

## 0741P DUCTUS IN DUCTWORK

### Branded worksection

This branded worksection *Template* has been developed by NATSPEC in conjunction with **DUCTUS** (the Product Partner) and may be used whilst the Product Partner is licensed to distribute it. The copyright remains with NATSPEC. As with all NATSPEC worksections, it is the responsibility of the user to make sure it is completed appropriately for the project. The user should also review its applicability for local conditions and regulations. Check [www.natspec.com.au](http://www.natspec.com.au) for the latest updated version.

### Worksection abstract

This branded worksection *Template* is applicable to pre-insulated rigid ductwork fabricated using DUCTUS supplied ALP materials and methods. It also covers sheet metal ductwork fabricated from galvanised steel, stainless steel, aluminium and PVC-U. It includes ductwork ancillaries such as flexible duct, duct fire-resistance level, dampers, fabricated hoods and canopies. The reference standards are AS 4254.1 (flexible duct) and AS 4254.2 (rigid duct).

### Guidance text

All text within these boxes is provided as guidance for developing this worksection and should not form part of the final specification. This *Guidance* text may be hidden or deleted from the document using the hidden text *Hide* and *Delete* functions of your word processing system. For additional information visit FAQs at [www.natspec.com.au](http://www.natspec.com.au).

### Optional style text

Text in this font (blue with a grey background) covers items specified less frequently. It is provided for incorporation into *Normal* style text where it is applicable to a project.

### Related material located elsewhere in NATSPEC

If a listed worksection is not part of your subscription package and you wish to purchase it, contact NATSPEC.

Related material may be found in other worksections. See for example:

- 0724 *Air handling plant – combined* for fan coil and other air handling units.
- 0744 *Ductwork insulation* for insulation of ductwork.
- 0745 *Attenuators and acoustic louvres*.
- 0746 *Air grilles*.
- 0747 *Variable air volume terminals*.
- 0748 *Chilled beams*.
- 0771 *Automatic controls* for motors for motorised dampers.

### Material not provided by DUCTUS

This branded worksection *Template* includes generic material which may not be provided by the Product Partner including:

- Sheet metal ducts.
- PVC-U ducts.
- Fire protection of ducts.
- Volume control dampers.
- Motorised dampers.
- Non-return dampers.
- Fire and smoke dampers.
- Subducts.
- Electric duct heaters.
- Kitchen hoods.
- Fume cupboards.

### Documenting this and related work

You may document this and related work as follows:

- Refer to AIRAH DA03 for duct design and NATSPEC TECHnote DES 033 on duct leakage and leakage design.
- This worksection includes a range of ductwork materials. If only some are required (e.g. sheet metal or composite panels) delete the others or leave to the contractor to select.
- The worksection provides default locations of minor components such as access panels. Additional panels and other minor items should be shown on the drawings.
- See AS/NZS 3666.1 and the recommendations of SA/SNZ HB 32 for requirements for duct access for cleaning and inspection.

- Show the location of fire dampers and subducts on the drawings. Make sure fire dampers are provided with adequate access for statutory inspection and replacement of fusible links.
- For fume cupboards, see AS/NZS 2243.8, AS/NZS 2243.9 and AS/NZS 2982.
- For exhaust systems, specify duct type and material type of effluent being removed, any special treatment, e.g. scrubbers.
- For documenting fire-resisting duct, see *Guidance* in the **FIRE PROTECTION OF DUCTWORK** clause.
- *0931 Power generation – engine driven* includes text for ductwork for associated cooling and so does not require this worksection for most situations.
- This worksection contains text, including *Optional* text, which may be adapted for use in design and construct projects. See NATSPEC TECHreport TR 03 for information on specifying Design and Construct for mechanical services.

The *Normal* style text of this worksection may refer to items as being documented elsewhere in the contract documentation. Make sure they are documented.

### Specifying ESD

The following may be specified by retaining default text:

- ALPactive antimicrobial embedded into the duct face material to control microbial growth on duct surfaces.
- ALP duct sealing system which exceeds the minimum sealing performance in AS 4254.1 and AS 4254.2. This reduces operating costs and greenhouse gas emissions.
- ALP panels with metal internal facing that do not shed fibres into the air stream.
- ALP systems with aluminium facing making them an excellent solution for computer room air conditioning (CRAC) and other applications in which shedding of zinc whiskers from metallic coated steel must be prevented.
- ALP 200 and 500 micron facings that are suitable for outdoor locations.
- ALP systems that are up to 85% lighter than typical sheet metal ductwork, reducing the load on the building structure and potentially reducing the cost of the building structure.
- ALP panels and materials that are corrosion resistant, including salty environments.
- ALP systems with a neutral pH corrosion resistant aluminium facing suitable for swimming pool applications (provided they do not contain sulphur) and other corrosive or chemical-laden air environments.
- ALP panels are easy to clean using water washing, brushing or disinfection.
- ALP panels with zero VOC's and zero formaldehyde content.
- Leakage testing more stringent than AS 4254.1 and AS 4254.2 for reducing operating costs and greenhouse gas emissions. BCA J5.6 requires duct sealing to AS 4254.1 and AS 4254.2 on systems over 3000 L/s. This worksection requires sealing of all systems.
- Microbial control for improved indoor air quality and reducing Legionella risk.
- Selection of corrosion resistant materials for fire dampers and ductwork based on atmospheric corrosivity category.
- PVC-U ductwork for durability in very corrosive environments.
- Low leakage motorised dampers for reducing operating costs and greenhouse gas emissions.
- Access provisions for improved maintenance (and durability) and to facilitate duct cleaning for improved indoor air quality and reducing Legionella risk.

Refer to the NATSPEC TECHreport TR 01 on specifying ESD.

## 1 GENERAL

DUCTUS is Australia's leading light weight pre-insulated duct supplier. Its partnership with ALP out of Italy has gained world-wide recognition and has been used in tens of thousands of applications globally. The system replaces the use of heavy, leaking, oxidising, low performing sheet metal duct. DUCTUS began its operation in 2015 and has quickly become the leading/benchmark pre-insulated duct provider within the region. "The Evolution of Air" is our aim in introducing the Australasian market to a sustainable, smarter, efficient, futuristic light weight duct solution.

### 1.1 RESPONSIBILITIES

#### General

Requirement: Provide ductwork, including ALP light-weight, pre-insulated ductwork, as documented.

*Documented* is defined in *0171 General requirements* as meaning contained in the contract documents.

**DESIGN**

The *Optional* style text in this clause may be used when the contractor is to design and select the ductwork and components. Use the *0701 Mechanical systems* worksection to describe design parameters for mechanical systems, as a whole, including the basis for calculating the air quantities and definition of areas to be served by ductwork.

**General**

Requirement: Design ductwork, as documented.

**Ductwork selection**

Selection parameters included in the **SELECTIONS** schedules should not be repeated here. The schedules' *Guidance text* includes suggestions for modification to suit design and construct projects.

General: Select ductwork to handle the air quantities calculated, in conformance with *0701 Mechanical systems*, for the spaces and functions served and under the documented conditions.

**Ductwork design, application and calculations**

Standards: Conform to the recommendations of one or more of the following:

- AIRAH Design Application Manuals.
- ASHRAE Handbooks.
- CIBSE Guides.

Methods of calculation: Manual or software that employs the data and methods in the applicable standard.

**Rigid ductwork**

The standards in **Ductwork design, application and calculations** give recommended duct design parameters. Alternatively, include specific values, for example:

Duct design: Size ductwork as follows:

- Velocity:  $\leq 6$  m/s.
- Pressure loss:  $\leq 1.2$  Pa/m.

**Flexible duct**

Requirement: Conform to the following:

- Velocity:  $\leq 4.0$  m/s.
- Length: No more than 6 m total flexible duct length in the air path between the fan and furthest outlet or grille served. Provide rigid duct for the remainder of the air path between the fan and furthest outlet or grille served.

This prevents excessive use of flexible duct. See BCA J5 in particular. State and territory variations may also apply.

**Documentation**

This is a partial list of items only. Edit to suit the project. Drawings relating to whole systems should be included in *0701 Mechanical systems*.

Drawings: Show the following on the drawings:

- Identify rigid and flexible ducts.
- For ducts other than metallic-coated steel, show material, material grade and thickness. Alternatively, complete the **Ductwork schedule**.
- Location of all minor components including access panels and doors, volume, non-return, fire and motorised dampers, damper motors and subducts.
- Kitchen and other exhaust hoods.
- Means of draining ducts.
- Access panels and minor items.
- Fire-resisting ducts and means of access to the interior of fire rated ducts.

**1.2 COMPANY CONTACTS****DUCTUS technical contacts**

Website: [www.ductus.com.au/contact-us](http://www.ductus.com.au/contact-us)

### 1.3 CROSS REFERENCES

#### General

Requirement: Conform to the following:

- 0171 *General requirements*.

0171 *General requirements* contains umbrella requirements for all building and services worksections.

List the worksections cross referenced by this worksection. 0171 *General requirements* references the 018 *Common requirements* subgroup of worksections. It is not necessary to repeat them here. However, you may also wish to direct the contractor to other worksections where there may be work that is closely associated with this work.

NATSPEC uses generic worksection titles, whether or not there are branded equivalents. If you use a branded worksection, change the cross reference here.

- 0701 *Mechanical systems*.

0701 *Mechanical systems* deals with matters common to more than one Mechanical worksection.

- 0731 *Fans*.
- 0744 *Ductwork insulation*.
- 0791 *Mechanical commissioning*.

### 1.4 STANDARDS

#### General

Flexible ductwork: To AS 4254.1.

Rigid ductwork: To AS 4254.2.

See AS 4254.1 clause 1.1 and AS 4254.2 clause 1.5 for limitations on the scope of the standard. For example, the following are excluded and so any requirements will need to be documented:

- Noise generation and transmission.
- Exposure to damage from: transportation and handling; weather and temperature extremes; flexure cycle; chemical corrosion; and other in-service conditions specific to the installation.
- Impact loading such as: fire; earthquake; and sudden stoppage of airflow.
- Cleanability.
- Resistance to airflow.

#### Proprietary and non-standard systems

Standard: Conform to the test criteria in AS 4254.1 and the functional criteria in AS 4254.2.

This provides scope for alternatives for rigid ducts. These criteria relate to structural performance (e.g. stiffness) and not sealing or leakage. Delete if alternatives are not acceptable.

Some proprietary jointing and stiffening systems are covered in AS 4254.2 Table 2.3(H).

Non-standard systems (such as proprietary duct jointing systems) and proprietary fire-resisting duct should meet the performance criteria in AS 4254.2 particularly with respect to deflection and sealing. See AS 4254.2 Section 4.

#### Microbial control

Microbial control: To AS/NZS 3666.1 and the recommendations of SA/SNZ HB 32.

See AS/NZS 3666.1 clause 2.11 and AS 4254.2. These standards are referenced in 0171 *General requirements*. Refer also to SA/SNZ HB 32. See NATSPEC TECHnote DES 022 for more information on requirements for microbial control in buildings.

### 1.5 MANUFACTURER'S DOCUMENTS

#### Technical manuals

Website: [www.ductus.com.au/media-downloads/private-media](http://www.ductus.com.au/media-downloads/private-media)

### 1.6 INTERPRETATION

#### Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- FRL: Fire-resistance level.

Edit the **Abbreviations** subclause suit the project or delete, if not required. List alphabetically.

#### Definitions

General: For the purposes of this worksection the following definition applies:

- Pre-insulated rigid ductwork (also referred to as composite board ductwork): Rigid ductwork fabricated from panels consisting of an insulating core faced on each side with metal.

Edit the **Definitions** subclause suit the project or delete, if not required. List alphabetically.

## 1.7 SUBMISSIONS

### Certification

Fire and smoke dampers: Submit test certificates showing conformance as follows:

- Fire and smoke dampers: To AS 1682.1 for air leakage.
- Fire dampers: To AS 1530.4 for FRL.

AS 4254.2 clause 2.1.1 requires testing to the AS 1682 series and AS 1530.4 for both mechanical and intumescent types of fire dampers.

Flexible duct: Submit the AS 4254.1 Appendix A Flexible duct compliance report summary for each type of flexible duct.

The Appendix A Flexible duct compliance report summary is a normative requirement of AS 4254.1.

Rigid ductwork: Submit test data verifying the assembled ductwork conforms to AS 4254.2 clause 2.1.2.

ALP active antimicrobial properties: Submit microbial test data to EN 13403 for panels, glue and sealant.

Contact DUCTUS for test results.

ALP system seismic resistance: Submit evidence that the ALP duct system resists the lateral and longitudinal earthquake demand loads.

Contact DUCTUS for a test report which indicates that the ALP system, using Gripple supports, was shown to be capable of resisting the earthquake demand loads of 3.6g, determined in accordance with NZS 4219. The seismic resistance of the system is dependent on the duct size, layout, support spacing, supports used and will be project specific. Input from a seismic specialist is required.

### Execution details

Access panels: Submit proposed alternative sizes, if any.

Mechanical fire dampers: For positions where dampers cannot be installed to close in the direction of the air flow, submit proposed installation details.

Sealing: Submit details of proposed sealing methods and materials. Include the following:

- Proposals for conforming to the sealing requirements of AS 4254.2 and this specification.
- Proposed sealing materials including mastics and tapes.
- Proposed standard for leakage testing.

See the Building and Engineering Services Association publication B&ES DW/143 or ANSI/SMACNA 016.

- Proposals for sealing builders' work components incorporated into the air path including, but not limited, to plenum ceilings, outside and return air plenums and risers.

Because of the divided responsibilities, builder's work comments have potential for being significant leak sources. Sealing them will not normally be the responsibility of the mechanical trade so this provision is intended to address this problem.

- For each system to be leakage tested, a drawing showing the extent of the system to be tested including the total surface area of the system and the surface area of the portion to be tested.

### Fire performance

Fire hazard properties: Submit evidence of conformity to PRODUCTS, **FIRE PERFORMANCE, Fire hazard properties.**

Fire-resistance level: Submit evidence of conformity to PRODUCTS, **FIRE PERFORMANCE, Fire-resistance of building elements.**

### Products and materials

Type tests: Submit type test certificates showing conformance with the following standards:

Type tests are carried out off-site. However, submission of evidence of a successful type test may be called up here for requirements specified in **SELECTIONS** or **PRODUCTS**, if there are no **SELECTIONS**.

- Sealants: To AS/NZS 1530.3.

### Samples

Consider also obtaining samples of proprietary jointing systems and dampers.

A sample length of duct with a typical joint may also assist in assessing the adequacy of proposed sealing, stiffening, etc.

Flexible duct: Submit sample 2 m length of 300 mm diameter flexible duct with sheet metal spigot attached.

Pre-insulated rigid ductwork: Submit a sample 1.2 m length of 400 x 300 mm section pre-insulated rigid ductwork with joint flange in the middle, and a circular sheet metal spigot and access panel installed.

### Tests

0171 *General requirements* covers tests in **Definitions** and calls for an inspection and testing plan under **SUBMISSIONS, Tests**.

Leakage testing reports: Submit a report on each system tested. Include in the report:

- Details of the system tested including a sketch of the portions of the system tested.
- Test pressure in Pa and as a percentage of the design operating pressure.
- The measured leakage rate in L/s and as a percentage of the design air quantity.
- If the section tested exceeded the maximum permissible leakage rate under test, provide details of the leakage sources identified and measures taken to rectify them.

Leakage retesting: If a system is retested, provide additional reports containing the information above.

### Subcontractors

Training: Submit evidence that persons manufacturing and installing ALP ductwork have received training from DUCTUS.

All DUCTUS distribution partners and fabricators have participated in a 2 to 3 day training course carried out by an ISO certified instructor from ALP Italy and are issued with a diploma in pre-insulated duct fabrication. DUCTUS can provide a sample diploma on request. DUCTUS will not approve any duct supplied unless fabricated by a ALP trained fabricator. Training courses are held every two years.

### Warranty

ALP product: Submit ALP standard product warranty on completion and as follows:

- Minimum warranty period: 15 years.

Contact DUCTUS for details of product warranty conditions. To meet ALP product warranty, only proprietary ALP products are to be used.

ALP warrant the supplied products only. The fabricator warrants the fabrication and duct system in accordance with the defects provisions of this contract.

## 1.8 INSPECTION

### Notice

Inspection: Give notice so that inspection may be made of the following:

- Installation: DUCTUS inspection at the start of installation, at 50% completion and during end of commissioning.
- Leakage testing of each duct system documented to be tested.

This is included as leakage testing represents a radical departure from past practice. Consider deleting it as industry experience of leakage testing matures.

Amend to suit the project adding critical stage inspections required.

**Hold points**, if required, should be inserted here.

## 2 PRODUCTS

### 2.1 GENERAL

#### Product substitution

Other products: Conform to PRODUCTS, **GENERAL, Substitutions** in *0171 General requirements*.

The *0171 General requirements* clause sets out the submissions required if the contractor proposes alternative products. Refer also to NATSPEC TECHnote GEN 006 for more information on proprietary specification.

**Storage and handling**

Storage: Transport and store all ALP products under cover.

ALPActive: Supply to site with ends capped by plastic covering to make sure no contaminant enters the duct before installation.

**Product identification**

General: Marked to show the following:

- Manufacturer's identification in the form of regularly embossed ALP logo on the facing.

The logo may be omitted on request to DUCTUS.

- Product brand name.
- Product type.
- Quantity.
- Product reference code and batch number.
- Date of manufacture.

Edit the list to suit the project or delete if not required.

**2.2 FIRE PERFORMANCE****Fire hazard properties**

ALP ductwork materials: Tested to AS/NZS 1530.3. Fire hazard indices as follows:

- Ignitability: 0.
- Spread-of-Flame Index: 0.
- Heat evolved: 0.
- Smoke-Developed Index: 0.

Other ductwork materials: Tested to AS/NZS 1530.3. Fire hazard indices as follows:

- Spread-of-Flame Index: 0.
- Smoke-Developed Index:  $\leq 3$ .

Facing materials: Tested to AS 1530.2: Flammability Index  $\leq 5$ .

Assembled duct systems: Pass the UL 181 burning test.

The UL 181 burning test is more severe than the AS/NZS 1530.3 tests. A duct system that fails the UL 181 test is unlikely to pass the other tests.

See NATSPEC TECHnote DES 003 for more information on fire hazard properties of insulation and pliable membranes.

The requirements above are consistent with NCC and AS 4254.2.

**Fire-resistance of building elements**

Fire-resistance level of ductwork: Tested to AS 1530.4.

This applies to ducts such as smoke spill and some kitchen exhaust. See **FIRE PROTECTION OF DUCTWORK**.

**2.3 MATERIALS AND COMPONENTS****Corrosion resistance**

General: Conform to the **Corrosion resistance table** for the external and internal atmospheric corrosivity categories documented in *0171 General requirements*. Alternatively, provide proprietary products with metallic and/or organic coatings of equivalent or higher corrosion resistance.

Requirement: In the **Corrosion resistance table** ductwork includes fittings and dampers other than fire, smoke and motorised dampers.

External category:

- Ductwork outside the building.
- Fire, smoke and motorised dampers in ductwork outside the building.
- Fire, smoke and motorised dampers located in the discharge air path within 3 m of the point of discharge from the building.
- Fire, smoke and motorised dampers located in the outside air or mixed air/recycle air path up to the filters.

Internal category:

- Ductwork inside the building not included in external situation.

**Corrosion resistance table**

Atmospheric corrosivity category to AS 4312	Fire, smoke and motorised dampers	Ductwork	ALP pre-insulated rigid ductwork
C1 C2 and C3	Metallic-coated sheet Z275/AZ150	Metallic-coated sheet Z275/AZ150	Aluminium foil facing 60, 80, 200 or 500 micron thick with UV resistant varnish applied at $\geq 3$ g/m <sup>2</sup>
C4	Stainless steel Type 316	Stainless steel Type 316	Stainless steel foil facing $\geq 100$ micron thick

Note: For categories C5 and CX seek specialist advice and include text here.

The atmospheric corrosivity category is documented in 0171 *General requirements* and will apply to the project as a whole. Rows in the table for categories not relevant to the project may be deleted. Refer to NATSPEC TECHnote DES 010.

ALP pre-insulated rigid ductwork is available in a range of facing thicknesses including 60, 80, 200 and 500 micron. Consult DUCTUS for available combinations of materials and thicknesses.

### Duct tapes

Requirement: Provide only ALP Art. 201 adhesive aluminium tape.

## 2.4 ALP RECTANGULAR DUCTWORK

### Materials

Requirement: Use only ALP composite polyurethane panels, components, materials and fasteners.

### Panels

Construction:

- Core: Polyurethane closed cell insulation in the documented R-Value.
- Facing: Provide facing materials, as documented:
- Aluminium: pH neutral aluminium foil with UV resistant varnish applied at  $\geq 3$  g/m<sup>2</sup>.
- ALPactive: Aluminium with ALPactive antimicrobial auto-sanitising silver zeolite compound impregnated finish.
- Stainless steel.

Facing materials may be documented in **SELECTIONS**, **Ductwork schedule** or on the drawings.

### Performance

Requirement: Conform to the following:

- Operating temperature range: -35°C to +110°C.
- Operating pressure:  $\leq 2000$  Pa.
- Panel stiffness: Class R5 ( $> 358$  kN/mm<sup>2</sup>).
- Corrosion resistance: Withstand saturated salt mist spray for 96 hours.
- Water vapour transmission:  $> 2000$  m<sup>2</sup>.hPa/mg.
- Insulation structure: 95% closed cell.
- Stability: Dimensionally stable.
- Frictional resistance: No greater than that of sheet metal ductwork constructed to AS 4254.2.
- Formaldehyde content: Zero.

### Antimicrobial properties

ALPactive panels, glue and sealant: Tested to EN 13403 for zero microbial growth of the following:

- Aspergillus niger.
- Penicillium pinophilum.
- Chaetomium globosum.
- Gliocadium virens.
- Aureobasidium pullulans.



**Chemical resistance**

ALP ductwork: Resistant to the following chemicals (except for fumes resulting from the batteries of cars and trucks):

- Carbon dioxide (CO<sub>2</sub>).
- Hydrocarbons.
- Nitrogen oxide (NO).
- Nitrogen dioxide (NO<sub>2</sub>).
- Nitrogen oxides (NO<sub>x</sub>).

**Extrusions**

Requirement: Provide ALP extruded aluminium profiles to suit the documented panel thickness.

Turning vanes: Provide turning vanes constructed from ALP components.

**Insulation**

Exemption: The insulation of ALP ductwork is not required to conform to *0744 Ductwork insulation* provided it conforms to **Insulation performance**.

**Insulation performance**

Insulation R-Value: To BCA J5.5 and as documented. Material R-Values and thicknesses for ALP panels are as follows:

- R1.0: 21 mm thick.
- R1.2: 25 mm thick.
- R1.5: 30 mm thick.
- R2.0: 42 mm thick.
- R3.0: 63 mm thick.

Conformance to BCA J5.5 meets mandatory energy requirements but may not be adequate to prevent condensation on ducts. See NATSPEC TECHnote DES 005 for more information.

BCA J5.5 clause (c) exempts some kinds of ducts (e.g. return air ducts within conditioned spaces). Insulation may be required for other reasons, for example to prevent condensation.

See NATSPEC TECHnote DES 031 for information on specifying R-Values.

**2.5 ALP RECTANGULAR DUCTWORK FABRICATION****Fabrication methods**

Requirement: Conform to *Technical manual for the construction of the ALP system ducts*.

The *Technical manual for the construction of the ALP system ducts* is available from DUCTUS.

Fabrication methods: Fabricate ducts using ALP manual or automatic equipment to ALP recommendations.

**Stiffening**

Requirement: Provide internal or external stiffening to ALP recommendations to meet the documented pressure class.

**Bends**

Select from:

- Long radius bend with dimensions to AS 4254.2 Figure 2.3(J) (a), formed to ALP recommendations.
- Square back bend with ALP turning vanes.

**Fittings and installation details other than bends**

Requirement: Fabricate to ALP recommendations.

Fittings incorporating bends: Conform to **Bends**.

**ALPactive panels**

Requirement: Use only ALPactive components and material supplied by DUCTUS for use as part of the ALPactive system.

This is required to maintain the antimicrobial properties.

**2.6 ALP ROUND DUCTWORK****Materials**

Requirement: Use only the ALP supplied materials and fasteners, as follows:

- Straight duct: ALP Round System composite polyurethane sections.
- Fittings: ALP Round System composite polyurethane fittings.

### Round system

Construction:

- Core: 25 mm thick polyurethane closed cell insulation.
- Internal and external facing: Embossed pH neutral 120 micron aluminium foil with UV resistant varnish applied at  $\geq 3 \text{ g/m}^2$ .

### Performance

Requirement: Conform to the following:

- Operating temperature range:  $-35^\circ\text{C}$  to  $+110^\circ\text{C}$ .
- Operating pressure:  $\leq 2000 \text{ Pa}$ .
- Panel stiffness: Class R5 ( $> 358 \text{ kN/mm}^2$ ).
- Corrosion resistance: Withstand saturated salt mist spray for 96 hours.
- Water vapour transmission:  $> 2000 \text{ m}^2 \cdot \text{hPa/mg}$ .
- Insulation structure: 95% closed cell.
- Stability: Dimensionally stable.
- Frictional resistance: No greater than that of sheet metal ductwork constructed to AS 4254.2.
- Formaldehyde content: Zero.

### Antimicrobial properties

ALP active panels, glue and sealant: Tested to EN 13403 for zero microbial growth of the following:

- Aspergillus niger.
- Penicillium pinophilum.
- Chaetomium globosum.
- Gliocadium virens.
- Aureobasidium pullulans.

### Chemical resistance

ALP ductwork: Resistant to the following chemicals (except for fumes resulting from the batteries of cars and trucks):

- Carbon dioxide ( $\text{CO}_2$ ).
- Hydrocarbons.
- Nitrogen oxide (NO).
- Nitrogen dioxide ( $\text{NO}_2$ ).
- Nitrogen oxides ( $\text{NO}_x$ ).

### Extrusions

Requirement: Provide ALP extruded aluminium profiles to suit the documented panel thickness.

### Insulation

Exemption: The insulation of ALP ductwork is not required to conform to *0744 Ductwork insulation* provided it conforms to **Insulation performance**.

### Insulation performance

Insulation R-Value: To BCA J5.5 and as documented.

### Anti-condensation tape

Requirement: If there is a risk of condensation, provide ALP Art. 516 anti-condensation tape on profiles and flanges. Apply tape over the profiles.

## 2.7 ALP ROUND SYSTEM FABRICATION

### General

Fabrication methods: Conform to *ALP roundSYSTEM Pre-insulated circular air ducts - Fabrication manual*.

The ALP roundSYSTEM Pre-insulated circular air ducts - Fabrication manual is available from DUCTUS.

Bends and fittings: Provide only ALP supplied pre-insulated bends and fittings.

Joints in exposed round duct: Provide ALP invisible joints.

## 2.8 ALP DUCTWORK ADHESIVES AND SEALING

When fabricated and erected to ALP recommendations, ALP ductwork can achieve lower leakage rates than conventional sheet metal ductwork. ALP ductwork has been certified to EUROVENT 2/2 Class B and C.

### Duct seal class

Standard: EUROVENT 2/2.

Requirement: Conform to the **Duct sealing performance table**.

### Duct sealing performance table

Duct internal pressure	Duct seal class to EUROVENT 2/2
-700 to 0 Pa	C
1 to 400 Pa	C
401 to 1000 Pa	B
1001 to 2000 Pa	B

These performance characteristics are achieved with standard ALP fabrication methods and exceed AS 4254.2 performance requirements. Higher duct seal class can be reached with ALP materials. Contact DUCTUS for details.

### Adhesive

Requirement: Provide ALP Art.202/C3 and ALP Art. 202/C2 2 part water based adhesive.

### Sealants

Requirement: Provide ALP sealants as documented:

- Internal seams: ALP Art. 203.
- Between aluminium profiles and ALP panels: ALP Art. 202/G.

ALP Art. 202/G is also known as Tecnofix.

### Tapes

Sealants: Provide ALP tapes, as documented:

- Over external joints: ALP Art. 201 adhesive aluminium tape.
- Between flanges: ALP Art. 204 adhesive plastic foam gasket.
- Anti-condensation tape: If there is a risk of condensation, provide ALP Art. 516 anti-condensation tape on profiles and flanges. Apply tape over the profiles.

## 2.9 SHEET METAL DUCTWORK

### Material

Rigid aluminium ductwork is covered in AS 4254.2. It may be used for special purposes e.g. clean room conditions where the cleaning agent may affect the galvanized coating of steel and other materials such as stainless steel may be too expensive. Specify extent in **Ductwork schedule** or on the drawings.

Stainless steel ductwork is covered in AS 4254.2. It may be used for special purposes such as laboratory exhaust or clean rooms, where the extra cost is acceptable. Specify extent in **Ductwork schedule** or on the drawings.

Galvanized steel duct and steel components less than 3 mm thick: Prime quality lockforming galvanized steel to AS 1397 Grade G2 or G3 to AS 2338 with Z275 coating to AS 1397.

AS 4254.2 covers galvanized steel, stainless steel and aluminium ductwork. As it does not specify a material for galvanized ductwork, one is provided here.

Thickness: To AS 2338.

Components for stainless steel and aluminium ductwork: Use materials with corrosion resistance not less than that of the duct wall material.

AS 4254.2 provides only limited material specification for stiffening on ducts fabricated from these materials.

### Fasteners

Fastener materials and sizes are not included in AS 4254.2.

Selection: Conform to **Fasteners material table**.

Rivets: Minimum size:

- For sheet metal to sheet metal: 3 mm.
- For sheet metal to supports, brackets and rolled steel angles: 4.8 mm.

Self-drilling and tapping screws: Provide only if base material into which they screw is thicker than 1.5 mm and they are unlikely to be removed or replaced.

Washers: Provide washers under nut and bolt heads.

#### Fasteners material table

Type	Galvanized steel duct	Aluminium duct	Stainless steel duct
Rivets	Expanding solid end type, aluminium base alloy	Expanding solid end type, aluminium base alloy	Stainless steel
Self-tapping screws	Zinc-plated steel	Stainless steel	Stainless steel
Self-drilling and tapping screws	Zinc-plated steel	Stainless steel	Stainless steel
Bolts, nuts washers and drop rods	Zinc-plated steel, service condition number 2	Stainless steel. Exception: Parts not in contact with air stream or corrosive conditions may be zinc-plated steel, service condition number 2	Stainless steel. Exception: Parts not in contact with air stream or corrosive conditions may be zinc-plated steel, service condition number 2

#### Drawbands

Material: Select from the following:

- Metallic-coated steel or stainless steel worm drive hose clamps.
- Metallic-coated steel or stainless steel packaging binders tensioned with a proprietary device designed for the material used.

This clarifies AS 4254.1 clause 1.4.3. which also includes plastic and nylon drawbands. US research indicates that plastic drawbands may fail prematurely.

#### Duct sealing

For Class 1 buildings, the minimum seal class to BCA 3.12.5.3 is class C to AS 4254.2. For Class 2 to 9 buildings, BCA J5.6 only requires sealing of systems over 3000 L/s. As BCA 3.12.5.3 requirement is a reasonable minimum, this worksection applies it to all systems.

See AS 4254.2 clause 2.2.1(h) Note which advises that the sealing requirements of the standard do not deal with chemical attack, submersion, etc.

Duct seal class: Not lower than Class C to AS 4254.2 Table 2.2.1 regardless of air quantity, duct pressure or location.

Class B requires sealing of all transverse joints and seams whereas Class C (under 500 Pa) requires sealing of transverse joints and longitudinal seams only for 50 mm from the end of each piece of duct.

Extent of sealing:

- If AS 4254.2 requires use of duct sealant throughout, apply sealant to the full length of all joints so no gaps or holes remain through which air might leak.

This clarifies AS 4254.2 Table 2.3(H). For example, drive slip joints must have sealants the full length of each slip, not just at corners.

- Seal all holes, gaps and other openings in ductwork including, but not limited to branches, access doors, access panels, and connections to equipment.

This clarifies the requirement of BCA J5.6.

- Seal as specified for ductwork all associated air handling equipment including but not limited to air handling units, fan coil units, diffusers and grilles, plenum and cushion head boxes, terminal equipment including VAV terminals and chilled beams.
- Seal holes for pipes, conduits, cables and rotating shafts including damper shafts.

Sealant materials: Use only sealants that:

- Do not foster microbial growth.
- Have a Smoke-Developed Index less than 3 and a Spread-of-Flame Index of 0 tested to AS/NZS 1530.3.
- Will maintain their sealing performance for the life of the duct system.

- Bond to the surface of application without primers.
- Are resistant to oils, refrigerants and water after curing.
- Are non-toxic.
- Have high elastomeric properties over the range of operating temperatures after curing.
- Are suitable for application by gun or hand tools.

The requirement that sealants not foster microbial growth is consistent with AS/NZS 3666.1.

Duct tapes: Do not use duct tape as the primary duct sealing agent. Use only as a secondary sealant on joints sealed by other means such as mastic, liquids or gaskets. Do not use duct tapes for non-sealant purposes.

This paragraph puts into effect a requirement that adhesive tapes shall not be used as the primary sealing agent. It also prohibits misuses of duct tape such as to support flexible duct and tie cables together.

Machine rolled flanges: Seal holes at corners.

Machine rolled flanges: AS 4254.2 omits this sealing requirement for machine rolled flanges but includes it for other similar types that leave holes at corners such as drive slip.

Chapter 21 of the ASHRAE Fundamentals provides analysis of duct leakage issues.

## 2.10 PVC-U DUCTWORK

### Material

Fire hazard properties: To AS 4254.2 clause 2.1.2.

Sheet:

- External applications: Pressed grey PVC-U sheet with UV inhibitors.
- Internal applications: Extruded grey PVC-U sheet with or without UV inhibitors..

Round ducts: PVC-U pipe, with UV inhibitors for external applications.

### Sheet stiffening

General: Attach stiffeners on edge, at 600 mm maximum centres. If necessary, provide additional stiffening to prevent flexing, drumming or sagging.

Material: Same as duct.

### PVC-U ductwork thickness and stiffening table

Round duct diameter (mm)	Rectangular duct longest side (mm)	PVC-U sheet thickness (mm)	Rectangular duct stiffening (mm)	Flange width(mm)	Flange thickness (mm)
≤ 400	≤ 400	3	-	25	4
> 400, ≤ 600	> 400, ≤ 600	4	-	30	6
> 600, ≤ 750	> 600, ≤ 680	4.5	-	40	6
> 750, ≤ 900	> 680, ≤ 750	5	-	40	6
> 900, ≤ 1200	> 750, ≤ 1050	6	-	40	8
> 1200, ≤ 1500	> 1050, ≤ 1300	6	40 x 5	40	8
> 1500, ≤ 2100	> 1300, ≤ 1800	6	50 x 5	50	10

### Welding

General: Continuously weld joints, including seams, stiffeners, flanges, and corners of fabricated bends, tees and fittings. Weld stiffeners on both sides. Back weld slip socket joints.

Butt welding: Vee type. Use hot air equipment.

- Thickness ≤ 4 mm: One run of 3 mm welding rod.
- Thickness > 4 mm: Triple welding rod or 3 runs of 3 mm welding rod.

Locations inaccessible for butt welding: Solvent weld, with continuous PVC-U H-section jointing sockets, heat formed for round duct cross joints.

**Bending**

Requirement: Immediately before bending sheet material, heat both sides to avoid thinning and high stress concentrations. Heat bend corners of rectangular ductwork to an inside radius equal to the material thickness, or 5 mm, whichever is the greater.

**Seams**

Requirement: Minimise longitudinal seams. Locate welded seams away from corners, preferably in the middle of a short side.

**Cross joints**

Flanged: Weld flanges to ductwork and connect using 6 mm diameter bolts at 25 mm maximum centres. Provide soft PVC gaskets or non-setting compound resistant to the duct's internal and external environmental conditions.

Slip sockets: Heat form sockets or form by welding PVC-U collars on to adjoining duct sections. Solvent weld overlapping duct sections before back welding.

**Fittings**

Material: The same material as the duct.

Joints: Welded.

Lobster-back bends: Fabricate bends for round ductwork from at least 5 segments, butt welded, with centreline radius at least 1.5 times the duct diameter.

**Dampers**

Requirement: Fabricate parts within ducts from PVC-U.

**Supports for PVC-U ductwork**

Requirement: Do not fix self-tapping screws into the duct.

**2.11 FLEXIBLE DUCT****ALPactive ductwork systems**

Requirement: Provide only ALP ALPactive Antimicrobial flexible duct for use with ALP ALPactive ductwork systems.

**Materials**

Refer to AS 4254.1 for details of flexible duct jointing, supports and bend radius.

Make sure drawings show realistic flexible duct lengths and bend radii consistent with AS 4254.1.

Duct types include plain, with options and combinations for acoustic insulation, thermal insulation and fire-resisting. Some types of flexible duct use a zinc-plated steel helix that is exposed to the air stream. This will corrode rapidly if the duct carries moist air, e.g. bathrooms and wet areas. AS 4254.1 clause 2.3.1 mandates corrosion resistant materials for these situations.

Uninsulated flexible duct: Select from the following:

- Aluminised fabric clamped on a formed metal helix. Do not use adhesives. Reinforce lap joints in the fabric.
- Coated steel wire laminated between two layers of aluminised polyester fabric using fire-resisting adhesive. Reinforce lap joints in the fabric.

The contractor chooses which suits (often, but not always, on price). Alternatively, delete one or the other, if a particular product type is required.

Flexible ducts used for air containing free moisture: Locate supporting helix outside airstream.

Insulated flexible duct: As for uninsulated flexible duct with flexible blanket insulation wrapped around duct and covered with an outer vapour barrier and as follows:

- Insulation joints: Lap insulation at least 50 mm at longitudinal and transverse joints.
- Minimum insulation R-Value ( $\text{m}^2\cdot\text{K}/\text{w}$ ): To BCA J5.5.

Conformance to BCA J5.5 meets mandatory energy requirements but may not be adequate to prevent condensation on ducts. See NATSPEC TECHnote DES 005 for more information. BCA J5.5 requires a minimum insulation R-Value of 1.0, equivalent to about 50 mm of fibreglass.

- Insulation material: Conform to *0744 Ductwork insulation*.

See NATSPEC TECHnote DES 031 for information on specifying R-Values.

## 2.12 KITCHEN EXHAUST DUCTWORK

### Standard

Requirement: To AS 1668.1.

See in particular AS 1668.1 clause 6.2.3.

### Construction

See AS 1668.1 Section 6. Consider specifying stainless steel for the initial 6 m length of dishwasher exhaust duct.

Ductwork: Do not crossbreak.

Grading: To AS 4254.2 and AS 1668.1.

i.e. 1 in 200.

Joints: Seal to AS 4254.2 clause 2.2.2.

Access panels: Provide access panels in the locations requiring liquid-tight cleanouts to AS 4254.2 and in addition at:

- The bottom of kitchen exhaust risers.
- Adjacent to sprinkler heads and duct sampling units inside the duct.

Drains: Provide a grease gutter and DN 25 drain socket and plug as follows:

- At the lowest point of each run of ducting.
- At the bottom of vertical risers.

Spark arresstance: To AS 1668.1 clause 6.2.9.

This requires spark arresstance to UL 1046 if the cooking process appliance produces flame or embers.

## 2.13 FIRE PROTECTION OF DUCTWORK

See AS 1668.1 clause 2.3. For subducts see clause 3.6.

Show fire resisting ductwork on the drawings and show where ductwork penetrates a fire wall. See AS 1668.1 Section 3. For provision of duct sampling units (DSUs), see AS 1603.13 and coordinate with *1072 Fire detection and alarms* and *0752 Mechanical piping insulation*.

The application of fire-resisting material to equipment items requires detailed attention. In particular, consider the following:

Because sprayed and trowelled on finishes are dry and rigid they may impair the effectiveness of flexible duct connections and dampers.

Fire-resisting material that is applied wet is extremely heavy until dry. It can cause large ducts to collapse if additional support is not provided while it is drying.

If the duct is fire-resistance rated, access panels must also be fire-resistance rated. Consider detailing duct access on the drawings.

Large items of plant present a particular problem in terms of access if fire-resistance level is to be maintained. If the items are merely sprayed, fan casing access panels may be rendered useless and the only way to remove the item is to remove all fire-resistance first. In practice this may not be replaced, rendering the system non-compliant. Consider housing the items in fire-resisting rooms or enclosures so the whole of the fan or item can be accessed or removed.

If AS 1668.1 or NCC require a duct system to be fire-resisting, that fire-resistance rating also applies to fans in the system unless they have been tested and certified to be fire-resisting. Few fans meet this testing requirement, so most fans in fire-resisting ductwork require fire-resisting coatings or enclosures.

See also AS 1668.1 Section 6 in relation to kitchen hood exhaust systems and plant.

### Sprayed coatings

Type: Fire-resisting sprayed coating to achieve the required FRL. Provide additional cement hard set finishing coat in locations requiring protection against damage or water.

Available materials include vermiculite and gypsum coatings and intumescent paint.

### Composite systems

Type: Wraps or modular duct systems to achieve the required FRL.

### Access

Fire damper access: Where access is required to the duct interior such as at fire damper access panels and damper quadrants, provide easily removable panels of FRL equivalent to the required FRL of the duct.

Exhaust fan access: For items such as smoke exhaust and kitchen exhaust fans that are too large or heavy to remove through access panels, provide a fire-resisting enclosure around the item with fire-resisting doors or removable fire-resisting panels large enough to permit removal of the item.

## 2.14 FLEXIBLE CONNECTIONS

### ALP ductwork system

Requirement: Provide only ALP flexible connections for use with ALP ductwork.

#### General

Requirement: Isolate fans and air handling unit casings from ductwork, by means of airtight flexible connections.

Materials:

- Generally: ALP Art. 505.
- In kitchen exhaust ductwork: To AS 4254.2 clause 2.1.3.

Length: Provide enough slack to allow free movement and vibration isolation under operating and static conditions.

Alignment: Align openings of connected equipment.

Fixing: Fix to attachments with metallic-coated steel strip. Seal joints. Do not paint flexible material.

Fire protection: To achieve the FRL of the attached duct.

Maintenance: Arrange to permit easy removal and replacement without disturbing ductwork or plant.

Restriction: Do not protrude connections or frames into the airstream if this would be detrimental to the air flow.

## 2.15 DAMPERS – GENERAL

### Location

Balancing dampers: Provide at each branch duct or tee, as follows:

- Splitter type: Use only for supply branches up to 300 mm maximum dimension and with velocity in main duct less than 10 m/s. Do not use on return or exhaust ducts.

This is consistent with AS 4254.2 Figure 2.3 (H). Splitter dampers are ineffective in converging air flows in return and exhaust systems hence the prohibition on their use such situations.

- Opposed blade dampers: Use for any size supply and for all return and exhaust ducts. Locate in each branch.

Although this clause clarifies location of dampers it is advisable to also show locations on the drawings.

Dampers for grilles and diffusers are covered in 0746 Air grilles.

## 2.16 VOLUME CONTROL DAMPERS

Consider specifying acceptable air leakage.

### General

Requirement: Provide dampers which are free of rattles, fluttering or slack movement and capable of adjustment over the necessary range without excessive self-generated noise or the need for special tools.

Materials: To **Corrosion resistance** and the **Corrosion resistance table**.

Dampers required by AS 1668.1: To AS 1682.1.

These are referred to as air dampers in these standards.

Face dimensions: Duct size.

Connections: Mating angle flanged cross joints.

Frames: 1.6 mm minimum thickness metallic-coated steel or 2 mm minimum thickness aluminium folded to form channel sections at least 150 mm wide and welded at corners.

Dampers required to provide tight shut-off: Conform to the following:

- Side seals: Aluminium or stainless steel.
- Blade tip seals: Neoprene or silicone rubber.
- Leakage:  $\leq 25 \text{ L/s.m}^2$  at 1.5 kPa pressure differential.
- Bearings: Sealed-for-life ball bearings only.



- Drive shafts: Keyed, square or hexagonal.

Dampers in smoke-spill systems: Metallic-coated steel or stainless steel blades and frames.

### Blades

Material: Metallic-coated steel, aluminium or stainless steel.

Form: No sharp edges. Sufficiently rigid to eliminate movement when locked.

Minimum thickness:

- Metallic-coated sheet steel and stainless steel:
  - Single thickness blades: 1.6 mm.
  - Double thickness blades: 1.2 mm.
- Aluminium:
  - Single thickness blades: 2.4 mm.
  - Double thickness blades: 1.8 mm.

Maximum length: 1200 mm. If necessary, provide intermediate mullions.

Single blade dampers:

- For single thickness blades: 600 mm maximum length, 600 mm maximum width or 600 mm maximum diameter.
- For single thickness blades with 6 mm minimum edge breaks: 1200 mm maximum length x 175 mm minimum width.
- For double thickness blades: 1200 mm maximum length x 300 mm minimum width.

Multi-blade dampers:

- For single thickness blades with 6 mm minimum edge breaks: 1200 mm maximum length 175 mm minimum width.

### Bearings

Type: Oil impregnated sintered bronze bearings, sealed-for-life ball bearings or engineering plastic sleeve bearings that do not require lubrication for the life of the duct system. If the operating temperature is more than 50°C, provide sealed-for-life ball bearings only.

Housings: Rivet to damper frames.

### Spindles

Material:

- Stainless steel dampers: Stainless steel.
- Other dampers: Zinc-plated steel or stainless steel.

Construction: Securely fix to damper blades.

Minimum diameter:

- Blade lengths  $\leq$  600 mm: 10 mm.
- Blade lengths  $>$  600,  $\leq$  1200 mm: 12 mm.

### Linkages

Fixing: Fix securely to blades so that the blades rotate equally and close tightly without slip.

### Damper adjustment

Requirement: Provide a way to adjust the damper and lock it in position. Locate in an accessible position. Label the open and closed positions clearly and permanently.

## 2.17 SPLITTER DAMPERS

### Construction

Standard: Fabricate to AS 4254.2 Figure 2.3 (H) with a minimum length 1.5 times the width of the larger branch.

Push rods: 5 mm diameter on 600 mm centres with screw locking bushes to fix position.

## 2.18 MOTORISED DAMPERS

Show the motor location on the drawings. Consider motor operating torque, relative to the area of the damper.

Reference this clause if specifying proprietary air handling units where airtight damper shut off is essential.

For aggressive atmospheres not included in the **Corrosion resistance table** such as swimming pool exhaust consider stainless steel construction.

Motorised dampers that form part of a system complying with AS 1668.1 that are not fire or smoke dampers but required to operate in fire mode require special attention. Consider the following:

Material: Aluminium dampers in smoke spill systems are unlikely to meet the temperature limits (temperature of fusion greater than 1000°C). Given that the dampers may operate rarely, galvanized dampers may not close and seal properly due to corrosion. Consider stainless steel construction.

Access for inspection: AS 1851 requires six-monthly inspection. The dampers and automatic controls must also be accessible.

Seals: This clause requires seals although AS 1668.1 and AS 1668.2 do not. The absence of seals may make achieving required pressures difficult.

### Construction

Requirement: To **VOLUME CONTROL DAMPERS** and the following:

- Side seals: Aluminium or stainless steel.
- Blade tip seals: Neoprene or silicone rubber.
- Leakage:  $\leq 25$  L/s.m<sup>2</sup> at 1.5 kPa pressure differential.
- Bearings: Sealed-for-life ball bearings only.
- Drive shafts: Keyed, square or hexagonal.

### Control characteristics

Flow characteristics: Linear flow relative to damper motor drive shaft rotation.

Type:

- Outdoor air/return air mixing dampers: Parallel blade type with air streams directed towards each other.
- Face and bypass dampers: Parallel blade type with air streams directed towards each other.
- Other modulating dampers: Opposed blade type.
- Two position shutoff dampers: Parallel or opposed blade type.

## 2.19 NON-RETURN DAMPERS

### Construction

Requirement: Conform to **VOLUME CONTROL DAMPERS**. Counterweight the assembly so that it:

- Offers minimum resistance to air flow.
- Closes by gravity.

## 2.20 FIRE AND SMOKE DAMPERS

Specify maximum pressure drop, rating and thermal link release temperature.

See AS 1668.1 clause 2.5, which specifies AS 1682.1 and AS 1682.2. AS 1682.2 is referenced also in AS 4254.2.

Drawings should provide sufficient information for the contractor to select damper size, FRL and provide other information required by AS 1682.2 Appendix A.

AS 1682.2 Appendix D suggests information to be supplied by purchasers.

Make sure dampers are located and access panels provided so that inspection and reset to AS 1851 is possible.

AS 1682.1 requires that metal fire and smoke dampers be installed with a gap all round to permit expansion (e.g. height of opening = 1.01 x height of dampers + 10 mm). Gaps are not required if the damper (e.g. intumescent type) has been tested to AS 1530.4 without them.

AS 1668.1 permits intumescent dampers to take longer to close fully under test (120s) than acceptable for mechanical dampers.

Lintels will be required in brick and block construction. Coordinate with building trades.

Consider detailing special installation arrangements where damper is immediately below a slab (flange on top must be fixed to suitable material attached to the slab) and where dampers are immediately next to each other (gap must be filled and sealed to meet the standard). Additional framing may be required.

### General

Specification: To AS 1682.1.

Fire damper type: Mechanical or intumescent, as documented.

Type may be documented in the **Fire and smoke damper schedule**. Edit if only one type is permitted, otherwise contractor to choose.

Requirement: Provide free cross section area at least 85% of the face area. Provide oversize damper and enlarge duct both sides of damper if necessary to achieve this.

Material: As documented in the **Fire and smoke damper schedule**.

## Links

AS 1682.1 specifies AS 1890.

Mechanical fire dampers: Provide frangible bulb or fusible links.

Smoke dampers: Provide fusible links activated by either local heat or a low power external electrical impulse.

Installation: Mount for easy replacement.

### Access panels

General: Provide for maintenance of dampers and replacement of links.

## 2.21 SUBDUCTS

### General

See AS 1668.1 clause 3.6 and Figures 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9 and 3.10 for typical installation details. Since subducts can cause significant pressure drop both within the subduct itself and by obstructing the riser into which it is inserted, consider detailing radius back bend, fairing and/or enlarging the riser at the subduct. Make sure that the details conform to the requirements of AS 1668.1.

Standard: To AS 1668.1.

Material: Same as connecting ductwork or shaft.

## 2.22 ACCESS OPENINGS – LOCATION

The provision of adequate access is critical to the life and effectiveness of mechanical systems. It is also required to meet mandatory requirements for inspection and maintenance such as in AS/NZS 3666.2 and AS 1851.

See also 0171 *General requirements*.

The location of duct access panels should be coordinated with the location of the building work access (e.g. ceiling access openings) so that the intended access is possible and can be effected safely. In some cases it may be possible to coordinate with ceiling access provided for other services so that fewer ceiling access openings are required but the fundamental reason for providing the ceiling access, inspection and maintenance, must still be achievable. See AIRAH HVAC Hygiene Best Practice Guideline for recommendations related to cleaning and inspection.

### Access doors

Location: Provide an access door in each section of air handling units where access is required for maintenance, inspection or removal of components. Removable panels may be used instead of doors where access is required only for removal of coils.

### Access panels

Location: Conform to the following:

- Next to each component located inside the duct requiring regular inspection and maintenance including, but not limited to:
  - . Fire and smoke dampers.
  - . Smoke detectors.
  - . Motorised dampers.
  - . Filters.
  - . On the air entering side of electric duct heaters.
  - . On the air entering side of duct mounted heating coils.
- In air handling units where unit size is insufficient to fit an access door.
- As documented in **KITCHEN EXHAUST DUCTWORK**.
- In the vicinity of moisture producing equipment, to AS/NZS 3666.1 clause 2.11.3.
- In other documented locations.

## 2.23 ACCESS PANELS

### ALP ductwork system

Requirement: Provide only ALP supplied access panels for use with ALP ductwork.

### Sizes

Access panels: Minimum clear opening:

- Personnel access: 450 x 600 mm.
- Hand access: 200 x 300 mm.

The smallest size, 200 mm x 300 mm, typically requires at least a 250 mm wide duct and will not fit in narrower ducts. Consider other sizes, even L shaped screw-on panels, for small ducts.

For fire dampers the size and location of the panel in small ducts must be such that the damper can be released and reset with one hand and out of sight. Consider requiring the contractor to demonstrate that this is possible with the fire damper and access panel combination offered.

### Construction

Type: Double panel, deep formed, zinc-coated steel construction, insulated to match the duct, or filled with at least 25 mm glass wool or rock wool insulation.

Cold bridging: Arrange to prevent condensation on cold surfaces.

Frames: Provide rigid matching galvanized steel frames securely attached to the duct. Do not protrude any part of the panel or frame into the airstream.

Seals: Mechanically fixed to either the panel or the frame for an airtight seal against the operating pressure when latched in the closed position. Use a fixing method that permits easy replacement.

Conform to the following:

- Fire-resisting seals: Woven ceramic fibre material.
- Other seals: Silicone rubber or soft neoprene.

Latches: Wedge type sash latches.

Number of latches:

- For personnel access: 4.
- For hand access: 2.

Handles: Provide a D handle on access panels for personnel access.

## 2.24 ACCESS DOORS

### ALP ductwork system

Requirement: Provide only ALP supplied access doors for use with ALP ductwork.

### Construction

General: Provide rigid, reinforced access doors.

Thickness:  $\geq 50$  mm.

Construction: Provide either:

- Sandwich panel: As documented for wall and ceiling panels. Form door edging with a heavy gauge aluminium extrusion with double web seal to both skins. Mitre corner and firmly secure to panel with countersunk head screws.
- Folded: Two-piece press formed or machine folded from zinc coated steel at least 1.6 mm thick.

Size: 1350 mm high x 600 mm wide clear opening or larger dimensions if:

- Necessary to permit safe removal of equipment inside the section, or
- Chamber: To BCA G1.2 in which case the minimum clear opening is 1500 mm high x 600 mm wide.

For a chamber required to meet BCA G1.2 the minimum clear door size is 600 mm wide by 1500 mm high.

Door swing: Except where the pressure differential would require an excessive force to open the door, swing doors against air pressure as follows:

BCA G1.2 requires that such doors be capable of being opened by hand from inside without a key but does not nominate a maximum permissible force. AS 1668.1 clause 4.7 limits the force for fire doors to 110 N at the door handle. Local WHS regulations may give other values.

- Doors on the inlet side of the fan: To open outwards
- Doors on the discharge side of the fan: To open inwards.

This reduces the risk of injury when the latch is released and provides a more effective seal. Depending on the pressure of the system, emergency fan switches or similar unit may also be required inside the to prevent people being trapped if they cannot open the door against the air pressure.

Cold bridging: Arrange to prevent condensation on cold surfaces.

Jamb, stiles and head: Rigid matching  $\geq 2.5$  mm zinc coated steel, or  $\geq 3.0$  mm PVC-U or fibreglass securely mounted.

PVC-U or fibreglass for reduced cold bridging in critical locations.

Door hardware:

- Catches: Provide at least 2 heavy duty proprietary clamping-type latches with permanently attached handles that can be operated from both the inside and the outside of the door. Provide satin chrome plated finish to exterior components.
- Hinges: Hang doors on edge-mounted, rising butt type self-closing hinges capable of holding the door fully open. Construct from chrome plated brass or heavy duty aluminium alloy. Provide stainless steel hinge shaft and nylon bearing surfaces.
- Installation: Securely bolt hardware to the door and frame by a method which minimises cold bridging and prevents the forming of condensation on the outside of the air handling unit.

Seals: Mechanically fix to the door to create an airtight seal when the latched is closed. Use a fixing method that permits easy replacement:

- Fire-resisting seals: Woven ceramic fibre material.
- Other seals: Silicone rubber or soft neoprene.

Insulation: Construction and insulation properties including material R-Value to match the insulation of the duct, plenum or casing in which the door is located.

## 2.25 ELECTRIC DUCT HEATERS

### General

See AS 1668.1 clause 2.7. AS/NZS 3102 is cited in AS/NZS 3000 clause 4.11 and is mandatory.

AS/NZS 3000 is referenced in 0171 General requirements.

AS/NZS 3102 covers the design and installation of duct heaters including insulation and safety controls.

Fins should not be mechanically fixed. Specify fin rating, e.g. 20 W/m<sup>2</sup> (conservative).

Standards: To AS/NZS 3102 and AS 1668.1.

Elements: Sheathed in steel or nickel alloy. Provide brazed spiral steel fins.

Connections: Connect the elements in each heater bank so that the load is balanced over the three phases. Earth cover plate and frame.

Frames: Assemble elements in a metal frame with terminal connections in an enclosed terminal box.

Heating section: Install to allow access to the terminal box and removal of the assembly without disturbing other components.

Fin rating: < 20 W/m<sup>2</sup>.

Heat distribution: Provide uniform heating across the duct cross section.

Maximum temperature air rise across the heater: 7.5 K at the maximum supply air flow rate.

Airflow: Maintain uniform air velocity across the duct cross section.

Velocity: Between 2 m/s and 5 m/s.

Electrical connection: Permanent electrical connection to the heater.

AS/NZS 3102 also permits connection by means of socket outlet.

## 2.26 KITCHEN HOODS

See AS 1668.1 Section 6, for hoods which service appliances likely to generate grease vapour.

Keep fan motors out of the air stream to avoid grease build-up and fire hazard (fine oils are not arrested by standard filters).

### Standards

Requirement: To AS 1668.1 and AS 1668.2.

### Materials

Material: As documented, and as follows:

Show material in the **Kitchen hood schedule** or on the drawings.

- Stainless steel: 1.2 mm thick, 2B finish. Continuously weld seams. Grind the weld smooth and polish affected areas.
- Metallic-coated steel: Metallic-coated sheet Z275/AZ150.

Metallic-coated steel may be an acceptable for economy projects or where there is relatively little use of the hood.

### Volume dampers

General: If there is more than one duct take off, provide a volume damper at each duct take off. Adjust dampers for uniform air flow over the face of the hood.

## Luminaires

General: Provide access doors for the installation of luminaires.

Glass panels: Heat resistant and sealed to the hood with gaskets, to prevent entry of grease and moisture but allowing thermal expansion.

## 2.27 FUME CUPBOARDS

This clause is for typical simple fume cupboards e.g. for schools. Edit to suit project requirements e.g. materials, services and additional features such as scrubbers.

### Type

Requirement: Non-recirculating fume cupboards to AS/NZS 2243.8.

For recirculating type fume cupboards, see AS/NZS 2243.9.

Arrangement: Single sided or double sided, as documented.

### Standards

Safety in laboratories: To AS/NZS 2243.1.

Hazardous areas: To AS/NZS 60079.10.1.

Fume cupboards: To AS/NZS 2243.8.

### Fans

Requirement: To **FUME CUPBOARD FANS** in *0731 Fans*.

### Construction

Materials and fabrication: To **PVC-U DUCTWORK**.

Shell and interior generally: Welded PVC-U.

Work surface: One piece welded PVC-U.

Sash: Vertically sliding toughened glass or clear acrylic  $\geq 6$  mm thick with stainless steel sash cords and corrosion resistant counterweights. Arrange so sash stays in place at all stopped positions.

Double sided fume cupboards:

- Interlock sashes so both cannot be open at the same time.
- Provide control panel and service valves on both sides.

Fixed minimum opening: 50 mm.

Finish of internal fixtures and components: Of corrosion and solvent resistance not less than the material of the shell and interior.

### Ductwork

Material: PVC-U to **PVC-U DUCTWORK** or stainless steel Type 316 to **SHEET METAL DUCTWORK**, as documented.

Make sure the material has long term resistance to the substances used in the fume cupboard. Include duct material in **SELECTIONS, DUCTWORK, Fume cupboard schedule**.

Installation: Minimise horizontal duct runs. If horizontal ducts are unavoidable, slope downwards in the direction of air flow to trapped drain points.

Damper: Provide a lockable damper in each system for air flow adjustment.

Discharge: To AS/NZS 2243.8 clause 3.2.7.

### Drains

Location: Provide permanently connected drains for condensate removal at the lowest point of the fan casing and low points in ducts.

Construction:

- Material DN 50 PVC-U.
- Trap: Provide a removable water seal P-trap of sufficient depth to suit the duct pressure.

Discharge: Run drains to waste.

### Services

Requirement: Provide the following services integral to the fume cupboard and as documented:

The following are typical requirements. See also **SELECTIONS, DUCTWORK, Fume cupboard schedule**.

- Lighting: One separately switched fluorescent luminaire (flame proof, vapour sealed and corrosion proof) to provide 400 lux at the work surface.

- Power: Locate socket outlets outside the chamber.
- Waste treatment: Provide an acid neutralising tank and pass waste through it.

### Controls

Requirement: Provide the following outside the chamber:

- Separate fan and light controls.
- Controls for water and gas services.
- Automatic fan speed control to maintain constant face velocity at all sash opening heights.
- Labelled emergency isolation switches for electricity and gas.
- Automatic isolation of electricity and gas in the event of inadequate air flow.

## 3 EXECUTION

### 3.1 DUCTWORK INSTALLATION

#### Arrangement

Ductwork: Arrange ductwork neatly. Provide access to ductwork components which require inspection, entry, maintenance and repairs to *0171 General requirements ACCESS FOR MAINTENANCE*. Where possible, arrange duct runs adjacent and parallel to each other and to building elements.

#### Spacing

Requirement: Provide minimum clear spacing, additional to duct insulation, as follows:

- 25 mm between adjacent ducts.
- 25 mm between duct flanges or upper surfaces of ducts and undersides of beams and slabs.
- 50 mm between ducts and electric cables.
- 150 mm between ducts and ground, below suspended floors.

#### Flexible duct

Pressure loss in flexible duct increases dramatically if it is not fully extended. Research has shown that at 70% extension, the pressure drop is almost 10 times that of fully extended flexible duct. Even at 90% extension, the pressure drop is around 3 times that of fully extended flexible duct. Not fully extending flexible duct can be a major cause of air balancing problems, energy waste and increased greenhouse gas emissions.

General: Install flexible duct as straight as possible with minimum number of bends. Maximise bend radius but not less than required by AS 4254.1 clause 2.5.3(i).

This is a throat radius greater than the duct diameter.

Cutting to length: make sure the inner core is fully extended before cutting. Cut to this length. Do not leave excess lengths of flexible duct for possible future relocation of air terminal devices.

This repeats the often ignored requirements of AS 4254.1 including clause 2.5.3 (j).

Joints: Securely fix flexible duct to rigid spigots and sleeves using sealant and draw band encased in tape as detailed in AS 4254.1. If used, place mastic between the flexible and rigid duct, not as a fillet.

Support: To AS 4254.1. Limit sag to less than 40 mm/m.

Sag exceeding 40 mm/m indicates that the flexible duct is not fully extended.

Maximum length of flexible duct sections: 6 m including the length of any rigid duct or sleeves used to join lengths of flexible duct.

Substitution: If rigid duct is shown on the drawings do not substitute flexible duct.

#### Fire and smoke dampers

Installation: To AS 1682.2.

#### Motorised dampers

Maintenance access: Locate dampers and damper motors in accessible positions, for blade and motor maintenance and blade seal replacement.

Mounting: Sufficiently rigid to prevent flexing or distortion of the frame or ductwork during operation.

Operation: If 2 sets of dampers are connected to a single motor, provide linkages which allow either damper to be adjusted without affecting the other.

**Cleaning**

Requirement: During installation progressively remove construction debris and foreign material from inside ducts.

**Drainage**

Requirement: Provide drainage to AS/NZS 3666.1 at locations in ductwork where moisture may accumulate including at outside air intakes.

**Ductwork exposed to weather**

Requirement: Conform to the following:

- Seal all parts of all ductwork joints.
- Provide watertight protective shields over joints.
- Seal all duct supports where they attach to the duct.
- Seal all reinforcement attachments so that moisture is not retained in any gap or crevice.
- Profile or cover the top side of ductwork to shed water.

**3.2 ALP DUCTWORK INSTALLATION****Fire dampers in ALP ductwork**

Requirement: Install to AS 1682.2 and ALP recommendations, including the use of F profile extrusions.

**Duct supports**

Support spacing: To *ALP Hanging systems and methodology* and DUCTUS recommendations.

Because ALP ducting is lighter and comes in longer lengths than sheet metal, fewer supports are needed.

The *ALP Hanging systems and methodology* document is available from DUCTUS.

Support brackets: Select from the following, installed to DUCTUS recommendations:

- ALP Art. 503 screwed duct support brackets.
- ALP Art. 504 self-adhesive duct supports.
- Proprietary metallic-coated steel channel section support system.

e.g. Unistrut.

**Seismic restraint**

Requirement: To **Seismic restraint of non-structural components** in *0171 General requirements*.

Certification: Provide certification that the ALP ductwork resists the lateral and longitudinal earthquake demand loads.

Contact DUCTUS for a test report which indicates that the ALP system, using Grippe supports, was shown to be capable of resisting the earthquake demand loads of 3.6g, determined in accordance with NZS 4219. The seismic resistance of the system is dependent on the duct size, layout, support spacing, supports used and will be project specific. Input from a seismic specialist is required.

**3.3 LEAKAGE TESTING**

AS 4254.2 clause 2.2.4 mandates leakage testing of all systems with a capacity of 3000 L/s or greater. The standard does not mandate a method of testing so this clause draws on overseas standards to address these matters.

**Standard**

Leakage testing methods: Select from the following:

- ANSI/SMACNA 016.
- The Building and Engineering Services Association publication B&ES DW/143.

B&ES DW/143 is referred to in a note to AS 4254.2 clause 2.2.4. The Building and Engineering Services Association was previously known as the Heating and Ventilating Contractors' Association.

Test pressure: To AS 4254.2

Maximum leakage rate under test: Less than 5% of the total design air quality of the duct system, times the ratio of the duct surface area under test to the total duct surface area of the system.

This addresses a potential area of dispute in the interpretation of AS 4254.2 as the standard could be interpreted as meaning that the 5% leakage applied to the section under test so if 10% was tested and it leaked 5%, applied pro rata, the leakage rate for the whole system could be up to 50%.



**Test method**

Amount of system to be tested: At least 10% of the total surface area of the system including a pro-rata proportion of the following:

- Floor distribution, riser and plant room ducts.
- Each seam, joint and sealing construction type.
- Longitudinal seams.
- Circumferential joints.
- Rigid ductwork.
- Flexible ducts.
- Flexible connections.
- Diffusers grilles and other terminal devices.
- Air handling plant and plenums.
- VAV terminals and other duct mounted equipment.
- Supply, return, outside air and exhaust ducts.
- Builders' work risers used in lieu of ducts specified in this worksection.

This clarifies and extends the AS 4254.2 requirements. Since AS 4254.2 relates only to rigid ducts, its requirements might be interpreted as excluding, e.g. flexible ducts, air handling plant, grilles and diffusers. As the explicit objective of the standard is to reduce energy consumption and greenhouse gas emissions by reducing leakage, the above requirements make sure that the whole of the duct system is tested, not just the rigid ducts. Overseas research indicates that flexible ducts, diffusers and terminal devices are particularly susceptible to leakage.

Although the list above includes builders' work risers, it does not include plenum ceilings and other builders work items because they can be problematic contractually. Consider extending the list to include these as they can be a significant source of leaks.

Duration of the test: Maintain the test pressure within  $\pm 5\%$  for at least 5 minutes.

Instrumentation: Conform to *0791 Mechanical commissioning*.

Leakage flow rate measurement: Use only instruments that have current calibration certificates issued by an Accredited Testing Laboratory.

Maximum period since last calibration: As recommended by the manufacturer but not more than 12 months, except as documented.

Instruments:

- Accuracy: Better than  $\pm 5\%$  of measured value.
- Resolution: Better than 1% of measured value.
- Range: Measured velocity within 17% to 83% of the instrument calibrated range.

**Failure under test**

Requirement: If the leakage in the duct system exceeds the documented maximum leakage rate under test:

- Locate leaks and mark their position on the outside of the duct.

This is to facilitate inspection by the supervisor.

- Rectify leaks.
- Record the generic location of leaks and corrective action taken.
- Retest the system as above but with at least 20% of the total surface area of the system.

Repeat test: If the leakage in the duct system under retest exceeds the documented maximum leakage rate under test, retest with 100% of the total surface area of the system.

This is approach to retesting is in accordance with EUROVENT 2/2 clause 4.3.4.

**Leakage testing reports**

Requirement: Conform to **SUBMISSIONS, Tests**.

**4 SELECTIONS**

**Schedules** are a way of documenting a selection of proprietary or generic products or systems by their properties. Indicate their locations here and/or on the drawings. Refer to NATSPEC TECHnote GEN 024 for guidance on using and editing schedules.

## 4.1 DUCTWORK

### Ductwork schedule

Property	D1	D2	D3
Ductwork type			
Location			
Material			
Pressure class to AS 4254			
ALP panel R-Value			
ALP panel facing material, thickness and colour – external			
ALP panel facing material, thickness and colour - internal			

D1, D2, D3: These designate each instance or type of the item scheduled.

Ductwork type: e.g. Supply, return and exhaust, Operating theatre supply air, Kitchen exhaust, Fume cupboard exhaust.

Location: e.g. Inside the building, Outside the building.

Material: e.g. ALP Rectangular, ALP Round system, ALP ALPactive, PVC-u, Metallic coated steel.

ALP panel R-Value: e.g. 1.2, 2.0 3.0. Not required for ALP roundSYSTEM which is always 25 mm thick.

ALP panel facing material, thickness and colour – external/internal: Insert ALP facing material (aluminium, stainless steel, ALPactive) and details. Not required for ALP roundSYSTEM which is always 120 micron aluminium.

DUCTUS suggests the following facing material thicknesses:

Indoor locations: 60 micron external, 60 micron outside.

Plant rooms: 200 micron external, 80 micron internal.

Outdoor locations: 200 micron external, 80 micron internal.

Heavy duty applications: 500 micron external, 500 micron internal.

ALP panels are available in the following combinations:

R1.0: 60 micron Silver external, Black internal.

R1.2: 60 micron Silver external, Black internal.

R1.2: 80 micron Silver external, ALPactive internal.

R1.5: 80 micron Silver external, Silver internal.

R1.5: 80 micron Silver external, ALPactive internal.

R2.0: 60 micron Silver external, Black internal.

R2.0: 80 micron Silver external, ALPactive internal.

R2.0: 200 micron Silver external, 80 micron ALPactive internal.

R3.0: 200 micron Silver external, 200 micron Silver internal.

R3.0: 200 micron Silver external, 200 micron ALPactive internal.

R3.0: 500 micron Silver external, 200 micron Silver internal.

R3.0: 500 micron Silver external, 200 micron ALPactive internal.

Consider the following and expand if necessary to suit project:

Ductwork section.

Static pressure.

Mean air velocity.

Air leakage class.

#### Adapting the Ductwork schedule for design and construct projects

This may be used to specify permissible duct types included in this worksection, e.g:

Ductwork type	Material
Fume cupboard exhaust	Rigid PVC-U

Connections to supply diffusers	Flexible duct
All other ductwork	ALP panels

**Fire and smoke damper schedule**

Property	DM1	DM2	DM3
Location			
Fire damper type			
Fire damper material			

DM1, DM2, DM3: These designate each instance or type or location of the item scheduled.

Fire damper type: e.g. Mechanical or Intumescent.

Fire damper material: May be deleted if materials in **Corrosion resistance table** are suitable. See AS 1682.1 clause 2.3. Aluminium dampers are not suitable for smoke dampers because the temperature of fusion of aluminium is only around 650°C and AS 1668.1 clause 2.3.2 requires a temperature of fusion not less than 1000°C. Dampers in smoke spill and similar systems (including recycle air dampers) should be either galvanized or stainless steel. Consider stainless steel for:

- Less than 1 km from breaking surf.
- Less than 100 m from salt water not subject to breaking surf.
- Within industrial areas.
- Otherwise subject to aggressive atmospheres.
- Fume exhaust systems.
- Stainless steel duct.

**Kitchen hood schedule**

Property	KH1	KH2	KH3
Location			
Kitchen hood material			

KH1, KH2, KH3: These designate each instance or type or location of the item scheduled.

Kitchen hood material: e.g. Stainless steel, Metallic-coated steel.

**Fume cupboard schedule**

Property	FC1	FC2	FC3
Location			
Type			
Overall width mm			
Associated exhaust fan			
Ductwork material			
Services: Power and location			
Services: Water			
Services: Sink			
Services: Gas outlets			

FC1, FC2, FC3: These designate each instance or type or location of the item scheduled.

Location: Name or designation of room in which located.

Type: e.g. Single sided, Double sided.

Overall width: e.g. 1000 mm.

Associated exhaust fan: e.g. FCF 1.

Ductwork material: e.g. PVC-U, Stainless steel.

Services: Power and location: e.g. One double socket outlet located either at the external top or side of the chamber.

Services: Water: e.g. One gooseneck style cold water supply outlet the over sink.

Services: Sink: e.g. One conical cup sink, 200 mm diameter and 150 mm deep.

Services: Gas outlets: Insert number or Not required.

## REFERENCED DOCUMENTS

### The following documents are incorporated into this worksection by reference:

AS 1397	2011	Continuous hot-dip metallic coated steel sheet and strip - Coatings of zinc and zinc alloyed with aluminium and magnesium
AS 1530		Methods for fire tests on building materials, components and structures
AS 1530.2	1993	Test for flammability of materials
AS/NZS 1530.3	1999	Simultaneous determination of ignitability, flame propagation, heat release and smoke release
AS 1530.4	2014	Fire-resistance tests for elements of construction
AS 1668		The use of ventilation and air conditioning in buildings
AS 1668.1	2015	Fire and smoke control in buildings
AS 1668.2	2012	Mechanical ventilation in buildings
AS 1682		Fire, smoke and air dampers
AS 1682.1	2015	Specification
AS 1682.2	2015	Installation
AS/NZS 2243		Safety in laboratories
AS/NZS 2243.1	2005	General
AS/NZS 2243.8	2014	Fume cupboards
AS 2338	2004	Preferred dimensions of wrought metal products
AS/NZS 3102	2002	Electric duct heaters
AS/NZS 3666		Air-handling and water systems of buildings - Microbial control
AS/NZS 3666.1	2011	Design, installation and commissioning
AS 4254		Ductwork for air-handling systems in buildings
AS 4254.1	2012	Flexible duct
AS 4254.2	2012	Rigid duct
AS/NZS 60079		Electrical apparatus for explosive gas atmospheres
AS/NZS 60079.10.1	2009	Classification of areas - Explosive gas atmospheres (IEC 60079-10-1, Ed.1.0(2008) MOD)
SA/SNZ HB 32	1995	Control of microbial growth in air-handling and water systems of buildings
ALP Manual	2015	Technical manual for the construction of the ALP system ducts
ALP Round Manual	2015	ALP roundSYSTEM Pre-insulated circular air ducts - Fabrication manual
BCA G1.2	2019	Ancillary Provisions - Minor Structures and Components - Refrigerated chambers, strong-rooms and vaults
BCA J5.5	2019	Energy efficiency - Air-conditioning and ventilation systems - Ductwork insulation
EUROVENT 2/2	1996	Air leakage rate in sheet metal air distribution systems
ANSI/SMACNA 016	2012	HVAC Air Duct Leakage Test Manual
EN 13403	2003	Ventilation for buildings - Non-metallic ducts - Ductwork made from insulation ductboards

### The following documents are mentioned only in the *Guidance text*:

AS 1603		Automatic fire detection and alarm systems
AS 1603.13	2018	Duct sampling units
AS 1682		Fire, smoke and air dampers
AS 1851	2012	Routine service of fire protection systems and equipment
AS 1890	1999	Thermally released links
AS/NZS 2243		Safety in laboratories
AS/NZS 2243.9	2009	Recirculating fume cabinets
AS/NZS 2982	2010	Laboratory design and construction
AS/NZS 3000	2018	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3666		Air-handling and water systems of buildings - Microbial control
AS/NZS 3666.2	2011	Operation and maintenance
AIRAH DA03	1987	Duct design
AIRAH Hygiene	2010	HVAC hygiene: Best practice guidelines
BCA 3.12.5.3	2019	Acceptable construction - Energy Efficiency - Services - Heating and cooling ductwork
BCA J5.6	2019	Energy efficiency - Air-conditioning and ventilation systems -Ductwork sealing
BCA J5	2019	Energy efficiency - Air-conditioning and ventilation systems
NATSPEC DES 003	2018	Fire hazard properties of insulation and pliable membranes
NATSPEC DES 005	2019	Preventing condensation on ducts and air handling plant
NATSPEC DES 010	2020	Atmospheric corrosivity categories for ferrous products
NATSPEC DES 022	2014	Microbial control
NATSPEC DES 031	2019	Specifying R-Values
NATSPEC DES 033	2014	Duct leakage and leakage testing
NATSPEC GEN 006	2015	Product specifying and substitution
NATSPEC GEN 024	2015	Using NATSPEC selections schedules
NATSPEC TR 01	2019	Specifying ESD
NATSPEC TR 03	2018	Specifying design and construct for mechanical services
NCC	2019	National Construction Code
ASHRAE Fundamentals	2017	ASHRAE Handbook - Fundamentals
UL 1046	2010	Standard for grease filters for exhaust ducts