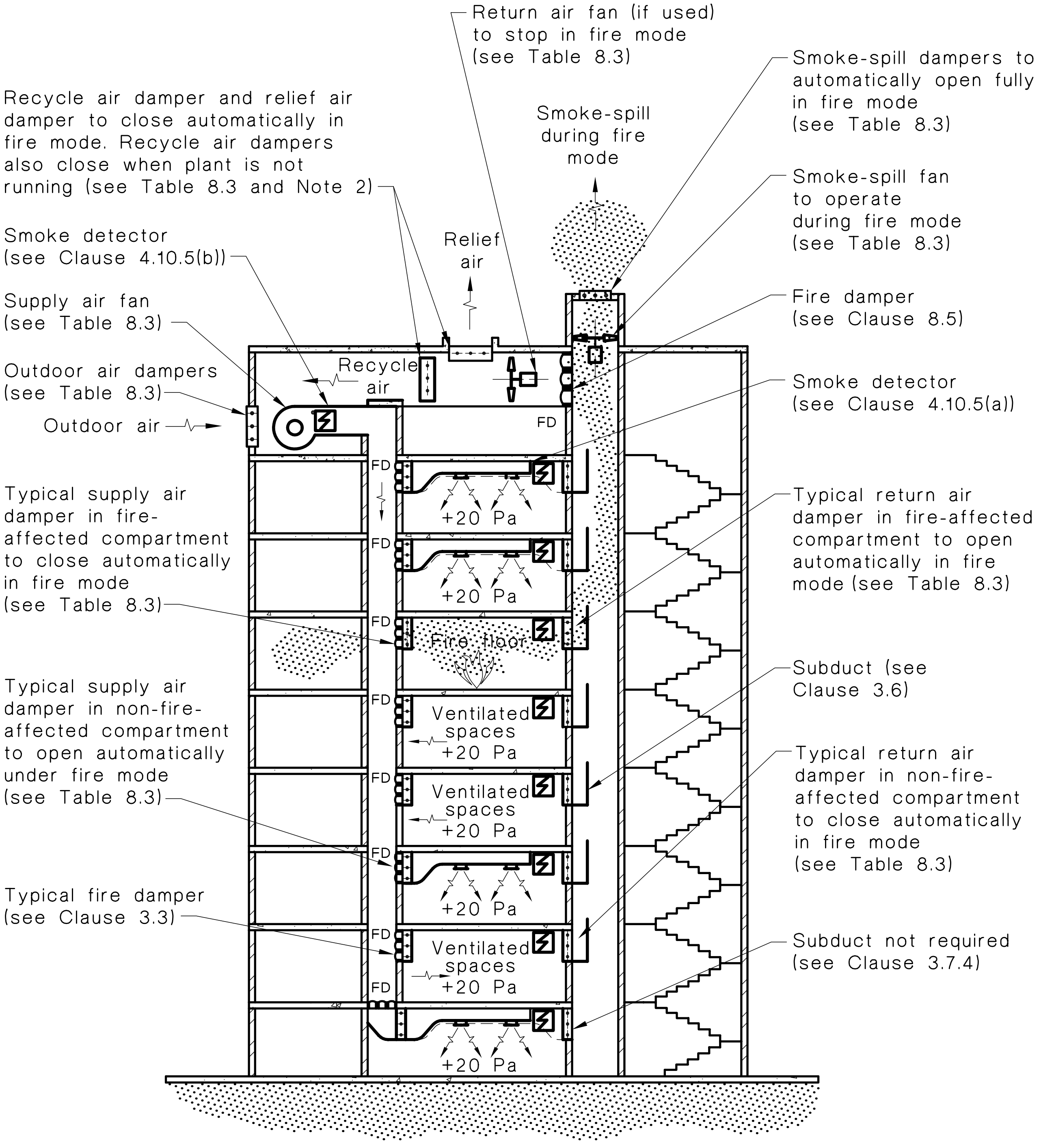
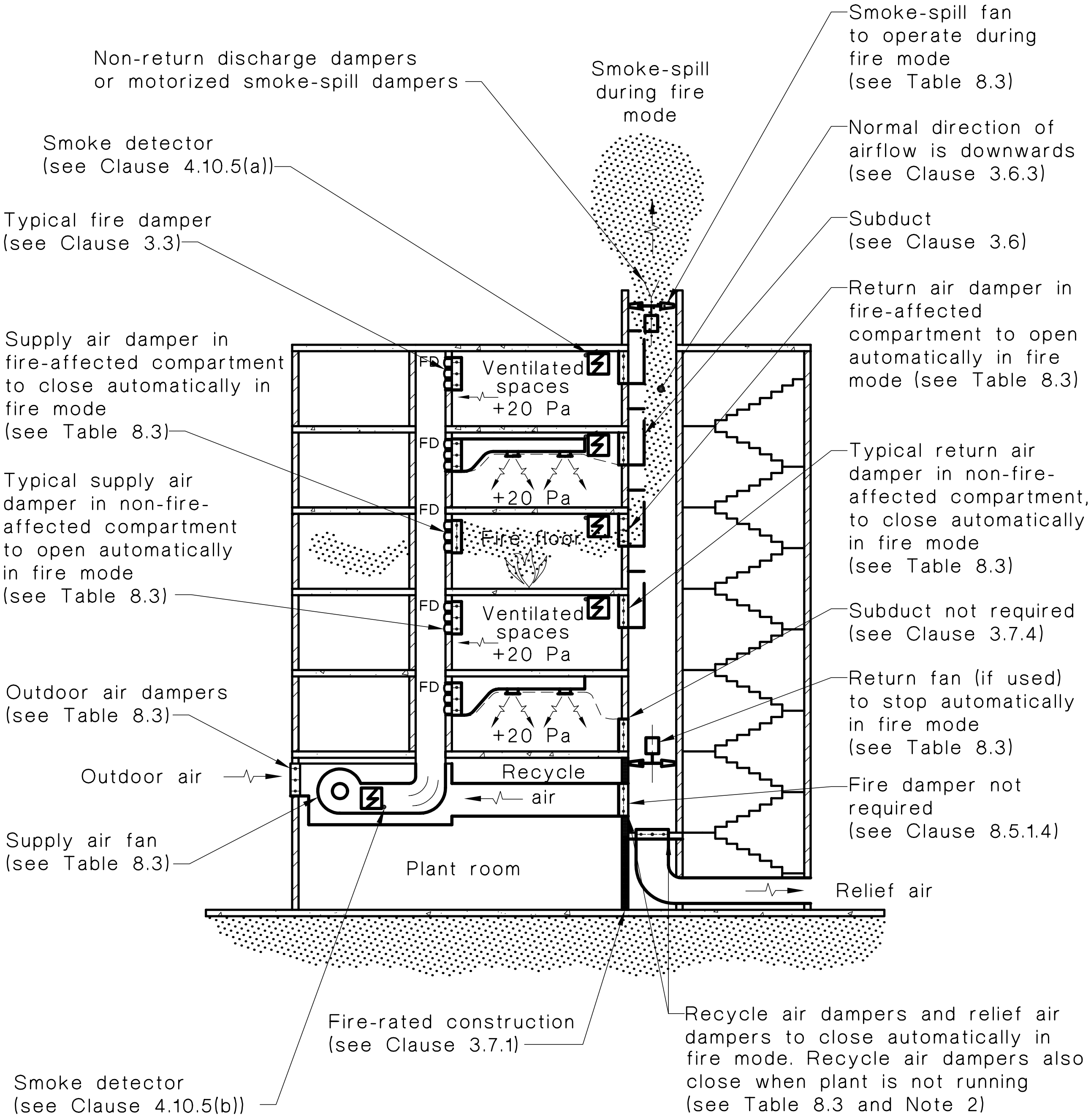


FIGURE 8.1 ZONE PRESSURIZATION SYSTEM—TYPICAL INSTALLATION WITH PLANT ROOM ABOVE SPACES BEING SERVED



NOTE: Non-return discharge dampers may only be used where they mechanically latch open on smoke-spill fan operation, except in sprinkler protected buildings (see Clause 2.4.7).

FIGURE 8.2 ZONE PRESSURIZATION SYSTEM—TYPICAL INSTALLATION WITH PLANT ROOM BELOW SPACES BEING SERVED

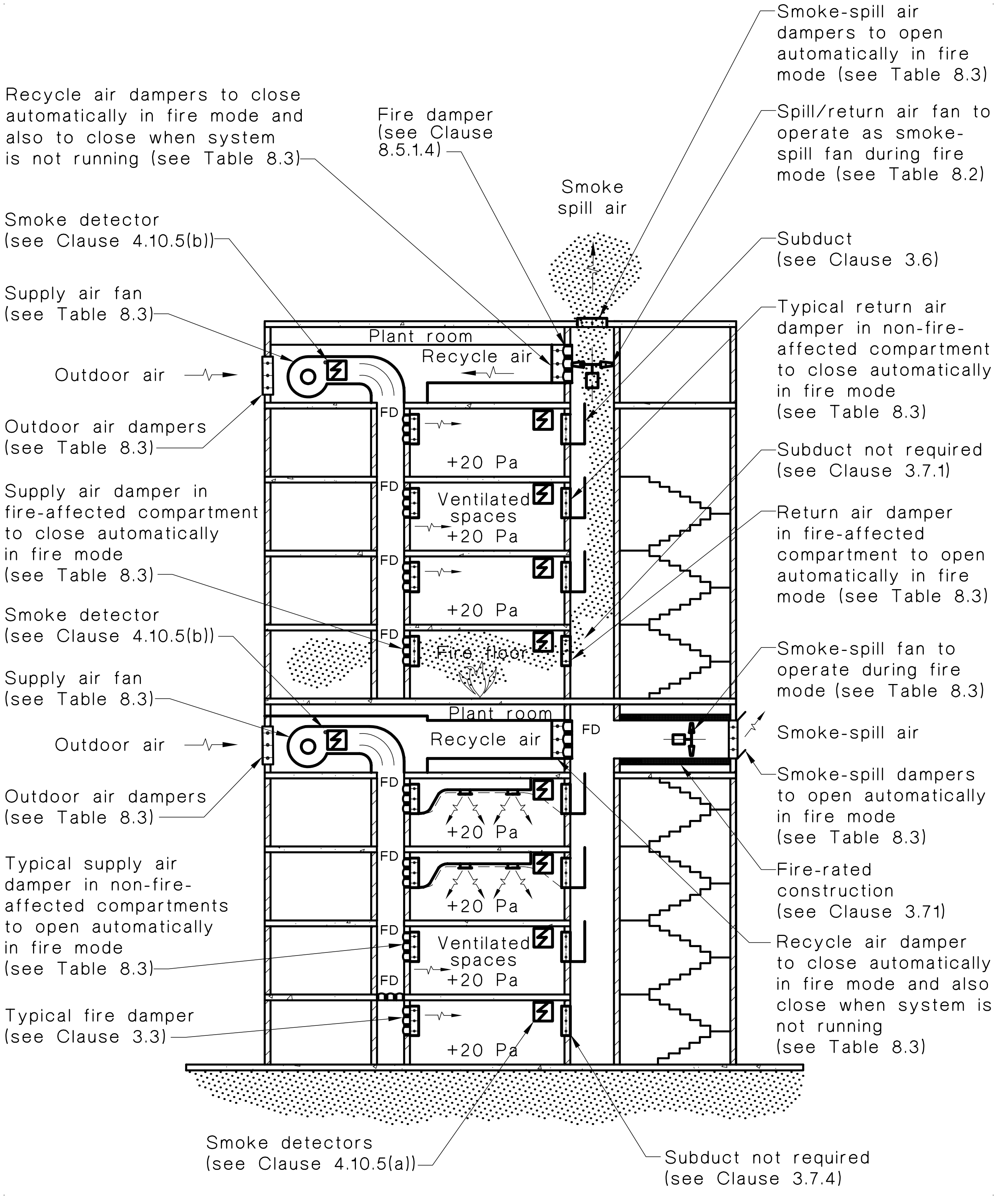


FIGURE 8.3 ZONE PRESSURIZATION SYSTEM—TYPICAL INSTALLATION WITH INTERMEDIATE PLANT ROOMS ABOVE COMPARTMENTS

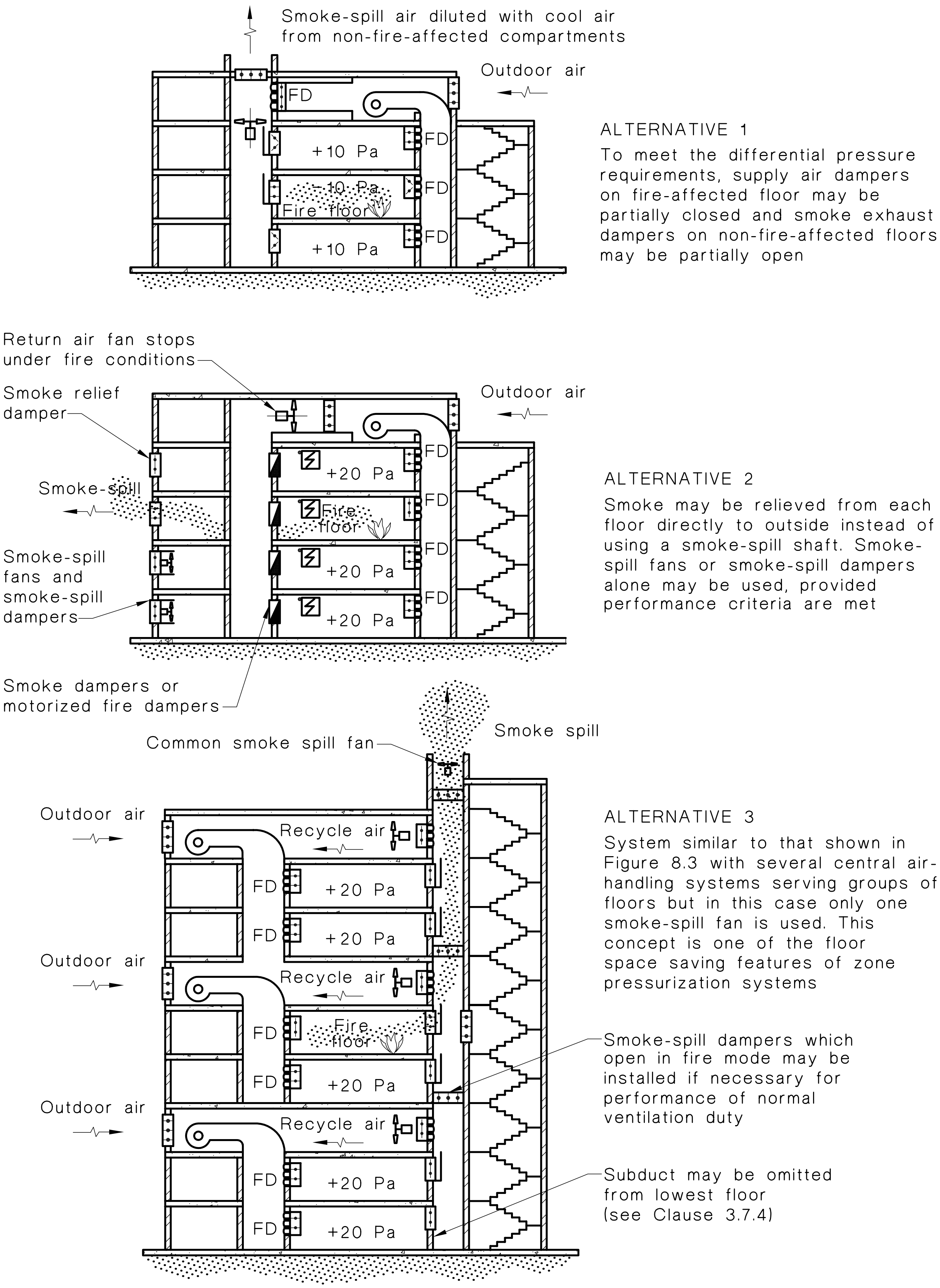


FIGURE 8.4 ZONE PRESSURIZATION SYSTEM—EXAMPLES OF ALTERNATIVES

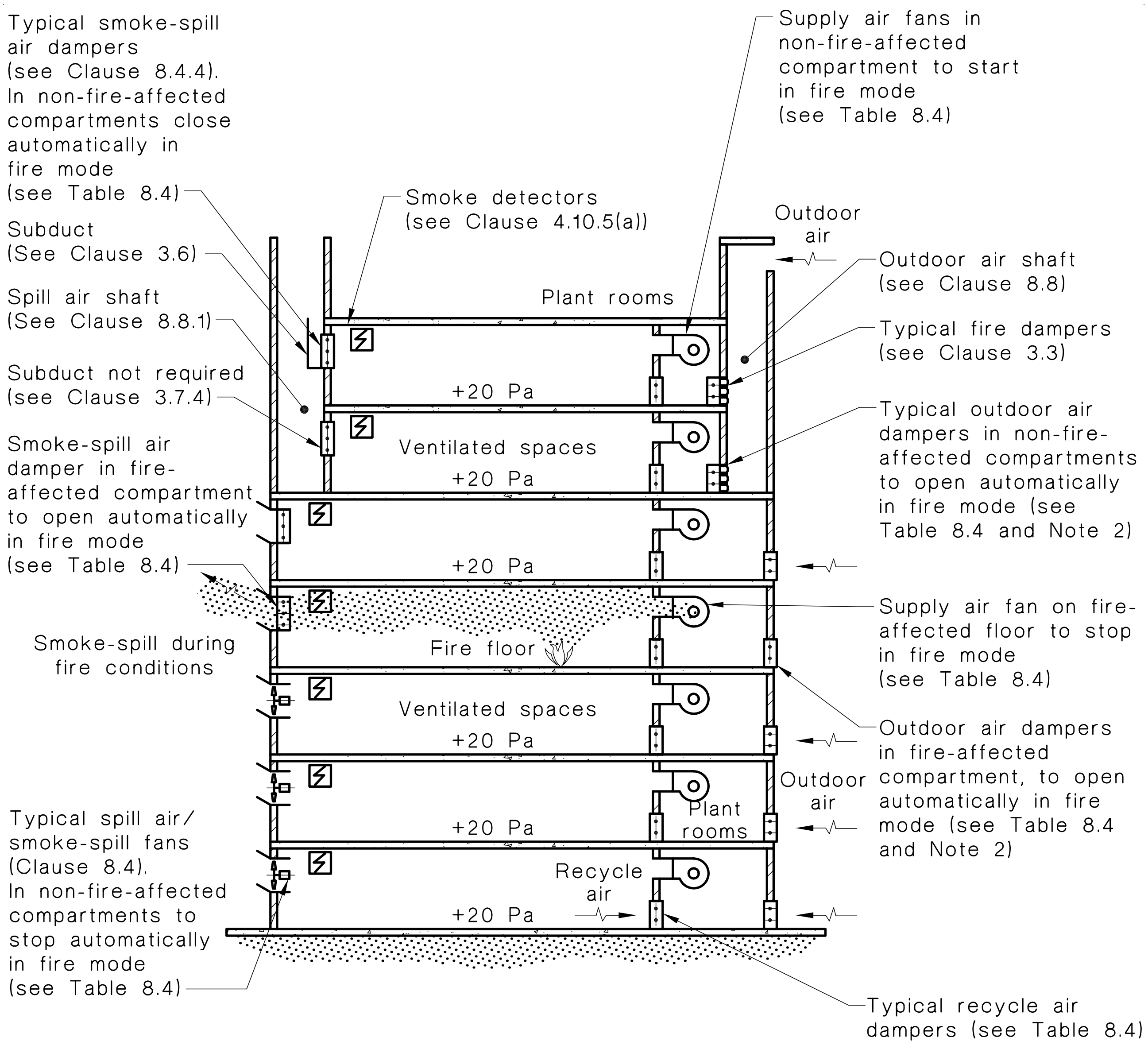
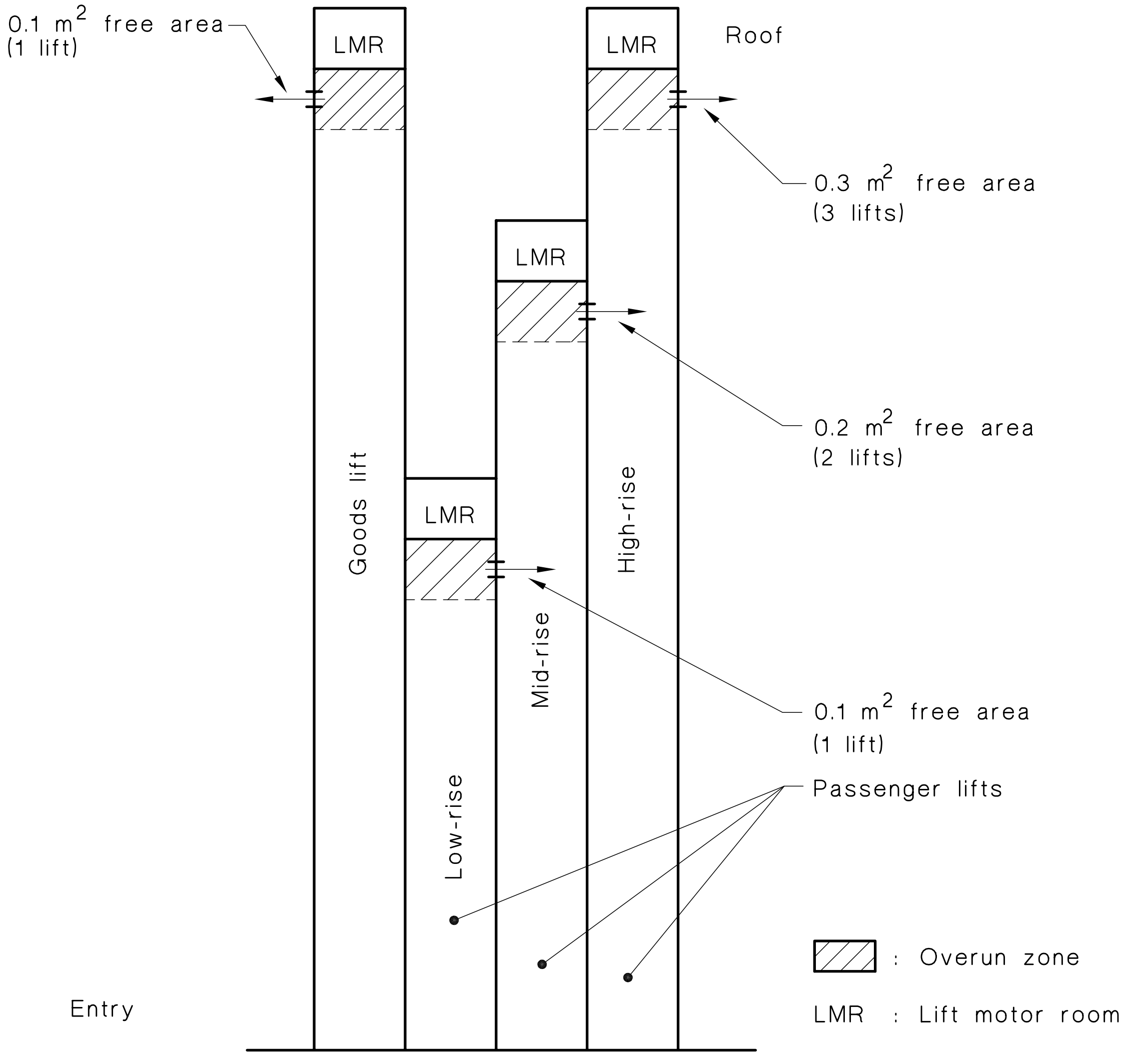


FIGURE 8.5 INDIVIDUAL AIR-HANDLING UNITS—TYPICAL INSTALLATION SHOWING THREE ALTERNATIVES OF ZONE PRESSURIZATION



NOTES:

1 This Figure is not applicable where lift shaft pressurization is required.

2 Where any lift acts as a fire lift, interconnection of vents between shafts is not allowed.

FIGURE 8.6 LIFT SHAFT AIR RELIEF

SECTION 9 FIRE-ISOLATED EXIT PRESSURIZATION

9.1 SCOPE OF SECTION This Section sets out the requirements for fire-isolated exit pressurization systems required to aid in smoke control. The requirements of this Section shall be read in conjunction with Sections 2, 3 and 4.

9.2 FIRE-ISOLATED EXIT PRESSURIZATION SYSTEM ARRANGEMENT The main feature of this arrangement is that a fire-isolated exit is pressurized with outdoor air to create a pressure difference between the fire-isolated exit (vertical and horizontal) and the occupied space.

> ***C9.2*** *The primary effect of the fire-isolated exit pressurization arrangement is to create an air velocity through openings from the fire-isolated exit to minimize the spread of smoke into the exits.*

9.3 PERFORMANCE REQUIREMENTS

9.3.1 Vertical fire-isolated exits To meet the objective of Clause 1.2, a fire-isolated exit pressurization system shall—

(a) with the main discharge doors and all doors to the fire-affected compartment fully open, sustain an airflow velocity of not less than 1 m/s into the fire-affected compartment through the doorway openings from that compartment, averaged over the full area of each door, whilst—

(i) for a purge system or system shutdown, all the doors to the compartment immediately above/adjacent to the fire-affected compartment are fully open; and

(ii) for a zone pressurization system all other doors are closed;

> ***C9.3.1(a)*** *Tests conducted by the CSIRO have demonstrated that airflows in excess of 0.8 m/s through a door incorporating a transom with a depth in the order of 500 mm, will minimize the spread of smoke against the direction of flow. A minimum airflow rate of 1 m/s has, therefore, been adopted. This airflow should be maintained across the doorway providing egress from the fire-affected compartment into the fire-isolated exit shaft during a fire. This performance needs to be achieved against the most demanding practical situation likely to occur in the early stages of fire development.*

(b) comply with door opening force and latching requirements of Clause 4.7, with—

(i) for a purge system or system shutdown, all doors to the fire-isolated exit closed; and

(ii) for a zone pressurization system, all doors to the fire-isolated exit closed except for the door immediately above/adjacent to the fire-affected compartment unless the door opening force is reduced by opening these doors, in which case the testing shall be carried out with these doors closed.

> ***C9.3.1(b)*** *Except for horizontal exit systems, the requirements for two compartment doors and the ground floor doors to be open at the same time has two applications. Initially, building occupants for both the fire-affected compartments and the floor above the fire-affected compartment will evacuate the building and, depending on the fire situation, this may be a simultaneous operation. When the fire brigade arrives and uses the fire-isolated exit for fire-fighting operations, initially hoses will be run from the floor below, up the fire-isolated exit and onto the fire-affected compartment floor, and hence, as a minimum, opening two doors. All required stairs should operate at once as either firefighters or evacuating occupants will be using the egress paths, resulting in the ground floor door to outside remaining open at all times.*

(c) be automatically controlled so that when operation of doors or other factors cause significant variation in airflow and pressure, Items (a) and (b) are restored with minimal delay, and not exceeding 10 seconds;

> ***C9.3.1(c)*** *The simplest way to meet the requirements of Clauses 9.3(b) and (c) is to provide dedicated grilles or ducts to relieve excess airflow/pressure to the outside of the building. This method provides near-instantaneous pressure control, thereby minimizing the period during which excessive force is required to open the doors to fire exits.*
>
> *Where such grilles or ducts are used for relief purposes, it is recommended that they are located at the highest level of the fire exit to assist in venting smoke in the event that smoke enters the exit. Manually openable doors, windows or similar, should not be considered as pressure-relief openings. Fixed openings in such items comply.*
>
> *If relief vents as described are not suitable for pressure control, then the following methods should be considered as alternatives: barometric dampers; motorized dampers in series with the pressurization fan; motorized relief dampers on the discharge of the pressurization fan; variable speed fans; or a combination of the above.*

(d) the required performance shall be achieved and sustained with any other smoke control or air pressurization systems operating concurrently in accordance with the relevant criteria for each system; and

(e) notwithstanding the requirements of Item (a), the flow across the top two-thirds of the doorway to the fire-affected compartment shall be in the direction from the stairway to the fire-affected compartment. This requirement may be waived where it can be demonstrated, when smoke logged under test, that any reverse flow is not detrimental to the safe operation of the fire-isolated exit pressurization system.

9.3.2 Horizontal fire-isolated exits Performance criteria for horizontal exits shall be in accordance with Clause 9.3.1 except that only the required exit doors to the largest compartment served are applicable for testing of airflow. Performance criteria for door opening force and latching shall be applied to all doors.

> ***C9.3.2*** *It is assumed that horizontal fire-isolated passageways are equivalent to fire-isolated stairs in multistorey buildings, irrespective of whether the passageway incorporates firefighting facilities for fire brigade access to the building or not. As the purpose is for smoke control, the dominant factor for design relates to the number of exit doors that need to be provided with air velocity. Therefore, the largest smoke compartment served may be more relevant for establishing the required number of open exit doors than the size of a fire compartment that may incorporate several smoke compartments (e.g. cinema complex). The number of doors open will be dependent on the likely evacuation procedures adopted which may provide appropriate design criteria.*

9.4 SYSTEM ARRANGEMENTS

9.4.1 Dedicated fire-isolated exit pressurization An independent dedicated fire-isolated exit pressurization system shall be installed to each fire-isolated exit where—

(a) a purge smoke control system is installed in accordance with Section 7; or

(b) a zone pressurization system is installed (with central or individual plant) in accordance with Section 8 and utilizing a common outdoor air intake (i.e. serving more than one plant) unless alternative combination provisions are available in accordance with Clause 9.4.2. (See Figure 9.1(a).)

> ***C9.4.1*** *The requirement for a dedicated pressurization system for each exit is to prevent failure of one system affecting all exits. Air supplied to the exit should be obtained from outside the building to minimize the risk of smoke contamination from the fire within. Intake connection should be as direct as possible although use of dedicated pressurization plant enclosure as a plenum could be expected to be acceptable.*

9.4.2 Combination systems Zone pressurization systems may be utilized to provide fire-isolated exit pressurization without the need for dedicated or separate systems subject to compliance with either of the following requirements:

(a) Where multiple outdoor air intakes are utilized, the system may use air leakage from the pressurized compartments or a combination of both dedicated fire isolated exit pressurization and air leakage from the pressurized compartments.

(b) Where a common outdoor air plenum is utilized—

  (i) air leakage from the pressurized floors may be used where separate air inlets and locations are provided to the outdoor air plenum arranged for automatic selection of duty or stand-by use controlled by dampers from smoke detector activation in accordance with Section 4 and incorporate dual fans or fans with dual drive (see Figure 9.1(b)); or

  (ii) air leakage from the pressurized floors may be used where the number of central plant systems exceeds three, all are automatically arranged for duty or stand-by operation and all utilize separate air inlets and locations controlled by dampers from smoke detector activation in accordance with Section 4 (see Figure 9.1(c)).

> ***C9.4.2*** *Combination arrangements of zone pressurization and fire-isolated exit pressurization systems may cause complications; however, they can be effective and may be necessary for the retrofitting of existing buildings where the pressurization is provided by the zone pressurization system and air velocity (for egress doors) is provided from the fire-isolated exit pressurization system. Where zone pressurization systems use a common outdoor air shaft, pressurization by air leakage from the pressurized storeys is not listed as an option by itself, as such a system would normally only include a single outdoor air fan and a single inlet. Exits would not, therefore, be provided with any form of backup. Provision of dual fans or a fan with dual drives together with two separate inlets, each controlled by smoke detectors and air dampers, is an alternative to the above. A dedicated pressurization system may be installed in lieu, to serve more than one exit and to act as the backup, should the common zone pressurization system fail.*
>
> *Options that may be considered are as follows:*
>
> *(a) Dual fans served by two separate inlets with non-return damper where necessary.*
>
> *(b) Use of central plant where air intakes to various systems are widely separated.*
>
> *(c) Dedicated fire-isolated exit pressurization systems each provided with smoke detectors.*

9.4.3 Protection of components Fire-isolated exit components shall comply with the following:

(a) Any part of a dedicated system, located external to the exit served, shall be enclosed by a construction having an FRL at least equal to that required for the exit or any compartment through which it passes, except that any part located on the roof of a building, where that roof has an FRL at least equal to that required for the exit, or otherwise external to the building, need not be so enclosed.

(b) Any shaft used for the protection of ductwork shall contain no other services except those permitted by the building regulations to be installed within fire-isolated exits.

(c) A dedicated fire-isolated exit pressurization system shall not incorporate fire dampers.

(d) The system shall comply with—

    (i) Clause 4.2 for the location of external openings for air intake and relief; and

    (ii) Clause 4.6 for noise limitations.

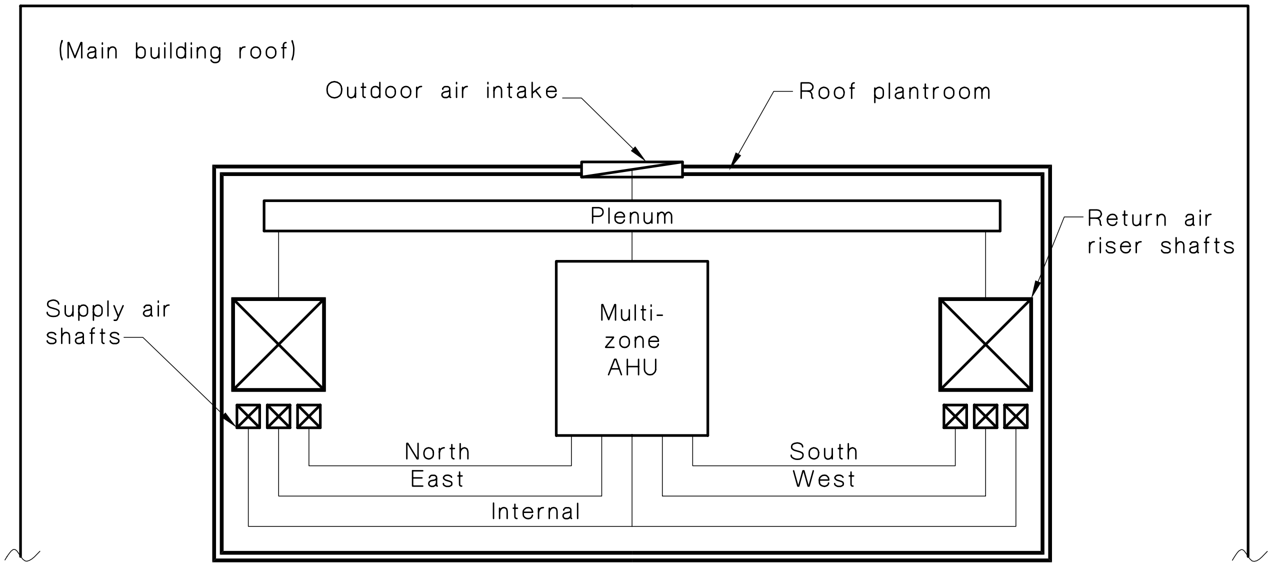
> ***C9.4.3*** *Components of the dedicated system should be afforded the same protection against a fire within the building as the exit itself and, consequently, components external to the exit should be protected with construction having at least the same level of fire resistance.*

9.4.4 Air pressurization fans Any fans used for pressurization purposes shall be selected to meet the requirements of Clause 9.3.

> ***C9.4.4*** *The air pressurization fan is required to deliver large airflows on demand whilst not causing excessive static pressure build-up when flows are small. Consequently, the fan selected should have a flat characteristic so that small changes in static pressure correspond to large changes in airflow, or suitable pressure control devices should be incorporated.*
>
> *To achieve the required airflow velocity on any storey, air supplied by the system should be evenly distributed throughout the height of the fire-isolated exit shaft. This is particularly important where buildings exceed 10 storeys. Due consideration should be given to stack effect in tall buildings and the effects of variations in outdoor temperature.*
>
> *Centrifugal fans will run on freely after shutdown and could continue to deliver smoke into the exit. Fans should be selected, or the system should be designed, to prevent this occurrence. Bypass provisions or smoke dampers controlled by the smoke detector and the manual override controls would be acceptable.*

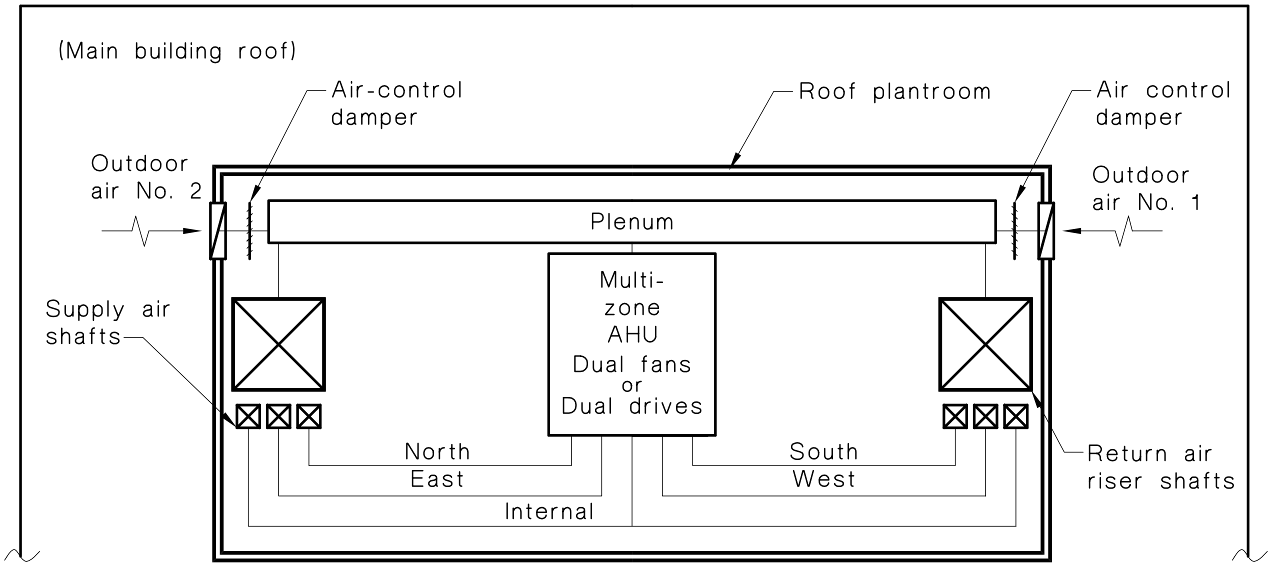
9.4.5 Automatic smoke detectors A detector shall be installed to sample air supplied by each fan in a dedicated pressurization system and, for this purpose, it shall be considered as a supply air detector and comply with the relevant requirements of Clause 4.10.5(b).

9.4.6 Control and indication The provisions of Clause 4.13 shall apply. Notwithstanding Clause 9.4.3, equipment associated with a dedicated air pressurization system may be located within the FFCP or the FIP.



NOTE: Failure of air-handling unit is supported by requirement of single dedicated fire-isolated exit pressurization system.

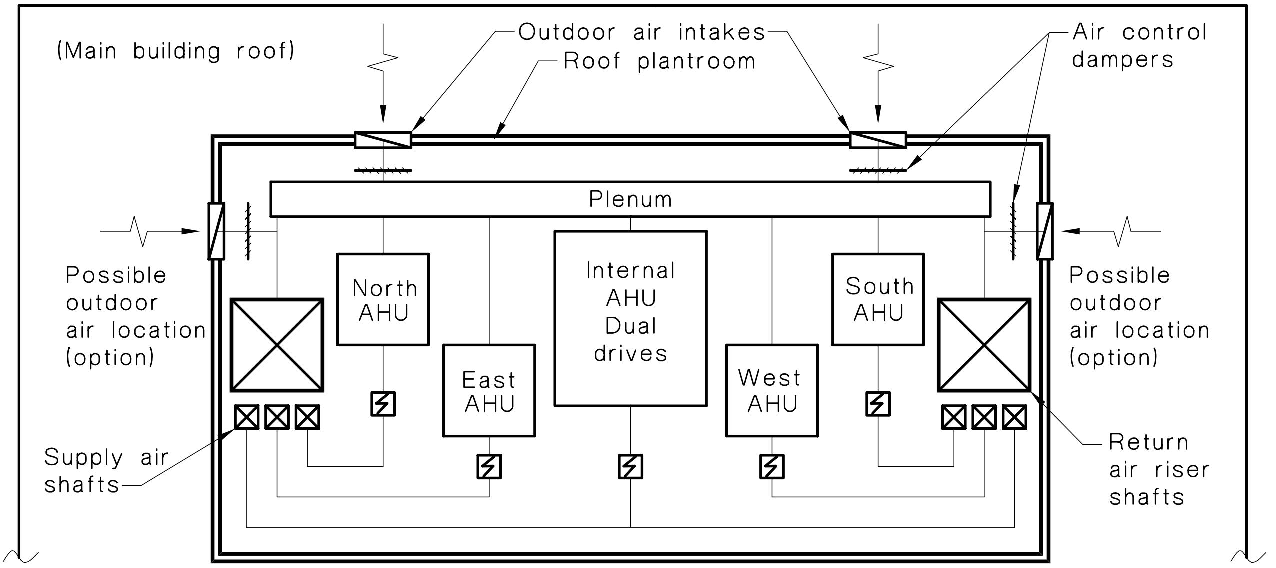
(a) Single point of failure (single intake, fan and drive)



NOTE: Compliance with Clause 9.4.2(b)(i) and the provision of dual intakes and dual fans (or fans with dual drive) allow for a combination system.

(b) Multiple point of failure (dual intake, dual fans or drive)

FIGURE 9.1 (in part) AIR INLET AND LOCATION DIVERSITY ARRANGEMENTS FOR COMBINATION SYSTEMS



NOTE: Compliance with Clause 9.4.2(b)(ii) and the provision of separate air inlet locations and duty/stand-by operation allow for a combination system

(c) Multiple point of failure (multiple central plant system)

FIGURE 9.1 (in part) AIR INLET AND LOCATION DIVERSITY ARRANGEMENTS FOR COMBINATION SYSTEMS

9.4.5 Operation under fire conditions Air pressurization fans shall be controlled in accordance with Table 9.1.

TABLE 9.1

OPERATIONAL REQUIREMENTS FOR FIRE-ISOLATED EXIT PRESSURIZATION FANS

Initiating conditions (see Note)	Fan operating status
Actuation of—	
(a) any smoke detector required by Clause 4.10.5(a), (c) and (d); or	Start
(b) building automatic fire sprinkler, smoke detection system or manual call point; or	Start
(c) supply air smoke detector required by Clause 9.4.5; or	Stop
(d) automatic reset of the supply air smoke detector	Restart

NOTE: Initiating conditions (a), (b), (c) and (d) represent the transmission of a signal to the air pressurization control system. Time delays required by Clause 4.10 shall have elapsed prior to signal transmission. Delays between receipt of the signal and system operation will include the inherent delay of the control equipment and any special delay necessary for reliable operation, e.g. opening/closing of air dampers prior to fan initiation. Within these limitations such delays should be minimized.

9.5 HORIZONTAL FIRE-ISOLATED EXIT PRESSURIZATION Pressurization systems for required horizontal fire-isolated exits shall be separately provided when a fire-isolated passageway is constructed independently from any fire-isolated vertical stairway that is served with an air pressurization system as part of a smoke control system.

C9.5 *Reference is made to building regulations which, in some jurisdictions, require an air pressurization system for certain fire-isolated passageways. Examples of passageway egress are as follows:*

(a) Egress to underground horizontal tunnel from centre of industrial buildings where maximum egress distance is exceeded due to building size and configuration or limited by equipment layout.

(b) Egress to horizontal corridor serving several retail tenancies within a large shopping complex, utilized for both emergency and normal service use.

(c) Egress to horizontal passageway serving multi-compartmentalized cinema auditoriums involving large occupancy evacuation.

9.6 AIR RELIEF

9.6.1 General Adequate provisions shall be made in each compartment to allow the relief or exhaust of airflows required by Clause 9.3 by either mechanical or non-mechanical means.

C9.6.1 *Zone pressurization and air purge systems have inherent relief via the smoke-spill provisions. Systems employing shutdown or lift shaft pressurization and fire-isolated exit pressurization alone will need specific relief/exhaust provisions. The incorporation of a fixed vent at the top of a stair (to the outside of the building) may assist to purge any smoke that has entered the stair shaft and prevent overpressurization of the stair shaft.*

9.6.2 Non-mechanical relief If non-mechanical systems are used to relieve exit pressurization airflows from the compartment, the following provisions apply:

(a) Relief ducts or vents from one compartment shall not be connected to or serve any other compartment.

(b) Relief ducts or vents passing through compartments other than the compartment being served shall be enclosed in construction having an FRL not less than that required for the construction separating the compartments.

(c) External openings of such systems shall be located on top of the building in a configuration that cannot be adversely affected by local wind conditions (see Clause 4.2). Alternatively, external openings of such systems shall be duplicated and each of the two openings for each compartment shall be located on opposite sides of the building, sized so that all the relief airflow can be adequately discharged through either opening.

9.6.3 Mechanical relief Where exist pressurization airflows into the compartment are relieved by a mechanical exhaust system, it shall be designed and installed as a smokespill system complying with this Standard.

9.7 OTHER SERVICES

9.7 OTHER SERVICES The use of fire-isolated exits as plenums for any part of return air or smoke-spill air systems is prohibited.

SECTION 10 LIFT SHAFT PRESSURIZATION SYSTEM

10.1 SCOPE OF SECTION This Section sets out the requirements for a lift shaft pressurization system when required to aid in smoke control. The requirements of this Section shall be read in conjunction with Sections 2, 3 and 4. Lift shafts that are external to the building or are naturally ventilated, and that cannot provide a smoke leakage path within the building, are not required to be pressurized.

10.2 LIFT SHAFT PRESSURIZATION SYSTEM ARRANGEMENT The main feature of this arrangement is that every separate lift shaft (or group of shafts) is pressurized with outdoor air to create a pressure difference between the shaft and all other compartments.

> ***C10.2*** *The primary effect of the lift shaft pressurization arrangement is to restrict the spread of smoke from a fire-affected compartment to a non-fire-affected compartment via the lift shafts.*

10.3 PERFORMANCE REQUIREMENTS The capacity of the pressurization system shall be sufficient to develop a pressure differential of between 20 and 50 Pa between the lift shaft and the occupied space of the building.

> ***C10.3*** *The range of 20–50 Pa allows for a flexible design tolerance, which is intended to achieve the minimum requirements but not subject the system to extensive modifications during commissioning or cause problems with lift door operation. In practice, higher pressure differentials may be acceptable on a project-specific basis subject to confirmation that the lift doors will not be adversely affected by the pressure differential.*

10.4 GENERAL REQUIREMENTS

10.4.1 Pressurization system Each separate lift shaft (or group of shafts) shall be equipped with a pressurization system capable of delivering, during fire mode, outdoor air into the lift shaft. Outdoor air shall be supplied either—

(a) into the lift shaft directly; or

(b) via the lift motor room.

NOTE: See Figures 10.1 and 10.2.

C10.4.1 *The lift motor room ventilation fan may be used as a dual duty fan which supplies (or exhausts) the lift motor room during normal operation and pressurizes the lift shaft during fire mode. Care should be exercised by the designer when selecting lift shaft pressurization fans, especially in the following areas:*

(a) Allow for leakage through cracks and around all landing door openings plus leakage through the clearance space between lift car and landing door surrounding frame in one floor only. (Refer to the ASHRAE publication, Design of Smoke Management Systems.)

(b) Ensure that the power supply is from the essential services mains and the fans can be controlled from the FFCP.

(c) If dual duty fans are proposed, any required fire-rated separation between lift motor room and lift shaft should be retained. In these situations it may be necessary to install motorized fire dampers to enable the changeover function. Note that the cable penetrations may create substantial openings between the lift motor room and lift shaft.

(d) It may be possible to run a lift motor room exhaust fan as a pressurizing fan simply by operating the fan in reverse and fitting it with appropriate interconnecting ducts and dampers. In these cases provision should be allowed for the exhaust fan to slow down before starting it in reverse as a pressurizing fan. Fan manufacturers can supply performance data for reversible fans.

10.4.2 Automatic smoke detectors A detector shall be installed to sample air supplied by each fan in the pressurization system and, for this purpose, it shall be considered as a supply air detector and comply with the relevant requirements of Clause 4.10.

10.4.3 System operation The lift shaft pressurization fan shall—

(a) automatically start up or, where applicable, change from its dual exhaust function, to provide air pressurization in the event of any fire alarm within the building, including outside normal hours;

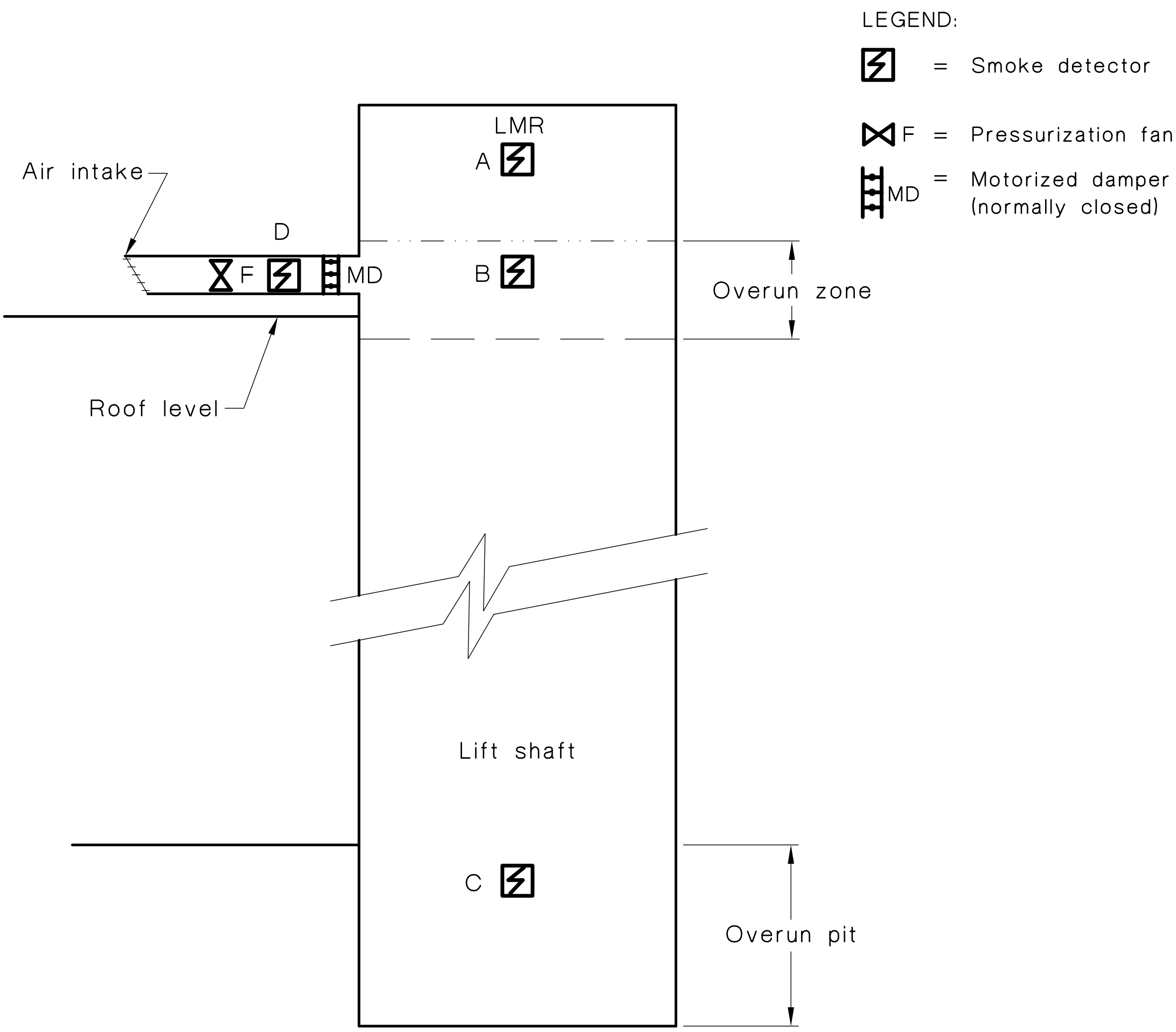
(b) open the normally closed motorized damper used for direct pressurization; and

(c) stop, if smoke detectors installed within the lift shaft or lift motor room are activated.

C10.4.3 *If practicable, the lift shaft pressurization fan should operate to exhaust the lift shaft rather than simply stop when smoke is detected.*

10.4.4 Motorized dampers Motorized dampers shall comply with Clause 2.4.

10.4.5 Override control The lift shaft pressurization fan shall have override control switches located on the FFCP.



NOTES:

1 Pressurization of the lift shaft is activated by the building smoke detection or sprinkler system.

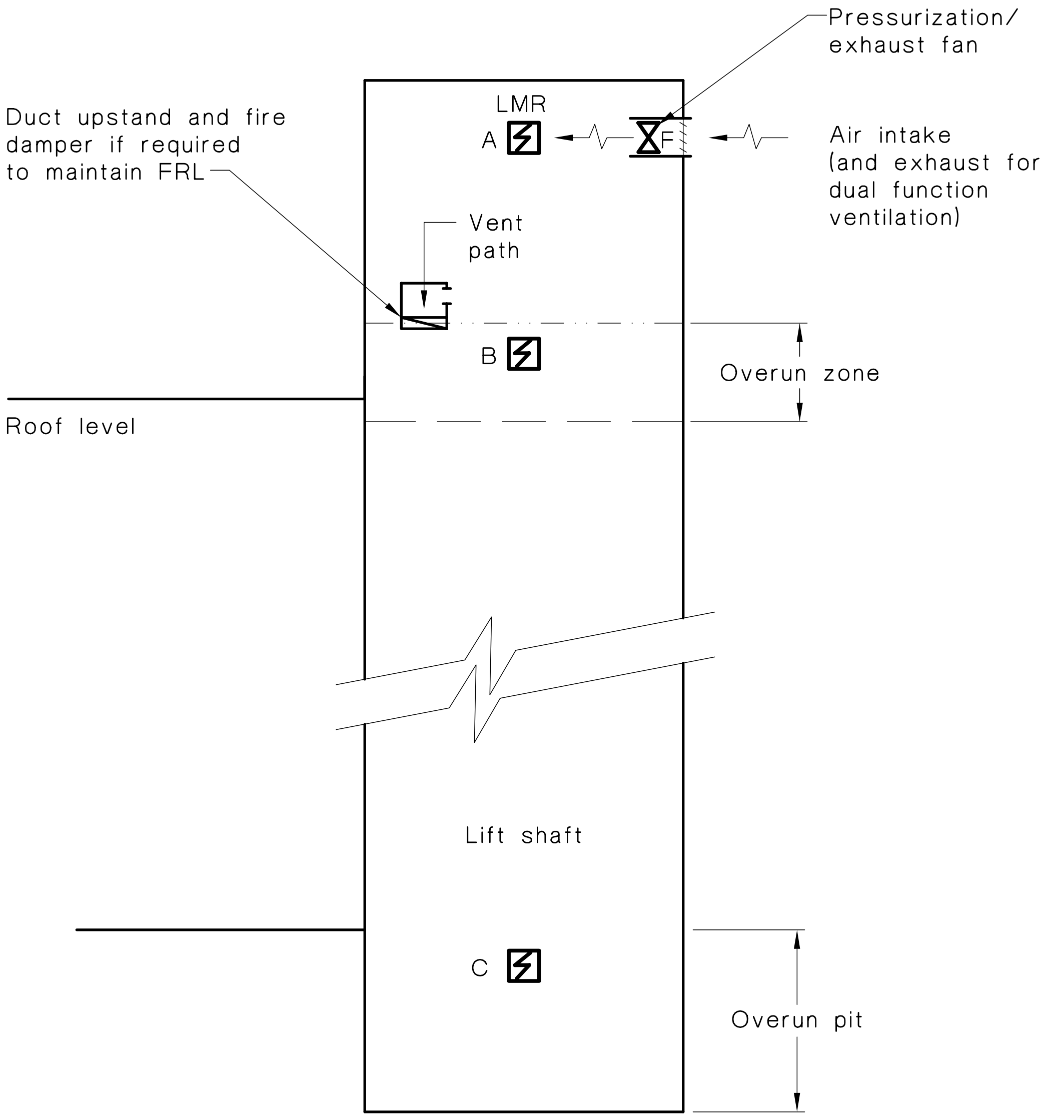
2 Smoke detectors A, B, C and D are on separate alarm circuits.

3 Smoke detectors A, B and C open MD and shut down pressurization fan (if running).

4 Smoke detector D shuts down pressurization fan (and closes MD).

5 All detectors are single point (including duct-mounted D).

FIGURE 10.1 TYPICAL LIFT SHAFT DIRECT PRESSURIZATION SYSTEM



NOTES:

1 Pressurization of the lift shaft is activated by the building smoke detection or sprinkler system.

2 Lift motor room exhaust ventilation fan may be used for lift shaft pressurization. Fan capacity should satisfy each operating mode as a minimum.

3 Smoke detectors A, B and C are on separate alarm circuits. Activation should shut down (or not allow) pressurization fan mode.

4 Smoke detector activation may allow fan to operate in exhaust mode.

5 All detectors are single-point detectors.

FIGURE 10.2 TYPICAL LIFT SHAFT INDIRECT PRESSURIZATION SYSTEM

SECTION 11 KITCHEN HOOD EXHAUST SYSTEMS

11.1 SCOPE AND APPLICATION This Section sets out requirements for kitchen hood exhaust systems. This Section shall apply to exhaust systems serving kitchen hoods installed above appliances as required by AS 1668.2 and likely to generate grease vapour. This Section shall be read in conjunction with Sections 2 and 3.

> ***C11.1*** *This Section is intended to cover kitchen hood exhaust systems associated with commercial type installations. It is not intended to apply to domestic type installations associated with home units, flats or facilities provided in office type accommodations for use by staff members. These latter systems would usually be treated as minor exhaust systems.*

11.2 SYSTEM REQUIREMENTS

11.2.1 General Notwithstanding the requirements of this Section, kitchen hood exhaust systems may form part of, or be used to assist, required smoke control systems. In such instances the relevant Sections of this Standard shall apply.

11.2.2 Common exhaust Kitchen hoods located in separate fire compartments shall have independent exhaust systems. An exhaust system may serve more than one hood located within the same fire compartment subject to the requirements of AS 1668.2. Kitchen exhaust ducts from separate fire compartments and of cross-sectional area less than 0.1 m^2 may share a common riser shaft provided that an FRL of -/-/30 is maintained between the ducts. Where the kitchen exhaust duct cross-sectional area is greater than 0.1 m^2 a separate riser shaft shall be provided. If the kitchen exhaust system forms part of a smoke-spill system, then the requirements of Clause 3.7 shall apply.

> ***C11.2.2*** *Kitchen exhaust ductwork presents two fire hazards, a fire within the duct itself and a fire within the fire compartment served. As fire dampers are not allowed to be installed on kitchen exhaust ductwork, fire spread between ducts could compromise the building's passive fire protection. It is considered that the likelihood of fire spread between ducts of small systems is low if an FRL of -/-/30 is maintained between the ducts. With larger ducts, the risks are considered greater and the building passive fire compartmentalization should be maintained (see Figure 11.1). One way that the -/-/30 FRL may be achieved is if the duct is wrapped in 50 mm mineral wool, held in place with steel wire mesh, or otherwise attached with non-combustible fastenings having a fusing temperature of not less than 1000°C.*

11.2.3 Ductwork

11.2.3.1 *Construction* Ducts shall be manufactured from material complying with Clauses 2.2.1 and 2.2.2 and, when not enclosed in a single dedicated shaft, shall be galvanized steel of a thickness not less than 1.2 mm, stainless steel not less than 0.9 mm thickness or other suitable material. Ducts shall be sealed in accordance with AS 4254 except that button punch snaplock joints shall not be used.

NOTE: Fittings (acoustic attenuators, seals or similar) having an aggregate length of not more than 2 m need not comply with the requirements of Clause 2.2.2.

11.2.3.2 *Installation* Ducts shall be installed vertically or near-vertically wherever practicable. Ducts installed horizontally shall be kept to a minimum and shall be installed with a rise in the direction of airflow of not less than 0.5%.

Access, large enough to enable cleaning of ducts, shall be provided at each change in direction and in horizontal runs at intervals not exceeding 3 m. A drain fitted with a grease-tight tap or plug shall be provided at the lowest point of each run of ducting.

11.2.3.3 *Ducts within the compartment being served* Ducts within the compartment of the kitchen hood(s) being served shall not be closer than 300 mm to any combustible material or shall be insulated to achieve 30 min fire insulation in accordance with AS 1503.4 with respect to a fire inside the duct.

11.2.3.4 *Ducts penetrating fire-resisting elements* Ducts penetrating floors, walls, ceiling/floor or ceiling/roof systems required to be fire-resisting shall comply with the relevant parts of Section 3.

11.2.4 Fire dampers Fire dampers shall not be installed in kitchen hood exhaust systems. Fire baffles may be incorporated as an integral part of a proprietary kitchen hood assembly.

> ***C11.2.4*** *Fire dampers are not permitted within the duct system because their effectiveness is questionable as grease on the downstream side would likely ignite before damper closure. The potential for false operation is also greater than normal and closure other than in a fire situation could have serious consequences. Some commercial kitchen hoods have their own in-built suppression system to reduce the risk of fire spreading into the duct.*

11.2.5 Fans and casings Kitchen exhaust fans and casings shall be manufactured from non-combustible materials.

11.2.6 Operation under fire conditions On activation of any installed general fire alarm, the exhaust system may continue to operate in the event of fire. Where a kitchen exhaust system includes a dedicated supply air system, it shall stop in the event of a fire.

On activation of any installed exhaust duct heat detector or monitored sprinkler head, a local alarm shall be initiated, any dedicated supply system shall stop and the exhaust system may continue to operate.

> ***C11.2.6*** *Generally, the appropriate strategy is to contain the smoke within the kitchen area or compartment of origin, utilizing the kitchen hood exhaust system wherever possible to assist in smoke removal. This should ideally create a negative pressure in the kitchen compartment. In some cases, an adjoining restaurant area may form part of the compartment within which the kitchen is located and may utilize to advantage the kitchen exhaust system for the purpose of smoke control.*
>
> *The installation of a suppression system within the kitchen hood and over the cooking areas is likely to reduce the gas temperatures passing through the extract fan, thus ensuring operation of the fan for as long as possible.*

11.2.7 Plant isolation Kitchen exhaust air-handling plant located within a fire compartment, other than the compartment(s) being served, shall be enclosed with construction having an FRL not less than that needed to maintain the required integrity between compartment.

Where located in a plant room such exhaust plant and associated ductwork serving other compartment(s) need not be enclosed in fire-resisting construction unless the plant room contains other (un-enclosed) essential services, e.g. essential switchboards, supply air systems, air pressurization systems, hydrant pumps and emergency batteries.

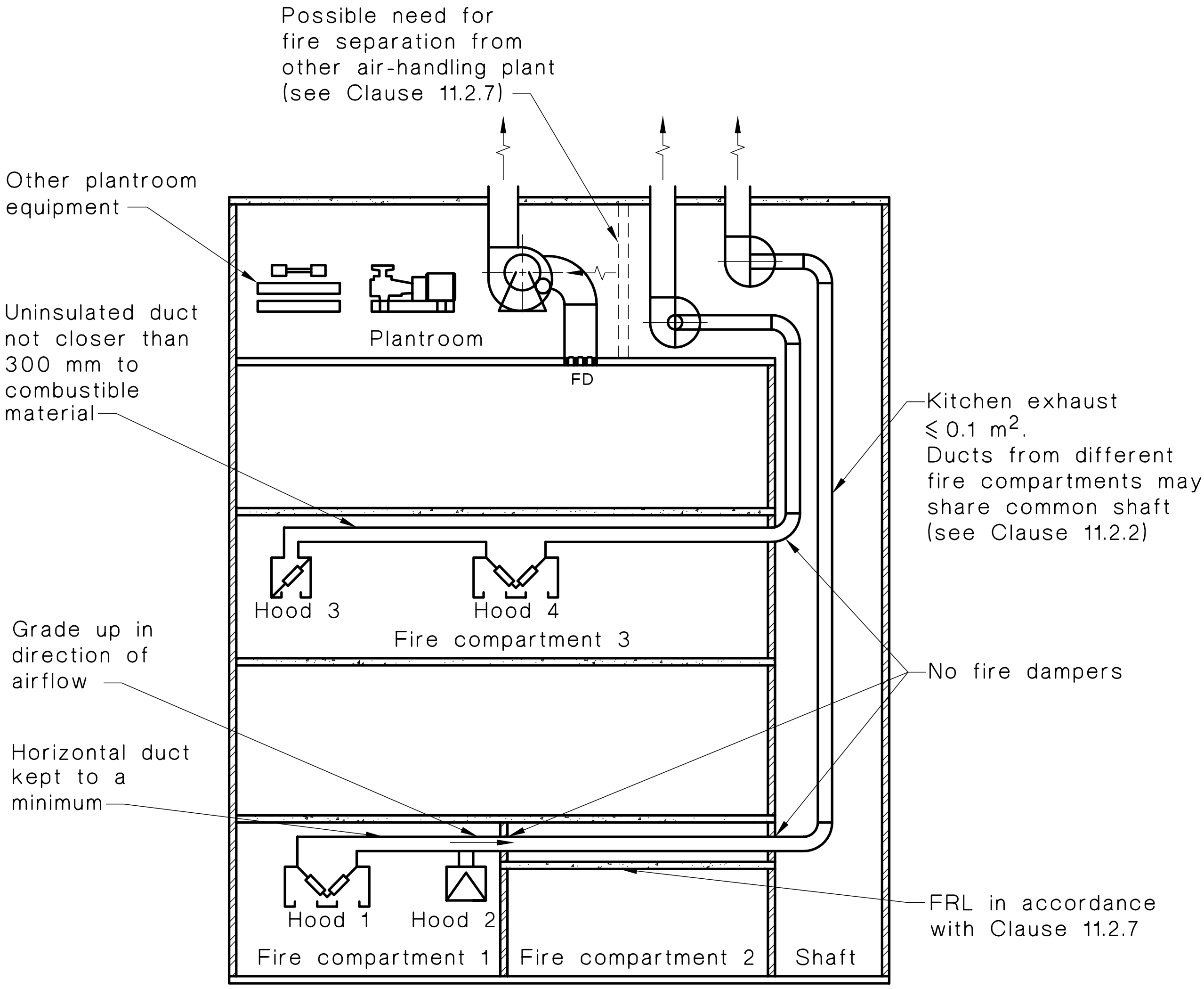


FIGURE 11.1 KITCHEN EXHAUST SYSTEMS

APPENDIX A
SMOKE CONTROL SYSTEM APPLICATION
(Informative)

A1 GENERAL This Appendix provides solutions to smoke control when applied to the building class, category and sprinkler protection in accordance with Table A1. This Table may be applied to parts of buildings. Reference should be made to Clause 1.3 on the application of this Standard. Alternative smoke control provisions may be formulated by using fire engineering principles to achieve the design objectives. Reference should be made to Performance Building Regulations for carrying out performance-based designs.

NOTE: The Building Code of Australia specifies minimum requirements for the application of smoke control systems in buildings in Australia. Where building regulations do not specify minimum requirements, guidance on the application of smoke control systems in buildings is provided in this Appendix.

A2 BUILDING CLASS AND CATEGORY This Appendix provides guidance on the use of air-handling systems in controlling the spread of smoke in multi-compartment buildings. These recommendations, whilst having a general similarity, cannot be applied identically to all multi-compartment buildings. For the purposes of application of this Standard, recommendations for different building types are defined according to the following criteria:

(a) *Class*—this terms covers variations in building occupancy characteristics which have a major influence on the strategies necessary for smoke control.

NOTE: For a definition of building class refer to the Building Code of Australia. Classes of building are functionally equivalent to purpose groups in the New Zealand Building Code Handbook and approved documents.

(b) *Category*—this term covers the variations of height, size, area, volume, and so on, of buildings within each class. Buildings are graded into category levels according to smoke management needs. Category 1 specifies the least need while higher Categories specify more stringent requirements.

A3 PRIORITY OF SMOKE CONTROL Table A1 recommendations are intended to restrict smoke spread into areas within a building, in the following order of priority:

(a) Fire-isolated exits, ramps, passageways and horizontal exits.

(b) Principal evacuation routes (e.g. public corridors) leading to a safe place (where practicable).

(c) Adjacent fire/smoke compartments via principal connecting paths such as stairs, lift and service shafts, airconditioning ducts, ventilation ducts and ceiling plenums.

(d) Throughout the building via minor paths such as structural joints, gaps, cracks and building services penetrations.

TABLE A1
SMOKE CONTROL SYSTEM APPLICATION

System application	Class	Residential									Health care (See Appendix B)				Other multi-compartment buildings								
	Category	≤6 Storeys			>6 Storeys ≤25 m			>25 m			≤2 Storeys	>2 Storeys ≤25 m		>25 m	≤4 Storeys			>4 Storeys ≤25 m			>25 m		
	Sprinklers	N			N			Y			N	N	Y	Y	N			N			Y		
	Option	1	2	3	1	2	3	1	2	3	1	1	1	1	1	2	3	1	2	3	1	2	3
System shutdown (Section 6)		✓ *			✓ *			✓ *			✓		✓		✓			✓			✓		
Purge system (Section 7)			✓ *			✓ *			✓ *							✓			✓			✓	
Zone pressurization (Section 8)				✓ *			✓ *			✓ *		✓		✓			✓			✓			✓
Fire-isolated exit pressurization (Section 9)					✓	✓	✓	✓	✓	✓		✓	✓	✓				✓	✓	✓	✓	✓	✓
Lift shaft pressurization (Section 10)		✓ †	✓ †		✓ †	✓ †		✓ †	✓ †		✓ ‡		✓					✓	✓		✓	✓	
Other systems	Miscellaneous systems (see Section 5). Commercial kitchens (see Section 11). Laboratories, correctional facilities and industrial premises (see Appendix C).																						

✓ Indicates that this system is necessary for this option.
* Required for systems penetrating required fire compartmentation only.
† Only necessary where the lift opens directly onto a sole occupancy unit, i.e. without a smoke lobby.
‡ Only necessary when the lift opens directly onto an occupied floor, i.e. without a smoke lobby.

NOTES:

1 Smoke control system applications have been selected on the assumption that only those buildings over 25 m effective height are sprinkler protected by automatic sprinkler or smoke detection systems. Where buildings less than 25 m effective height are protected by sprinkler or smoke detection systems, smoke control system application may be suitably modified.

2 Zone pressurization systems can, in some instances, achieve the required performance criteria for fire-isolated exit pressurization systems without the need for an independent fire-isolated exit pressurization system.

APPENDIX B
HEALTH CARE BUILDINGS
(Informative)

B1 APPLICATION This Appendix provides solutions for smoke control in health care buildings and in particular for those parts of a building used as patient care areas. Alternative smoke control provisions may be formulated by using fire engineering principles to achieve the design objectives. Reference should be made to building regulations for carrying out performance-based designs.

NOTE: The Building Code of Australia specifies minimum requirements for the application of smoke control systems in health care buildings in Australia. Where building regulations do not specify minimum requirements, guidance on the application of smoke control systems in health care buildings is provided in this Appendix.

B2 GENERAL REQUIREMENTS A smoke control system for a health care building should be designed to ensure that it inhibits the spread of smoke to non-fire-affected compartments and should incorporate smoke dampers where air-handling ducts penetrate any fire/smoke barriers. These dampers may be combined with any required fire dampers.

Systems complying with this Appendix are considered to satisfy the objectives of Clause 1.2 when applied in accordance with the category criteria of Paragraph B3 for health care buildings. Smoke control systems should comply with the relevant Sections of this Standard.

CB2 *Fire in a health care building can pose special problems for the evacuation of patients. Building regulations incorporate special requirements for compartmentalization provision of horizontal exits in patient care areas. It is important that the smoke control system complements the effectiveness of these passive fire and smoke control features in order to allow staff sufficient time to carry out a phased evacuation of patients to a safe place of refuge. On floors of a health care building smoke movement is principally restricted by smoke compartmentalization.*

B3 CATEGORY CRITERIA

B3.1 General Health care building categories detailed in Paragraphs B3.2 to B3.4 are assumed to have compartmentalization, egress, smoke detection, fire suppression and other fire safety systems in accordance with the deemed-to-satisfy provisions of building regulations.

CB3.1 *The classification of health care buildings in regard to smoke control is primarily based on building height and takes into account other fire safety systems installed in accordance with the deemed-to-satisfy provisions of building regulations.*

B3.2 Category 1 Health care buildings not more than two storeys high are classed as Category 1.

B3.3 Category 2 Health care buildings of more than two storeys and less than 25 m height which are sprinkler protected, are classed as Category 2.

B3.4 Category 3 Health care buildings of more than two storeys and less than 25 m height, which are not sprinkler protected, and all health care buildings over 25 m height are classed as Category 3.

B4 SYSTEM OPERATION

B4.1 Category 1 systems Any airconditioning or ventilation system (other than systems serving critical patient care areas) should be automatically shut down in accordance with Section 6, on the activation of smoke detectors and, where practicable, any other installed fire detection or alarm system (other than manual call points), including a sprinkler system. Smoke dampers installed where air-handling ducts penetrate fire or smoke barriers in patient care areas should be activated to close.

CB4.1 *The aim of Category 1 systems is to prevent the spread of smoke from a fire-affected compartment (smoke compartment in patient care areas) due to the continued operation of an air-handling system. Systems are required to automatically shut down and smoke dampers, installed on all smoke compartmentalization penetrations, close so as not to facilitate the spread of smoke and compromise the effectiveness of the installed passive fire and smoke protection systems. However, systems serving critical patient care areas, such as operating theatres, should remain under the manual control of the medical staff and not be controlled from the control panel.*

B4.2 Category 2 systems Category 2 systems should operate as for Category 1 and all required fire-isolated exits should be pressurized in accordance with Section 9.

CB4.2 *Category 2 systems recognize the importance of fire-isolated exit protection in health care buildings.*

B4.3 Category 3 systems Any airconditioning or ventilation system (other than systems serving critical patient care areas) shall be automatically controlled to operate as a zone pressurization system, in accordance with Section 8, on the activation of smoke detectors and, where practicable, any other installed fire detection and alarm system (other than manual call points), including a sprinkler system, and each required fire-isolated exit should be pressurized in accordance with Section 9. It is not intended that doors between smoke or fire compartments meet the velocity criteria for pressurized fire-isolated exits.

The smoke control system in patient care areas should be capable of achieving a positive pressure of not less than 20 Pa and not more than 100 Pa in all non-fire-affected compartments relative to the fire-affected (smoke) compartment. Smoke-spill from a fire-affected compartment in a patient care area should be achieved by mechanical means. Particular attention should be given to the location and distribution of smoke inlet (ceiling) grilles and the operation of the smoke-spill system to ensure that it inhibits the spread of smoke to principal evacuation routes. Where the smoke-spill air inlets are located in corridors only, the smoke-spill fan should be controlled to start on the activation of the corridor smoke detectors only, to avoid smoke from adjacent patient care areas being actively spread to corridor escape routes.

The fire mode operation of the smoke control system should be as follows:

(a) *System operation (with smoke-spill air inlets in corridors only)*

  (i) On activation of smoke detectors (other than corridor detectors)—

    (A) stop the supply/return air to/from the fire-affected area (smoke compartment in patient care area); and

    (B) pressurize non-fire-affected areas (smoke and fire compartments) with outdoor air to achieve the pressure differential.

  (ii) On activation of smoke detectors in corridor (in addition to the above actions)—

    (A) open smoke-spill dampers in fire-affected area (smoke compartment in patient care area); and

    (B) start the smoke-spill fan.

(b) *System operation (with smoke-spill air inlets distributed throughout rooms and corridors)*

On activation of smoke detector—

(i) stop the supply/return air to/from the fire-affected area (smoke compartment in patient care area);

(ii) pressurize non-fire-affected areas (smoke and fire compartments) with 100% outdoor air to achieve the pressure differential;

(iii) open smoke-spill dampers in fire-affected area (smoke compartment in patient care area); and

(iv) start the smoke-spill fan.

CB4.3 *Although it is desirable to supply 100% outdoor air to all smoke compartments in patient care areas that are not fire-affected, it is recognized that this may not be achievable in all instances due to the nature of the building and airconditioning system zoning. However, it should still be possible to achieve the required 20 Pa pressure difference through judicious use of supply air from other non-fire-affected compartments in conjunction with mechanically assisted smoke-spill from the fire-affected compartment. In such cases it may be necessary to use magnetic hold-back devices on smoke/fire doors in horizontal exits so that only doors to the fire-affected area close automatically on a fire alarm. The typical mode of operation of a zone pressurization system for patient care areas is shown in Figures B1 to B3.*

NOTE: The pressurization of lift lobbies is not a requirement of this Standard but where such a system is installed, it should be separate from any fire-isolated exit pressurization system and operate in a manner that does not compromise the operational effectiveness of the fire-isolated exit pressurization system.

B4.4 Fire doors and smoke doors To comply with relevant building regulations, patient care areas may be required to have fire and smoke doors separating fire and smoke compartments respectively. In many instances, these doors are kept open during normal usage of the health care establishment. For fire and smoke control purposes, however, it is necessary that these doors close to maintain the integrity of a fire-resistant wall, or in the case of smoke doors, to prevent smoke spreading from the fire-affected compartment.

Fire and smoke doors that are required to be kept open during normal usage for health care operational purposes, may only be held open by automatic hold-open devices which release the doors when activated by the fire/smoke alarm system, as given in Table B1.

TABLE B1

FIRE ALARM ACTION OF AUTOMATIC DOOR HOLD-OPEN DEVICES FOR USE IN HEALTH CARE BUILDINGS

Type of door	Action on fire alarm
Fire door	Release to allow closure of the door, on any fire alarm within the building.
Smoke door	(a) Release to allow closure, when fire or smoke is detected in either of the compartments separated by this door; or (b) May remain activated, holding the doors open, when both compartments separated by this door are non-fire-affected.

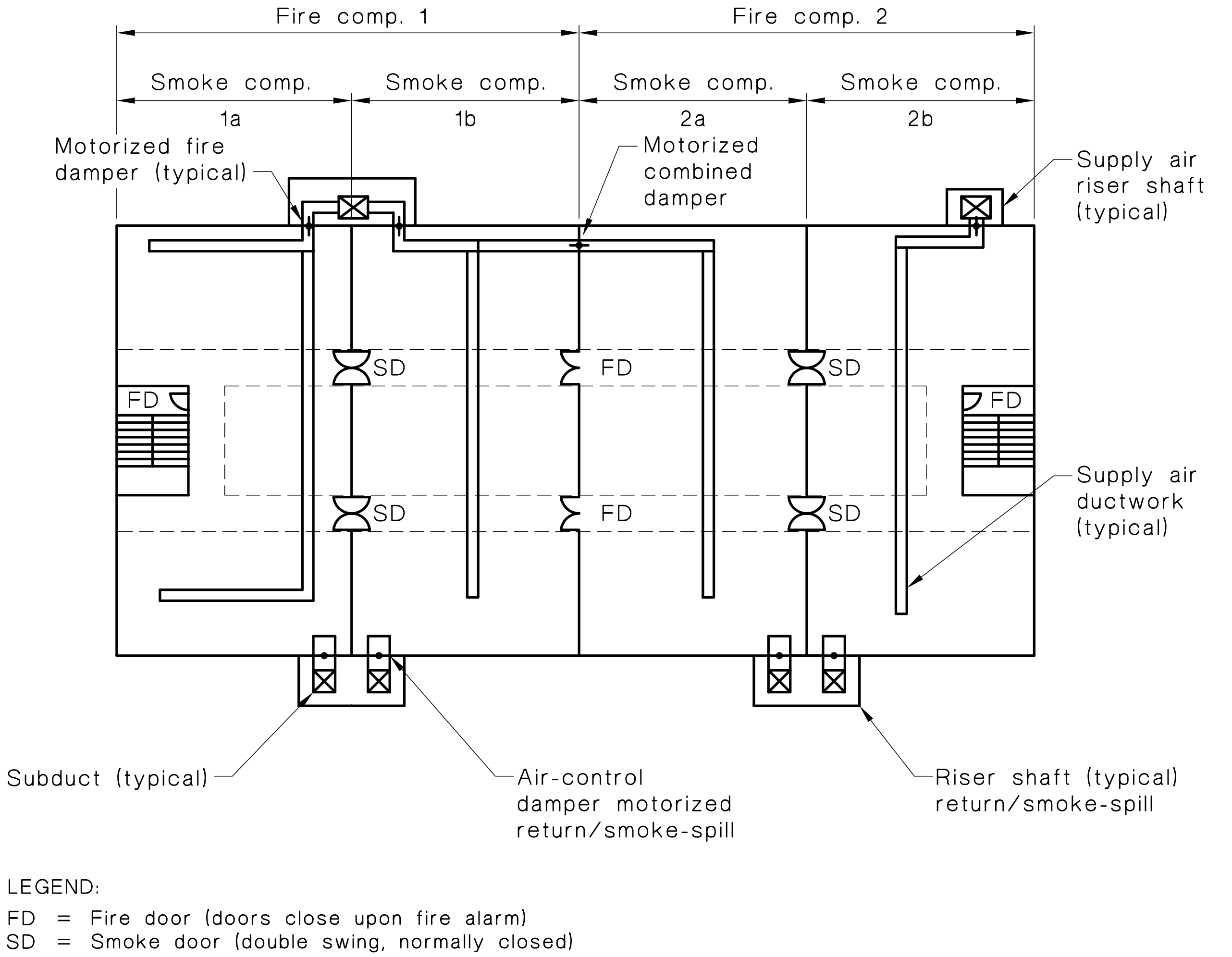


FIGURE B1 MULTISTOREY HEALTH CARE BUILDING ARRANGEMENT (EXAMPLE)

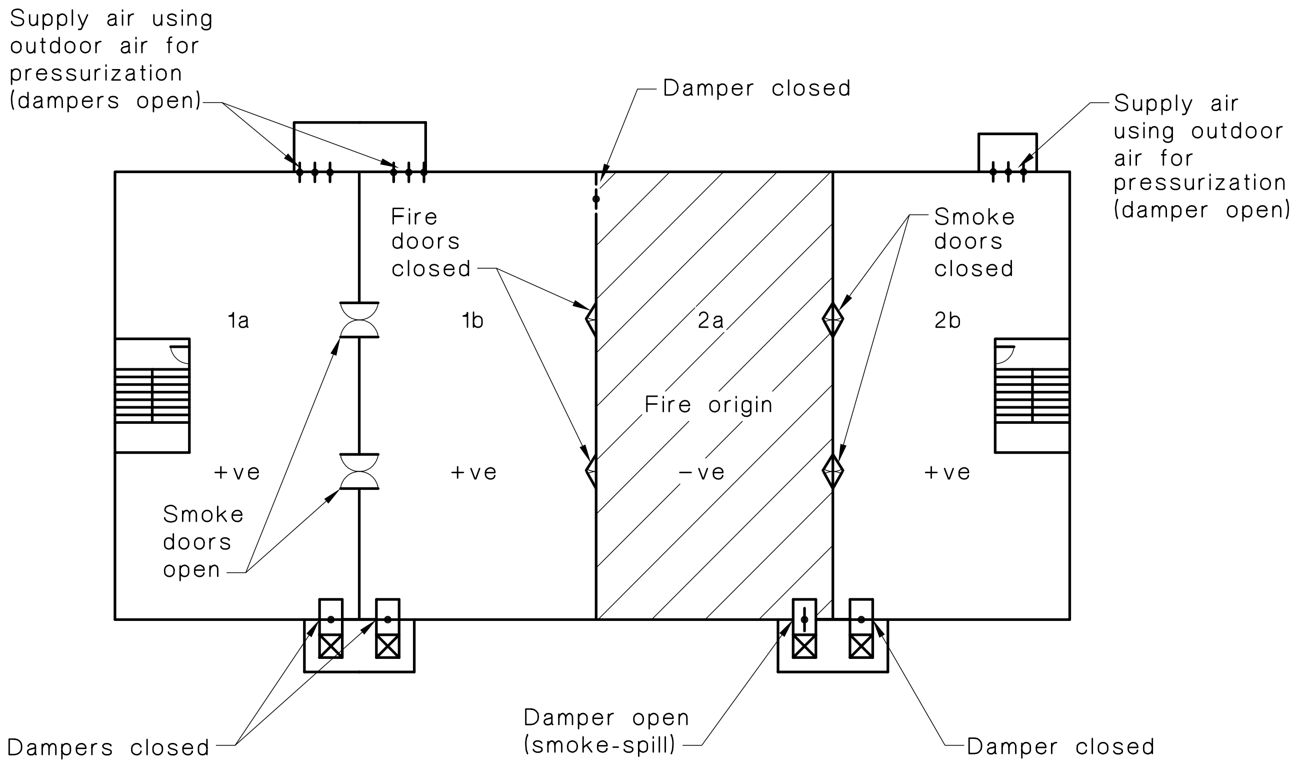


FIGURE B2 TYPICAL SMOKE CONTROL FOR A FIRE IN SMOKE COMPARTMENT 2a

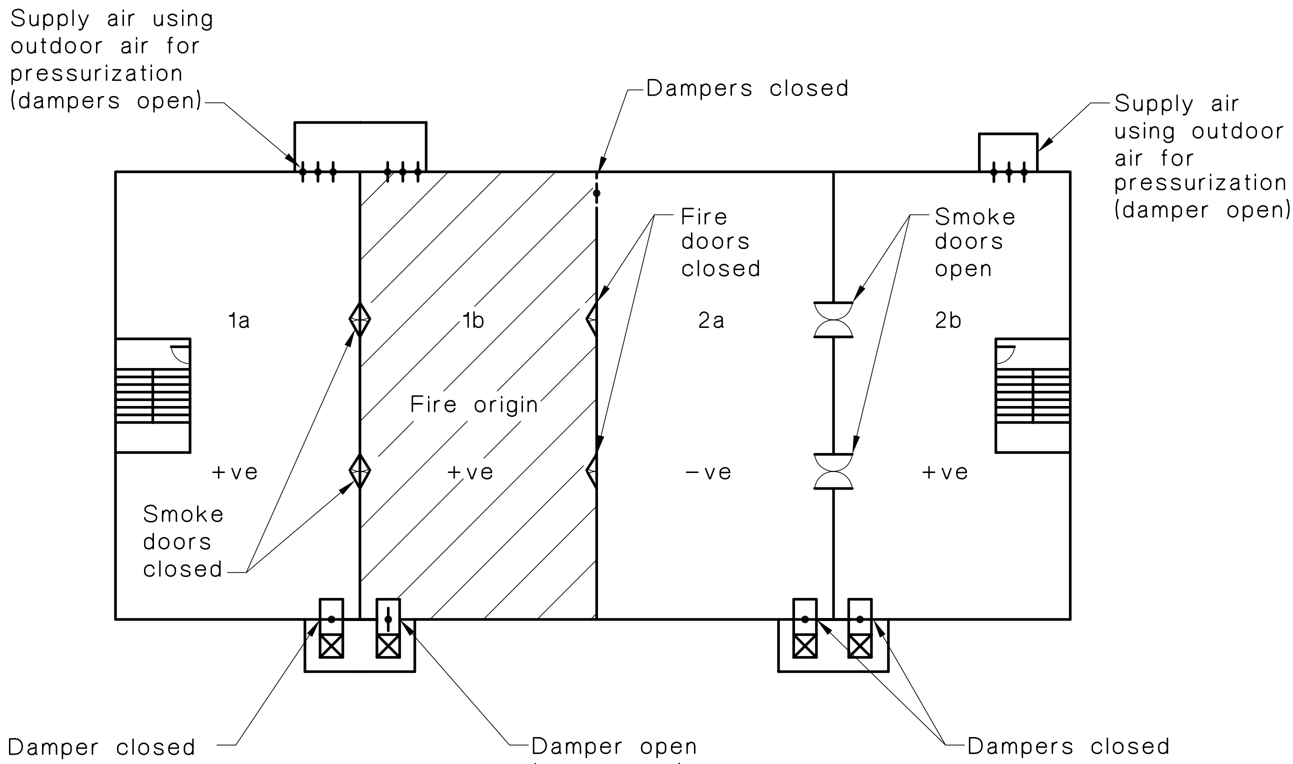


FIGURE B3 TYPICAL SMOKE CONTROL FOR A FIRE IN SMOKE COMPARTMENT 1b

APPENDIX C

SMOKE CONTROL IN LABORATORIES, CORRECTIONAL FACILITIES AND INDUSTRIAL PREMISES

(Informative)

C1 GENERAL This Appendix provides guidelines for smoke control in laboratories, correctional facilities and industrial premises.

NOTE: The Building Code of Australia specifies minimum requirements for the application of smoke control systems in laboratories, correctional facilities and industrial premises in Australia. Where building regulations do not specify minimum requirements, guidance on the application of smoke control systems in laboratories, correctional facilities and industrial premises is provided in this Appendix.

C2 LABORATORIES Laboratories present special problems when considering what is an appropriate smoke control system. The general strategy is to contain the smoke within the compartment of origin, utilizing existing systems wherever possible to create a pressure differential of not less than 20 Pa between the fire-affected and non-fire-affected compartments.

Each laboratory should be individually assessed, the outcome dependent upon the processes carried out therein. Where stopping and starting exhaust systems (including fume cupboard exhaust) is of no consequence, then traditional smoke extract or zone pressurization strategies may be used. Some laboratory complexes, especially single storey structures, may not require any smoke control systems, because their cellular construction will inhibit the movement of smoke by passive means (some laboratories are required to be fire-rated because of the processes carried out therein, thereby making each laboratory a separate compartment).

If stopping or starting in-house or ancillary systems will vary room pressures and adversely affect the performance of essential fume extraction systems to the detriment of occupants' health, then smoke control may not be possible. It is unlikely that safe effective smoke control using mechanical means can be achieved in a laboratory that handles infectious diseases.

C3 CORRECTIONAL FACILITIES Within correctional facilities, the movement of occupants is closely controlled as a fundamental requirement of the correctional process. Consequently, occupants may not be able to freely escape to fire-isolated exits during a fire alarm. For this reason, the fire safety tree for correctional facilities usually gives higher priority to protection of the occupants rather than to the moving of the occupants. Smoke control is but one component in an engineered system that protects the occupants.

The objectives of smoke control systems in correctional facilities are essentially as stated in Clause 1.2(a), (b), (c) and (d). The order of priority given to these four objectives depends very much on the security system employed in the correctional facility. Where occupant movement to fire exits is allowed, the priority is Items (a), (b), (c) and (d), but when occupants cannot move freely to fire exits, then greater priority should be given to early detection, reduction of fire and smoke load together with Items (c) and (d).

C4 INDUSTRIAL PREMISES In multi-compartment industrial premises, the general strategy is to contain the smoke within the compartment of origin and utilize existing air-handling equipment to create a minimum 20 Pa pressure differential, between the fire-affected compartment and all other compartments, generally in accordance with this Standard. This philosophy will usually only apply to industrial premises that incorporate discrete airconditioned compartments. In many types of industrial premises the construction of the building, or the processes carried out therein, prevent the achievement of this pressure differential. In these cases, prime consideration should be given to the objectives of Clause 1.2(a) and (b) and the design of an engineered solution to protect the occupants.

APPENDIX D
RELIABILITY
(Informative)

All equipment required to function and continue to operate in the fire mode, including motors, starter, controls, wiring, electronic speed controllers, actuators, control tubing and cabling, central processing units, and the like, should be designed, installed and operated to provide reliable operation under fire conditions. Failure of a system, or components of a system, should not create a situation that is worse than if no smoke control system had been provided.

Each component of the design and installation of the smoke control system should be analysed to ensure that its construction, installation and operation meet the following criteria:

(a) Its required function will be initiated and continue during the specified fire conditions at the location of the component.

(b) Its local failure will not render the smoke control system inoperable.

(c) It cannot be inadvertently deactivated, programmed or otherwise left in a non-functional condition by operating or maintenance personnel, thus rendering it incapable of operating correctly in fire mode.

(d) Communication lines and power lines serving essential smoke control equipment are protected where passing through other fire compartments and, where required to function in fire mode, are entirely protected to the point of entry to the actuator or motor being driven/controlled.

(e) Equipment protection devices (e.g. electrical overloads, overcurrent cut-outs, safety valves and thermal cut-outs) will not prevent the relevant equipment from functioning during fire mode.

(f) Equipment based on electronic circuitry will be installed so that it functions normally, or is tested and verified, at least four times per year.

The reliability of a smoke-control system decreases as the number of system components increases, unless the system includes redundancy (i.e. automatic stand-by/back-up facilities). This concept can be expressed mathematically for a simple linear series system as follows:

$$R_s = \prod_{i=1}^{n} R_i = R_1 \times R_2 \times R_3 \times \dots \times R_n$$

where

R_s = the system reliability factor

R_i = the reliability factor of the i^{th} component

n = the number of components

Any breakdown of equipment used for ventilation or airconditioning purposes is likely to cause occupant discomfort and generate corrective action. Therefore, equipment that is used regularly in the normal mode of operation is likely to have a greater reliability (of running in fire mode when required) than dedicated equipment that only operates in the fire mode. These two concepts are explored in greater detail in the ASHRAE publication, *Design of Smoke Management Systems*. Guidance on reliability management is given in AS 3960.

Designers, installers and building operators are advised to consider the following concepts for smoke control systems:

(i) Minimizing the number of components in the system without compromising performance.

(ii) Avoiding the use of complex components.

(iii) Maximizing the number of components that are operated regularly in normal mode.

APPENDIX E

WIRING SYSTEMS RATING

(Normative)

E1 PROTECTION AGAINST EXPOSURE TO FIRE All wiring systems required to have a protection against exposure to fire shall have a rating of not less than 120 min (WS5), and shall be protected against mechanical and water damage as appropriate to the installation in accordance with Paragraphs E2 and E3.

E2 PROTECTION AGAINST MECHANICAL DAMAGE

E2.1 General Protection against mechanical damage shall be provided for areas listed in Paragraphs E2.2, E2.3, E2.4, E2.5, E2.6 and E2.7. The areas indicated are not considered as a rigid list to be adhered to with no deviations; rather they are considered as a guide to the types of areas and causes of damage to be encountered. Details of ways to achieve the required grade of protection can be found in AS/NZS 3013.

E2.2 WS5X These are areas where physical damage is considered to be unlikely. Examples of these areas include—

(a) masonry riser shafts with strictly limited access;

(b) non-trafficable ceiling void areas;

(c) inaccessible underfloor areas;

(d) underground installation in accordance with building regulations; and

(e) internal domestic and office situations where cabling is mounted on walls at heights above 1.5 m.

E2.3 WS51 These are areas where physical damage by light impact is considered possible. Examples of these areas include—

(a) internal domestic or office situations where cable is mounted on walls at heights below 1.5 m; and

(b) trafficable ceiling void areas where access to building services for maintenance purposes is required.

E2.4 WS52 These are areas where physical damage by impact from manually propelled vehicles is possible. Examples of these areas are—

(a) passageways and storerooms in domestic, office, health care and commercial locations where hand trucks and barrows may be used, and cables are mounted at a height of less than 1.5 m;

(b) plant rooms where only minor equipment is installed; and

(c) workshops where repair and maintenance, on small equipment and furniture, or the like, is carried out, and cables are mounted at a height of less than 2.0 m.

E2.5 WS53 These are areas where physical damage by impact from light vehicles is possible. Examples of these areas include—

(a) car parks and driveways where cars and other light vehicles are present, and cables are mounted at a height of less than 2.0 m; and

(b) storage areas where manually operated devices such as pallet trucks may be operated, and cables are mounted at a height of less than 2.5 m.

E2.6 WS54 These are areas where physical impact from vehicles with rigid frames or rigid objects, the weight of which does not exceed 2.0 t, is possible. Examples of these areas include—

(a) small delivery docks where the cabling is mounted below a height of 3.0 m;

(b) warehouses with pallet storage up to 3.0 m and use of forklift trucks; and

(c) heavy vehicle workshops.

E2.7 WS55 These are areas where physical damage from impact by laden vehicles or objects the laden weight of which exceed 2.0 t, is possible. Examples of these areas include—

(a) loading and delivery docks;

(b) fabrication and maintenance areas for medium to heavy engineering; and

(c) large high pile storage warehouses with forklift trucks.

E2.8 Various protection Where any WS cabling traverses areas of various protection requirements, and it is neither viable nor practicable to change the degree of protection at the transition points, the installed cabling shall comply with the highest requirement of protection.

E3 PROTECTION AGAINST HOSING WITH WATER Where the wiring system is required to maintain its integrity after exposure to fire and subsequent hosing with water, it shall have the suffix W appended to its rating, i.e. WS5XW.

APPENDIX F
SMOKE CONTROL SYSTEM COMMISSIONING TESTS
(Informative)

F1 GENERAL The following test procedures are pertinent to all smoke control systems in buildings and detail a methodology for the commissioning engineer to ensure that the system complies with the requirements of this Standard. Commissioning tests should be conducted after the construction of the building, or relevant portion, is essentially completed and the air-handling systems have been installed and checked.

F2 EMERGENCY POWER Where emergency power supply has been provided to the smoke control systems, additional commissioning tests should only be carried out to demonstrate that the system operates and the provided capacity is adequate. Load tests should be carried out for a minimum of 30 min.

F3 TEST DOCUMENTATION Prior to any testing, a smoke control zone diagram of the building should be drawn up including the location of all zone boundaries, all doors in those boundaries and all smoke control system detectors located within the zone. A test schedule and report form should be prepared to the satisfaction of the regulatory authority.

NOTES:

1 Zone boundaries will be fire compartmentalization and doors will be fire doors.

2 Examples of typical inspection and test reports are given in Figures F4 to F6.

F4 NORMAL OPERATION Prior to any testing of the system in the fire mode, all building ventilation and airconditioning systems should be fully commissioned in the normal operation mode. The total maximum return airflow rate should be recorded for each purge system.

F5 PRECOMMISSIONING

F5.1 Component testing Each component of the smoke control system should be tested to verify that it functions and meets the specified performance criteria.

F5.2 Subsystem testing All subsystems should be tested to verify that they function and meet the specified performance criteria.

F6 FIRE MODE TEST PROCEDURES

F6.1 General Fire mode tests should be initiated with all building systems operating in the normal mode. Other building systems should have moved into their fire mode after initiation of the tests. Fire mode tests should be carried out to prove that other building systems will operate in that mode. Results should be recorded in accordance with Paragraph F3.

F6.2 Fire-isolated exit pressurization systems

F6.2.1 *Procedures* The procedure, listed in chronological order, is as follows:

(a) Move through each fire-isolated exit within the building, opening each door, checking that they close and latch automatically.

(b) When exits have been checked in accordance with Step (a), initiate the pressurization system by introducing smoke into a detector adjacent to a doorway from any compartment of the building.

(c) At this time all exit doors in the building should be shut and the following tests carried out:

  (i) Check the noise level within each exit at each door entry. Record the results (see Paragraph F8 for methodology).

  (ii) Check the force required to open each door against the maximum pressure generated within the exit by the pressurization system. Record the results (see Paragraph F9 for methodology).

(d) Whilst the pressurization system remains running in the prescribed manner, in each required exit, chock open the main discharge doors that open onto a street or public place so that all required exits may be tested simultaneously.

(e) Carry out air velocity and door opening force tests at each door location in accordance with Paragraphs F6.2.2, F6.2.3 and F6.3 as applicable.

F6.2.2 *Air purge systems* The following tests should be completed when an air purge system is also installed:

(a) *Air velocity* Selecting each compartment in turn to be a fire-affected compartment, chock open each required exit door opening into each required exit in both the fire-affected compartment and next adjacent compartment. Measure the air velocity through each exit door to the fire-affected compartment only.

Repeat the above velocity test for each compartment of the building in turn taken as the fire-affected compartment (see Paragraph F10 for methodology).

(b) *Door opening force* It is not necessary to re-check door opening forces again; these will be lower than the test carried out under Paragraph F6.2.1(c).

(c) *Noise* Noise levels should be checked in accordance with Paragraph F8.

F6.2.3 *Zone pressurization systems* The following test should be completed when a zone pressurization system is also installed:

(a) *Air velocity* Selecting each compartment in turn to be a fire-affected compartment, chock open each required exit door opening into each required exit in the fire-affected compartment only. Measure the air velocity through each exit door to the fire compartment.

Repeat the above velocity test for each compartment of the building in turn taken as the fire-affected compartment (see Paragraph F10 for methodology).

(b) *Door opening force* Where a building is equipped with a zone pressurization system, it will be necessary to check the door opening force to each exit door at each compartment in turn selected as the fire-affected compartment whilst the airconditioning system is operating in the fire mode and the door to the exit on an adjacent compartment is chocked fully open (see Clause F9 for methodology).

(c) *Noise* Noise levels should be checked in accordance with Paragraph F8.

Zone pressurization systems increase the differential pressure across the exit doors to the fire-affected compartment and, hence, increase the force required to open these doors; this will vary from compartment to compartment depending upon air leakage paths, stack effect and the like.

The differential pressure across doors servicing a non-fire-affected compartment is very low and the door opening forces on these doors will be lower than in a fire mode; therefore, it is not necessary to concurrently check adjacent compartments and the like.

F6.3 Shutdown systems Each system should be individually tested by activation of the smoke control system. This should be achieved by putting a smoke control detector into alarm, for example, by introducing a point smoke source or by conducting a hot smoke test in accordance with AS/NZS 4391(Int). Check that this puts all required systems into their fire mode. Where fire-isolated exit pressurization systems are installed, these should be tested in accordance with Paragraphs F6.2.2(a), (b) and (c) while the other systems are in fire mode.

NOTE: Activation of system by electronic/electrical means is not appropriate for this commissioning test.

F6.4 Air purge systems Each system should be individually tested by performing the following procedures:

(a) Activate the smoke control system. This should be achieved by putting a smoke control detector into alarm, for example, by introducing a point smoke source or by conducting a hot smoke test in accordance with AS/NZS 4391(Int). Check that this puts all required systems into their fire mode.

NOTE: Activation of system by electronic/electrical means is not appropriate for this commissioning test.

(b) Check that all fans operate as required by the specified performance criteria.

(c) Check that the exhaust system (smoke-spill fans) is operating at a rate not less than the maximum flow rate for return air recorded under Paragraph F4. Record the actual exhaust rate of the system.

(d) Check that the supply system is operating at the specified air quantity.

(e) Check that all fire doors identified on the zone diagram are closed.

(f) For each zone boundary door identified on the zone diagrams, check that the opening force against the combined effect of air pressure and automatic door closer is less than that specified in Clause 4.7. Also check that the door is not prevented from latching on release.

(g) Each supply air system required to operate during fire mode should be tested by the introduction of smoke into the outdoor air intake grille or return air grille as applicable. Detection of the smoke by the duct detector should stop the system after alarm verification and time delay as permitted under Clause 4.10 has elapsed. Automatic reset of the system should allow the fan to restart. Manual override should start or stop the fan in accordance with Clause 4.13.

(h) Each supply and exhaust system should be tested with smoke to ensure that the exhausted smoke does not re-enter the building through outdoor air intakes.

F6.5 Zone pressurization systems Each smoke zone should be individually tested by performing the following procedures:

(a) Activate the smoke control system in that zone. This should be achieved by putting a smoke control detector, located within the zone, into alarm, for example by introducing a point smoke source or by conducting a hot smoke test in accordance with AS/NZS 4391(Int). Check that this puts all systems into their fire mode.

NOTE: Activation of system by electronic/electrical means is not appropriate for this commissioning test.

(b) Check that all fans operate as required by the specified performance criteria. Air in the fire zone should be exhausted or relieved to atmosphere.

(c) Check that the position of all smoke dampers is correct and that any dampers required to be closed are fully and tightly closed.

(d) Check that all fire doors identified on the zone diagram are closed.

(e) For each zone boundary door identified on the zone diagrams check that the opening force against the combined effect of air pressure and automatic door closer is less than that specified in Clause 4.7. Also check that the door is not prevented from latching on release.

(f) For each boundary door in the zone under test, measure and record the pressure differential between zones. Pressure differences resulting in air flowing into the test zone are recorded as positive values and pressure differences resulting in air flowing out of the test zone are recorded as negative values.

(g) Each supply air system required to operate during fire mode should be tested by the introduction of smoke into the outdoor air intake grille or return air grille as applicable. Detection of the smoke by the duct detector should stop the system. Manual reset of the system should allow the fan to restart.

(h) Each supply and exhaust system should be tested with smoke sufficient to ensure that the exhausted smoke does not re-enter the building through outdoor air intakes

F6.6 Lift shaft pressurization systems Each lift shaft pressurization system should be individually tested by measurement of the required pressure differentials with the lift cars at their fire mode position. Operation of fans (and dampers) on detection of smoke within the pressurization intake or in the lift shaft should be verified

NOTE: The fire mode for lifts is often for the cars to be parked at the ground floor with the doors open.

F6.7 Measurement of pressure differentials Measurement of pressure differentials should be in accordance with the following:

(a) Pressure differentials between fire- and non-fire-affected compartments should be measured.

(b) Pressure differentials between lift shafts and fire-isolated exits or fire compartments should be measured at the base of the lift doors (of the compartment under review) or under the fire door as applicable.

F7 RESTORATION TIME PERFORMANCE In some cases, restoration time tests in one compartment will demonstrate that the automatic controls can restore the system to its required airflow and pressure criteria within the specified time period. There may, however, be installations where conflicting control functions dictate that restoration times are tested in two locations or even every location in each fire-isolated exit (one location near the fan, another at a point farthest from the fan in question).

Fire-isolated exits served by more than one fan, or provided with more than one pressure sensor, are examples of such installations, and selected compartments should be such that they fall within the bank of compartments served by each fan or each sensor.

F8 NOISE LEVEL MEASUREMENTS

F8.1 General Noise level measurements should be less than 80 dB(A) in fire-isolated exits and 65 dB(A) in occupied spaces or 5 dB(A) above ambient noise levels to a maximum of 80 dB(A). Paragraph F8.2 gives guidance on the use of a sound level meter.

F8.2 Procedure The procedure is as follows:

(a) Prior to checking the noise levels, check that the battery condition/level is satisfactory. If the meter has a slow (damped) response setting, use this to smooth out spikes in the sound level. Select a scale in the order of 80 dB(A).

(b) Open the door into the exit and note the meter reading when pointing the meter into the exit, then traverse the exit landing whilst sweeping the microphone in all directions. Be sure that the readings do not include transient ambient noises that will not normally be part of the building system, e.g. hammer drill, vacuum cleaner, voices shouting or aircraft. Should the needle swing off the scale, select a higher range (this may indicate that the noise level is above the acceptable limit of 80 dB(A)).

(c) With the doors to the fire-isolated exits closed, measure the sound level within the occupied space on a scale in the order of 65 dB(A) to 80 dB(A), as applicable.

F9 MEASUREMENT OF DOOR OPENING FORCE Measurement of the force required to open an exit door can be simply carried out by using a force-measuring instrument in the push or pull mode (e.g. a spring balance as used by anglers). Adhesive tape, twine, a few heavy elastic bands and a plastic (credit type) card may also be of use when carrying out the required check.

The object of this test is to measure the force required to open the door when in the unlatched mode.

The maximum force permitted to open a door in accordance with this Standard is 110 newtons. This equates to a force of—

$$\frac{110 \text{ newtons}}{\text{acceleration due to gravity}} = \frac{110}{9.81} = 11.2 \text{ kilograms}$$

Lever-operated latch sets are probably the easiest to measure. Simply hook a spring balance over the lever handle and depress same to unlatch the door, whilst taking care not to exert any push/pull force in doing so.

Round door knobs present difficulties in attaching the spring balance and in unlatching the door. It is suggested that, if possible, the door latch be taped back so that it does not engage the striker plate, or a credit card be used to prevent the door latching, provided this does not wedge the door.

The spring balance can be attached to the door knob with strong elastic bands, tape or string.

To take a reading, slowly and steadily pull the spring balance and read the scale as the door just starts to open.

F10 MEASUREMENT OF AIR VELOCITY THROUGH A DOORWAY

F10.1 General It is important to note that this Standard recognizes the time averaged velocities over the face of the fully open door, not a spot reading at a few points.

Furthermore, when measuring door air velocities, do not permit obstruction of the door opening by people or other objects. It is possible to increase the air velocity across a stair door by blocking off other doors, e.g. people standing in the doorway. This is especially relevant to the ground floor doors for base-injected fire-isolated exit pressurization systems in buildings employing a purge system.

F10.2 Time average method The equipment required for this method is a vane anemometer or other digital device capable of averaging velocity over a period of time. A watch with a readout in seconds may also be needed.

Many vane anemometers record the total velocity measure over a period of time, i.e. meters per unit time, those units being whatever you desire, e.g. metres/hour. This is achieved by switching on the meter for the desired period of time over which you want to measure the velocity in metres.

This Standard requires the velocity to be in metres per second. Because it is very imprecise to switch the anemometer on for 1 s, it is necessary that the test comprise not less than a 1 min traverse over the door opening. Where the reading is in units of metres/minute, these have to be divided by 60 to provide a time-averaged velocity in metres per second.

To time-average the air velocity through the door opening, make traverses of the door opening in accordance with Figure F1 and Figure F2.

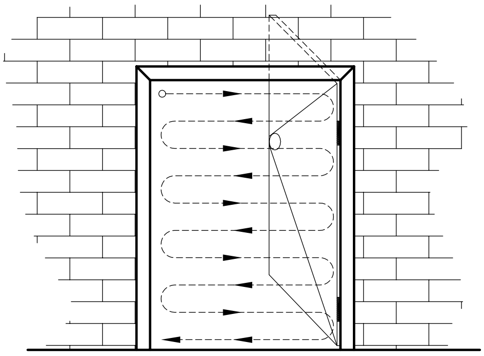
F10.3 Instantaneous readout average method If the only equipment available is that which provides an instantaneous velocity at the point of use, e.g. hot wire anemometer, then, in such cases, divide the doorway into not less than 18 imaginary squares (see Figure F3), take a reading in the centre of each square, add all together and divide by 18 for the average measured instantaneous velocity.

F11 DAMPER FAILURE POSITION Failure of the dampers should be simulated and the resulting position of the dampers should be as required by this Standard.

F12 TEST FAILURE Where any system or part of the system fails these tests, the fault should be identified and rectified and the system retested to provide assurance that the performance requirements of this Standard are met.

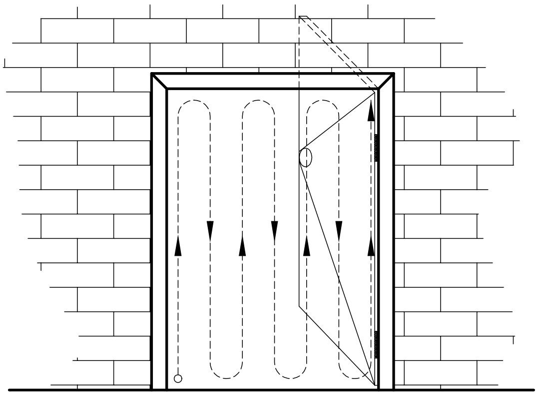
F13 SUPPLEMENTARY TESTING Where systems are particularly complex, where variations or modifications have occurred to designs or where regulatory authorities have granted concessions during design and construction, supplementary testing may be requested. Attention is drawn to the hot smoke test methodology of AS/NZS 4391(Int).

F14 MANUAL OVERRIDE All elements of the smoke control system that are required to be provided with manual override through the FFCP should have the manual override provision manually operated. Manual operation of each element should be confirmed and should be in accordance with the requirements of this Standard.



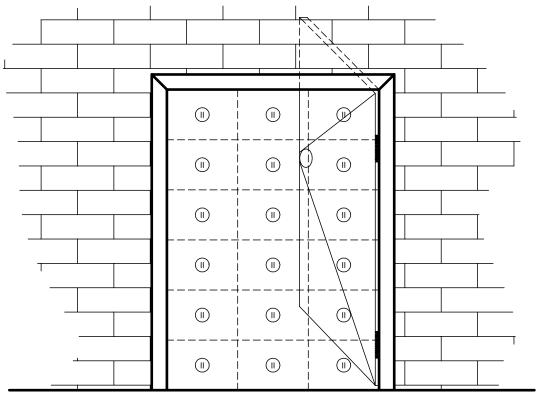
Make a steady (about 0.5 m/s) horizontal serpentine sweep traverse of the doorway as shown. After completion of the above sweep proceed with Figure F2.

FIGURE F1 TIME AVERAGE METHOD—STEP 1



Make a steady (about 0.5 m/s) vertical serpentine sweep traverse of the doorway as shown. If after completion of the above sweep the one minute has not expired, commence sweeping in accordance with Figure F1 and so on until one minute has elapsed.

FIGURE F2 TIME AVERAGE METHOD—STEP 2



In some instances there will be a negative velocity which must be deducted from the total, therefore this method is not as accurate or reliable as the time average method, especially where the velocity probe used is not sensitive to the direction of air movement.

FIGURE F3 INSTANTANEOUS METHOD

Job No.: . . . .
Project: . . . .
Address: . . . .
. . . .

Exit No.: . . . .
Fan No.: . . . .
Inspected by: . . . .
Approved by: . . . .

Sheet No.: . . . .
. . . .
Date: . . . .
Date: . . . .

Door location		Average velocity across door m/s	Door closes and latches correctly	Door opening force N	Maximum noise level stair dB(A)	Maximum noise level occupied space dB(A)	Pressure restoration time s	COMMENTS
Level	No.							

FIGURE F4 TYPICAL SYSTEM PERFORMANCE RECORD FOR FIRE-ISOLATED EXIT PRESSURIZATION INSTALLATION TESTS

Job No.: . . . . **Sheet No.:** . . . . **Date:** . . . .
Project: . . . . **Inspected by:** . . . . **Date:** . . . .
Address: . . . . **Approved by:** . . . .
. . . .

Exit No.	Fan No.	Normally off	Runs on fire trip	Stops with smoke in airstream	Auto reset when smoke cleared	FIP override operates	Cabling and fire rating correct	COMMENTS

FIGURE F5 TYPICAL SYSTEM QUALITY RECORD FOR FIRE-ISOLATED EXIT PRESSURIZATION SYSTEMS

Job No.: . . . . **Sheet No.:** . . . . **Date:** . . . .
Project: . . . . **Inspected by:** . . . . **Date:** . . . .
Address: . . . . **Approved by:** . . . .
. . . .

AHU No., Fan No. or zone dampers	Name of system area served location (etc)	Airflow rate L/s		Operation with fire in zone		Operation during general fire alarm (outside zone)		Manual control from FFCP			Indication at FIP		Fitted with supply air detector		Fitted with return air detector		Comments*
		Design requ't	Tested value	Design requ't	Tested value	Design requ't	Tested value	Design requ't	Tested		Design requ't	Test result	Design requ't	Tested with smoke	Design requ't	Tested with smoke	
									On	Off							

* Describe in comments, any fan with special override control and fans that operate only in certain fire zones.

FIGURE F6 TYPICAL INSPECTION RECORD FOR SMOKE CONTROL SYSTEM INSTALLATION TESTS