

AS 1668.2:2024



STANDARDS
Australia



The use of ventilation and airconditioning in buildings

Part 2: Mechanical ventilation in buildings



AS 1668.2:2024

This Australian Standard® was prepared by ME-062, Ventilation and Airconditioning. It was approved on behalf of the Standards Australia's Standards Development and Accreditation Committee on 14 June 2024.

This Standard was published on 28 June 2024.

The following are represented on Committee ME-062:

- Air Conditioning & Mechanical Contractors Association
- Australasian Fire and Emergency Service Authorities Council
- Australian Building Codes Board
- Australian Industry Group
- Australian Institute of Refrigeration Air Conditioning and Heating
- Chartered Institution of Building Services Engineers
- Construction Information Systems Limited (NATSPEC)
- Consumer Electronics Suppliers Association
- Engineers Australia
- Facility Management Association of Australia
- Fan Manufacturers Association of Australia and New Zealand
- Fire Protection Association Australia
- Property Council of Australia

This Standard was issued in draft form for comment as DR AS 1668.2:2022.

Keeping Standards up-to-date

Ensure you have the latest versions of our publications and keep up-to-date about Amendments, Rulings, Withdrawals, and new projects by visiting:

www.standards.org.au

ISBN 978 1 76139 703 5

The use of ventilation and airconditioning in buildings

Part 2: Mechanical ventilation in buildings

First published as AS 1668.2—1976.
Previous edition 2012.
Sixth edition 2024.

© Standards Australia Limited 2024

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Cth).

Preface

This Standard was prepared by Standards Australia Committee ME-062, Ventilation and Airconditioning, to supersede AS 1668.2:2012, *The use of ventilation and airconditioning in buildings*, Part 2: *Mechanical ventilation in buildings*.

The objective of this document is to provide users with requirements for mechanical ventilation of buildings. It includes minimum design parameters for determining ventilation rates for general application in buildings.

This document has been prepared for reference in the *National Construction Code (NCC)*.

This edition of the document has been revised and updated to improve users' ability to conform to the technical requirements and reflect contemporary technologies and practices. The main technical changes in this edition are:

- (a) Non-quantified performance requirements and terms have been replaced by quantified prescriptive requirements.
- (b) Calculation of minimum outdoor airflow rates have been presented in simple and detailed formats, the concept of borrowed ventilation air has been introduced for some spaces and residential exhaust ventilation requirements have been aligned with provisions for condensation management introduced by the NCC since the last revision of this document.
- (c) Contaminant generation rates for vehicles have been updated to reflect the more widespread use of emission control catalysts, engine technology advances, engine management systems and low-emission fuels in the contemporary Australian vehicle fleet, all leading to reduced required ventilation rates for car parks.
- (d) Sections on kitchen exhaust and health care ventilation have been generally updated and expanded to align with contemporary practice and technology, including a new compliance pathway for treated kitchen exhaust discharge.

The commentary in this document has been expanded to improve user understanding of the requirements.

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

This document includes 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 box. The commentary is for information and guidance and does not form part of the document.

Contents

Preface	ii
Introduction	vii
Section 1 Scope and general	1
1.1 Scope.....	1
1.2 Application – selection of mechanical ventilation	1
1.3 Normative references	3
1.4 Terms and definitions.....	4
1.5 Combination ventilation systems.....	9
1.6 Residual ventilation.....	10
1.7 System operation.....	10
Section 2 Mechanical ventilation — supply systems	11
2.1 Scope	11
2.2 Notation.....	12
2.2.1 Symbols.....	12
2.2.2 Occupancy.....	12
2.3 Outdoor air intakes.....	13
2.3.1 Location	13
2.3.2 Passage of air.....	14
2.4 Tundishes and floor wastes.....	14
2.5 Filtration	14
2.6 Prohibition of recycle air.....	15
2.7 Outdoor air mixing and distribution	15
2.8 Outdoor airflow rates.....	17
2.8.1 General.....	17
2.8.2 Simple procedure	17
2.8.3 Detailed procedure.....	18
2.8.4 Borrowed ventilation for secondary enclosures	22
2.8.5 Variable air volume systems	22
2.8.6 Make-up air requirement	23
2.9 Outdoor airflow adjustment.....	23
2.9.1 Systems serving enclosures in which the temperature may exceed 27 °C under normal operation.....	23
2.9.2 Systems serving enclosures with transient or variable occupancy	23
2.9.3 Demand control ventilation.....	26
Section 3 Mechanical ventilation — exhaust systems	28
3.1 Scope of section.....	28
3.2 General exhaust ventilation.....	30
3.2.1 General.....	30
3.2.2 Exhaust locations.....	30
3.2.3 Enclosures served by both supply and required general exhaust systems.....	30
3.3 Local exhaust ventilation.....	31
3.3.1 Types of effluent requiring local exhaust	31
3.3.2 Effluent management.....	32
3.4 Kitchen exhaust hoods.....	33
3.4.1 General.....	33
3.4.2 Hood type and cooking process type.....	33
3.4.3 Hood overhangs.....	34
3.4.4 Hoods serving non-grease-producing equipment	35
3.4.5 Proprietary exhaust allowance.....	35
3.5 Kitchen exhaust hood airflow — prescriptive procedure.....	36
3.6 Ventilated ceilings and proprietary kitchen exhaust equipment (hood types 5 and 7).....	37
3.7 Air from enclosures having exhaust air requirements.....	38
3.7.1 General requirements.....	38

3.7.2	Air pressures	38
3.8	Replenishment of exhaust air	38
3.8.1	Source	38
3.8.2	Amount	39
3.8.3	Make-up air for kitchen exhaust hoods	39
3.8.4	Pressure drop	40
3.8.5	Electrical interlocking of exhaust and supply air	40
3.9	Combination of exhaust systems	40
3.10	Air discharges	41
3.10.1	General	41
3.10.2	Discharges not deemed objectionable	41
3.10.3	Discharges deemed objectionable	42
3.10.4	Discharges treated to reduce objectionable Type B effluent	43
3.10.5	Non-required discharges	44
Section 4	Ventilation of enclosures used by vehicles with combustion engines	45
4.1	Scope of section	45
4.2	Application of section	47
4.2.1	General application	47
4.2.2	Other occupancies	47
4.3	Notation	48
4.3.1	Symbols	48
4.3.2	Number of car spaces	49
4.4	Car parks	49
4.4.1	General	49
4.4.2	Ventilation distribution	50
4.4.3	Simple procedure for small car parks	51
4.4.4	Detailed procedure	51
4.5	Enclosures other than car parks	53
4.5.1	Enclosed driveways associated with buildings	53
4.5.2	Loading docks	53
4.5.3	Automotive service and repair shops	53
4.5.4	Vehicular lifts and shafts	54
4.5.5	Areas used by special purpose vehicles	55
4.6	Queuing areas	55
4.6.1	General	55
4.6.2	Queuing length	55
4.6.3	Airflow rate and distribution of air	56
4.7	Air pressure	56
4.8	Make-up of exhaust air	56
4.9	Exhaust air discharge	56
4.10	Combination systems	56
4.11	Ventilation control	57
4.11.1	General	57
4.11.2	System operation	57
4.11.3	Small car parks	58
4.11.4	Make-up air	58
4.12	Monitoring of atmospheric contaminants	58
4.12.1	General	58
4.12.2	System requirements	59
4.12.3	Operation and accuracy of CO monitors	59
4.12.4	Analysis of CO response time of monitoring systems	59
4.12.5	Sampling points	60
Section 5	Mechanical ventilation of enclosures used for particular health care functions	61
5.1	Scope of section	61
5.2	Application of section	61
5.2.1	Enclosure types	61
5.2.2	HEPA filters	62

5.2.3	Door opening and closing.....	63
5.3	Operating theatres.....	63
5.3.1	General.....	63
5.3.2	Air change rate.....	63
5.3.3	Air distribution.....	63
5.3.4	Recirculation.....	63
5.3.5	Outdoor air rate.....	63
5.3.6	Supply air filtration.....	64
5.3.7	Recycle and exhaust device location.....	64
5.3.8	Room air pressure.....	64
5.4	Sterile store and set-up rooms.....	64
5.4.1	General.....	64
5.4.2	Outdoor air rate.....	65
5.4.3	Recirculation.....	65
5.4.4	Room air pressure.....	65
5.4.5	Air distribution.....	65
5.5	Anaesthetic/induction rooms and bays.....	65
5.5.1	General.....	65
5.5.2	Outdoor air rate.....	65
5.5.3	Recirculation.....	65
5.5.4	Recycle and exhaust device location.....	65
5.5.5	Room air pressure.....	66
5.5.6	Air filtration.....	66
5.6	Infectious isolation rooms.....	66
5.6.1	General.....	66
5.6.2	Supply air rate.....	66
5.6.3	Recirculation.....	66
5.6.4	Outdoor air rate.....	66
5.6.5	Exhaust air rate.....	66
5.6.6	Room air pressure.....	66
5.6.7	Air distribution.....	67
5.7	Protective isolation rooms.....	67
5.7.1	General.....	67
5.7.2	Supply air rate.....	68
5.7.3	Recirculation.....	68
5.7.4	Outdoor air rate.....	68
5.7.5	Room air pressure.....	68
5.7.6	Air distribution.....	68
5.8	Post anaesthetic care unit (PACU) (Recovery Stage 1).....	69
5.8.1	General.....	69
5.8.2	Recirculation.....	69
5.8.3	Exhaust air rate.....	69
5.8.4	Air Distribution.....	69
5.9	Birthing suites or rooms.....	70
5.9.1	General.....	70
5.9.2	Recirculation.....	70
5.9.3	Exhaust air rate.....	70
5.9.4	Room air pressure.....	70
5.9.5	Air distribution.....	70
5.10	Autopsy rooms.....	70
5.10.1	General.....	70
5.10.2	Recirculation.....	71
5.10.3	Outdoor air rate.....	71
5.10.4	Exhaust air rate.....	71
5.10.5	Air distribution.....	71
5.10.6	Room air pressure.....	71
5.11	Dirty utility rooms.....	71
5.11.1	General.....	71

5.11.2	Recirculation	71
5.11.3	Exhaust air rate	71
5.11.4	Room air pressure	71
5.11.5	Make up air	71
5.12	Emergency department areas	72
5.12.1	General	72
5.12.2	Outdoor air rate	72
5.12.3	Recirculation	72
5.12.4	Exhaust	72
5.12.5	Room air pressure	72
5.12.6	Air distribution	72
Appendix A	(normative) Minimum effective outdoor airflow requirements based on occupancy	73
Appendix B	(normative) Minimum mechanical exhaust air requirements based on use of enclosure	81
Appendix C	(informative) Outdoor air contaminant levels	84
Appendix D	(normative) Principles of ventilation airflow analysis	85
Appendix E	(normative) Kitchen exhaust hoods	98
Appendix F	(informative) Performance-oriented approaches to mechanical ventilation system design (including system component selection)	110
Appendix G	(informative) Rationale for lag or lead time for transient occupancy	115
Appendix H	(informative) Commentary on carbon monoxide exposure in occupational environments	117
Appendix I	(informative) Examples of layouts of car park ventilation	119
Appendix J	(informative) Basis of airflow rates formulae for car parks	123
Appendix K	(informative) Basis for length of vehicle queue in car parks	126
Appendix L	(informative) Derivation of airflow rates for queuing areas in car parks	128
Appendix M	(informative) Automatic monitoring systems for car parks — marking, commissioning, reliability and records	129
Appendix N	(informative) Performance application to car park ventilation	130
Appendix O	(informative) Local exhaust ventilation references	132
Bibliography		133

Introduction

This document sets permissible ventilation rates having consideration to health and ventilation amenity. The specified ventilation rates are intended to maintain general contaminants (e.g. body odours, volatile organic compounds and the like) at concentrations below exposures that have the potential to cause adverse health effects to a majority of occupants.

Ventilation rates specified may not ensure that specific contaminants (e.g. fumes from unflued gas-fired devices and other fumes) are maintained at concentrations below exposures that have the potential to cause adverse health effects. When specific contaminants are present, alternative or additional control measures (other than dilution) may need to be implemented to achieve an equivalent level of health and amenity.

This document includes prescriptive requirements. Where appropriate, ventilation calculations have been presented as options to use either “simple” or “detailed” procedures.

It is recognized that this document is likely to be used for occupational health and community health purposes; so, its provisions have been designed, to the extent possible, to community health criteria promulgated by peak health bodies. Implicit in this recognition is the possibility that the provisions of the document may, at least in part, be excessively conservative when applied in an occupational health context. The document has used a two-part approach to the setting of ventilation rates for health purposes, which comprises a general approach and a more specific approach where particular information is available.

The principal health basis of the ventilation requirements of this document are based on enclosures in which smoking does not occur. This represents acceptance that ventilation rates long in use in Australia for health purposes remain valid in circumstances where available information does not allow a more specific or scientific approach. Where there is reasonably predictable pollutant generation information and an authoritative community health exposure limit, then that information has been used to set ventilation rates.

NOTES

Australian Standard®

The use of ventilation and airconditioning in buildings

Part 2: Mechanical ventilation in buildings

Section 1 Scope and general

1.1 Scope

This document sets out design requirements for mechanical air-handling systems that ventilate buildings and car parks (see Note 1), and requirements for ventilation based on the need to control odours, particulates and specific gases (e.g. CO, NO_x, CO₂, VOCs, SO₂, O₃).

This document does not include requirements —

- (a) associated with comfort (e.g. temperature, humidity, air movement or noise);
- (b) for the maintenance of ventilation and air-handling systems;
- (c) for natural ventilation systems, apart from natural make-up or relief to mechanical systems (see Note 1);
- (d) for the elimination of condensation;
- (e) for the provision of ventilation to ensure the safe operation of gas appliances; and
- (f) for safety aspects associated with fire and smoke.
- (g) for control of infectious aerosols.

NOTE 1 Requirements for natural ventilation of buildings (including car parks) are covered by AS 1668.4 and the National Construction Code (NCC).

NOTE 2 Road tunnels and other non-building related applications are outside the scope of this document.

NOTE 3 Fire and smoke control aspects of air-handling systems are covered in AS 1668.1.

NOTE 4 Requirements for system design in respect of microbial control are given in AS/NZS 3666.1.

NOTE 5 Air-handling systems should be designed, constructed and installed so that their use does not give rise to a noise or vibration nuisance. For guidance on noise and vibration control, refer to AS 1055.1 and AS 2107.

NOTE 6 Information on thermal comfort conditions is given in ISO 7730 and ASHRAE 55.

NOTE 7 This document covers the design of ventilation systems for industrial processes.

NOTE 8 Requirements for ventilation in relation to the safe operation of gas appliances are covered in AS/NZS 5601.1.

NOTE 9 For further guidance regarding infectious aerosols, refer to ASHRAE 241.

1.2 Application – selection of mechanical ventilation

The following applies to the selection of mechanical ventilation systems:

- (a) For processes or enclosures listed in [Appendix A](#) and similar enclosures, supply ventilation conforming to [Section 2](#) shall be provided. Alternatively, mechanical exhaust air ventilation together with appropriate make-up air may be provided in lieu of supply ventilation, provided the minimum outdoor air quantities are achieved and any adjacent enclosure of different use, as listed in [Appendix B](#), is maintained at a lower pressure at all times.

- (b) For processes or enclosures listed in [Appendix B](#) and similar enclosures, general exhaust conforming to [Section 3](#) shall be provided.

Alternatively, the following may be provided:

- (i) Local exhaust air systems may be used as an alternative to part of, or whole of, the general exhaust ventilation, provided it can be demonstrated they are as effective in the removal of effluent as the required general exhaust system.
 - (ii) For enclosures for which discharges are not deemed objectionable (see [Table 3.4](#)) mechanical supply air ventilation, together with permanently open natural relief air openings, may be provided as an alternative to general exhaust ventilation, provided any adjacent enclosure of different use is maintained at a higher pressure at all times. In such cases, relief air openings shall conform to [Clause 3.10.2](#).
- (c) For processes or enclosures subject to Type A or Type B effluent, as described in [Clause 3.3](#), local exhaust conforming to [Section 3](#) shall be provided.
- (d) For enclosures accommodating automotive vehicles with combustion engines, mechanical supply or mechanical exhaust or both shall be provided as necessary to meet the requirements of [Section 4](#).
- (e) For enclosures used for particular health care functions, ventilation systems shall conform to [Section 5](#).

NOTE Guidance on the selection of ventilation systems is given in [Figure 1.1](#).

C1.2 Enclosures that may need mechanical ventilation are as follows:

- (a) *Enclosures that are not naturally ventilated.*
- (b) *Industrial or other premises where it is essential to remove dust, toxic or noxious contaminants at, or near, their source (see [Section 3](#)).*
- (c) *Health care facilities where it is needed to control infection (e.g. operating theatres), or to control cross-infection [e.g. between isolation wards (see [Section 5](#))].*
- (d) *Spaces where unfavourable external environmental conditions exist (e.g. excessive noise, pollution or dust).*
- (e) *Enclosed car parks, driveways and similar spaces where it is necessary to dilute hazardous gases and fumes (see [Section 4](#)).*
- (f) *Spaces with a high density of continuing occupancy expected (e.g. auditoriums or clubs).*
- (g) *Spaces where high heat and vapour generation is likely [e.g. large commercial kitchens and laundries (see [Section 3](#))].*

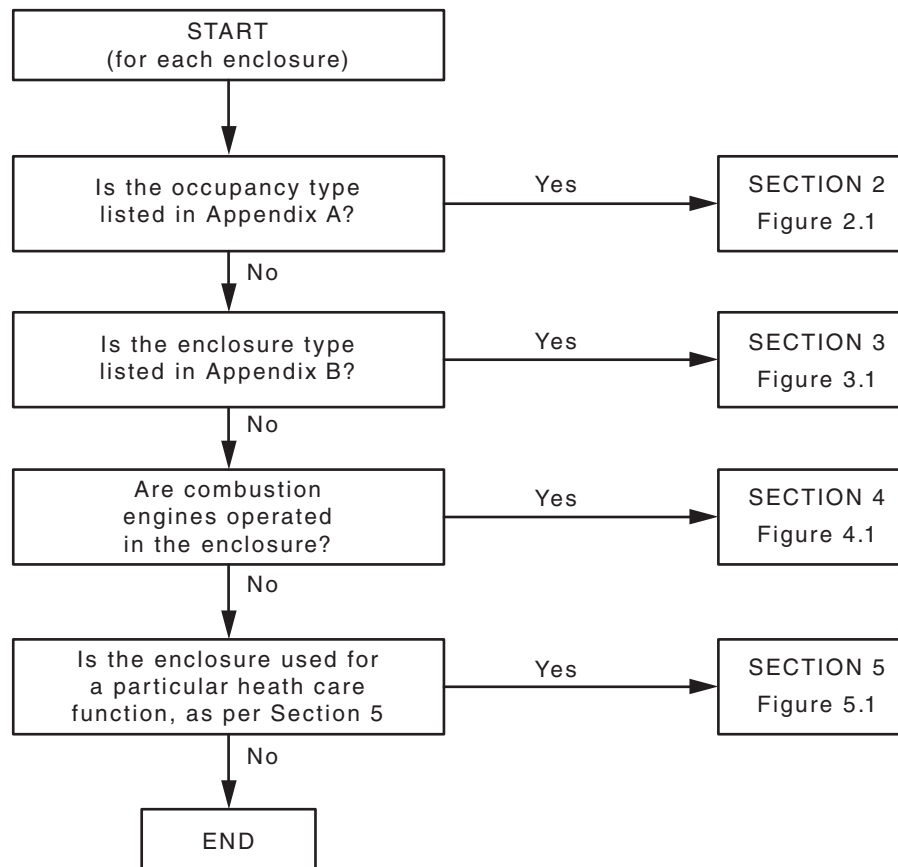


Figure 1.1 — Flow chart for the selection of ventilation systems

1.3 Normative references

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

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

AS 1324.1, *Air filters for use in general ventilation and airconditioning, Part 1: Application, performance and construction*

AS 1530.1, *Methods for fire tests on building materials, components and structures, Part 1: Combustibility test for materials*

AS 1735.1, *Lifts, escalators, and moving walks, Part 1: General requirements*

AS 1807, *Separative devices — Biological and cytotoxic drug safety cabinets, clean workstations and pharmaceutical isolators — Methods of test*

AS 2676.1, *Installation, maintenance, testing and replacement of secondary batteries in buildings, Part 1: Vented cells*

AS 3772, *Pre-engineered fire protection systems for cooking equipment*

AS 4260, *High efficiency particulate air (HEPA) filters - Classification, construction and performance*

AS/NZS 3500.2, *Plumbing and drainage, Part 2: Sanitary plumbing and drainage*

AS/NZS 5601.1, *Gas installations, Part 1: General installations*

AS/NZS 5149.3, *Refrigerating systems and heat pumps — Safety and environmental requirements Installation site (ISO 5149-3:2014, MOD)*

AS ISO 14644-3, *Cleanrooms and associated controlled environments, Part 3: Test methods*

AS/NZS ISO 9972, *Thermal performance of buildings — Determination of air permeability of buildings — Fan pressurization method*

ISO 16890-1, *Air filters for general ventilation — Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)*

ISO 29463-1, *High efficiency filters and filter media for removing particles from air — Part 1: Classification, performance, testing and marking*

ACGIH, *Industrial Ventilation: A Manual of Recommended Practice*

ANSI/ASHRAE Standard 154, *Ventilation for Commercial Cooking Operations*

ASHRAE 52.2, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*

ASTM-F1704, *Standard Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems*

DW-172, *BESA Specification for Kitchen Ventilation Systems*

EN 1822-1, *High efficiency air filters (HEPA and ULPA) — Part 1: Classification, performance testing, marking*

EN 16282-1, *Equipment for commercial kitchens — Components for ventilation in commercial kitchens — Part 1: General requirements including calculation method*

UL 710, *Exhaust Hoods for Commercial Cooking Equipment*

ULC S649, *Standard for grease filters for commercial and institutional*

VDI 2052, *Ventilation equipment for kitchens*

Loss Prevention Standard (LPS) 1263, *Requirements for the LPCB approval and listing of the fire performance of grease filters used in commercial kitchen extract systems*

1.4 Terms and definitions

For the purpose of this document, the definitions given in the NCC and the following apply.

NOTE A representation of selected definitions is shown in [Figure 1.2](#).

1.4.1

accessible

capable of being reached for inspection, maintenance or repairs but does not include the destructive dismantling of structural components

1.4.2

airflow rate

volumetric flow rate of air derived from the mass flow rate by dividing it by the density, normalized to 1.2 kg/m³ (1.2 g/L)

Note 1 to entry: For buildings located at an altitude substantially differing from sea level, specified airflow rates should be adjusted to achieve the equivalent mass flow rate.

1.4.3**air-handling plant**

component part of an air-handling system that includes equipment that provides air movement, as well as equipment for the purpose of controlling the direction, rate of airflow, division of airflow and condition of air

1.4.4**air-handling system**

system for the purpose of directing air in a controlled manner to or from specific enclosures or parts of enclosures by means of air-handling plant, ducts, plenums, and air-distribution devices, which include industrial ventilation for the removal of Type A effluents

Note 1 to entry: See [Clause 3.3.1\(a\)](#) for Type A effluents.

1.4.5**airlock**

room or compartment provided to disconnect a sanitary compartment or other enclosure from another room or space in the building

1.4.6**air outlet**

opening through which air is delivered to an enclosure by an air-handling system of a building

1.4.7**duct**

component part of an air-handling system that is intended for the passage of air from one part of an air-handling system to another

Note 1 to entry: See also [Clause 1.4.31](#).

1.4.8**effective outdoor airflow**

sum of introduced outdoor air, residual effective outdoor air recycled from the enclosure(s), air-cleaning device effective outdoor air and transferred effective outdoor air

1.4.9**enclosure**

individual room, space or part thereof

1.4.10**exhaust air**

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

1.4.11**exhaust air intake**

opening through which air is extracted from an enclosure by an air-handling system

1.4.12**exhaust discharge**

outlet from an air-handling system discharging exhaust air to atmosphere

1.4.13**exposure limit****EL**

for occupational exposure, values designated by NOHSC. For community exposure, values based on standards and goals set by NHMRC and NEPC

Note 1 to entry: NOHSC (National Occupational Health and Safety Commission; NHMRC (National Health and Medical Research Council); NEPC (National Environment Protection Council).

1.4.14**general exhaust ventilation**

ventilation of an enclosure by the extraction of air from that enclosure, thereby allowing contaminants to be diluted by supply air or make-up air, the mixture being collected at exhaust air intakes and discharged to atmosphere

1.4.15**general contaminants**

contaminants that are generated by occupants, the building or devices and found within most buildings

Note 1 to entry: Examples of general contaminants include body odours, volatile organic compounds, and the like.

1.4.16**grease removal device**

device that removes grease from the airstream

1.4.17**hood**

component part of a local exhaust system intended for collecting effluent

1.4.18**indoor air**

air inside the enclosure under consideration

1.4.19**infiltration air**

air (other than supply air and make-up air) that enters an enclosure or an air-handling system in an uncontrolled manner

1.4.20**introduced outdoor airflow**

air introduced to an air-handling system via an outdoor air intake

1.4.21**leakage air**

air (other than exhaust air return air and relief air) that escapes from an air-handling system or enclosure in an uncontrolled manner

1.4.22**local air**

enclosure air that passes through a local air-cleaning unit and returns to the same enclosure

1.4.23**local exhaust**

extraction of objectionable or hazardous effluent close to the source and discharging to atmosphere

1.4.24**make-up air**

air that enters an enclosure or an air-handling system in a controlled manner but not by direct mechanical means

1.4.25**may**

indicates the existence of an option

1.4.26**occupied enclosure**

enclosure within a building that is intended to be occupied by any individual for 30 minutes or more per day

1.4.27**occupied zone**

region within an occupied enclosure between planes 75 mm and 1 800 mm above the floor and more than 600 mm from the walls or fixed air-handling equipment

1.4.28**outdoor air**

air outside the building

1.4.29**outdoor air intake**

opening through which outdoor air is admitted to an air-handling system of a building

1.4.30**plant room**

room that contains any items of plant or machinery

1.4.31**plenum**

air compartment or chamber intended for the passage of air, to which one or more ducts may be connected and which forms part of an air-handling system

1.4.32**privacy lock**

room or compartment whose function is to provide a visual or acoustic barrier, and not provided to disconnect a sanitary compartment from another room or space through which persons pass to enter the sanitary compartment

1.4.33**property boundary**

boundary between the block of land on which the building in question is constructed and any adjacent building blocks

Note 1 to entry: The term "property boundary" does not include Strata Title boundaries, Community Title boundaries or similar boundaries.

1.4.34**recycle air**

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

1.4.35**relief air**

air that leaves an enclosure in a controlled manner by other than direct mechanical means

1.4.36**residual effective outdoor airflow**

proportion of effective outdoor airflow that is in excess to the requirements of an enclosure that is recycled back to the air-handling system

1.4.37**return air**

air removed from an enclosure by mechanical means

Note 1 to entry: All of the return air may be expelled as spill air, or all or part of it may be recycled (see [Figure 1.2](#)).

1.4.38**shall**

indicates that a statement is mandatory

1.4.39**should**

indicates a recommendation

1.4.40**specific contaminants**

contaminants that are generated by occupants, the building or devices other than those generally found within most buildings

Note 1 to entry: Examples of specific contaminants include fumes from unflued gas devices, incense, scented candles, indoor pyrotechnics, and sparklers, etc.

1.4.41**spill air**

portion of return air that is not recycled

1.4.42**supply air**

air introduced into an enclosure by mechanical means

1.4.43**transfer air**

air that transfers between enclosures in an uncontrolled but predictable manner

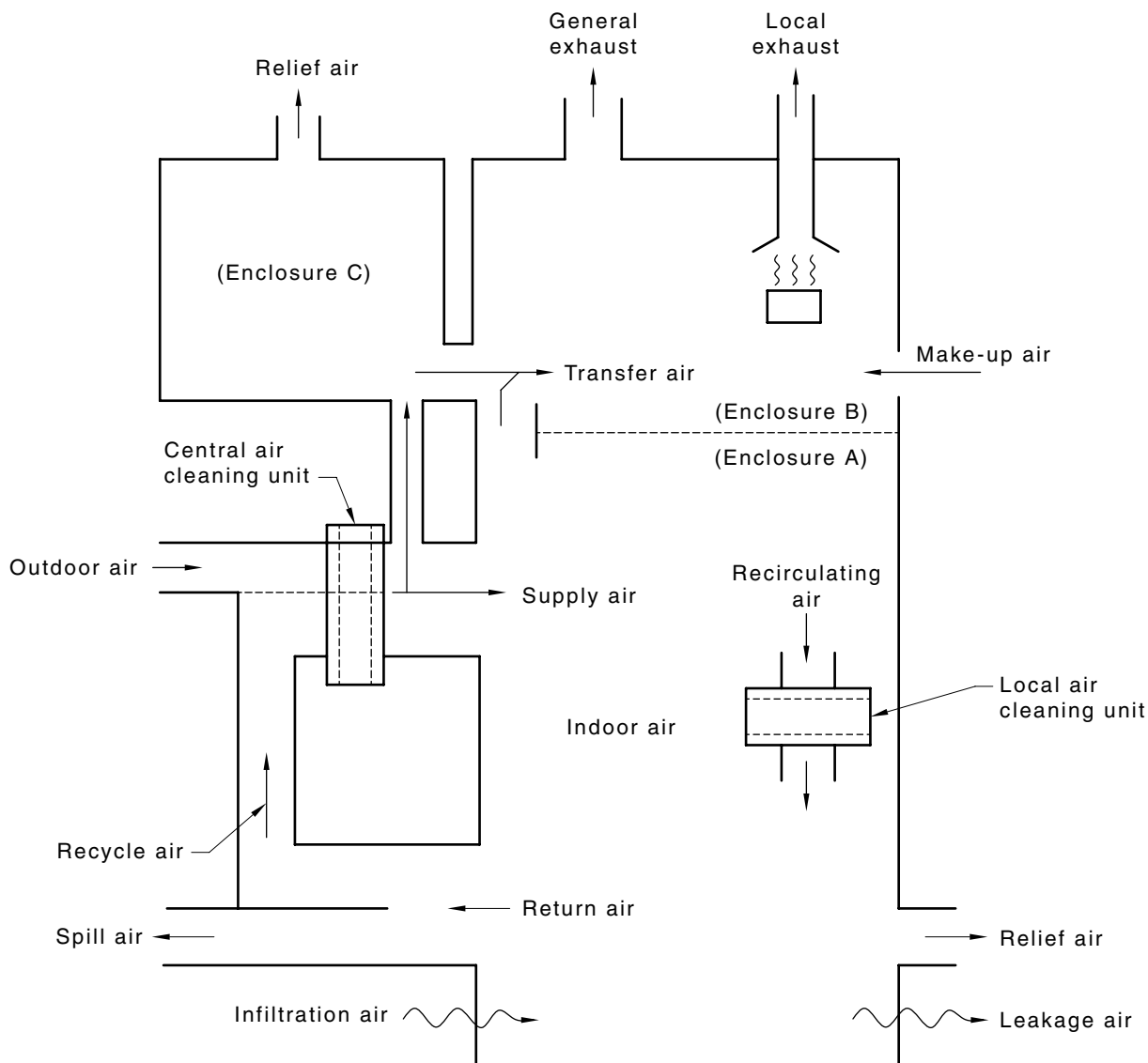


Figure 1.2 — Representation of selected definitions

1.5 Combination ventilation systems

Mechanical ventilation systems serving enclosures or parts of enclosures shall be arranged so that their operation does not interfere with any natural ventilation systems serving remaining parts of the enclosure or other enclosures. An enclosure that is only provided with devices for the improvement of air movement within that enclosure shall be considered as being naturally ventilated.

NOTE Ventilation systems may be combined to meet the requirements of this document.

C1.5 Possible combinations of ventilation systems include the following:

- (a) Mechanical supply with mechanical exhaust.
- (b) Mechanical supply with natural relief.
- (c) Natural make-up air with mechanical exhaust.

1.6 Residual ventilation

Residual ventilation (i.e. transfer air) may be used for areas of low or transient occupancy such as corridors or similar. Residual ventilation may be incorporated into the calculations of effective outdoor airflow rate.

NOTE For determination of residual effective outdoor airflows, see [Clause D.4](#).

1.7 System operation

Ventilation systems that are not designed to operate continuously shall be designed to be operable to suit the building occupancy.

Section 2 Mechanical ventilation — supply systems

2.1 Scope

Mechanical supply ventilation systems shall be designed and installed in accordance with the requirements of this Section.

NOTE 1 A flow chart on the application of this Section is shown in [Figure 2.1](#).

NOTE 2 For guidance on a performance-oriented approach to mechanical ventilation design, see [Appendix E](#).

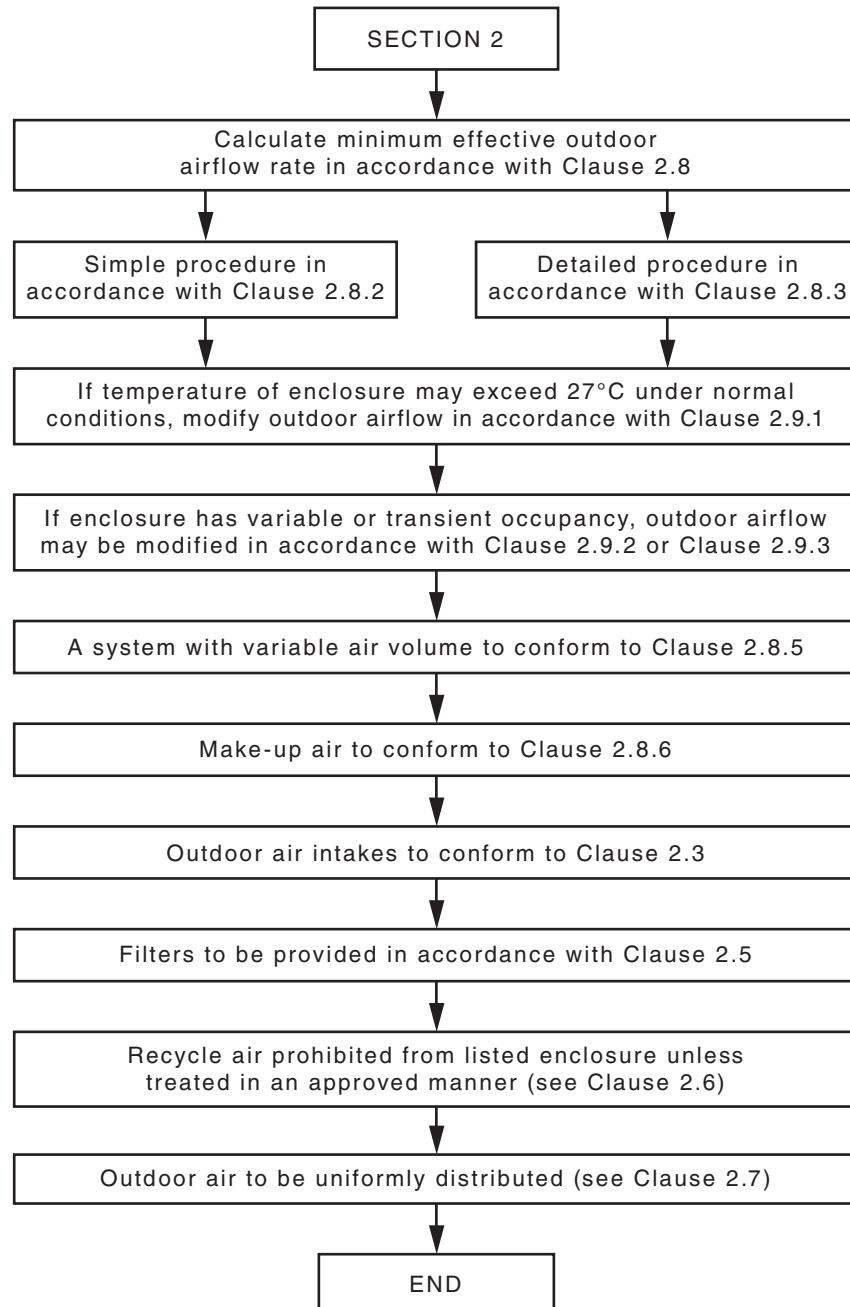


Figure 2.1 — Flow chart on the application of [Section 2](#)

2.2 Notation

2.2.1 Symbols

The following symbols are used in this Section:

A	=	the area of the enclosure, in square metres
M	=	multiple enclosure factor
n	=	the occupancy for the enclosure served, as defined in Clause 2.2.2
N	=	the occupancy, for all enclosures served by the air-handling system in accordance with Clause 2.2.2
Q_f	=	the flow rate of introduced outdoor air to the system, in litres per second
Q_r	=	the flow rate of return air drawn from all enclosures served by an air-handling system to be used as recycle air, in litres per second
Q_s	=	the flow rate of supply air to all enclosures served by an air-handling system, in litres per second
q_f	=	the minimum introduced outdoor airflow rate utilizing the values given in Appendix A for effective outdoor air, in litres per second per metre squared of the floor area or litres per second per person
$q_{\min}$	=	the minimum effective outdoor airflow rate
q_s	=	the flow rate of supply air to the enclosure, in litres per second
R	=	the ratio of the sum of required effective outdoor airflow rates for all enclosures served to the total supply air for all enclosures served
r	=	the ratio of supply air to required introduced outdoor air for each enclosure
r_c	=	the highest ratio, for any of the enclosures served, of effective outdoor airflow required by Clause 2.8.5 to the corresponding supply air

2.2.2 Occupancy

The occupancy (n) of enclosures shall be nominated for the purposes of ventilation system design.

The occupancy of an enclosure shall be the greater of —

- (a) the maximum number of occupants present in the enclosure for any period exceeding 30 min; or
- (b) one-third of the maximum number of occupants present in the enclosure at any time.

Where the occupants of a group of enclosures, served by a single air-handling system, move between those enclosures, it is not necessary to treat the total occupancy as the sum of the maximum occupancies of each enclosure (Σn), rather, the distribution of occupants that gives the highest required outdoor airflow rate shall be used (N).

C2.2.2 In the absence of other information, the number of occupants should be not less than that estimated on the basis of floor area per person. See [Table A.1](#), Footnote ^a, for occupant density.

The occupancy values given in [Appendix A](#) are conservative and it is recommended that actual values be nominated for design purposes. In some cases, the occupancies used for the purposes of determination

(continued)

of outdoor airflow rates may differ in aggregate for a given floor from those used for egress provisions in the NCC. This can arise as a result of the use of the maximum occupancy for each area with no account taken of movement of people from one area to another at different times during the period of occupancy. An example would be a conference room used substantially by the occupants of adjacent areas on the same floor.

2.3 Outdoor air intakes

2.3.1 Location

Intakes for outdoor air shall be located such that the separation distance is not less than the distance given in [Table 2.1](#), except that where the dimensions of the property make this impossible, then the greatest possible distance applies.

Table 2.1 — Separation distances between intakes and discharges

Discharge	Minimum separation distance
Exhaust system ^a	See Section 3 ^b
Cooling towers	10 m ^c
Gas Flues	6 m ^b
Sewer vents	6 m ^b
Fixed diesel engine tail pipe exhaust	6 m ^b
^a These distances only apply to mechanical ventilation systems required to operate concurrently. ^b This distance is determined using the shortest path between the intake and discharge (i.e. as measured by stringline). ^c This distance is measured horizontally.	

C2.3.1 *This document assumes that the outdoor air is generally acceptable for the purposes of dilution ventilation. Where it has been established that the outdoor air is not acceptable, pre-treatment of the outdoor air may be needed.*

For guidance on acceptable contaminant concentrations in outdoor areas, see [Appendix C](#).

The ASHRAE Handbook — Fundamentals addresses airflow around buildings, dispersion of building exhaust gases and design to minimize re-entry. Particularly critical cases may warrant wind tunnel testing of models.

Intakes for outdoor air should be located and arranged so that under all conditions of normal operation —

- (a) *contamination from air exhausts, cooling tower discharges, gas flues, work processes, generators, fire pumps and other sources of pollution do not reduce the quality of outdoor air entering the intake to a level significantly below that of outdoor air in the locality, except where outdoor air entering the intake is treated to achieve the same effect; and*
- (b) *the effects of wind, adjacent structures and other factors do not cause the flow rate of outdoor air to be reduced below the minimum requirements of this Section.*

2.3.2 Passage of air

2.3.2.1 General

Outdoor air shall pass to the air-handling plant directly through a duct, plenum or plant room connected to the intake.

Enclosures used for storage of equipment, plant or materials likely to contaminate the air shall not be used as a plenum.

NOTE A plant room housing equipment or materials that do not contaminate the air may act as a plenum.

2.3.2.2 Warning label

The door to a room used as a plenum for the intake of outdoor air shall have a visible warning label fixed to the door with the following text:

OUTDOOR AIR PLENUM NO STORAGE PERMITTED

Lettering on labels shall be not less than 20 mm high and be in a colour directly contrasting to that of the background.

2.4 Tundishes and floor wastes

A duct or plenum shall not contain a tundish or floor waste that is not —

- (a) Permanently charged by means other than solely by condensate; or
- (b) Disconnected from sanitary plumbing or stormwater system via an air break outside the duct or plenum.

The installation of tundishes and floor wastes shall conform to AS/NZS 3500.2.

2.5 Filtration

Any individual mechanical supply air ventilation system incorporating heating/cooling coils, heat exchangers or humidifiers shall incorporate an air filter rated to ISO 16890-1, ASHRAE 52.2 or AS 1324.1, and in accordance with [Table 2.2](#). Such filters shall be positioned before supply air fans and any coils or humidifiers. Both the outdoor and recycle air shall be filtered as applicable.

NOTE This requirement does not preclude the use of additional filters in other parts of the air-handling system. Filters shall be accessible.

C2.5 Filters can assist in the following:

- (a) *The removal of particulate contaminants from the air.*
- (b) *The reduction of energy consumption through the reduction of dirt build-up on heat transfer equipment.*
- (c) *The maintenance of design airflows and aerodynamic performance of system through the reduction of dirt build-up.*
- (d) *The maintenance of the accurate response of control system components.*
- (e) *The prevention of the malfunction of fire control equipment due to dust build-up reducing the ability of a system to respond to a fire event.*

Refer to AS/NZS 3666.1 for access provisions.

(continued)

Table 2.2 — Minimum filter rating

System characteristics	Minimum ISO 16890-1 rating	Minimum ASHRAE 52.2 MERV "A" rating	Minimum AS 1324.1 Class
≥ 1 000 L/s ducted	ISO Coarse > 65 %	MERV 7	G4
≥ 1 000 L/s non-ducted	ISO Coarse > 65 %	MERV 7	G4
< 1 000 L/s ducted	ISO Coarse > 35 %	MERV 4	G2
< 1 000 L/s non-ducted	NR	NR	NR
Evaporative coolers	NR	NR	NR

NR no requirement

NOTE 1: An ASHRAE 52.2 MERV "A" rating includes the (otherwise optional) test specimen pre-conditioning step of ASHRAE 52.2, Appendix J.

NOTE 2: The AS 1324.1 classes are not equivalent classifications to ISO and ASHRAE ratings, however they are included to align with the previous edition of this document.

2.6 Prohibition of recycle air

Air-handling systems serving more than one enclosure shall not recycle air to dissimilar occupancies from any of the following enclosures:

- (a) Any enclosure listed in [Appendix B](#).
- (b) Any enclosure used by vehicles with internal combustion engines.
- (c) Any enclosure listed in [Clause 5.2](#).
- (d) Any enclosure of the following types:
 - (i) Equipment and store enclosures holding materials generating odours or noxious gases.
 - (ii) Animal enclosures, pet shops, veterinary centres, kennels.
 - (iii) Swimming pools, deck and pool and ancillary areas.
 - (iv) Embalming enclosures, autopsy enclosures.
 - (v) Warehouses for products that give off odours or noxious gases (e.g. particleboard products such as formaldehyde).
- (e) Any enclosure required to be ventilated by a local exhaust ventilation system.
- (f) Any enclosure that contains specific contaminants.

NOTE Similar occupancies may be served by common recirculation systems.

2.7 Outdoor air mixing and distribution

Ventilation devices, including those used to mix and distribute outdoor air, shall be located such that the maximum distance between any part of the enclosure and a ventilation device are the greater of —

- (a) the requirement listed in [Table 2.3](#);
- (b) twice the height of the enclosure; or

- (c) 10 m from the point where the terminal velocity generated by a ventilation device drops below 0.2 m/s.

Table 2.3 — Ventilation device distribution

Enclosure	Maximum distance between any part of the enclosure and a ventilation device
Corridors	10 m
Lobbies	10 m
Halls and auditoriums	10 m with ceiling heights up to 4 m 20 m for ceiling heights above 4 m
Offices	10 m
Classroom	10 m
Theatres	10 m
Concourse	20 m with ceiling heights up to 4 m 30 m for ceiling heights above 4 m
Sports playing floors	10 m with ceiling heights up to 4 m 20 m for ceiling heights above 4 m
Sales floor or showrooms	10 m
Malls	10 m
Warehouses	20 m with ceiling heights up to 4m 30 m for ceiling heights above 4 m
NOTE 1 Distances are taken as the shortest physical air path measured in plan.	
NOTE 2 Table 2.3 is not an exhaustive list and is considered to extend to enclosures of similar use.	

C2.7 As it is not possible to measure the proportion of effective outdoor air and its distribution in the air supply duct, the requirements of this Clause will be satisfied if the system design provides for minimum outdoor air to be carried at all times by the supply ducts from the air-handling plant to all enclosures and sufficient mixing of outdoor air with the recycle air in the air-handling plant to supply all enclosures with air of about the same ratio of outdoor to recycle air.

It may be practicable to express the aim of this Clause in a particular enclosure by the introduction of ventilation air in a limited number of places, provided that the airflow in the enclosure is adequately arranged.

The effects of partitioning

The partitioning of floor areas (for example, during refurbishments) can affect the performance of the ventilation system. These problems can occur if partitioned offices are installed in areas with ventilation systems designed for open plan floor space and no review of the ventilation system is undertaken. The review may indicate a need to provide additional transfer grilles (in doors or walls) or additional supply/return air grilles in partitioned offices if these have been left with no local return grilles. If these alterations are not carried out, the ventilation effectiveness of the existing system may be reduced.

Even small-scale alterations to layouts can cause problems if partitions or walls are placed in locations that impede the flow of air. Other obstructions to airflow, such as large arrays of demountable panels and bookshelves, can reduce ventilation effectiveness, even in an open plan office.

2.8 Outdoor airflow rates

2.8.1 General

Ventilation shall be provided in accordance with one of the following methods:

- (a) The simple procedure provided in [Clause 2.8.2](#);
- (b) The detailed procedure provided in [Clause 2.8.3](#); or
- (c) Ventilation borrowed in accordance with [Clause 2.8.4](#).

C2.8.1 *The simple procedure is limited in its application and is less complex but will potentially result in higher outdoor airflow rates for systems serving multiple enclosures. It does not account for transfer air or unused recirculated outdoor air and only allows limited reductions of minimum outdoor air rates for a specified particulate air cleaning efficiency. The detailed procedure is more comprehensive and complex in its application and allows for the full range of strategies to create effective outdoor air including from transfer air, unused outdoor air in the recirculation airstream and from the application of a range of particulate and odour cleaning strategies and efficiencies. The borrowed ventilation procedure allows ventilation air to be borrowed from adjoining mechanically ventilated enclosures under specific circumstances.*

2.8.2 Simple procedure

2.8.2.1 Single enclosure system

For a single enclosure system, the minimum amount of introduced outdoor air required for the system (Q_f) shall be calculated in L/s as the greater of —

$$(a) \quad Q_f = n \times q_f \quad 2.8.2.1(1)$$

q_f shall be taken as the minimum outdoor airflow rate in L/s.person listed in [Table A.1](#);

$$(b) \quad Q_f = A \times q_f \quad 2.8.2.1(2)$$

q_f shall be taken as the minimum outdoor airflow rate in L/s.m² floor area listed in [Table A.1](#);
or

$$(c) \quad Q_f = A \times 0.35 \text{ L/s.m}^2 \quad 2.8.2.1(3)$$

2.8.2.2 Multiple enclosure system

The minimum introduced outdoor airflow rate shall be provided to each enclosure(s) served by a ventilation system. For each enclosure served, calculate —

$$(a) \quad r = A \times q_f / q_s \quad 2.8.2.2(1)$$

q_f shall be taken as either the area-based (L/s.m² floor) minimum introduced outdoor airflow rate for the enclosure provided in [Table A.1](#) or 0.35 L/s.m², whichever is the greater; and

$$(b) \quad r = n \times q_f / q_s \quad 2.8.2.2(2)$$

q_f shall be taken as the occupant-based (L/s.person) minimum introduced outdoor airflow rate for the enclosure provided in [Table A.1](#).

For the ventilation system, calculate the total introduced outdoor air flowrate—

$$(i) \quad Q_f = r_c \times Q_s \quad 2.8.2.2(3)$$

r_c shall be taken as the highest r calculated in (a) and (b) above.

2.8.2.3 Outdoor air reductions

Where the enclosure ventilation is occupancy based (only where q_f is listed in [Appendix A](#) as L/s. person), the minimum introduced outdoor airflow rate as calculated in [Clause 2.8.2.1](#) or [Clause 2.8.2.2](#) may be reduced by 25 % for each enclosure where —

- (a) at least 50 % of the supply air is recirculated; and
- (b) all recirculated air passes through a particulate filter with a minimum efficiency of ISO ePM2.5 > 50 %.

2.8.3 Detailed procedure

2.8.3.1 General

The minimum effective outdoor airflow rate required by [Appendix A](#) shall be provided to each enclosure(s) served by a ventilation system. This may be achieved by —

- (a) bringing in outdoor air directly into the system (with minimum quantities in accordance with [Clause 2.8.2](#));
- (b) using residual outdoor air in recycle or transfer airstreams;
- (c) using air-cleaning devices to provide an equivalent outdoor air effect; or
- (d) by a combination of all of the above.

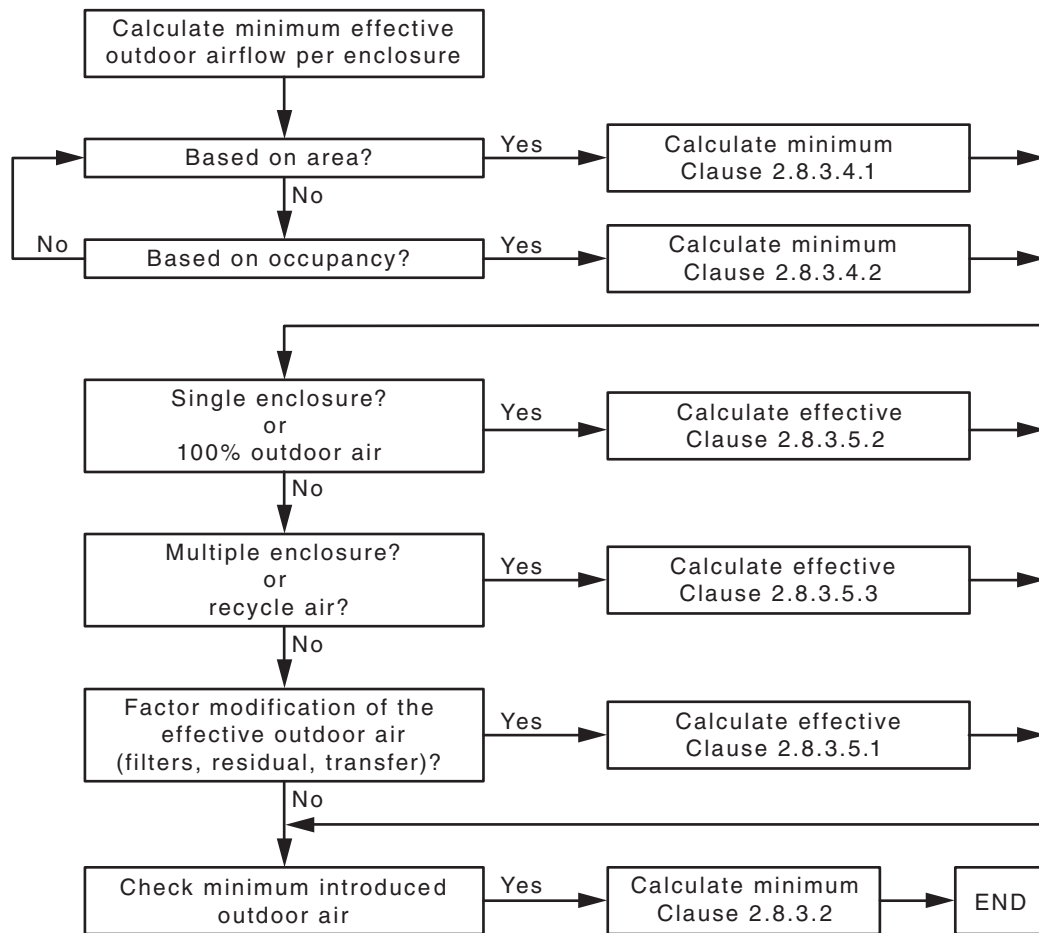


Figure 2.2 — Flow chart on the application on [Section 2.8](#)

2.8.3.2 Minimum required introduced outdoor airflow rate

Where the minimum amount of introduced outdoor air is nominated in [Table A.1](#) as L/s.person, the outdoor air required for the system (Q_f) shall be calculated as the greater of the area-based minimum and the occupancy-based minimum as follows:

- (a) Area-based minimum:

$$Q_f = A \times 0.35 \text{ L/s.m}^2. \quad 2.8.3.2(1)$$

- (b) Occupancy-based minimum:

$$Q_f = n \times q_f \quad 2.8.3.2(2)$$

where the system provides 100 % outdoor air or filtration in accordance with [Appendix D](#) is not proposed for a single enclosure system;

or

$$Q_f = \sum (n \times q_f) \times M \quad 2.8.3.2(3)$$

where the system provides 100 % outdoor air or filtration in accordance with [Appendix D](#) is not proposed for a multiple enclosure system;

or

$$Q_f = n \times 0.75 \times q_f \quad 2.8.3.2(4)$$

where only particulate filtration in accordance with [Appendix D](#) is proposed for a single enclosure system;

or

$$Q_f = \sum (n \times 0.75 \times q_f) \times M \quad 2.8.3.2(5)$$

where only particulate filtration in accordance with [Appendix D](#) is proposed for a multiple enclosure system;

or

$$Q_f = n \times 0.25 \times q_f \quad 2.8.3.2(6)$$

where particulate filtration and odour treatment in accordance with [Appendix D](#) are proposed for a single enclosure system;

or

$$Q_f = \sum (n \times 0.25 \times q_f) \times M \quad 2.8.3.2(7)$$

where particulate filtration and odour treatment in accordance with [Appendix D](#) are proposed for a multiple enclosure system.

NOTE The application of the above procedure is not appropriate for enclosures listed in [Table A.1](#) where the outdoor airflow rate is nominated as L/s.m².

2.8.3.3 Minimum required effective outdoor airflow rate

The minimum required effective outdoor airflow rate provided by a mechanical ventilation system to each served enclosure shall conform to [Clauses 2.8.3.4](#) to [2.8.3.5](#).

The minimum effective outdoor airflow required for each enclosure shall be calculated on the basis of either the area of the enclosure ([Clause 2.8.3.4.1](#)) or the number of occupants in that enclosure ([Clause 2.8.3.4.2](#)) as required by [Appendix A](#).

NOTE The minimum effective outdoor airflow supplied to an enclosure may be calculated for simple systems in accordance with [Clause 2.8.3.5.2](#) and [Clause 2.8.3.5.3](#) and for more complex systems that incorporate features such as transfer air, local air cleaning or central air cleaning in accordance with [Clause 2.8.3.5.4](#).

2.8.3.4 Minimum effective outdoor air

2.8.3.4.1 Based on area of the enclosure

For an enclosure where the minimum outdoor airflow rate in [Appendix A](#) is based on the area of the enclosure (litres per second per square metre (L/s.m²) of floor area), the minimum effective outdoor airflow rate ($q_{\min}$) shall be as follows:

$$q_{\min} = q_f A \quad 2.8.3.4.1$$

where

q_f = the minimum effective outdoor airflow rate given in [Appendix A](#), in litres per second per square metre of the floor area

A = the area of the enclosure, in square metres

2.8.3.4.2 Based on the number of occupants in the enclosure

For an enclosure where the minimum outdoor airflow rate in accordance with [Appendix A](#) is based on the number of occupants (litres per second per person), the minimum effective outdoor airflow rate ($q_{\min}$) shall be as follows:

$$q_{\min} = q_f N \quad 2.8.3.4.2$$

where

q_f = the minimum effective outdoor airflow rate given in [Appendix A](#), in litres per second per person

N = the occupancy, in accordance with [Clause 2.2.2](#)

2.8.3.5 Calculation of effective outdoor airflow rate

2.8.3.5.1 General

The effective outdoor airflow rate shall be in accordance with [Clauses 2.8.3.5.2](#), [2.8.3.5.3](#) or [2.8.3.5.4](#) as applicable.

2.8.3.5.2 Air-handling system serving a single enclosure or providing 100 % outdoor air

For an air-handling system serving a single enclosure or supplying 100 % outdoor air with no additional factors that might modify the quantity of effective outdoor airflow, the effective outdoor airflow rate shall be equal to the outdoor air component of the supply airflow rate. For these systems the minimum introduced outdoor airflow rate (Q_f) shall be the sum of the required minimum effective outdoor airflow rates for all enclosures served, as follows:

$$Q_f \geq \sum q_{\min} \quad 2.8.3.5.2$$

2.8.3.5.3 Air-handling system supplying air to multiple enclosures

For an air-handling system supplying air to multiple enclosures with recycle air, the effective outdoor airflow rate may be different to the introduced outdoor air component of the supply airflow rate. If there are no additional factors that might modify the quantity of effective outdoor airflow, the minimum introduced outdoor airflow rate (Q_f) shall be the sum of the required minimum effective outdoor airflow rates ($\sum q_{\min}$) for all enclosures served multiplied by the multiple enclosure factor (M), as follows:

$$Q_f \geq M \sum q_{\min} \quad 2.8.3.5.3$$

where

M = the multiple enclosure factor

$$= \frac{1}{(1 + R - r_c)}$$

R = the ratio of the sum of required effective outdoor airflow rates for all enclosures served to the total supply air for all enclosures served

$$= \frac{\sum q_{\min}}{\sum q_s}$$

$$r_c = \text{the highest ratio, for any of the enclosures served, of effective outdoor airflow required by [Clauses 2.8.4](#) to the corresponding supply air}$$

$$= \max \frac{(q_{\min})}{(q_s)}$$

2.8.3.5.4 Air-handling system that includes factors that might modify the quantity of effective outdoor air

For an air-handling system where there are factors that might modify the quantity of effective outdoor air, the minimum introduced outdoor airflow rate (Q_f) shall be that required to satisfy the minimum required effective outdoor airflow determined by [Clause 2.8.3.4](#) to all enclosures, calculated using ventilation airflow analysis in accordance with [Appendix D](#).

2.8.4 Borrowed ventilation for secondary enclosures

Ventilating a secondary enclosure with borrowed ventilation from a primary enclosure shall be subject to all of the following:

- (a) The primary enclosure provides borrowed ventilation to the secondary enclosure.
- (b) The primary enclosure is not listed in [Clause 2.6](#).
- (c) The primary enclosure is provided with outdoor air at least equal to the minimum effective outdoor air that is required for the primary and secondary enclosures.
- (d) The secondary enclosure receives borrowed ventilation from the primary enclosure.
- (e) The secondary enclosure is not an occupied enclosure.
- (f) For secondary enclosures with a plan area larger than 10 m² the maximum occupant density is less than 1 person per 10 m².
- (g) The sum of all internal openable ventilation openings provided between the primary and secondary enclosures has a minimum free area of at least 10 % of the floor area of the secondary enclosure.
- (h) All parts of the secondary enclosure are within 7 m of the opening between the enclosures.

When the multiple enclosure factor calculation is being applied, the primary and secondary enclosures shall be considered as a single enclosure.

NOTE Secondary enclosures that are not ventilated in accordance with [Clauses 2.8.2](#) and [2.8.3](#) can be ventilated with borrowed ventilation.

C2.8.4 Secondary enclosures that may utilize the borrowed ventilation provisions include storerooms, cool rooms, utility rooms, equipment rooms, saunas, fire isolated exits used during normal building operation etc but would not include habitable rooms (as defined by the NCC).

2.8.5 Variable air volume systems

For a system with a variable supply airflow rate, provision shall be made to ensure that the minimum effective outdoor airflow rate conforms to [Clauses 2.8.1](#), under all operating conditions.

Groups of enclosures used for a similar purpose and subject to the same density of occupancy and pro rata rate of supply air, such as general office space, may be regarded as a single enclosure.

NOTE A suitable provision may include demand control ventilation.

C2.8.5 One way of satisfying the requirements of this Clause is to introduce sufficient outdoor air into the air-handling plant. In this case, the outdoor air content in the air supplied by the air-handling plant is determined by the use of the highest ratio of outdoor air to total supply air for any enclosure, applied to the total of air supplied to all enclosures. This solution satisfies this document but may not be economical since all enclosures with lower ratios are oversupplied with outdoor air.

The calculations in this Section are based on the fact that air returned from enclosures oversupplied with outdoor air still has some potential to dilute pollutants to satisfactory levels when introduced into the supply duct from the air-handling plant to enclosures. It should be evident that further economies can be achieved by the grouping of enclosures with like ratios of outdoor air to total air on the same air-handling plant. This solution may not be possible or appropriate in many cases for a variety of reasons.

Under certain circumstances, variable air volume systems are known to reduce the amount of effective outdoor air supplied to an enclosure via the supply air systems and, as such, these systems require further assessment of introduced outdoor airflow rates filtration and possibly lead/lag provisions. Areas such as meeting rooms may require a dedicated outdoor air supply.

2.8.6 Make-up air requirement

For a system serving enclosures from which make-up air for general or local exhaust is drawn, the outdoor air shall be in accordance with [Clause 3.8](#).

2.9 Outdoor airflow adjustment

2.9.1 Systems serving enclosures in which the temperature may exceed 27 °C under normal operation

During periods of normal operation when the temperature in the enclosure is expected to exceed 27 °C, the introduced outdoor airflow rate shall be increased to a minimum of 15 L/s.person.

C2.9.1 It is well recognized that additional body odour is generated at elevated temperatures and/or that the perception of body odours is enhanced under these conditions. Where temperatures in excess of 27 °C occur under normal operation, the introduced outdoor airflow rates will need to be adjusted upwards to compensate for increase in body odour generation or perception by occupants. Otherwise appropriate odour filtration should be provided to achieve the same resulting effective outdoor airflow.

Where necessary, adjustment may be controlled manually or automatically.

2.9.2 Systems serving enclosures with transient or variable occupancy

Where specific contaminants that require the provision of general or local exhaust systems continue to be generated in the enclosures during unoccupied periods, the increase in introduced outdoor airflow shall lead the increase in occupancy by a time not less than that shown in [Figure 2.4](#).

NOTE Rationale for lag or lead time for transient occupancies is provided in [Appendix G](#).

During periods of reduced occupancy, the introduced outdoor airflow rate may be adjusted to the flow rate in response to the actual occupancy.

When contaminants are generated independent of occupants or their activities and the contaminants do not present a short-term health hazard, air-handling systems may be shut off during unoccupied periods.

When contaminants, other than those associated with occupants, are dissipated by natural means during unoccupied periods, the increase in outdoor airflow rate may lag behind the increase in occupancy provided the following conditions are met:

- (a) The lag time between increases in occupancy and the adjustment does not exceed that determined in [Figure 2.3](#).
- (b) If the adjustment is subject to manual control, the control is operable from the enclosure with the largest occupancy load.
- (c) If the adjustment is subject to automatic control, means to be provided to manually override the automatic control.
- (d) The means of adjustment and of control of adjustment to ensure that contaminants do not exceed acceptable levels during occupied periods.

C2.9.2 *Although a system may be turned off during periods of non-occupancy, a period of post-purging by natural or mechanical means may be needed after departure of occupants to clear pollutants generated by the occupants. Also a period of pre-purging may be required before entry of occupants to clear accumulation of pollutants generated by furnishings, other materials, and the like, within the space.*

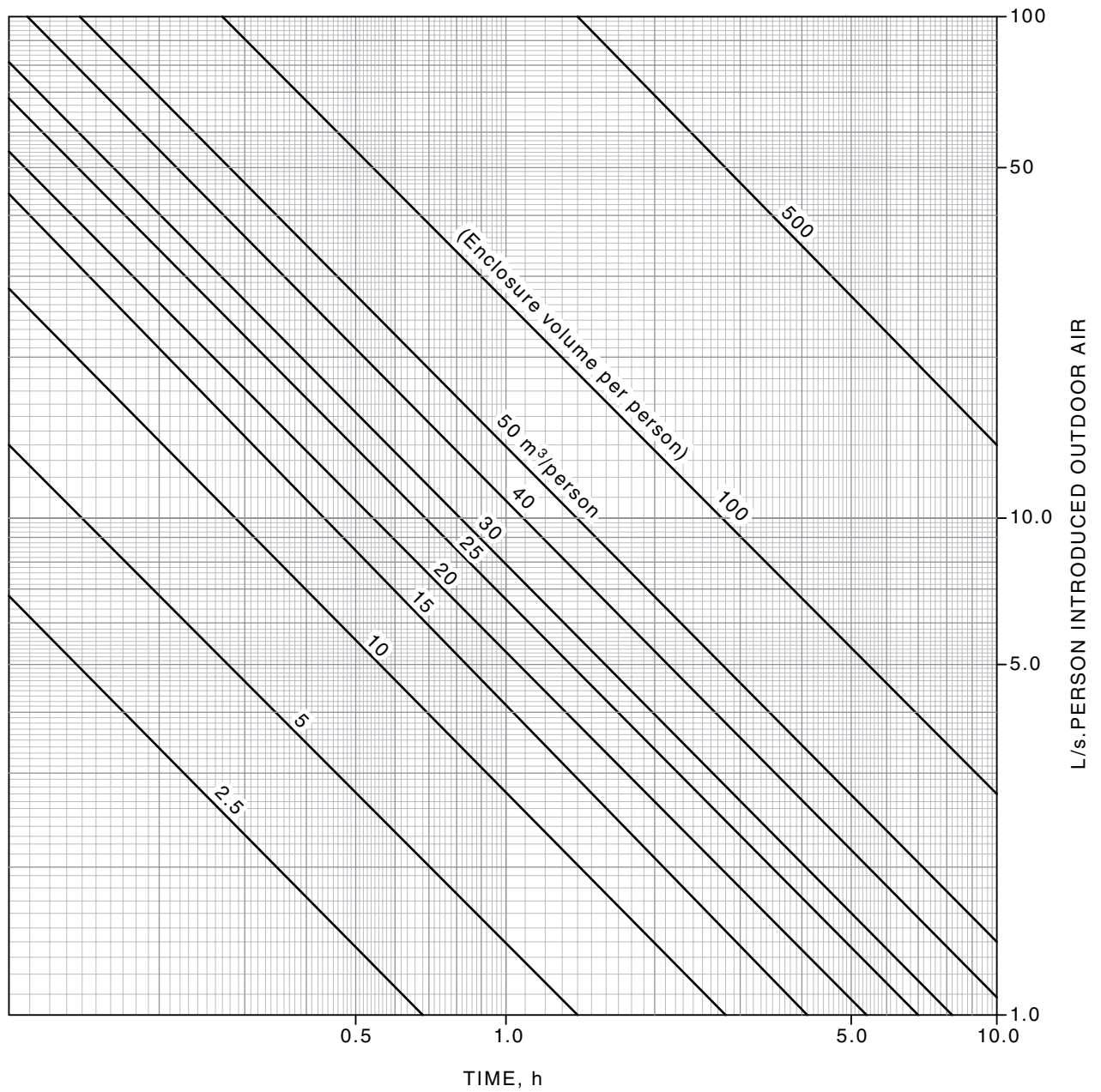


Figure 2.3 — Permissible lag time — hours

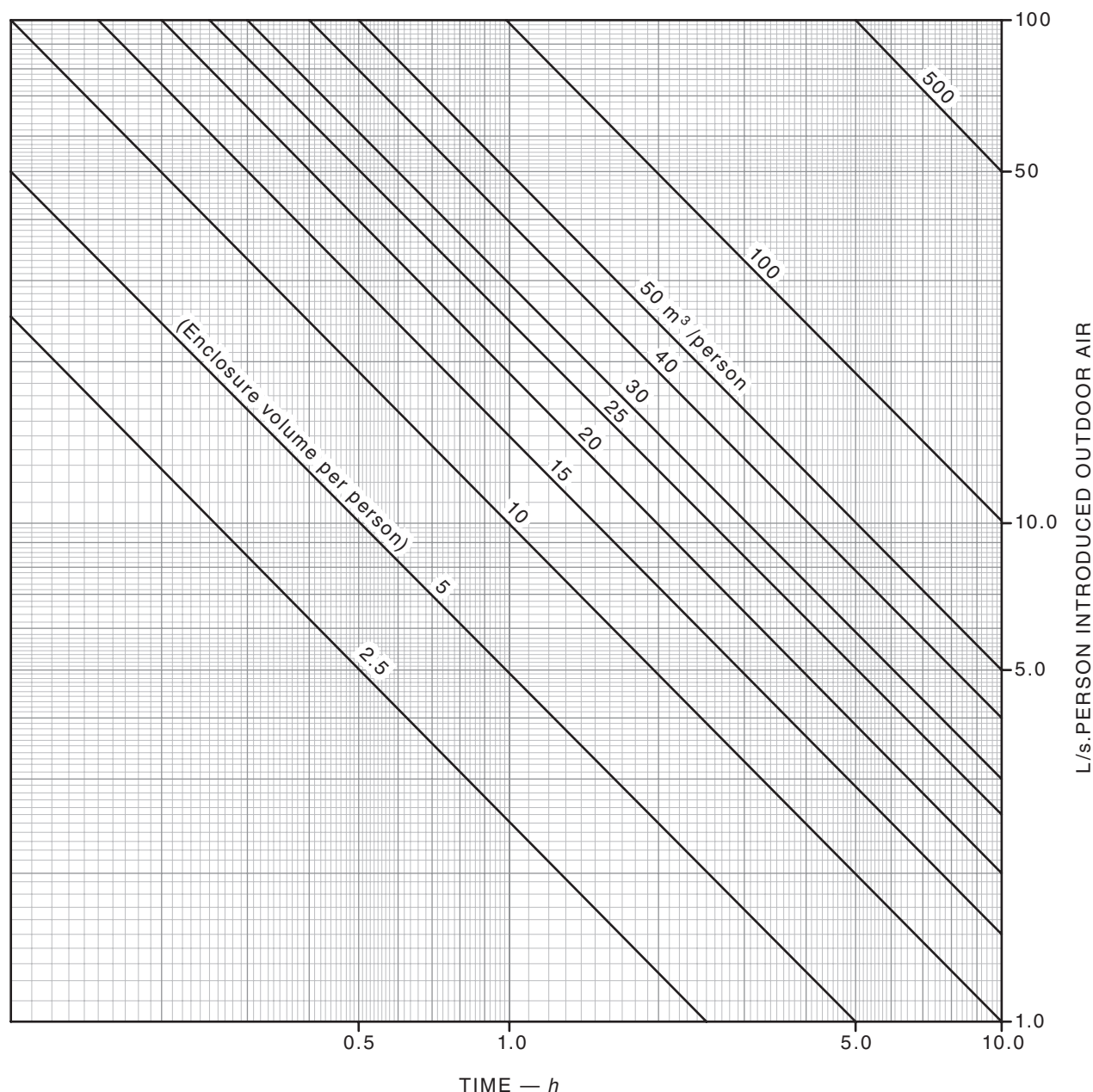


Figure 2.4 — Permissible lead time—hours

2.9.3 Demand control ventilation

During periods where occupancy is less than design (n), demand control ventilation (DCV) may be used to reduce the amount of introduced outdoor airflow in proportion to the actual enclosure population.

When the actual occupancy is below the maximum occupancy assumed for system design, the occupancy-based introduced outdoor air rate may be reduced accordingly, but not below the minimum area-based introduced outdoor air ventilation rate of 0.35 L/s.m^2 .

Where a group of enclosures are supplied by a single air-handling system, each enclosure shall have its actual population demand included in the control strategy for the volume control of introduced outdoor airflow.

Population indicators shall correlate to the actual population. In multiple enclosure systems, population indicators shall be placed in each enclosure served by the system.

NOTE DCV is most suitable for large single enclosures with transient occupancy but may be applied to any enclosure.

C2.9.3 *Demand control ventilation (DCV) is an optional control strategy, whereby the introduced outdoor airflow is modulated (controlled) in response to the actual occupancy (demand) of each enclosure served. When the actual occupancy is below the maximum occupancy assumed for system design, the occupancy-based outdoor air rate may be reduced accordingly. Population indicators that are used have to provide a reasonably accurate representation of the current enclosure occupancy.*

Where CO₂ is used as an indicator, CO₂ sensors control the outdoor air intake flow rate to maintain a predetermined set point or equilibrium level. Typical set points are 600 ppm–850 ppm and should be selected based on the ambient CO₂ levels of the site and the enclosure characteristics.

CO₂ based DCV should not be applied in zones with indoor sources of CO₂ other than occupants.

Acceptable methods for population indicators are:

- (a) An occupancy schedule.*
- (b) Gas contaminant sensors.*
- (c) Digital occupancy tracking.*
- (d) Visual occupancy tracking.*

Temperature sensing alone is not considered to be an acceptable form of monitoring for demand control.

Section 3 Mechanical ventilation — exhaust systems

3.1 Scope of section

Mechanical exhaust ventilation systems shall be designed and installed in accordance with the requirements of this Section.

NOTE 1 This Section sets out exhaust ventilation requirements for enclosures in which contaminants are generated or contained, whereby indoor air contaminants are diluted or removed entirely by exhausting indoor air and providing make-up air.

NOTE 2 A flow chart on the application of this Section is shown in [Figure 3.1](#).

NOTE 3 For enclosures used by vehicles with combustion engines, see [Section 4](#).

NOTE 4 For guidance on a performance-oriented approach to mechanical ventilation design, see [Appendix F](#).

C3.1 *This document allows two approaches to exhaust air dilution — general or local exhaust. It is intended that where enclosures contain processes that generate contaminants of a type or concentration deemed to be objectionable or that may have adverse health effects [defined in [Clause 3.3.1\(a\)](#)], that these should be removed directly from the enclosure by a separate exhaust system and not be recirculated through the supply air system. It is also intended that the exhaust airflow rate be adequate to dilute the contaminants and be arranged to discharge them outside the building in such a manner that no danger or nuisance results to people outside the building.*

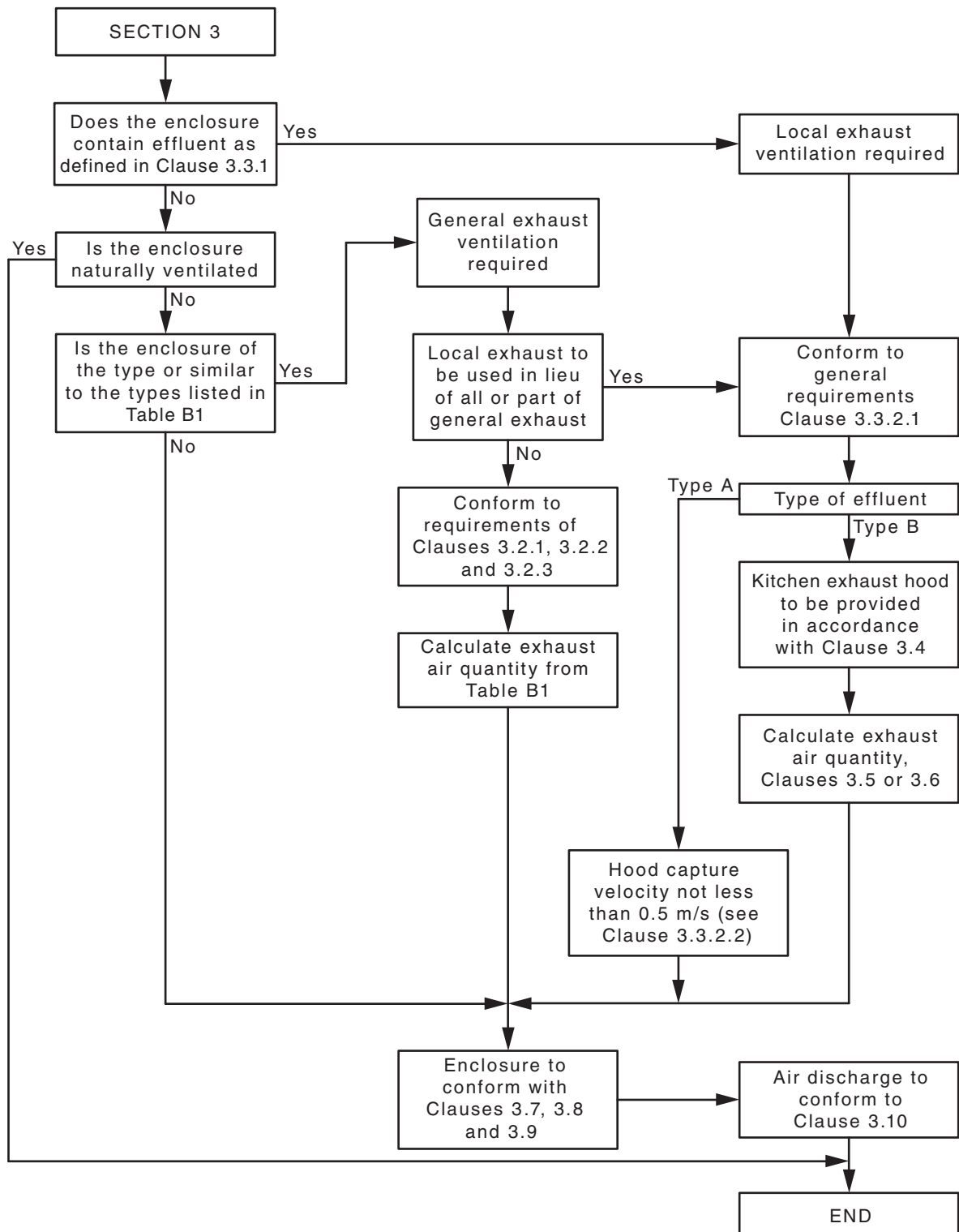


Figure 3.1 — Flow chart on the application of [Section 3](#)

3.2 General exhaust ventilation

3.2.1 General

Unless naturally ventilated, enclosures listed in [Appendix B](#) shall be provided with general exhaust ventilation. Exhaust airflow rates shall be as specified in [Appendix B](#).

NOTE 1 Supply air ventilation may be used as an alternative to exhaust air systems in accordance with [Clause 1.2\(b\)\(ii\)](#).

NOTE 2 Local exhaust ventilation may be used in lieu of part or whole of the general exhaust ventilation.

C3.2.1 [Appendix B](#) of this document specifies rates for general exhaust ventilation. These rates are deemed adequate except for such applications as bathrooms, laundries and hospital sterilizing rooms where excessive heat or steam is generated, or sanitary compartments where excess odours are generated. In kitchens where the size of cooking apparatus exceeds the limits stated, local exhaust should be used.

3.2.2 Exhaust locations

For enclosure sizes of less than 20 m², exhaust-air intakes that are used for general exhaust-air collection shall be located such that no part of the enclosure is more than 50 % of the longest dimension of the enclosure away from the path of the make-up air [from the source(s) of make up to the exhaust(s)].

For enclosure sizes of 20 m² or greater, exhaust-air intakes that are used for general exhaust-air collection shall be separated from the sources of make-up air into the enclosure by at least by at least 30 % of the longest dimension of the enclosure away from the path of the make-up air [from the source(s) of make up to the exhaust(s)].

NOTE 1 Multiple exhaust intakes may be necessary.

NOTE 2 Where the enclosure contains a shower, the exhaust should be located over the shower.

3.2.3 Enclosures served by both supply and required general exhaust systems

Where the enclosure is served by both a supply air system and a general exhaust system required by this Section, the exhaust airflow rate shall exceed the supply airflow rate by at least 10 %. The difference between the exhaust air quantity and supply air quantity shall be provided in accordance with [Clause 3.8](#).

NOTE 1 For applications associated with particular healthcare enclosures, see [Section 5](#).

NOTE 2 For applications associated with car parks, see [Section 4](#).

C3.2.3 The aim of the requirement for the general exhaust rate to exceed the supply rate (where used) by 10 % is to ensure that effluent cannot flow to adjacent enclosures. Where mechanical ventilation is used to produce pressure differentials between enclosures or where a specified general exhaust is replaced by a local exhaust system, this requirement for general exhaust to exceed supply may be waived.

Consideration of AS/NZS 5601.1 is of particular importance for enclosures containing open-flued gas heating appliances.

3.3 Local exhaust ventilation

3.3.1 Types of effluent requiring local exhaust

Type A and B effluents shall be managed by local exhaust in accordance with [Clause 3.3.2](#), where effluents are —

- (a) *Type A effluents:* Significant localized sources of toxic, irritant, asphyxiant, flammable or explosive effluents which include the following:

- (i) Gases.
- (ii) Dusts.
- (iii) Fumes (including direct ducting from tail pipes in accordance with [Clause 4.5.3.2](#)).
- (iv) Vapours.

Excluding —

- (A) contaminants controlled in accordance with [Section 2](#);
 - (B) contaminants controlled in accordance with [Section 4](#) (other than direct ducting from tail pipes in accordance with [Clause 4.5.3.2](#));
 - (C) contaminants controlled by a general exhaust ventilation from enclosures listed in [Appendix B](#);
 - (D) contaminants from apparatus used solely for domestic purposes; or
 - (E) cooking processes with Type B effluents.
- (b) *Type B effluents:* Heated air with or without water or grease vapour produced by cooking or dishwasher equipment employed for the preparation of food within an enclosure, where —
- (i) any single apparatus having a total maximum input exceeding —
 - (A) 3.6 kW if it is a deep fryer and 8 kW for any other electrical apparatus; or
 - (B) total gas input 29 MJ/h for a gas apparatus.
 - (ii) multiple apparatus having a total maximum input exceeding —
 - (A) 0.5 kW/m² for electrical apparatus;
 - (B) 1.8 MJ/m² for gas apparatus; or
 - (C) 3.6 kW for Type 3, 4, 5 and 6 cooking processes where apparatus are located within 2 m of each other.
 - (iii) any cooking apparatus fuelled with solid fuel.

Excluding —

- (A) Coffee machines of all sizes.
- (B) Microwave ovens and under bench ovens, dish or glass washers, that are less than 3.6 kW where these apparatus are positioned greater than 1.5 m apart.
- (C) Appliances or apparatus used solely for the purposes of reheating or maintaining the temperature of food (e.g. bain-marie).
- (D) Apparatus used specifically for space heating.

(E) Apparatus used solely for domestic purposes.

C3.3.1 *These requirements are intended to apply to apparatus that cause objectionable conditions.*

3.3.2 Effluent management

3.3.2.1 General requirements

Effluent is managed by means of local exhaust as follows:

- (a) Effluent shall be collected as it is being produced near the source of generation in accordance with at least one of the following:
 - (i) [Clause 3.3.2.2](#);
 - (ii) [Clause 3.3.2.3](#);
 - (iii) [Clause 4.5.3.2](#); or
 - (iv) ACGIH Industrial Ventilation: A manual of Recommended Practice.
- (b) Local exhaust may complement and/or substitute for general exhaust.
- (c) Make-up air shall be provided in accordance with [Clause 3.8](#).
- (d) Where an exhaust hood with multiple duct connections is used to capture effluent from multiple apparatus, the ductwork shall allow exhaust airflow through each connection such that all effluent is collected.

C3.3.2.1 *Apart from establishing requirements for local exhaust, this document does not attempt to prescribe the former airflow rates of hoods or other means used for local exhaust of effluents with the exception of kitchen exhaust. Australian Standards for the design of laboratories should be referred to in regard to local exhaust and make-up air provisions in such applications.*

Local exhaust airflow rates vary depending on the application. Users and designers should refer to relevant guidance material, including Standards, for applications outside the scope of this document. Some of the relevant Australian Standards are included in [Appendix O](#).

3.3.2.2 Type A effluent removal

The capture velocity of the air, as it enters the capture device surrounding the source of Type A effluent generation, shall be not less than 0.5 m/s averaged across each opening in the capture device. For the purposes of this Clause, the capture device shall be deemed to comprise the exhaust hood as well as any impervious walls, floors or benchtops that, together with the exhaust hood, serve to contain the source of effluent generation.

C3.3.2.2 *This document is not intended to apply to materials of duct or hood construction, industrial process system design, ignition prevention, explosion venting, pneumatic conveying systems, fire safety venting and other aspects of ventilation system design and installation that are dependent on the process, the product and materials used in industrial ventilation systems. Where specific industrial processes require special ventilation systems to suit such processes, including conveying of Type A effluents [see examples (a) and (b) below], the design and construction of these ventilation systems should be in accordance with the requirements of relevant Standards, industry guidelines and requirements of authorities. In the absence of requirements of authorities, codes of practice and/or relevant Standards, the recommendations of the ACGIH Industrial Ventilation: A Manual of Recommended Practice should be adopted (see [Appendix O](#)).*

(continued)

Examples:

- (a) *Where flammable atmospheres could be present as a consequence of dusts, gases or vapours within an enclosure or within exhaust ductwork, the exhaust ventilation systems, including materials and methods of duct construction should be designed and constructed to mitigate ignition, flammability and/or explosion risks, in accordance with requirements of authorities, relevant codes of practice and Standards (e.g. grain milling dust removal, spray painting booth ventilation systems, etc.).*
- (b) *Where toxic, irritant, asphyxiant or offensive dusts, gases or vapours could be present in an enclosure, within exhaust ductwork or in airstreams discharged to atmosphere, personnel inside and outside the building should be protected from being harmed by such materials by exhaust ventilation systems that are designed and constructed in accordance with requirements of authorities, relevant Codes of practice and Standards (e.g. welding booth exhaust, fume cupboards, etc.).*

3.3.2.3 Type B effluent removal

Hoods shall be provided for the collection of Type B effluent. Where the apparatus specified in [Clause 3.3.1\(b\)](#) is a cooking appliance, a kitchen exhaust hood conforming to [Clause 3.4](#) shall be installed above the appliance.

Where Type B effluent is likely to include grease vapour, the kitchen exhaust hood shall be provided with a grease removal device in accordance with [Clause E.6](#).

3.4 Kitchen exhaust hoods

3.4.1 General

Required kitchen exhaust hoods shall conform to either —

- (a) [Clause 3.4.4](#) where the exhaust hood is located over a non-grease-producing apparatus used for Process Type 1 in accordance with [Clause 3.4.2.3](#);
- (b) [Clause 3.5](#) with construction and installation requirements in accordance with [Appendix E](#); or
- (c) [Clause 3.6](#).

C3.4.1 *The relevant fire and smoke control for kitchen exhaust hood systems can be found in AS 1668.1. Requirements for kitchen exhaust hoods are set out in this Clause for the seven common types and configurations of hoods that apply to seven common types of cooking processes. [Clause 3.5](#) sets out a prescriptive procedure for hood design.*

3.4.2 Hood type and cooking process type

3.4.2.1 General

Hoods shall be selected for the hood type and cooking process type in accordance with [Clauses 3.4.2.2](#) and [3.4.2.3](#).

3.4.2.2 Hood type

Hood type shall be as follows (see [Appendix E](#)):

- (a) *Hood Type 1* Low sidewall where the canopy set back does not exceed 150 mm from the front edge of the cooking surface (see [Figure E.3](#)).

- (b) *Hood Type 2* Corner-mounted (see [Figure E.4](#)).
- (c) *Hood Type 3* Sidewall (see [Figure E.6](#), [E.7](#), [E.8](#) and [E.9](#)).
- (d) *Hood Type 4* Island (see [Figure E.2](#) and [E.5](#)).
- (e) *Hood Type 5* Ventilated ceiling (see [Figure E.12](#)).
- (f) *Hood Type 6* Eyebrow hood (see [Figure E.11](#)).
- (g) *Hood Type 7* Proprietary equipment.

3.4.2.3 Cooking process type

Cooking process type shall be as follows:

- (a) *Process Type 1* — does not emit grease. It includes apparatus that emit non-greasy heat or steam only.

NOTE 1 Examples include dishwashers, non-grease emitting ovens, warming cabinets, sous vide cookers, tea kettles, urns and rice cookers.
- (b) *Process Type 2* — emits grease with moderate heat but little steam.

NOTE 2 Examples include Induction cooktops, countertop skillets/fryers and fry tops, gas or electric ranges and convection ovens, target tops and salamanders.
- (c) *Process Type 3* — emits steam and grease.

NOTE 3 Examples include tilting steam kettles, stock pots, pasta or noodle cookers, yum cha and dim sum steamers and pressure cookers.
- (d) *Process Type 4* — emits high levels of grease.

NOTE 4 Examples include deep fryers, bratt pans, induction woks and high-energy burger fry tops.
- (e) *Process Type 5* — emits high levels of heat with or without grease.

NOTE 5 Examples include char grills, lava rock grills, broilers, BBQs, Tandoor ovens, and any open-flame apparatus.
- (f) *Process Type 6* — emits very high levels of grease, heat and vapour.

NOTE 6 Examples include woks and Oriental cooking tables.
- (g) *Process Type 7* — releases large surges of contaminants.

NOTE 7 Examples include full-height and multistack ovens and steam-producing combination ovens.
- (h) *Process Type 8* — emits smoke and embers.

NOTE 8 Examples include solid fuel apparatus including open flame grills and enclosed ovens that burn charcoal and/or wood. This excludes electric or gas-heated ovens that use a small amount of moist smouldering wood purely for flavouring the food where the smouldering wood is enclosed in a spark-arresting device.

3.4.3 Hood overhangs

Except on sides adjoining a wall, minimum hood overhangs beyond the edge of the cooking surface, or source of effluent if not a cooking apparatus, shall be in accordance [Table 3.1](#).

The hood overhang shall be measured to the inside edge of the capture zone or gutter.