



The use of ventilation and air conditioning in buildings

Part 1: Fire and smoke control in buildings



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- Air Conditioning and Mechanical Contractors Association
 - Australasian Fire and Emergency Service Authorities Council
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 - Australian Institute of Refrigeration Air Conditioning and Heating
 - Chartered Institution of Building Services Engineers
 - Climate Control Companies Association
 - Consumer Electronics Suppliers Association
 - Department of Health and Human Services, Tas.
 - Engineers Australia
 - Facility Management Association of Australia
 - Institute of Refrigeration Heating and AirConditioning Engineers of New Zealand
 - Insulation Contractors Association of Australia, NSW
 - NATSPEC
 - Victorian Building Authority
-

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Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

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Australian Standard®

The use of ventilation and air conditioning in buildings

Part 1: Fire and smoke control in buildings

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PREFACE

This Standard was prepared by the Standards Australia Committee ME-062, Ventilation and Air conditioning, to supersede AS/NZS 1668.1:1998, *The use of ventilation and airconditioning in buildings*, Part 1: *Fire and smoke control in multi-compartment buildings* and AS 1668.3—2001, *The use of ventilation and airconditioning in buildings*, Part 1: *Smoke control systems for large single compartments or smoke reservoirs*.

This Standard incorporates Amendment No. 1 (December 2018). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

A1 | Amendment No. 1 to this Standard was prepared by the Australian members of Joint Standards Australia/Standards New Zealand Committee ME-062, Ventilation and Airconditioning. As a consequence of Amendment No. 1, which is published as an Australian-only amendment, the designation of this Standard has been changed from AS/NZS 1668.1:2015 to AS 1668.1:2015.

The objective of this Standard 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

There is a considerable body of fire research that indicates that when a fire occurs in a building, the smoke from the fire is a far greater hazard to occupant safety than the fire itself, that is:

- A1 |
- (a) Smoke obscures vision, preventing occupants from finding safe escape routes.
 - (b) Smoke hinders the emergency services personnel during intervention activities (including 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.

The main technical changes made in this edition are as follows:

- (i) A hot layer smoke control arrangement has been added.
- (ii) The function of car park ventilation systems has been revised.
- (iii) The requirements for detection and initiation of smoke control systems have been transferred to AS 1670.1.
- (iv) The requirements for construction and installation of fire dampers, smoke dampers and air dampers have been transferred to AS 1682 series.
- (v) Mandatory requirements for baseline data have been included.
- (vi) Inclusion of requirements for flame and spark arrestance in certain kitchen exhaust systems.
- (vii) Amendments to text to clarify various clauses of the previous edition, which were often misunderstood.
- (viii) Additional informative appendices including guidance on subduct use and testing criteria exit pressurization systems.

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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FOREWORD

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

This edition of the Standard includes provisions for an additional method of smoke control within large interconnected volumes whereby smoke is allowed to collect in smoke reservoirs in the vicinity of the ceiling/roof and is removed by fans from the high level reservoirs, with make-up air at low level. This hot layer smoke control system arrangement is similar to that detailed previously in AS 1668.3—2001, *The use of ventilation and air-conditioning in buildings, Part 3: Smoke control systems for large single compartments or smoke reservoirs*; however only the mechanical exhaust arrangement has been incorporated into this Standard. (The buoyancy driven arrangement is not incorporated in this Standard.)

STANDARDS AUSTRALIA

Australian Standard

The use of ventilation and air conditioning in buildings

Part 1: Fire and smoke control in buildings

SECTION 1 GENERAL

1.1 SCOPE

This Standard sets out minimum requirements for the design, construction, installation and commissioning of mechanical smoke control systems in buildings. Specific methods of smoke control are defined and the appropriate requirements specified for each.

The design information given in this Standard in respect to hot layer smoke control is based on a single axisymmetric plume, which is confined to one reservoir. Smoke plumes spilling across multiple reservoirs are not considered.

Requirements for the maintenance of smoke control systems are not included.

This Standard applies to Class 2 to Class 9 buildings where smoke control is required.

NOTES:

- 1 The Standard does not identify those buildings in which smoke control systems or pressurization systems are required. This is covered in the *National Construction Code* (NCC).
- 2 AS 1851 outlines management procedures for maintaining the fire and smoke control features of mechanical services.

1.2 EXCLUSIONS

This Standard does not apply to the following:

- (a) Buildings or facilities where occupant risk due to building operation could be prejudiced by the operation of a smoke control system (see Note 1).
- (b) Class 1 and Class 10 buildings.

NOTES:

- 1 Examples of such buildings where the operation of a smoke control system may be detrimental to the prime function of the space include correctional facilities, buildings with special security arrangements, laboratories, specialized industrial premises or particular areas of health care buildings such as operating theatres and infectious disease wards (see Appendix A).
- 2 For a description of building class, refer to the National Construction Code (NCC).
- 3 The NCC specifies minimum requirements for the application of smoke control systems in buildings in Australia.

Cl.2 *Typical classes of buildings (or parts of buildings) include but are not limited to multistorey, multi-compartment, large single compartment, high- or low-rise buildings such as the following:*

- (a) *Offices and educational.*
- (b) *Residential—high-rise units and hotels.*
- (c) *Health and aged care buildings (see Appendix A).*

- (d) *Laboratories, correctional facilities and industrial premises.*
- (e) *Fire-isolated exits (see Section 10).*
- (f) *Lift shafts (see Section 12).*
- (g) *Commercial kitchens (see Section 6).*
- (h) *Large, single compartment buildings—shopping centres, exhibition halls, theatres and atriums.*
- (i) *Multi-classification buildings (see interaction requirement of Section 2).*

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 detailed 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.

1.3 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard:

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

AS

- 1324 Air filters for use in general 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
- 1530.4 Part 4: Fire-resistance test of elements of building construction
- 1668 The use of ventilation and airconditioning in buildings
- 1668.2 Part 2: Mechanical ventilation in buildings
- 1670 Fire detection, warning, control and intercom systems—System design, installation and commissioning
- 1670.1 Part 1: Fire
- 1682 Fire, smoke and air 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
- 2118 Automatic fire sprinkler systems
- 2118.1 Part 1: General systems
- 2484 Fire—Glossary of terms
- 2484.1 Part 1: Fire tests
- 3102 Electric duct heaters
- 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
- 4254.1 Part 1: Flexible duct
- 4254.2 Part 2: Rigid duct

AS	
4260	High efficiency particulate air (HEPA) filters—Classification, construction and performance
4429	Methods of test and rating requirements for smoke-spill fans
AS/NZS	
1530.3	Part 3: Simultaneous determination of ignitability, flame propagation, heat release and smoke release
3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
3013	Electrical installations—Classification of the fire and mechanical performance of wiring system elements
3103	Approval and test specification—Electric room heaters
3179	Approval and test specification—Refrigerated room air-conditioners
ABCB	
NCC	National Construction Code
AS/CA S009	
	Installation requirements for customer cabling (Wiring rules)

1.4 DEFINITIONS

For the purpose of this Standard, the definitions given in the NCC, AS 2484.1 and those below apply.

1.4.1 Air

1.4.1.1 Exhaust air

Air, other than return air, removed from an enclosure by mechanical means and discharged to atmosphere.

1.4.1.2 Outdoor air

Air outside the building.

1.4.1.3 Recycle air

That portion of air removed from enclosures as return air and returned as part of the supply air by mechanical means.

1.4.1.4 Relief air

That portion of return air that is not recycled, including air leakage through a facade or discharge through specific relief paths.

1.4.1.5 Return air

Air removed from an enclosure by mechanical means, all of which may be expelled as relief air, or all or part of it may be recycled.

1.4.1.6 Smoke exhaust air

Air handled by the smoke exhaust system during operation in the smoke-control mode.

NOTE: Also known as smoke-spill air.

1.4.1.7 Supply air

Air introduced into an enclosure by mechanical means.

1.4.2 Air damper

A motorized mechanical damper that opens or closes to control air as part of a smoke control system.

1.4.3 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).

1.4.4 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.

1.4.5 Air-pressurization system

An air-handling system designed to establish a pressure differential in accordance with this Standard.

1.4.6 Atrium

As defined in Part G3 of the NCC.

1.4.7 Automatic

The process of a system having the capability of starting or operating without user intervention.

1.4.8 Automatic suppression system

A system, when activated by the heat of a fire or its products of combustion, that will actively have an impact on the rate of growth of the fire and which may contain the size of the fire, reduce it or extinguish it.

NOTE: Active systems include fire sprinklers, inert gas flooding, and deluge and water spray systems.

1.4.9 Baseline data

Data derived from the approved design and commissioning, which serve as a basis for subsequent comparison with the data derived from inspection, test and survey.

1.4.10 Building classification

As defined in the NCC.

1.4.11 Central air-handling system

An air-handling system that is capable of recycling air from one or more fire compartments to another one or more fire compartments.

1.4.12 Circulation space

Area within a building that is used for pedestrian travel, which is a passageway, corridor, hallway, stairway, lobby, atrium, enclosed walkway and mall, shop, area in a room that leads to another room, path of travel in car park and loading dock that leads to an exit or other path of travel to an exit.

1.4.13 Combustible

As defined in the NCC.

1.4.14 Damper

An automatic operable device mounted in a duct, plenum or opening for the purposes of controlling air or smoke flow.

1.4.15 Downstream

In the direction of airflow, away from a nominated reference point.

1.4.16 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

NOTE: See also the definition of 'plenum'.

1.4.17 Economy cycle

The automatic operation of an air-handling system whereby outdoor air is used to provide cooling when ambient conditions are suitable.

1.4.18 Enclosure

An individual room, space or part thereof.

1.4.19 Equipment plenum

An air chamber, integrated with air-handling plant, 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.

1.4.20 Essential services

Safety services, as defined in AS/NZS 3000.

1.4.21 Failure position

The position the device reverts to upon loss of operating power or control.

1.4.22 Fire compartment

As defined in the NCC.

1.4.23 Fire-affected zone

A smoke control zone where fire or smoke has been detected.

1.4.24 Fire alarm signal

A signal received to initiate fire mode and which may be of a general or a zone-specific nature.

1.4.25 Fire damper

A device that operates to restrict the passage of fire or products of combustion through a duct or opening for the passage of air.

***CI.4.25** During recent years, fire collars have been used to protect openings in riser shafts where ventilation ducts penetrate the fire-resistant shaft wall, in lieu of mechanical or intumescent fire dampers. Typically, the ducts are PVC pipes not greater than 200 mm in diameter and are used as bathroom exhaust, laundry exhaust, fume cabinet exhaust or outdoor air supply. Such arrangements are not acceptable under this Standard.*

1.4.26 Fire detection control and indicating equipment (FDCIE)

As defined in AS 1670.1.

A1 | NOTE: The FDCIE panel was formerly known as FIP and SIP.

1.4.27 Fire-isolated

Separated by fire-resistant construction.

1.4.28 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.

1.4.29 Fire mode

The required mode of operation intended to control smoke movement within the building.

1.4.30 FRL (fire resistance level)

As defined in the NCC.

1.4.31 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.

1.4.32 Hot layer

A buoyant layer of hot smoky gases contained by a ceiling or roof above it, and characterized by a relatively clear smoke-free zone beneath it.

1.4.33 Individual air-handling system

An air-handling system that is only capable of recycling return air to the fire compartment from which it was drawn.

1.4.34 Kitchen exhaust hood

A component part of a kitchen exhaust system, intended for collecting the heat, fumes and other aerosols arising from cooking appliances, where such installation is required by the NCC.

1.4.35 Major exhaust system

An exhaust system (other than a car park exhaust system) installed as a stand-alone system or in conjunction with a recycle or supply system and having total aggregate opening area exceeding 0.1 m² from a fire compartment into a separate shaft or duct within a shaft.

1.4.36 Major supply system

A supply system (other than a car park supply system) installed as a stand-alone system or in conjunction with recycle or exhaust systems and having an inlet total aggregate opening area exceeding 0.1 m² into a fire compartment from a separate shaft or duct within a shaft.

1.4.37 Make-up air

Replacement air for smoke exhaust systems introduced below the hot layer, usually at ambient temperature/density.

1.4.38 Masonry

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.

1.4.39 Mechanical services switchboard (MSSB)

The mechanical services switchboard supplied by mains or emergency power, which may incorporate a motor control centre (MCC).

1.4.40 Minor exhaust system

- A1 | An exhaust system forming an air path between two or more fire compartments, with a total aggregate of penetrations from any individual connected fire compartment not exceeding 0.1 m².

1.4.41 Minor supply system

- A1 | A supply system forming an air path between two or more fire compartments, with a total aggregate of penetrations into any individual connected fire compartment not exceeding 0.1 m².

1.4.42 Motor control centre (MCC)

The electrical part of the mechanical services installation that normally controls and monitors mechanical services.

NOTE: The MCC may be incorporated in the mechanical services switchboard (MSSB).

1.4.43 Multiple compartment building

A building containing two or more fire or smoke compartments required to have fire- or smoke-resisting separation.

NOTES:

- 1 A fire-isolated exit, ramp or passageway is considered to be a separate fire or smoke compartment.
- 2 Also known as multi-compartment building.

1.4.44 Non-essential services

Non-safety services, as defined by AS/NZS 3000.

1.4.45 Non-fire-affected zone(s)

Smoke control zone(s) where fire or smoke has not been detected.

NOTE: See Clause 1.4.23, fire-affected zone.

1.4.46 Plantroom

A room within a building dedicated for the housing of plant or equipment.

1.4.47 Plenum

A chamber intended for the passage of air, which is remote from the air-handling plant, to which one or more ducts may be connected and which forms part of an air-handling system, excluding a ceiling void, used as a—

- (a) return air path; or
- (b) smoke exhaust path where the failure of the ceiling does not reduce the performance of the smoke exhaust system.

1.4.48 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.

1.4.49 Shaft

The walls or other parts of a building bounding a well or a vertical chute, duct or similar passage.

NOTE: Shafts may be required to carry hot products of combustion under conditions of smoke exhaust operation.

1.4.50 Shall

Indicates that a statement is mandatory.

1.4.51 Smoke

A generally visible suspension in air of solid or liquid particles or gases resulting from combustion or pyrolysis and entrained air.

1.4.52 Smoke compartment

An area within a fire compartment that is required to be separated by barriers, such as walls and/or floors and ceilings, having the appropriate resistance to the spread of smoke.

1.4.53 Smoke control fan

Any fan required to meet the performance requirements of this Standard.

1.4.54 Smoke control zone

An area or volume as determined for smoke control, which, where applicable, is—

- (a) a smoke compartment within a building;
- (b) a fire compartment; or
- (c) a smoke reservoir contained within appropriate construction, including the occupied space below it.

1.4.55 Smoke damper

A device that operates to restrict the passage of smoke through a duct or opening for the passage of air and operates automatically on receipt of a signal from a remote device.

NOTE: Remote devices include internal detector, fire alarm panel, fire fan control panel, manual release, etc.

1.4.56 Smoke exhaust

The action of an air-handling system in exhausting smoke from the building to the outside in the event of fire.

NOTE: Also known as smoke-spill.

1.4.57 Smoke exhaust fan

A fan that exhausts smoke in the event of a fire, in accordance with Clause 4.8.

NOTE: Also known as smoke-spill fan.

1.4.58 Smoke exhaust system

A1

A special configuration of those elements of an air-handling system that is used to conduct smoke exhaust air by use of a smoke exhaust fan, and extends from the most upstream smoke or fire-resistant barrier that is being penetrated to the point of discharge outside the building.

NOTE: Also known as smoke-spill system.

1.4.59 Smoke reservoir

A volume within the upper portion of a smoke control zone that is capable of collecting and containing a layer of hot buoyant smoke.

1.4.60 Sprinkler system

An automatic fire sprinkler system designed and installed in accordance with AS 2118.1.

1.4.61 Subduct

- A1 | A device, when constructed and installed in accordance with Section 3, is deemed to provide an acceptable level of protection to an opening in a building element required to have a fire resistance level, and is intended to limit the backflow of smoke under fire conditions.

1.4.62 Upstream

Against the direction of airflow, away from a nominated reference point.

1.4.63 Zone pressurization system

A system designed and installed in accordance with Section 8.

1.4.64 Zone smoke control dampers

Air dampers, associated with a particular fire or smoke compartment or zone, which form part of a zone pressurization smoke control system.

1.4.65 Zone smoke control system

- A1 | A zone pressurization system applicable to multi-compartment buildings.

1.4.66 Temperature of fusion

For the purposes of this Standard, the temperature of fusion is deemed to be the melting point of the material under consideration.

1.5 ABBREVIATIONS

The following abbreviations are used in this Standard.

AHU	air handling unit
AVF	alarm verification facility
AZF	alarm zone facility
BMS	building management system
FBP	fire brigade panel, as defined in AS 1670.1
FDCIE	fire detection control and indicating equipment as defined in AS 1670.1
FFCP	fire fan control panel, as defined in AS 1670.1
FRL	fire resistance level
HVAC	heating, ventilating, and air-conditioning
LMR	lift motor room
MCC	motor control centre
MD	motorized damper
MIMS	mineral insulated metal sheathed
MSSB	mechanical services switchboard
SCZ	smoke control zone
SEF	smoke exhaust fan
VAV	variable air volume

1.6 SYSTEM OBJECTIVES

Systems designed in accordance with this Standard are intended, for a single fire event, to achieve the following:

- (a) Restrict the spread of fire via ventilation openings in building elements with a required FRL.
- (b) Restrict the spread of smoke between smoke control zones, fire-isolated exits, ramps and passageways, via the following pathways:
 - (i) Principal connecting paths such as stairs, lift and service shafts, air-conditioning ducts, ventilation ducts and ceiling plenums.
 - (ii) Minor paths such as structural joints, gaps, cracks and building services penetrations.
- (c) Restrict the spread of smoke into principal evacuation routes (e.g. public corridors, fire-isolated exits) leading to a safe place (where practicable).
- (d) In the case of hot layer smoke control systems, maintain the smoke layer above egress paths.
- (e) Restrict the initiation of fire within ductwork.
- (f) Restrict the spread of fire and smoke within ductwork.

Systems are required to react to the spread of smoke outside the smoke control zone of origin. Systems that achieve the specified airflow rates, air velocities or pressure differentials for more than one fire event are considered to exceed the minimum requirements of this Standard.

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C1.6 This Standard sets out requirements for using air-handling system(s) to reduce smoke spread from fire-affected areas to other areas. Possible leakage paths are shown in Figure C1.6. Systems designed in accordance with this Standard are expected to maintain a tenable atmosphere within fire-isolated exits to enable occupant evacuation and emergency services personnel intervention activities (including search and rescue operations).

Multi-compartment building systems designed in accordance with this Standard are not specifically required to clear smoke from the fire-affected compartment.

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Smoke layer exhaust systems are intended to maintain the smoke layer above occupants to facilitate occupant evacuation and intervention activities by emergency services personnel (including search and rescue operations).

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.

C1.6 (continued)

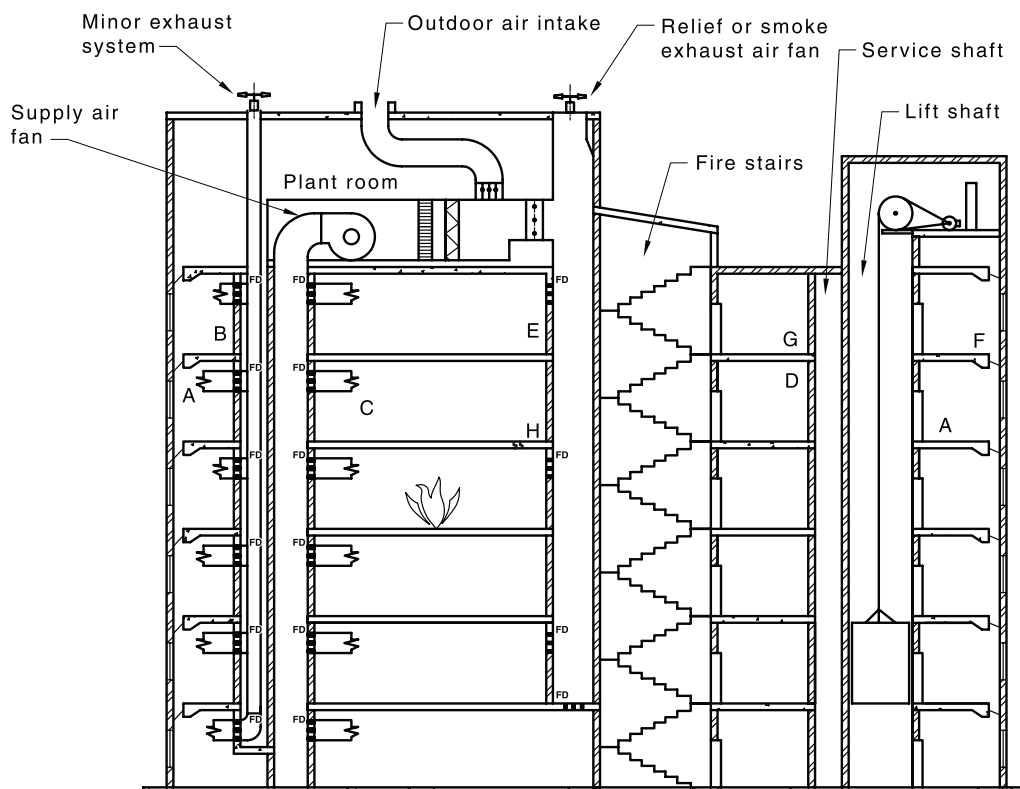
LEGEND FOR ALL DIAGRAMS:



Fan—(centrifugal, axial, inline, etc.)



Fan—(centrifugal, axial, inline, etc.)

**LEAKAGE PATHS SHOWN ABOVE:**

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

FIGURE C1.6 TYPICAL MULTI-COMPARTMENT SHOWING POSSIBLE SMOKE LEAKAGE PATHS (CENTRAL SYSTEM—NOT RUNNING)

1.7 NEW DESIGNS AND INNOVATIONS

This Standard is a prescriptive document. Alternatives to this Standard are outside the scope of this Standard.

SECTION 2 AIR - HANDLING SYSTEMS — GENERAL REQUIREMENTS

2.1 SCOPE OF SECTION

This Section sets out general requirements for air-handling systems and pressurization systems, as defined in this Standard.

2.2 INTERACTION

The interaction of any fire and smoke control system, as detailed in Sections 5, 6, 7, 8, 9, 10, 11 or 12, shall not adversely impact the performance of any other required fire and smoke control systems.

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2.3 DUCTWORK MATERIALS AND INSTALLATION

2.3.1 Materials

The material, or any composite material, used in the construction of ductwork shall be in accordance with the fire hazard property requirements of AS 4254.1 and AS 4254.2.

2.3.2 Combustibility and temperature of fusion

Where required by Clauses 6.2.3 and 3.7.2, 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) *Concessions to combustibility* Concessions shall apply to acoustic attenuators not longer than 3 m.
- (d) *Concessions to the temperature of fusion* Concessions shall apply to the following components and materials:
 - (i) *Insulation* Where faced with sheet metal (perforated or non-perforated), and having a temperature of fusion more than 500°C.
 - (ii) *Flexible connections* Flexible connections with a temperature of fusion of more than 500°C.
 - (iii) *Duct sealants* Complying with AS 4254.2.

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

2.3.3 Fire resistance

Where required by Clause 3.7.2—

- (a) the form of construction shall be equivalent to that of a test specimen tested in accordance with AS 1530.4 and shall comply with the fire resistance requirements specified in this Standard; or
- (b) the duct shall be enclosed in a construction having the FRL required by Clause 3.7.2.

Unless otherwise indicated, the FRL shall be not less than that required for the construction separating different fire compartments.

2.3.4 Duct installation

Ducts and components associated with systems required to operate in the fire mode shall be installed in accordance with Clause 3.6, AS 4254.1 and AS 4254.2, and shall not reduce the fire resistance of the construction through which the duct passes.

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2.3.5 Duct construction

Ducts and components associated with systems required to operate in the fire mode shall be constructed in accordance with the fire hazard properties, construction and installation requirements of AS 4254.1 and AS 4254.2 (excluding insulation fixing requirements).

2.4 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/NZS 1530.3:

- (a) A spread of flame index 0.
- (b) A smoke-developed index 3.

Masonry, concrete, metal or metal-faced sandwich construction shall be 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.

NOTE: Metal-faced sandwich constructions is not intended to include foil-faced insulation.

2.5 DAMPERS

2.5.1 Manufacture and installation

The following dampers shall comply with AS 1682.1 and AS 1682.2:

- (a) Mechanical fire dampers (thermally released type).
- (b) Motorized fire dampers.
- (c) Intumescent fire dampers.
- (d) Smoke dampers.
- (e) Air dampers.

2.5.2 Combined damper arrangements

Where a single fire-resistant damper is installed to comply with a fire damper and a smoke damper or a fire damper and an air damper are required to be installed in the same location, their combination shall have the same performance as required for each individual damper.

2.5.3 Motorized operation

Where dampers are motorized, they shall operate to their required position within a time period in accordance with the requirements of Tables 8.3, 8.4, 11.2 and Clause 10.3.

The sequence of fan and damper initiation shall ensure system performance, provided the system response time meets the requirements of Tables 8.3, 8.4, 11.2 and Clause 10.3(e).

2.6 AIR FILTERS

2.6.1 Fabric filters

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

2.6.2 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.

2.6.3 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.

2.6.4 Cleaning or replacement

Safe and convenient access for maintenance shall be provided to all filter installations.

2.7 ELECTRIC HEATERS

2.7.1 General

All electric heaters installed in ducts and air-handling plant shall comply with the requirements of AS 3102 and Clauses 2.7.2 and 2.7.3 as appropriate.

2.7.2 Casing

The thermally insulated case, as required by AS 3102, shall have a coefficient of heat transfer not greater than 30 W/m²K at 100°C.

C2.7.2 AS 3102 describes manufacturing type tests applicable to electric duct heaters and allows a maximum rating of 50 kW per unit.

2.7.3 Small electric heaters

Small electric heaters integral with factory-built air-handling plant shall comply with AS/NZS 3103 or AS/NZS 3179. These shall have a maximum rating of 2.4 kW for single phase, or 2 kW per phase. Electrical heaters in accordance with AS 3102 shall be deemed to be compliant.

2.8 ELECTRICAL INSTALLATION

The installation of electrical components of air-handling systems shall comply with—

- (a) relevant regulations;
- (b) AS/NZS 3000; and
- (c) this Standard.

2.9 SUPPORT AND ISOLATION

Supports or vibration isolation mounts for smoke control systems shall resist the effects of fire or earthquake such that their failure does not cause the system to become incapable of achieving its required performance.

C2.9 AS 1170.4 provides calculation methods for determining the seismic loads imposed on building services. Captive supports around vibration isolators, diagonal bracing and other such provisions may need to be provided.

Smoke control systems may include switchboards, wiring, control panels, ductwork, fans, dampers and the like.

SECTION 3 FIRE PROTECTION OF OPENINGS IN FIRE-RESISTANT ELEMENTS

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 air-conditioning ducts, openings or equipment.

C3.1 Building regulations require certain building elements to be fire-resistant. 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, the air-handling systems should be designed to maintain fire-resisting performance.

3.2 GENERAL

3.2.1 General requirements

Except where excluded or exempt by Clauses 3.3.2 and 3.3.3, opening in building elements that are required to have an FRL shall be protected with fire dampers, such that the required FRL of the building element is maintained as follows:

- (a) The structural adequacy component of the FRL for the building element shall be maintained by the building element, independent of the fire damper.
- (b) The integrity component of the FRL for the building element shall be maintained by providing a fire damper that has an integrity performance equal to that required of the building element.
- (c) The insulation component of the FRL for the building element shall comply with Clause 3.2.3.

NOTE: Typical arrangements for protection of openings are shown in Figures 3.1 and 3.2.

3.2.2 Packing

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

3.2.3 Insulation

3.2.3.1 Vertically mounted

The following apply to the insulation of vertically mounted (e.g. wall) fire dampers:

- (a) For a shaft-mounted fire damper, insulation is not required.
- (b) For a fire damper that is connected to ductwork conforming with Clause 2.3.2 and with a minimum total duct length of 2 m (with or without breakaway joints), insulation shall not be required.

NOTE: Omission of breakaway joint(s) is to be supported by documentation demonstrating that the building element's FRL will not be adversely affected. Such documentation is to be based on a prototype test as specified in Clause 3.3.2(d) or soundly designed in accordance with fire engineering principles.

- (c) In all other instances, insulation shall be not less than the insulation required of the FRL of the building element in which the fire damper is mounted.

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3.2.3.2 Horizontally mounted

The following apply to the insulation of horizontally mounted (e.g. floor) fire dampers:

- (a) For a fire damper mounted at the bottom of a shaft, insulation is not required.
- (b) For a fire damper that is mounted at the top of a shaft and connected to ductwork that is insulated with or surrounded by materials that are not deemed to be combustible and not less than 2 m in length and complying with Clause 2.3.2, insulation is not required.
- (c) For a fire damper mounted in a floor without a shaft and connected to ductwork that is insulated with or surrounded by materials that are not deemed to be combustible and not less than 2 m in length and complying with Clause 2.3.2, insulation is not required.
- (d) In all other instances, insulation shall be not less than the insulation performance required of the FRL of the building element in which the fire damper is mounted.

C3.2.3 *For the purposes of this Clause, the provisions outlined relate to various construction/installation applications such as in the passage of a duct or the use of a wall grille in a firewall, intended to reflect the FRL insulation criteria for the minimization of heat radiation and hence fire spread beyond the fire-resistant barrier.*

For a fire door, the required insulation performance is 30 min and where a door grille is proposed for installation to provide air relief, such door grille acting as a fire damper will also need to have an equivalent FRL (including insulation performance) of the fire door so as to reinstate the fire resistance performance of the fire door. This is not necessarily achieved with a fire damper installation in conjunction with a simple air transfer wall grille (acting similarly to that of a door) where ducting is not connected as part of a ventilation system incorporating the complying installation requirements for a duct-mounted fire damper.

The insulation requirement in Item (d) does not apply to vertical fire dampers and wall grilles that are connected to a fire-resistant riser shaft or ductwork with an insulation performance level and of minimum 2 m in length because the insulation performance is considered to have been provided by the riser shaft or ductwork. 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 FRL, 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.

Fire dampers are an acceptable method of protecting openings but may not meet the required insulation performance. Therefore, installation is restricted in most instances to the vertical plane. Horizontal mounting may be used where the damper is designed to provide a barrier to heat transfer and has achieved the required FRL with respect to both integrity and insulation. Conventional dampers may be used in floors where protection is provided above the damper to prevent ignition of combustibles. Such protection may 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.

3.3 METHOD OF PROTECTION

3.3.1 General

Openings in building elements required to have an FRL shall be protected with fire dampers except where they are exempted or excluded as specified in Clauses 3.3.2 and 3.3.3.

NOTE: Typical arrangements are shown in Figures 3.1 and 3.2.

3.3.2 Exemptions

Concessions shall apply for the omission of fire dampers for openings that are—

- (a) located in an external element where an unprotected opening is permitted by building regulations;
- (b) located in a loadbearing element required to have an FRL with respect to structural adequacy only;
- (c) protected with enclosing construction in accordance with Clause 3.4;
- (d) protected by construction equivalent to a prototype test specimen in accordance with Clause 3.5;
- (e) contained in a shaft such that the required level of fire separation is maintained (see Figure 3.1);
- (f) located at the entry to a shaft where the FRL of the shaft is maintained through all other fire compartments traversed by that shaft (see Figure 3.1); or
- (g) located at the entry to a shaft forming part of a mechanical smoke exhaust system (in accordance with Clause 3.6) or a minor exhaust system (in accordance with Clause 5.3.1), which continue to operate in fire mode and are protected by a subduct.

For the purposes of Items (e), (f) and (g), shafts shall not form part of multiple fire compartments simultaneously.

3.3.3 Exclusions

Openings in building elements that are required to have an FRL shall NOT include fire dampers and shall be protected by other means in accordance with this Standard, where such openings are—

- (a) protected by a required subduct (see Clause 3.7.4);
- (b) in series and downstream of another opening that is protected with a subduct in accordance with Clause 3.6 or Clause 5.3;

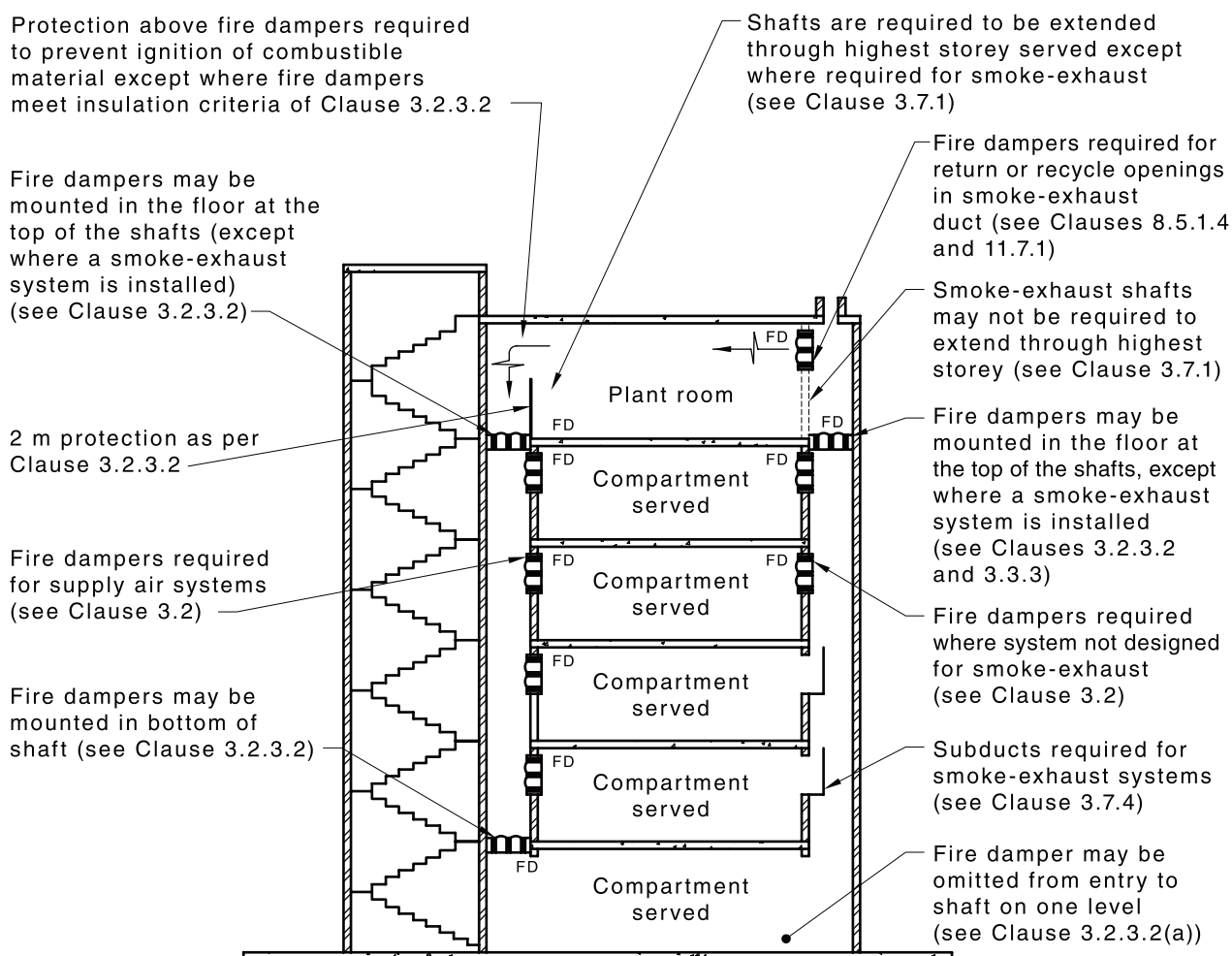
C3.3.3(b) *Minor exhaust systems may be protected with subducts in lieu of fire dampers. Subducts can take up more shaft space but do not require maintenance. System operational requirements are different depending on the type of protection employed.*

Fire dampers and subducts may be installed in the same system, provided a fire damper is not in series and downstream of any subduct.

- (c) associated with a duct forming part of a kitchen exhaust system required to conform with AS 1668.2, which shall be installed in accordance with Section 6;
- (d) associated with a duct forming part of a common residential kitchen exhaust system that is configured as a minor exhaust system and provided with subducts in accordance with Clauses 3.6 and 3.7.4;
- (e) part of a lift vent, which shall be configured in accordance with Clause 3.4;
- (f) associated with a diesel fire pump room ventilation system, which shall be configured in accordance with Clause 3.4;

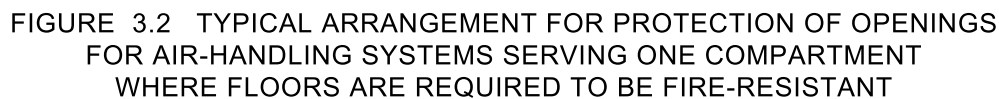
- A1 (g) associated with a dedicated fire-isolated exit pressurization system, which shall be configured in accordance with Section 10; and
- (h) associated with a fume cupboard exhaust system where—
- (i) accelerated corrosion of the fire damper resulting in failure in less than 5 years;
 - (ii) exposure of maintenance personnel to toxic substances during inspection; or
 - (iii) exposure of laboratory staff to toxic substances in the event of faulty fire damper closure, cannot be avoided, in which case the system shall be configured in accordance with Clause 3.4.

C3.3.3 *The exemptions and exclusions 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 or where conditions of installation of a fire damper will not allow reliable protection of the building element's FRL.*



NOTE: Fire dampers at the top or bottom of a shaft are omitted where the shaft forms 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



Where a duct, with or without a sheet metal lining, passes from a single fire compartment directly to outside the building, through another fire compartment boundary or back into the same fire compartment through other fire compartments without fire dampers at any of the openings in the compartment boundary, it shall be fabricated using construction that has an FRL with insulation and integrity equal to the requirements of construction required to separate the fire compartments through which it passes.

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 to 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

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Within the shaft or fire-resisting duct where subducts are used, each subduct shall have an outlet projection facing downstream and extending not less than 500 mm in the direction of exhaust airflow. The air entering the shaft or duct shall travel in an upward direction for not less than 500 mm with no downturns before entering the main exhaust airstream. Where the normal direction of airflow is downwards in a shaft, or horizontal in a duct, the subduct shall discharge the exhaust air horizontally.

NOTES:

- 1 For typical arrangements, see Figures 3.3 to 3.10.
- 2 If required to improve airflow, subducts may be constructed with a mitred back. Fairings may also be attached to the upstream or downstream sides of subducts.
- 3 Vertical shafts or individual exhaust systems should be considered in preference to horizontal systems, as they offer reliable natural venting in the event of fan failure.

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 AS 4072.1;
- (b) has a fusion temperature not less than 1000°C;
- (c) prevents excessive leakage of combustion products; and
- (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 *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 exhaust 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 exhaust 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.

The packing material between the subduct and the fire-resisting structure will need to be 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 clearance may rupture the wall. (See Clause 3.6.3.2.)

3.6.3 Smoke exhaust systems

3.6.3.1 Manufacture

Subducts shall be manufactured from steel not less than 2 mm thick, or be otherwise constructed to achieve an FRL not less than that required for the 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.

NOTES:

- 1 An example of an acceptable alternative material to steel is reinforced concrete integral with the reinforced concrete shaft.
- 2 Steel used for subducts should be painted with a zinc-rich paint, galvanized, stainless or otherwise protected against the corrosive effects of the subduct's environment.
- 3 Alternatively, to facilitate erection, subducts may be made in sections, provided 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.

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 not less than 2.5 mm thick. Attachment of the flange shall be by means of—

- (a) grouted steel bolts or by steel bolts that engage in expanding anchors of material having a temperature of fusion not less than 1000°C; or
- (b) 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 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 accordance 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 exhaust 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 at 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. For example, 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 specification 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 4254.1, AS 4254.2 and 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 duct constructed in accordance with AS 4254.1 and AS 4254.2 and fixed to the riser duct with a mounting flange not less than $30 \times 30 \times 1.6$ mm steel, utilizing metal fastenings having a temperature of fusion not less than 1000°C. The sheet metal riser duct shall be enclosed in a shaft.

NOTE: Water supply, soil and waste services may be used in the same shaft as the sheet metal riser duct.

3.6.5 Exhaust or relief airflow

The use of subducts shall allow continuous exhaust or relief airflow through the smoke exhaust or relief system during a fire, while still maintaining acceptable fire separation between fire compartments.

NOTE: For guidance on performance of subducts, see Appendix B.

3.7 SMOKE EXHAUST SYSTEMS

3.7.1 System enclosure

Smoke exhaust 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 fire separation between fire compartments.

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Where located in a fire-isolated plantroom, smoke exhaust plant and associated ductwork are not required to be enclosed in a fire-resisting construction unless the plantroom contains commercial kitchen exhaust systems or other non-fire-isolated essential services, (e.g. essential switchboards, supply air systems, air pressurization systems, hydrant pumps and emergency batteries).

C3.7.1 The smoke exhaust system is required to maintain its fire separation when handling smoke exhaust air to ensure the supply air system remains operative and the supply air uncontaminated. Where smoke exhaust 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 exhaust plant, general ventilation plant and general pumps, or similar.

3.7.2 Ductwork

Ductwork, plenums (excluding ceiling voids used as plenums) and equipment plenums used in smoke exhaust systems shall comply with Clause 2.3.2.

Ductwork, plenums (excluding ceiling voids used as plenums) and equipment plenums, forming part of a smoke exhaust system and connecting more than one fire compartment and outside any fire-resisting enclosure, shall comply with Clause 2.3.3 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.

NOTE: Ducts forming part of smoke exhaust systems may traverse other fire compartments provided the integrity of the fire compartments is maintained.

C3.7.2 *Smoke exhaust ducts need not have fire resistance with respect to insulation when exposed to an external fire. For satisfactory performance of the smoke exhaust system, it is recommended that the prototype duct, tested in accordance with AS 1530.4, 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 smoke exhaust system.

3.7.3 Shafts

Smoke exhaust air within a fire-resisting shaft is not required to be ducted. Where ducting is not provided, other building services shall not be included within the shaft.

Where ducts are provided, they shall comply with Clause 3.7.2. Where other ducts are installed within the same shaft, they shall comply with Clauses 3.2 and 3.3.

C3.7.3 *The use of ducts within a smoke exhaust 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 smoke exhaust air stream.*

3.7.4 Entry of smoke

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Where smoke or air enters a smoke exhaust system, a subduct, in accordance with Clause 3.6, shall be fitted at each point of entry to the shaft or fire-resisting duct, unless the point of entry is the most upstream point of a smoke exhaust system.

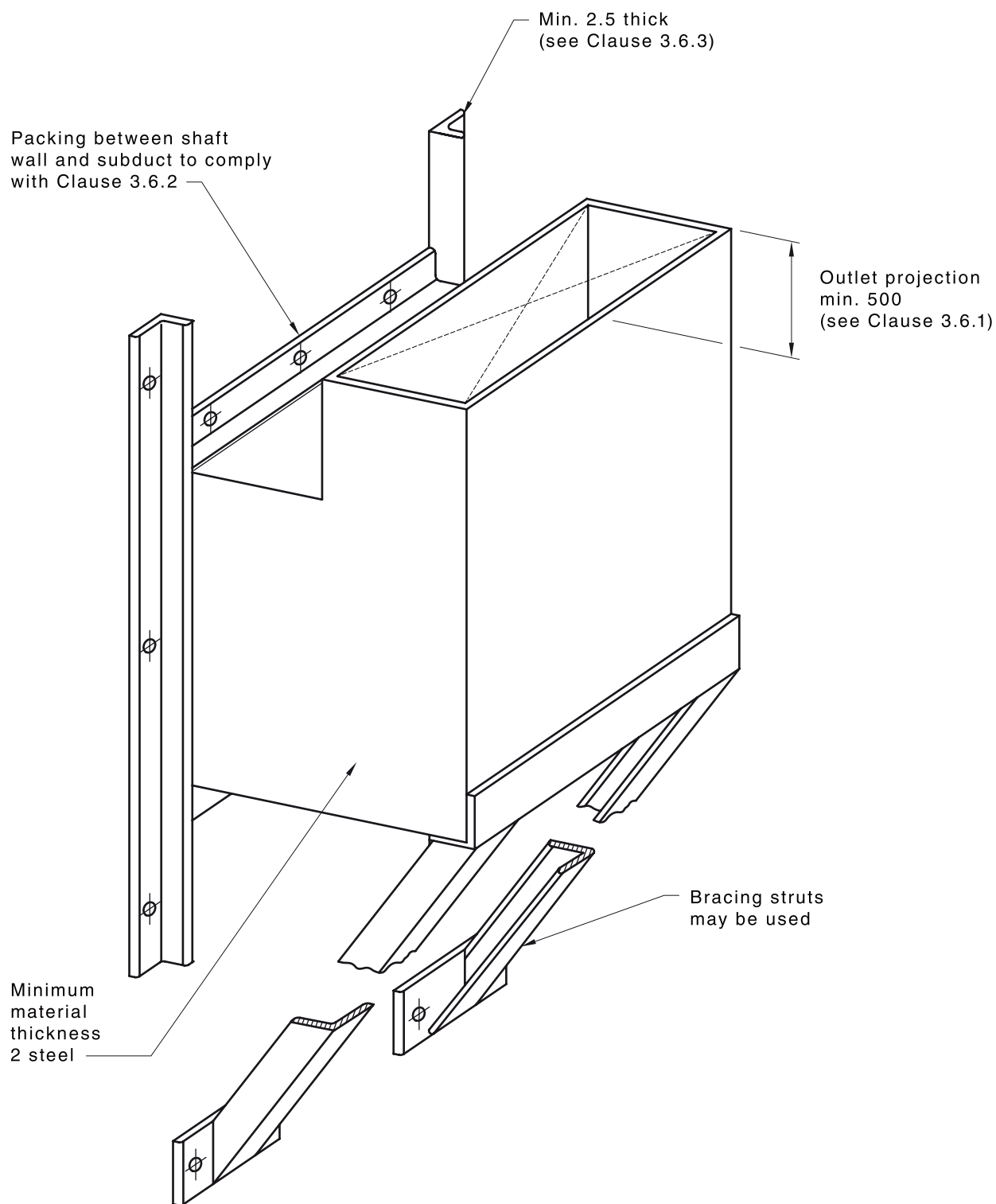
NOTE: An air damper (smoke exhaust) is permitted at each of these entries.

3.8 INDIVIDUAL AIR-HANDLING SYSTEMS

Mechanical components of an individual air-handling system that forms part of a smoke control system located in areas outside the fire compartment it serves shall be separated from all such areas with construction to maintain the required FRL.

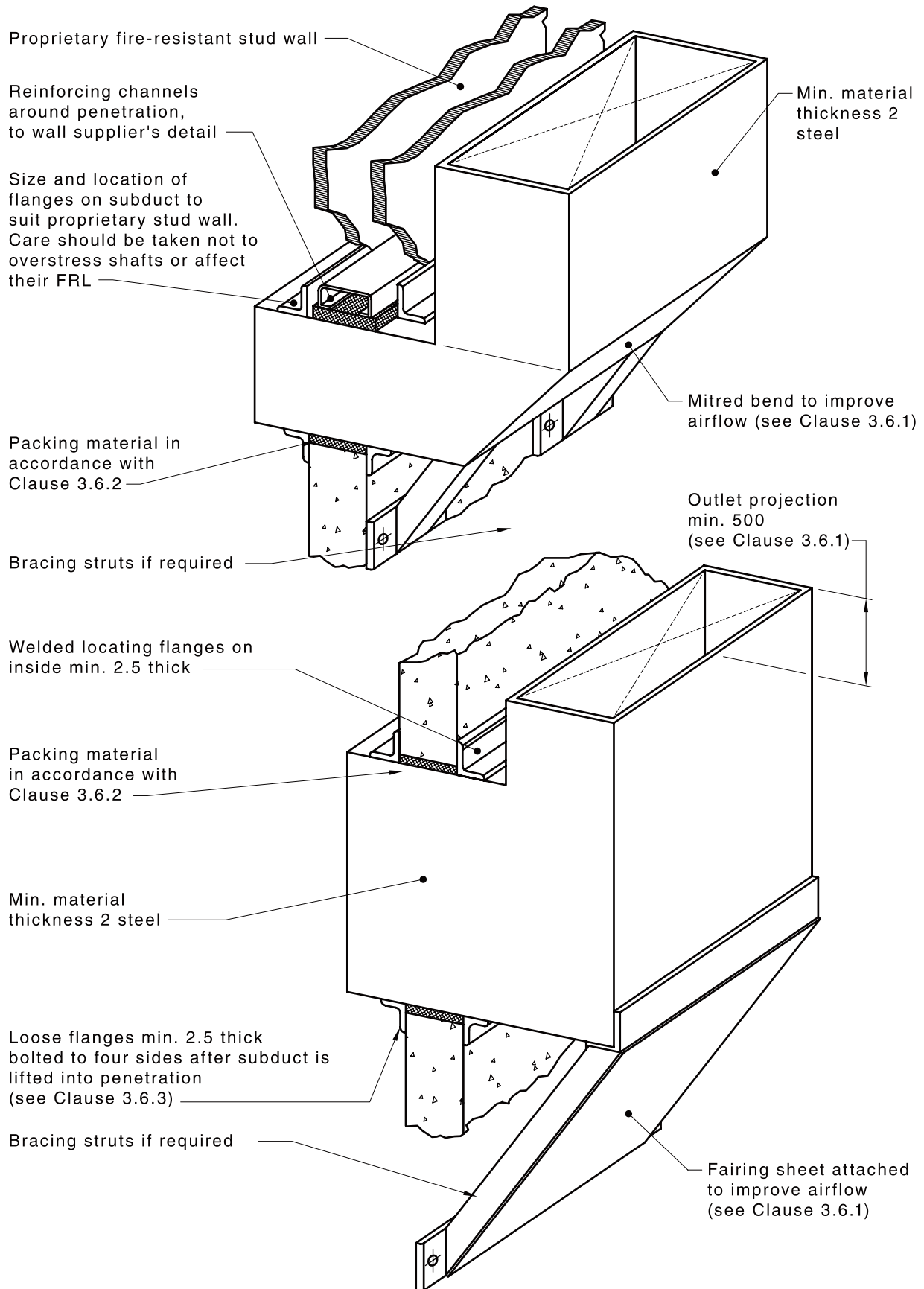
A smoke control system that has some components located outside the fire compartment served shall be protected with fire-resisting construction so that the whole system is fire separated from areas outside the fire compartment served.

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 that they do not serve, they are required to be fire-separated to maintain the FRL between each compartment.*



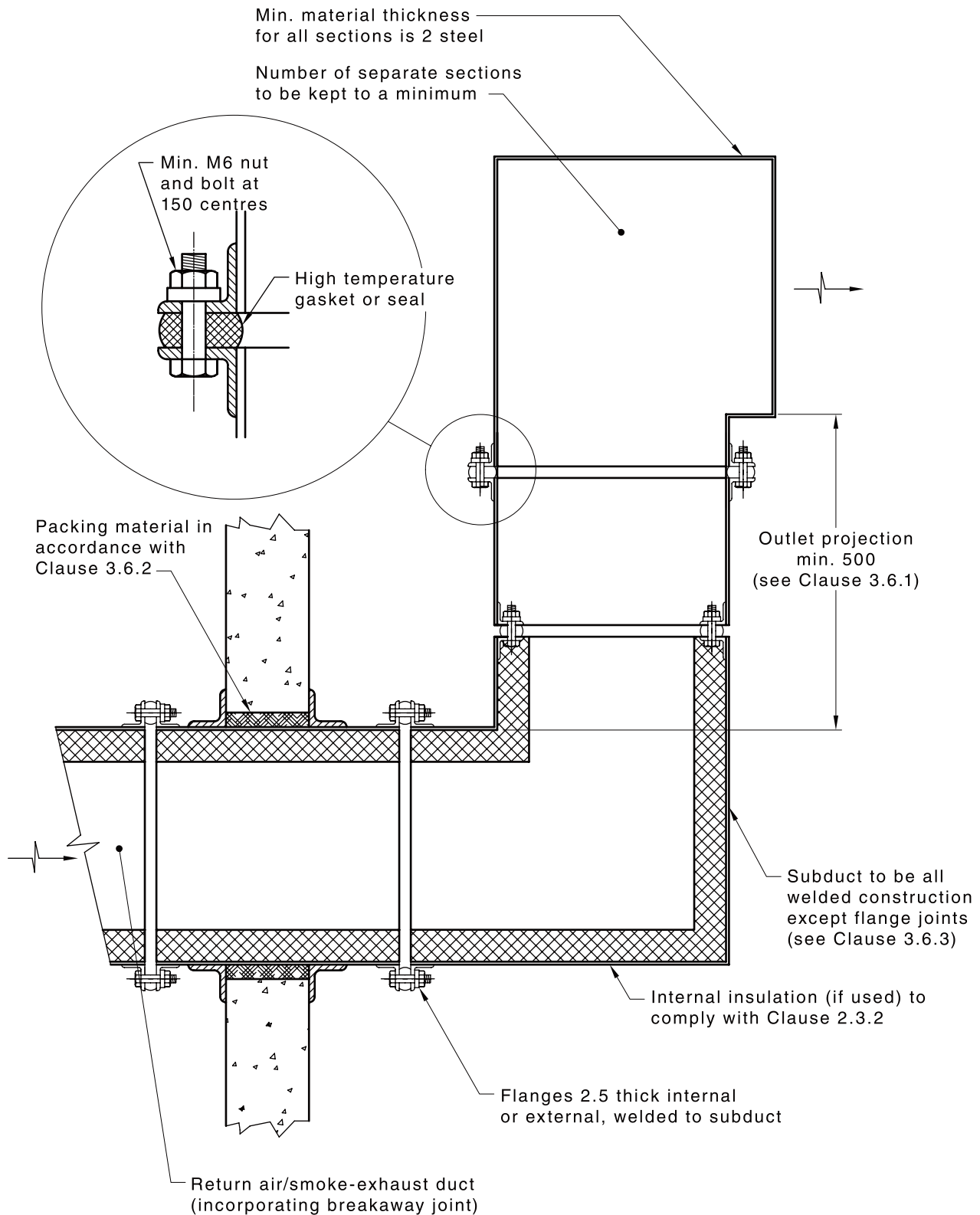
DIMENSIONS IN MILLIMETRES

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



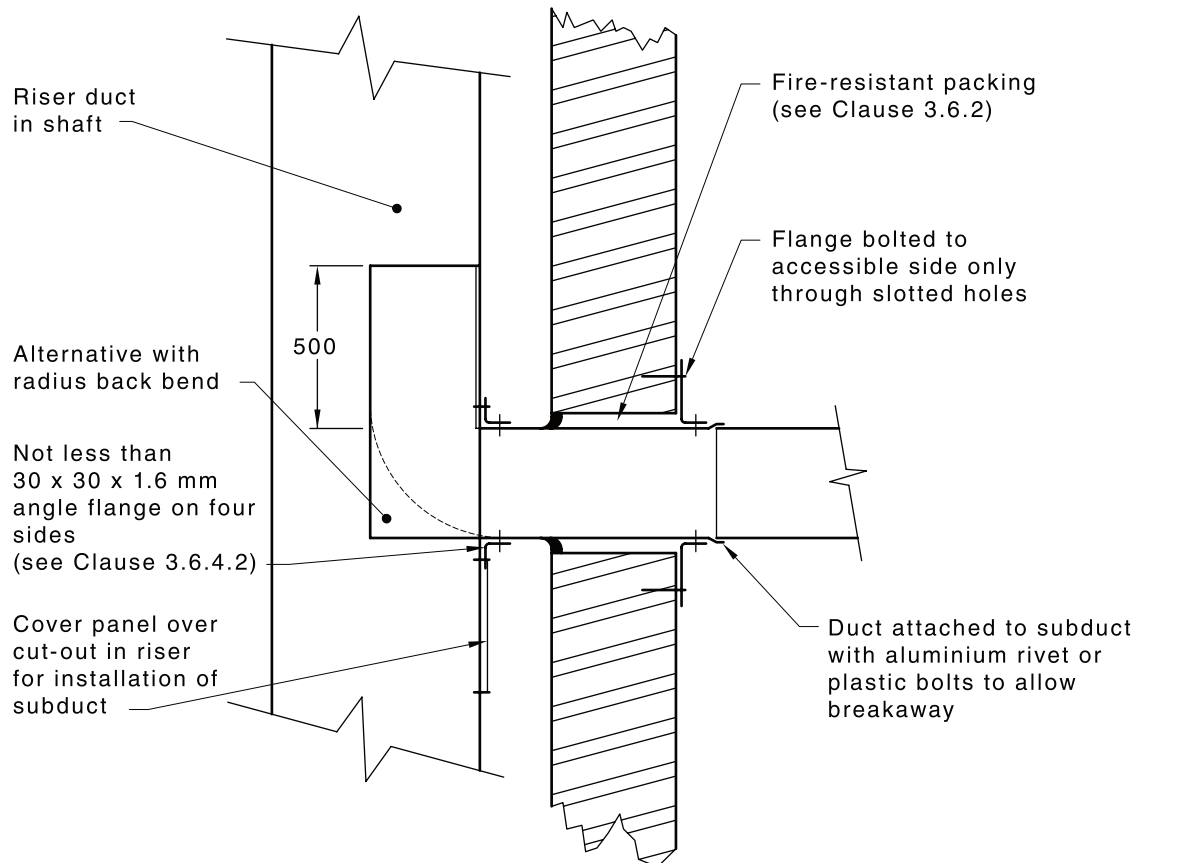
DIMENSIONS IN MILLIMETRES

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

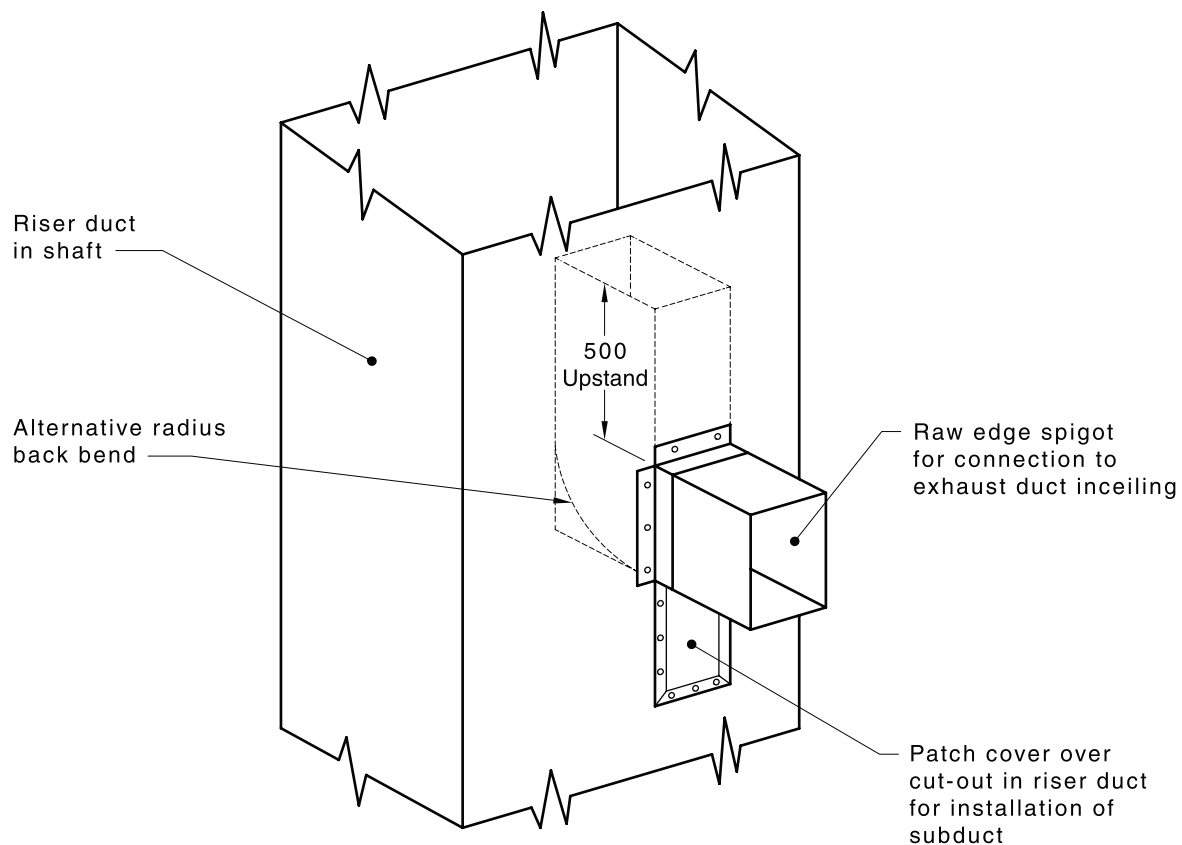


DIMENSIONS IN MILLIMETRES

FIGURE 3.5 TYPICAL CONSTRUCTION OF SECTIONAL SMOKE EXHAUST SUBDUCT



SECTIONAL ELEVATION



ISOMETRIC VIEW

DIMENSIONS IN MILLIMETRES

FIGURE 3.6 TYPICAL CONSTRUCTION OF MINOR EXHAUST SUBDUCT

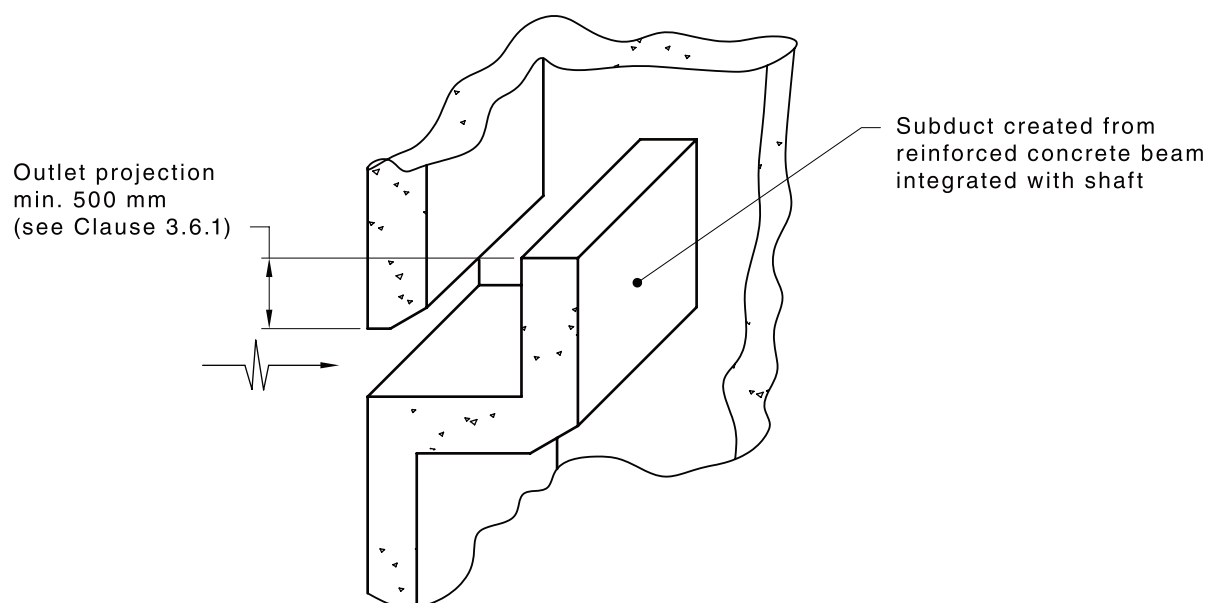


FIGURE 3.7 TYPICAL 'ALTERNATIVE MATERIAL' SUBDUCT
USING REINFORCED CONCRETE

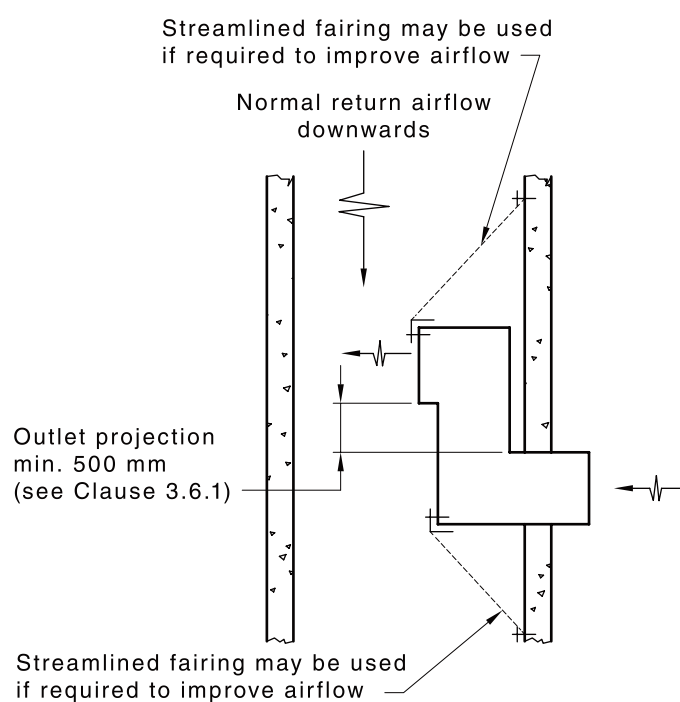


FIGURE 3.8 NORMAL DIRECTION OF AIRFLOW DOWNWARDS

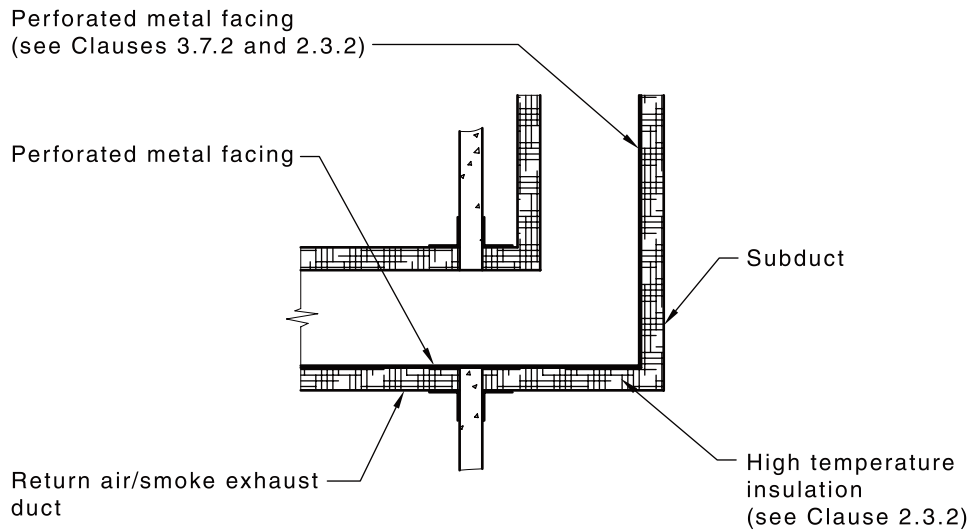


FIGURE 3.9 TYPICAL INTERNALLY INSULATED SMOKE EXHAUST DUCTWORK

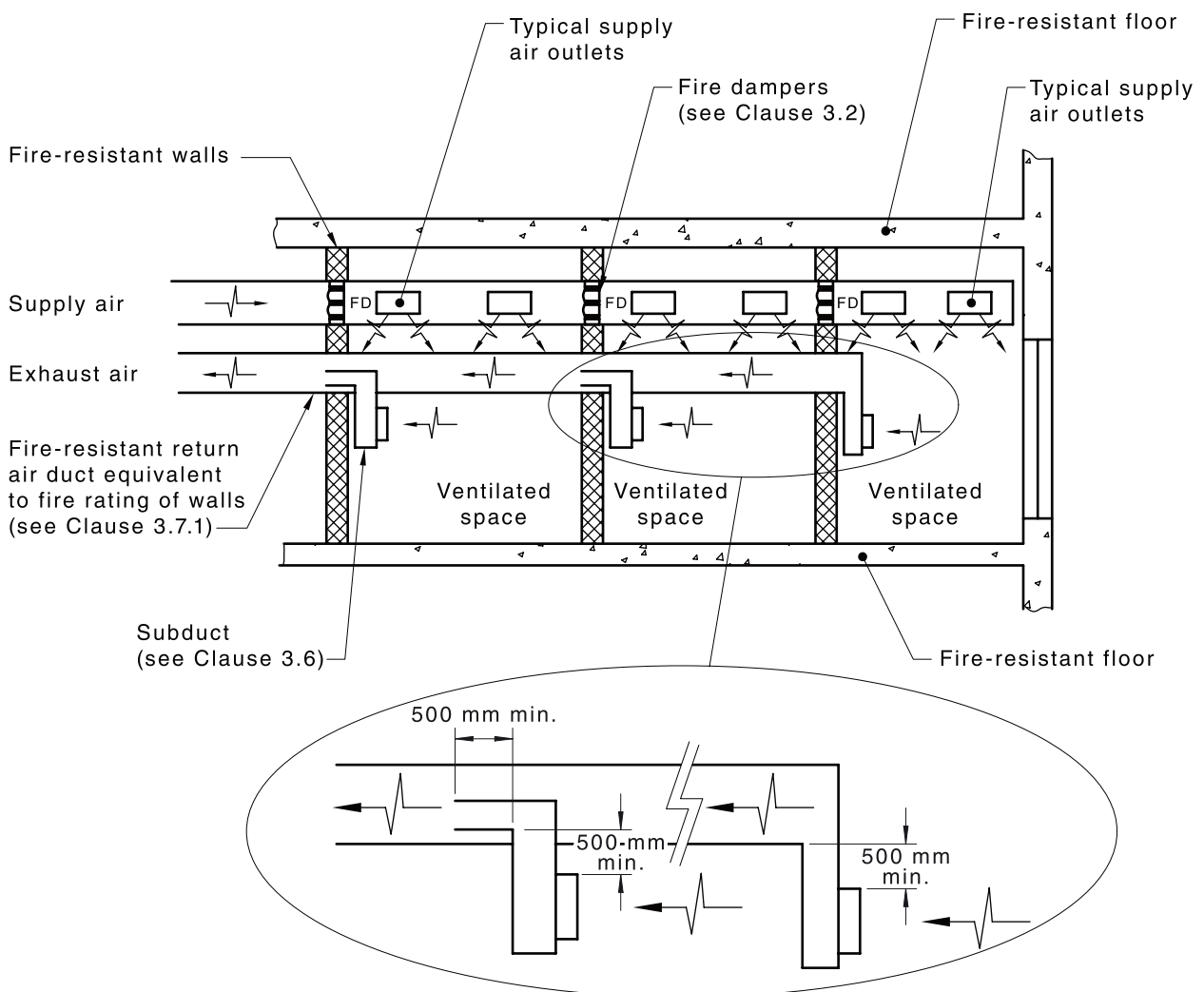


FIGURE 3.10 TYPICAL INSTALLATION WHERE INDIVIDUAL STOREYS ARE SUBDIVIDED INTO SEPARATE COMPARTMENTS

SECTION 4 SMOKE CONTROL SYSTEMS — GENERAL REQUIREMENTS

4.1 GENERAL

This Section sets out general requirements for air-handling systems used for smoke control. All mechanical air-handling systems required to incorporate smoke control provisions shall comply with this Section and the specific requirements of Sections 2, 3, 5, 6, 7, 8, 9, 10, 11 and 12.

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C4.1 *There are various air-handling system arrangements that may be used to achieve the objectives of smoke control (see Clause 1.6). This Section sets out requirements for those components and aspects common to such air-handling systems.*

4.2 LOCATION OF EXTERNAL OPENINGS

A1

External openings shall be located such that the risk of smoke contamination of outdoor air intakes and make-up air inlets is reduced.

Intakes for fire-isolated exit pressurization systems shall be separate and located to minimize the risk of the simultaneous contamination of multiple fire-isolated exits, except where the intakes only serve a single above ground and single below ground pressurized exit.

NOTE: For air-intake and air-discharge locations requirements, see AS 1668.2.

C4.2 *Potential sources of smoke contamination include smoke exhaust discharge, operating or idle minor toilet exhaust systems, idle minor supply systems, permanent natural ventilation systems, kitchen exhausts, and combustion engine exhausts.*

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 exhaust 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 exhaust 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 exhaust 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 exhaust 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 24 of the 2013 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 EXHAUST AIRFLOW UNDER SMOKE-CONTROL CONDITIONS

Where a smoke exhaust system incorporates subducts, the direction of airflow in the smoke exhaust system shall be such that the natural convection flow of smoke is assisted.

C4.3 This Clause emphasizes that regardless of whether the direction of return airflow is upwards or downwards under normal operating conditions, it is required that the flow of smoke exhaust 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 exhaust air be designed to flow substantially downwards. An example would be to accommodate major building geometry that prevents continuous upward flow. In this case, an alternative solution may be required.

4.4 LOCATION OF SMOKE EXHAUST SYSTEM INLETS

Smoke exhaust system inlets shall be located at high level within the smoke control zone and in a location that prevents the movement of smoke in the direction of an 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 exhaust 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. Therefore, it is important to ensure that such inlets are not located so as to assist the movement of smoke to principal evacuation routes leading to exits (e.g. public corridors). The use of return air ceiling plenums as the smoke exhaust path is particularly appropriate for zone smoke control systems.

4.5 HEAT EXCHANGE EQUIPMENT

Air-to-air heat exchange equipment located in the smoke exhaust path and also forming part of the supply air system shall not be exposed to the smoke exhaust stream when operating in the fire mode.

4.6 NOISE

The noise level in occupied spaces during operation of the smoke control systems (including smoke exhaust fans and air pressurization fans) shall not exceed 65 dB(A). Where the internal occupied ambient noise levels exceed 60 dB(A), the smoke control systems shall not exceed 5 dB(A) above the internal occupied ambient noise levels, to a maximum level of 80 dB(A).

A1 | Noise levels in fire-isolated exits and car parks, as well as and smoke control zones served by hot layer smoke control systems 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 is required to 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 is required to 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.

Location of noise measurements for smoke control systems are specified in Clause 4.14.7.

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, that is the force due to air pressure on any door when opening does not exceed the force of the self-closing or automatic-closing device and latching device (where provided), which shall apply during normal mode as well as in fire mode.

NOTE: For automatic-closing force, see AS/NZS 1905.1.

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 may prevent the doors from closing. Whilst this is unlikely to cause pollution of the exit, it may affect the pressure differential between the compartments. Therefore, the principle of requiring doors to close and latch in a fire situation has to be retained.

4.8 SMOKE EXHAUST FANS

4.8.1 General

Each smoke exhaust fan, complete with all associated componentry, shall be constructed and installed so that it is capable of continuous operation and status indication at its rated capacity as follows:

- (a) In a building or part of a building protected by a sprinkler system, the fan serving the protected parts of the building shall operate for a period of not less than 2 h with a smoke exhaust air temperature of 200°C.
- (b) In a building or part of a building not protected by a sprinkler system, the fan shall operate for a period of not less than 30 min with a smoke exhaust air temperature of 300°C.

The smoke exhaust fan shall be type-tested for these rating requirements in accordance with AS 4429.

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

C4.8.1 *Some examples of componentry associated with a smoke exhaust fan are flow switches, sensor tubing, wiring, control gear, variable speed drives, flexible connections, vibration isolators, damper control motors.*

Calculation of expected smoke exhaust air temperatures at the smoke exhaust 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 exhaust 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 exhaust fan to fire source.*

4.8.2 Selection criteria

Smoke exhaust fans shall be selected to handle the design volumetric airflow rate (calculated at the smoke exhaust 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 AUTOMATIC INITIATION OF SYSTEMS

Systems shall be automatically initiated in accordance with the smoke control requirements of AS 1670.1.

C4.9 *It may be necessary for designers of smoke control systems in accordance with this Standard and designers of initiation systems in accordance with the requirements of AS 1670.1 for smoke control to coordinate, such that required system operation is achieved.*

4.10 ELECTRICAL INSTALLATION

4.10.1 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 provide a high degree of reliability under likely fire conditions. Overload safety devices of variable speed drives associated with smoke exhaust fans shall be automatically overridden when operating in the fire mode.

NOTE: For guidance on the reliability of a system, see Appendix C.

C4.10.1 *Selection of electrical equipment can have a significant effect on the reliability of the smoke control system. For example, variable speed drives used in variable air volume systems and fire-isolated exit pressurization systems may shut down if ambient temperatures exceed 40°C–50°C or if the power supply is disturbed, both of which are likely scenarios during a fire.*

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4.10.2 Wiring systems

4.10.2.1 General

Wiring systems required to function in fire mode shall meet the fire resistance and mechanical protection requirements of Table 4.1, Appendix D and AS/NZS 3013. Any wiring installed within a lift shaft shall comply with AS 1735.2.

NOTE: Equipment to be wired in this manner includes 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.

4.10.2.2 Exceptions

Apart from wiring systems that serve fire-isolated exit pressurization systems, any wiring systems serving smoke control equipment listed in Clause 4.10.3 is not required to comply with the fire resistance and mechanical protection requirements of AS/NZS 3013 provided the following cases apply:

- (a) When installed entirely within a plantroom that is fire-isolated from the occupied spaces by construction having FRL not less than -/120/120.
- (b) Where loss of voltage cannot adversely affect the operation of the smoke-control system.
- (c) Where control wiring to motorised air dampers within the supply air stream branches (including VAV, but excluding the compartment's supply air dampers) is protected in such a manner that a failure in one fire compartment does not render systems in other fire compartments inoperative.

NOTE: For a schematic of the fire integrity of a wiring system see Figure 4.1.

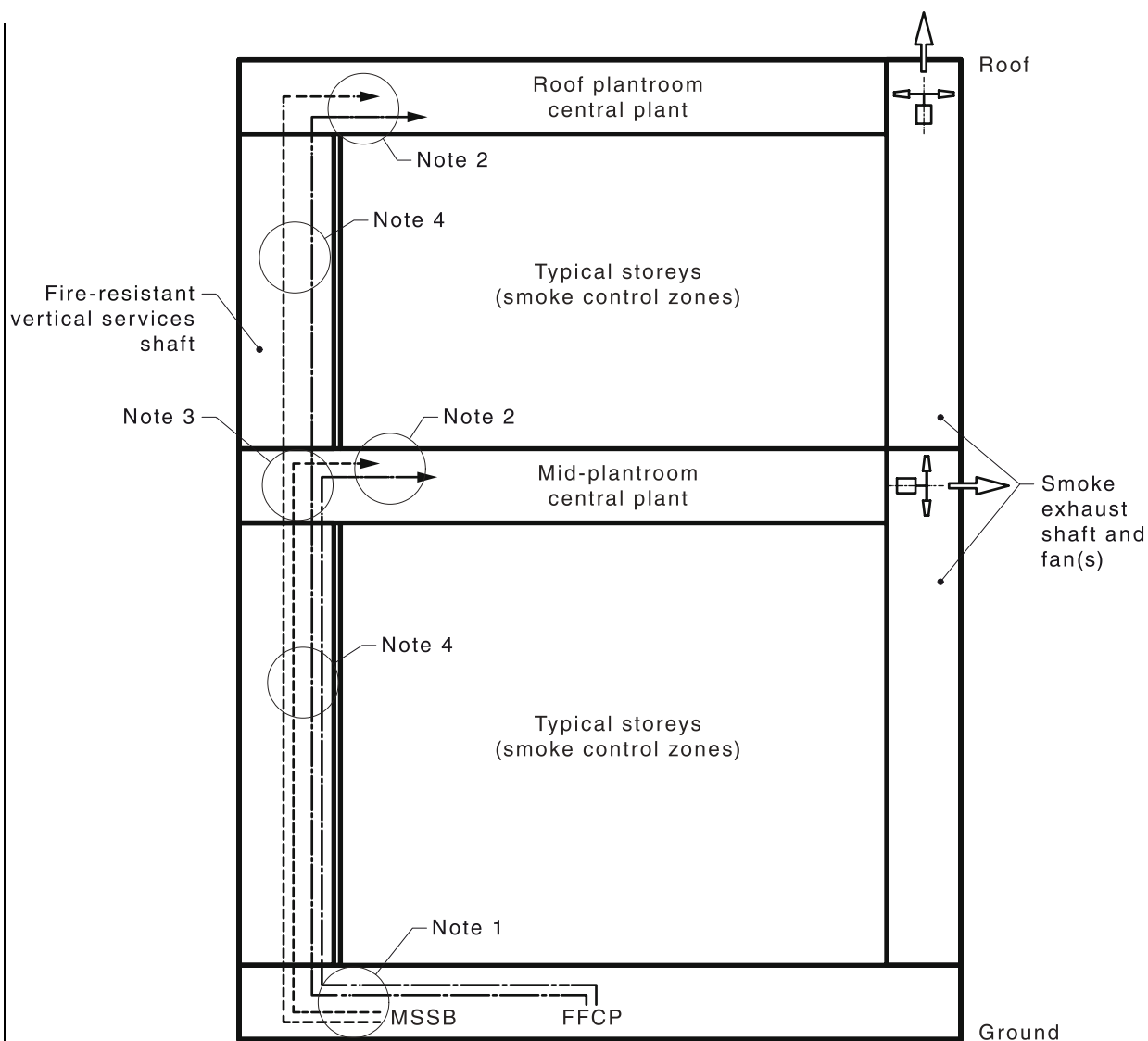
C4.10.2.2 *It is not intended to require a fire-resistant power supply or actuator system to each variable air volume (VAV) damper; however, the VAV damper power supply should be protected in such a manner that a failure in one compartment does not render the whole system inoperative and, therefore, prevent the necessary opening of VAV dampers. This exception also applies to other air dampers within the supply air stream, such as those used for out-of-hours isolation.*

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 and loss of power to those supply fans, which would be shut down during a fire, will not affect the performance of the system in the event of a fire.

These provisions are intended to provide reliable power supply to equipment required to operate in fire mode as well as reducing the likelihood of damage to the central distribution power and control circuits of systems required to function and provide ongoing control during a fire.

Fans that have been installed to ventilate diesel fire pump rooms (sprinkler pump, hydrant pump, etc.) are required to operate in fire mode and so would be required by Clause 4.10 to have fire-resistant wiring and be connected to the essential electrical power supply. If these pumps are required to continue running when the building's power supply has failed, the designer should consider permanent natural ventilation of the diesel pump room or allow for the provision of independent power supplies for these fans.

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LEGEND:

- Power cabling from MSSB to mechanical equipment
- Control and status indication cabling from FFCP to mechanical equipment

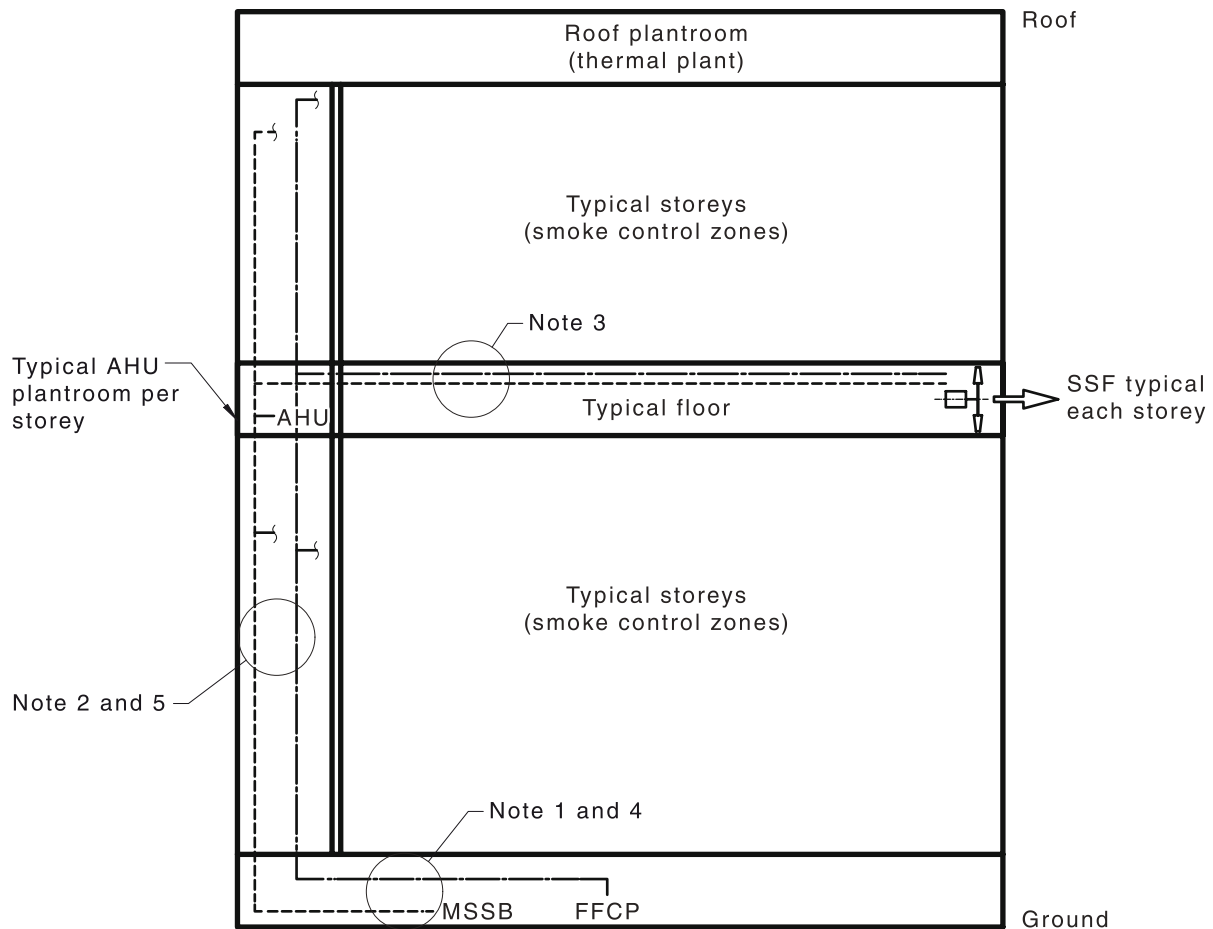
(a) Power, control and status indication cabling—Central plant

NOTES:

- 1 All cabling, where not protected from fire by fire-resistant construction is to be fire-resistant.
- 2 Cabling within plantrooms serving AHUs operating in fire mode may be non-fire-resistant but is to be fire-resistant when serving smoke exhaust fans.
- 3 Fire-resistant cabling is required for plantroom equipment operating in fire mode if fire-resistant riser shaft is not constructed through plantroom.
- 4 Cabling within fire-resistant riser shafts may be non-fire-resistant. In practice, fire-resistant cabling is likely to be installed throughout, to minimize changes to cable type and associated junctions.
- 5 For control and indicating circuits, similar integrity should apply.
- 6 Wiring may be individual cables or multi-core as required to suit system type.

FIGURE 4.1 (in part) FIRE INTEGRITY OF WIRING SYSTEMS

A1



LEGEND:

- Power cabling from MSSB to mechanical equipment
- Control and status indication cabling from FFCP to mechanical equipment

(b) Power, control and status indication cabling—Individual storey plant

NOTES:

- 1 All cabling, where not protected from fire by fire-resistant construction is to be fire-resistant.
- 2 Cabling serving equipment required to run in fire mode is to be fire-resistant if located in a non-fire-resistant service riser. Fire-stopping is required at cable penetrations through building elements that separate fire compartments.
- 3 Each typical floor smoke exhaust fan is to be served by fire-resistant cabling.
- 4 Each AHU required to run in fire mode and each smoke exhaust fan require independent control/status indication cabling.
- 5 Cabling within fire-resistant riser shafts may be non-fire-resistant. In practice, fire-resistant cabling is likely to be installed throughout, to minimize changes to cable type and associated junctions.
- 6 For control and indicating circuits, similar integrity should apply.
- 7 Wiring may be individual cables or multi-core as required to suit system type.

FIGURE 4.1 (in part) FIRE INTEGRITY OF WIRING SYSTEMS

4.10.3 Protection of electrical components

Electrical components (such as switchgear, control gear, accessories, variable speed drives) associated with smoke control systems (excluding fire-isolated exit systems) shall be fire-isolated from occupied spaces with construction having an FRL not less than $-/120/120$.

Electrical components associated with fire-isolated exit pressurization systems shall be fire-isolated from the occupied spaces by—

- (a) installation within the fire-isolated exit served or installation in a dedicated plantroom;
- (b) installation above a roof; or
- (c) a dedicated equipment enclosure for each fire-isolated exit pressurisation system, having construction with an FRL not less than $-/120/120$.

Variable speed drives associated with smoke exhaust fans shall be fire-isolated from other equipment and the occupied space with construction having an FRL of not less than $-/120/120$, or shall be designed or arranged to ensure continuous operation of the fan throughout the duration required in Clause 4.8.

C4.10.3 *A general-purpose equipment plantroom, which is fire separated from the occupied spaces, would meet the requirements of the first paragraph of Clause 4.10.3 above. Switchboards, variable speed drives and other electrical components associated with fire isolated exit pressurization systems may require additional separation within this plantroom.*

4.10.4 Isolation switches

Isolation switches that are exposed to high temperatures (such as those used for smoke exhaust fan isolation, or are within the hot layer of a hot layer smoke control system) shall comply with the relevant requirements of Clause 4.8.1.

NOTE: This requirement does not apply to isolation switches protected in accordance with Clause 4.10.3.

Any switch that is capable of isolating power in fire mode associated with fans required to operate during a fire shall be lockable and shall be fitted with a prominent warning label as follows:

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

4.10.5 Power supply

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

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

4.10.6 Variable speed drives

Any variable speed drives serving fan motors associated with fans required to operate during a fire shall be fitted with a prominent warning label stating the following:

WARNING: THIS VARIABLE SPEED DRIVE SHALL REMAIN ENABLED AS THE FAN IS REQUIRED TO OPERATE DURING A FIRE.

4.11 CONTROL AND INDICATION

4.11.1 General

A fire fan control and indication panel (FFCP) and the method of transmission and interface to smoke control systems shall be provided in accordance with AS 1670.1.

A1 | Controls, indication and labelling shall be in accordance with Table 4.1 and AS 1670.1.

4.11.2 Location

The FFCP shall be incorporated into or located adjacent to the FBP and constructed in accordance with the FDCIE requirements in AS 1670.1.

4.11.3 Function

A fire fan control 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) Control of zone smoke control dampers located within a smoke control zone that is served by a central ventilation system.
- (c) Provide manual controls to override the automatic operation of the ventilation systems in accordance with the requirements of this Standard.

NOTE: Systems incorporating system shutdown for smoke control are not required to comply with the above.

- (d) Indicate the status of the air-handling equipment.

NOTE: Systems incorporating system shutdown for smoke control are not required to comply with the above.

The FFCP shall provide manual control of the functions of each item of air-handling equipment such as, supply air fan, exhaust fan, smoke exhaust fan and zone smoke control dampers required to operate in the fire mode, except for minor exhaust and supply systems.

NOTE: Air-handling equipment that is not required to operate in fire mode is not required to have manual control or indicators.

C4.11.3 Designers should be aware that the use of an automated building management system as part of the interface to the smoke control system does not meet the requirements of AS 1670.1.

4.11.4 Signal transmission and system interface

4.11.4.1 General

The interface between the FFCP and MCC shall comply with the requirements of AS 1670.1.

NOTE: For indicative interface arrangements, see Figure 4.2.

4.11.4.2 Low level interface

A low-level interface shall meet the following conditions:

- (a) Control signals from the FFCP to the MCC interface shall—
 - (i) use electromagnetic relays;
 - (ii) provide voltage-free contacts rated for the required current and voltage to switch the MCC controls;
 - (iii) not switch control voltages that exceed ELV as defined AS/CA S009; and
 - (iv) not provide power to operate the MCC control inputs.
- (b) The FFCP shall monitor the status of voltage-free contacts at the MCC interface, which shall signal the following:
 - (i) Each fan stopped/running status.

- A1 | (ii) Phase failure/reversal at each MCC providing power to air-handling equipment that is required to operate in fire mode.

The number of relays and functions required shall be determined from the mechanical services design.

NOTES:

- 1 The MCC relay contacts should be suitable for switching the typically low current (less than 10 mA) of the FFCP interface equipment inputs.
- 2 The coil to contact dielectric strength of all relays should be not less than 2500 V a.c.

4.11.4.3 High level interface equipment

A high-level interface (data protocol) between the FFCP and the MCC shall allow the transmission of the signals and controls specified for the low level interface.

The high-level interfaces shall comply with all the relevant smoke control requirements of AS 1670.1.

The high-level interface shall provide electrical isolation and withstand not less than 2500 V a.c.

The high level interface shall be independent of the building management control system.

A1 | **4.11.4.4 Interface cabinet**

The MCC interface shall be mounted in a separate cabinet and not contained within the MCC.

4.11.5 Transmission paths

- A1 | Control signals between the FFCP and MCC or MCC and any smoke control system equipment shall not be transmitted or rely on any networked control system other than the networking system utilised by the FFCP and in accordance with AS 1670.1.

Control signals within the MCC shall be via relays or dedicated programmable electronic controllers. Where programmable electronic controllers are used, they shall be programmed and arranged such that a failure of any other programmable electronic controller outside of the MCC cannot adversely affect the operation of the programmable electronic controller in the MCC or the operation of smoke control equipment controlled by the MCC.