Ausgrid

NS200

Major Substations Ventilation Design Standard

JULY 2010

Amendments: NSA 1608A Mar 2011.

SUMMARY

Network Standard NS200 details the general requirements for natural, mechanical and other types of ventilation to be considered and included into the design of *major substations*.

ISSUE

Ausgrid staff: for issue to all staff involved with the design of *Major substations*.

Where this standard is issued as a controlled document replacing an earlier edition; remove and destroy the superseded document.

Accredited Service Providers: document issued on an uncontrolled basis. Users are responsible for ensuring that the document they are using is current and includes any amendments issued since the date on the document. Ausgrid will not accept any liability for work carried out to a superseded standard. Ausgrid may not accept work carried out which is not in accordance with current standard requirements.

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As Ausgrid's standards are subject to ongoing review, the information contained in this document may be amended by Ausgrid at any time.

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INTERPRETATION

In the event that any user of this Standard considers that any of its provisions is uncertain, ambiguous or otherwise in need of interpretation, the user should request Ausgrid to clarify the provision. Ausgrid's interpretation shall then apply as though it was included in the Standard, and is final and binding. No correspondence will be entered into with any person disputing the meaning of the provision published in the Standard or the accuracy of Ausgrid's interpretation.

Network Standard
NS200
Major Substations Ventilation Design Standard
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1 SCOPE

This Network Standard details the technical aspects to be considered in the design of ventilation systems for Ausgrid *major substation* buildings. Generally this includes new zone and sub-transmission substations.

This Network Standard provides the requirements for natural and mechanical ventilation systems. Other types of ventilation systems, specifically dehumidifiers and air conditioning, are also covered by this standard

The ventilation of Ausgrid *major substation* buildings shall comply with this Network Standard.

Refer to NS113 for ventilation requirements associated with chamber substations.

This Network Standard should be read in conjunction with other relevant Ausgrid Network Standards and Engineering Guidelines.

2 DEFINITIONS

Active System	A system that has moving parts or relies on mechanical, chemical or electrical controls in order to function. Examples of active systems include mechanical fans and fire protection systems such as fire dampers and smoke detection systems.
Access requirements	Requirements for openings, loading docks corridors and passages and for supporting the weight of all equipment and personnel.
Air Conditioning	A system that uses a heat exchanger to provide the necessary temperature differential to enable cooled air to be delivered to the required locations.
Approved	Requires written consent from Ausgrid. Such written approval may contain authorised specific departures from the Standard.
BCA	Building Code of Australia.
Bush Fire Prone Area	An area of land that can support a bush fire or is likely to be subject to bush fire attack. Bush fire prone land maps are prepared by local councils and certified by the Commissioner of the Rural Fire Service.
Cage	As defined in Ausgrid Electrical Safety Rules.
Dehumidifying	A system that uses a heat exchanger to provide the necessary temperature differential to enable dehumidified air to be delivered to the required locations.
Design	The substation design that is to be provided by the Designer in compliance with Ausgrid requirements.
Design Life	The timeframe in which the building can operate efficiently and be fit for purpose without break down of the building fabric or structure.
Designer	A nominated party responsible for the layout and design of the project under the overall direction of Ausgrid. The Designer may be an internal group within Ausgrid, an Alliance Partner or an external party appointed to the project.
Electrical Layout Plan	A concept plan showing the spatial arrangement of equipment and the minimum dimensions of the substation building and yard. Electrical Layout Plans are provided for specific projects by Ausgrid.
Ember	Smouldering or flaming wind-borne debris that is capable of entering or accumulating around a building.
Ember Guard	A cover inserted in or over an opening or cavity to prevent the entry of burning embers.
Equipping	Installation of substation equipment, including but not limited to cables, busbars, switching and control equipment and transformers.
Fire Resistance Level (FRL)	The ability of an element of construction, component or structure to maintain its structural adequacy, integrity and thermal insulation during exposure to a fire for a specific fire resistance period.
Fire Stopping	Measures that are adopted to prevent the spread of fire, smoke and acid residues from one compartment to another.
GIS	Gas Insulated Switchgear.
High voltage	A voltage above 1,000 volts alternating current or 1,500 volts direct current.
Layout Drawings	Drawings to scale showing the dimensions and relative locations of substation equipment and infrastructure.
Low maintenance	Low required return period for inspection and maintenance.
Major Substation	Zone and sub-transmission substations with primary voltages of 132, 66 or 33 kV.

Mechanical Ventilation	Mechanically assisted airflow utilising motorised fans to provide the necessary pressure differential to deliver the required air flow.
Natural Ventilation	Non-assisted airflow caused by a decrease in air density as temperature is raised. The decrease in air density causes a pressure differential which provides the energy to drive the natural ventilation system.
Overpressure	A rapid rise in the enclosure pressure caused by high voltage electrical equipment failing in an enclosed compartment.
Passive System	Describes a system with no moving parts which does not rely on other external controls in order to function as intended. Examples of passive systems include natural ventilation and fire rated building elements such as fire barrier walls etc.
Self Cleaning	Uses natural weather conditions to remove dust, debris and other airborne materials.
STS	Sub-transmission substation. Normally 132/33 kV or 132/66 kV.
Substation	In this standard, the term substation refers only to Zone or Sub-transmission substations. This includes substations with 132/11 kV, 66/11 kV, 33/11 kV, 132/66 kV and 132/33 kV. This may include temporary STS or Zone substations as defined below.
Switch building	Building housing electrical switchgear and equipment.
Switch room	A room for housing switchgear, also known as switchgear room.
Switchgear	Equipment for controlling the distribution of electrical energy or for controlling or protecting circuits, machines, transformers, or other equipment.
Switching equipment	Switchgear, circuit breakers, fuse switches, ring main switches and isolators.
Switchyard	Outdoor yard containing high voltage electrical substation equipment.
Transformer	A static piece of apparatus with one or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values but with the same frequency, for the purpose of transmitting electrical power.

3 REFERENCES

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards including but not limited to:

- All Relevant WorkCover documentation
- http://www.aedconsulting.com.au/docs/forms/Capability%20Statement.pdf
- AS 1324 Air filters for use in air conditioning and ventilation
- AS 1324.1 Part 1: Application, performance and construction
- AS 1530 Methods for fire tests on building materials, components and structures
- AS 1530.1 Part 1: Combustibility test for materials
- AS 1530.3 Part 3: Simultaneous determination of ignitability, flame propagation, heat release and smoke release.
- AS 1530.4 Part 4: Fire resistance test of elements of building construction.
- AS 1668 The use of ventilation and air conditioning in buildings
- AS 1668.1 Part 1: Fire and smoke control in multi-compartment buildings
- AS 1668.2 Part 2: Ventilation design for indoor air contaminant control
- AS 1682 Fire dampers
- AS 1682.1 Part 1: Specification
- AS 1682.2 Part 2: Installation
- AS 1890 Thermally released links
- AS/NZS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors
- AS 2676.2 – 1992 Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings – Part 2: Sealed cells
- AS 2865 – Confined Spaces
- AS 3011.2 – 1992 Electrical installations – Secondary batteries installed in buildings – Part 2: Sealed cells
- AS 4254 Ductwork for air handling systems in buildings
- AS 4436 Guide for the selection of insulators in respect of polluted conditions
- NS113 Site Selection and Construction Design Requirements for Chamber Substations
- NS185 Major Substations Design Standard
- NS187 Passive Fire Mitigation Design of Substations
- NS188 Design for Substation Overpressure
- NS191 Batteries and Battery Chargers in Major Substations
- NS210 Documentation and Reference Design Guide for Major Substations
- NS212 Integrated Support Requirements for Ausgrid Network Assets
- Building Code of Australia (BCA)
- ENA Standards/Guidelines (www.ena.asn.au)
- ENA NENS 01-2006 National Electricity Network Safety Code
- Ausgrid Drawing No. 209935

- Ausgrid Drawing No. 210818
- Ausgrid Electrical Safety Rules
- ISSC 28 – Guideline for Enclosed Spaces in NSW Electricity Networks
- Occupational Health and Safety Act 2000 and Regulation 2001

Current Network Standards are also available on Ausgrid's internet site at www.ausgrid.com.au.

4 FUNCTIONAL REQUIREMENTS

4.1 General

The main purpose of ventilation in *major substation* buildings is as follows:

- Provide cooling to dissipate heat from equipment and any heat that may enter the building through the building fabric.
- Minimise the entry of dust and other airborne contaminants.
- Provide a supply of fresh air necessary to maintain satisfactory working conditions for personnel.

In addition to the heat loss from equipment, heat can enter a substation building via the roof, walls and floor by a combination of conduction, convection and radiation. In order to minimise unnecessary heat build-up inside substation buildings due care shall be taken in the overall building design and orientation and also in the selection of construction materials to be employed.

The ventilation system installed shall fully satisfy the equipment manufacturer's recommendations relating to air quality and temperature control for the equipment accommodation.

4.2 Preferred Ventilation System

For reasons of reliability, simplicity and low maintenance the use of natural ventilation is preferred over the use of mechanical ventilation systems.

Natural ventilation shall be adopted where site conditions, building layout and heat loads allow.

Unless stated otherwise in this Network Standard, the open area provided for natural ventilation of electrical equipment shall not exceed a nominal 1% of the floor area of the room.

4.3 Building Code Of Australia Compliance

The BCA has performance requirements for ventilation. However, the "Deemed to Satisfy" provisions of the BCA apply to habitable and occupied spaces in a building and, hence, may not always be applicable to electricity substations.

The BCA Functional Statement FF4.3 states "*A space used by occupants within a building is to be provided with adequate ventilation consistent with its function or use.*" The BCA requires a habitable room, office, shop, factory etc. to have either natural or mechanical ventilation.

The BCA generally requires the aggregate size of openings for natural ventilation (when provided) in a habitable room to be not less than 5% of the floor area of the room.

However, *major substation* buildings are for the most part unoccupied and generally are not considered to contain habitable rooms. As such, rooms housing electrical equipment inside *major substation* buildings are generally granted an exemption from the ventilation requirements of the BCA by the relevant certifying authorities.

4.4 Fire Resistance and Compartmentation

At some locations, the design of a *major substation* building may incorporate the use of fire compartment construction to segregate switchrooms, cable basements, cable risers, control rooms etc.

The ventilation of these areas shall be treated individually and different ventilation solutions may be required for each compartment to address the specific requirements of the installed equipment. The FRL between the compartments shall be maintained by the use of fire dampers, fire rated construction of ventilation ducts, etc and by adequate separation of ventilation openings in external walls.

The requirements for FRL and compartmentation of *major substation* buildings are provided in NS187.

4.5 Overpressure

Overpressure requirements, where applicable, shall be assessed separately from ventilation requirements. Where provision needs to be made for overpressure relief any openings that are provided for ventilation shall be included as part of the overpressure relief. NS188 and NS185 provide details of overpressure requirements for substations.

Overpressure relief openings shall be normally closed to minimise infiltration and dust entry. Wherever possible, overpressure relief panels shall be suitably located, designed and insulated so as to minimise the thermal load from the panels into the building. This will enable the resulting ventilation requirements to also be minimised.

4.6 Control of Dust and Contaminants

In aggressive environments, such as moist, salt laden or dusty air, electrical equipment designed for indoor applications may need additional protection to prevent damage due to exposure

In rooms housing indoor electrical equipment ingress of dust and other contaminants is a major concern. If dust and other contaminants are allowed to accumulate on open high voltage bushings, insulators, etc, the likelihood of flashover is increased. The probability of this occurring is even greater if high humidity situations also exist inside the rooms.

The ventilation of these areas shall consider suitable protection measures that may include vent filtration, leeward facing vents and fully sealed equipment rooms. Alternative design approaches should also be considered and may include dehumidifiers, air conditioning and internal equipment heaters.

AS 4436 (Section 7) provides some guidance on the evaluation of pollution severity for outdoor insulators including various site measurement methods. This guide should be considered as a potential technique in assessing the expected air quality for dusty or contaminated environments and as an input into the ventilation requirements for air insulated equipment.

4.7 Confined Spaces

Ventilation to all rooms and accessible locations within the building shall be sufficient to ensure that confined spaces are eliminated wherever possible.

ISSC 28 *Guideline for Enclosed Spaces in NSW Electricity Networks* contains useful material to assist in the evaluation and classification of enclosed spaces in electricity networks, and also provides information on appropriate risk controls.

All confined spaces shall be managed in accordance with the requirements of AS 2865 and the NSW Occupational Health and Safety Regulation 2001.

5 DESIGN REQUIREMENTS

5.1 General

This Network Standard deals with the design of the following types of ventilation systems:

- Natural Ventilation
- Mechanical Ventilation
- Air Conditioning
- Dehumidifying

Other types of ventilation systems are not covered by this standard.

5.2 Natural Ventilation

The operation of a system of natural ventilation is as a result of a decrease in air density as its temperature is raised due to the heat gain from various sources. This decrease in air density causes a pressure differential which provides the energy to drive the natural ventilation system.

Because the pressure differential developed is relatively small, ventilation louvers and grilles, etc, need to be of a design that offers little resistance to air flow.

To harness the thermal effects and maximise the performance of a natural ventilation system the air inlet openings should be located at low level and the exhaust openings should be as high as possible.

Any ventilation ducts shall have a large cross sectional area and a minimum number of bends to minimise losses. Long horizontal runs of exhaust duct shall be avoided.

Due to a natural ventilation system's sensitivity to the direction of the prevailing wind, the location of ventilation openings on the external face of a building shall be carefully selected to minimise any negative effect. The benefit of wind effects can be maximised by positioning ventilation openings on adjacent or opposite sides of the building, the inlet on the windward side and the exhaust on the leeward side.

5.3 Mechanical Ventilation

A mechanical ventilation system involves the use of a fan to provide the necessary pressure differential to deliver the air flow required.

Mechanical ventilation systems are to be designed in accordance with the requirements of AS 1668.2.

Mechanical ventilation systems incorporate a supply air fan, exhaust fan and supply air and exhaust ductwork to distribute the air throughout the space to be ventilated.

Supply air systems draw fresh air from outside and are provided with filters to minimise the amount of dust that is allowed to enter the ventilated space.

Depending on the mechanical ventilation system design air flowrate, system resistance and the space available for ventilation plant, the types of fans selected can be either axial or centrifugal.

Centrifugal fans are generally used for higher pressures and flowrates and offer lower sound levels for an equivalent duty compared to an axial fan. By comparison, axial fans are lower cost and physically smaller but require multiple stages to generate higher pressures and are less efficient and noisier.

Fresh air intakes shall be located clear of exhaust openings or other sources of pollution that may reduce the quality of the air entering the system.

Fresh air intake plenums and ducts shall be maintained dry in service. Provision should also be made for inspection and cleaning of the internal surfaces.

The preferred method of control for a typical mechanical ventilation system serving a substation area is a fully adjustable 7 day time clock for automatic operation, with light switch over-ride to initiate fan start when the lighting serving that particular area is switched on. The light switch over-ride function shall be limited to up to 8 hours operation by an adjustable timer so that if the lights are left on for an extended period of time the fan will not continue to operate unnecessarily and control will revert to time clock mode.

5.4 Air Conditioning and Dehumidifying

An air conditioning and dehumidifying system involves the use of a heat exchanger to provide the necessary temperature differential to enable cooled and/or dehumidified air to be delivered to the required locations.

Air conditioning and dehumidifying systems are to be designed in accordance with the requirements of AS 1668.2.

Refer to Section 8 for the design requirements of air conditioning and dehumidifying systems.

5.5 Air Quality and Temperature Control

The equipment manufacturer's recommendations relating to air quality and temperature control for equipment accommodation shall always be considered and adopted.

The substation switch room / control room shall be fitted with a ventilation system that is sized to maintain a temperature within the range $+5^0$C to $+40^0$C unless specific equipment requirements mandate otherwise.

The design of the ventilation system shall consider both the heat load of the equipment housed in the building and the external solar loading on the building.

Provision shall be made for clean filtered air to be supplied to the communications panels holding the fibre patch cords. Clean air fans do not require battery back-up.

5.6 Ventilation Assessment

A ventilation assessment shall be carried out for each building / room, as early as practicable in the design stage. Only the necessary measures required to meet the minimum ventilation rates, as determined by the assessment, shall be incorporated into the substation design.

The ventilation assessment shall consider the minimum airflow requirements of the equipment, the internal and external heat loads, air quality, local environmental issues, building constraints and safety aspects.

6 SPECIFIC VENTILATION REQUIREMENTS

6.1 General

Specific ventilation requirements have been determined for the following rooms with a *major substation*:

- Cable Basements
- Switchrooms
- Control Rooms
- Capacitor Rooms
- Battery Accommodation
- Indoor Transformer Bays

6.2 Cable Basements

Major substation cable basements are often mostly situated below ground level and as such they pose a particular challenge with regard to natural ventilation in order to avoid creating a confined space.

In most instances, on sloping sites and/or where there is adequate external wall area above ground level, a cable basement should preferably be naturally ventilated. This can be achieved by utilising banks of fixed ventilation louvers at high level in the above ground walls to act as exhaust openings supplemented by ventilation stacks or similar to provide inlet openings at low level.

In order to avoid the confined space issues in naturally ventilated cable basements ventilation openings in the order of 5% floor area are generally provided. In determining the area provided by ventilation openings, all external doors shall be considered to be open to supplement other fixed ventilation.

In CBD and underground locations where it is found that natural ventilation is not possible because of building or other constraints, mechanical ventilation systems shall be adopted. Mechanical ventilation systems incorporate a fresh air fan, filters, exhaust fan and supply and exhaust ductwork to distribute the air throughout the cable basement and to dilute or remove any hazardous gasses present.

Because the cable basement is the lowest level in the substation the exhaust ventilation system is provided with droppers to exhaust at both high level and low level.

6.3 Switchrooms

The ventilation requirements for a switchroom are determined by:

- heat loss from the switchgear and cabling,
- heat gain through the building fabric,
- ventilation requirements for personnel, and
- temperature limitations inside the room for a particular set of outdoor conditions.

A further consideration is the minimisation of dust entry to the room and the impact of aggressive external environments on equipment within the room.

In most instances, where there is adequate external wall area above ground level, the switchroom should preferably be naturally ventilated.

For a switchroom of masonry construction with a concrete or well insulated ceiling and a ventilated roof space, the open area required for natural ventilation to dissipate the heat loss from the switchgear is generally in the order of 1% to 1.5% of the floor area. This value shall be checked in each instance for the particular construction adopted and the heat loss from the equipment used.

Any overpressure requirements associated with the equipment used shall be addressed separately from the ventilation requirements.

In CBD and other locations where natural ventilation may not be possible, mechanical ventilation systems are to be adopted. These incorporate a fresh air fan, filters and ductwork to distribute the air throughout the switchroom together with an exhaust fan and ductwork. Where GIS equipment is installed the exhaust system ductwork is provided with droppers to exhaust at both high and low level.

6.4 Control Rooms

The ventilation rate for a control room is determined from the following:

- heat loss from the equipment, control panels, battery chargers etc.,
- heat gain through the building fabric,
- ventilation requirements for personnel,
- ventilation requirements for any battery enclosures in the room, and
- temperature limitations inside the room for a particular set of outdoor conditions.

A further consideration is the minimisation of dust entry to the room and the impact of aggressive external environments on equipment within the room.

In most instances, where there is adequate external wall area above ground level, the control room should preferably be naturally ventilated.

For a control room of masonry construction with a concrete or well insulated ceiling, the open area required for natural ventilation to dissipate the heat loss from the electrical equipment is generally in the order of 1.0% of floor area. This value shall be checked in each instance against the heat loss from the equipment.

In CBD and other locations where natural ventilation may not be possible, mechanical ventilation systems are to be adopted. They shall incorporate a fresh air fan, filters and ductwork to distribute the air throughout the control room together with an exhaust fan and ductwork.

6.5 Capacitor Rooms

The ventilation rate for a capacitor room is determined from the following:

- heat loss from the capacitors and cabling,
- heat gain through the building fabric,
- ventilation requirements for personnel, and
- temperature limitations inside the room for a particular set of outdoor conditions.

A further consideration is the minimisation of dust entry to the room and the impact of aggressive external environments on equipment within the room.

In most instances, where there is adequate external wall area above ground level, the capacitor rooms should preferably be naturally ventilated.

Capacitor rooms should preferably be of concrete or masonry construction with concrete or well insulated ceilings to minimise the heat that enters the room. This will enable the ventilation openings to be made as small as possible to minimise dust and contaminant entry.

Because of the variability in the layout of capacitor rooms, and the difference in the operation of the capacitors between city and suburban substations, the requirements for ventilation area are typically determined on a site specific basis.

In each instance the open area required for natural ventilation to dissipate the heat loss from the capacitors shall be determined for the particular construction adopted and heat loss from the equipment used.

Any overpressure requirements associated with the equipment used shall be addressed separately from the ventilation requirements.

In CBD and other locations where natural ventilation may not be possible, mechanical ventilation systems are used. They incorporate a fresh air fan, filters and ductwork to distribute the air throughout the capacitor room together with an exhaust fan and ductwork.

6.6 Battery Accommodation

For new *major substations*, NS185 requires that batteries are to be located in suitable accommodation within the control room / switch room, in accordance with the report prepared by AE&D Consulting entitled “Alternate Solution & Performance Verification Report Developed Under the Performance Requirements of the BCA” (June 2008).

All battery enclosures shall have ventilation provided in accordance with the requirements of AS 2676.2 to keep the average concentration of hydrogen gas within the limits specified in AS 3011.2. The AE&D report also contains specific ventilation requirements that shall be applied to the design of battery enclosures within major substations.

The battery enclosures should preferably be naturally ventilated.

Refer to the following Ausgrid drawings:

- A1-209935: Describes the ventilation requirements for battery enclosures.
- A1-210818: Describes the enclosure layout and clearance requirements when installed in a control room.

Refer also to NS191 for the specific battery enclosure requirements applicable for major substations.

6.7 Indoor Transformer Bays

The heat dissipated by a transformer is as a result of the electrical losses which increase the temperature of the windings and core. The heat from the windings is in turn transferred to the surrounding insulating medium, then to the heat exchangers, usually radiators. Due to the temperature difference the heat from the transformer radiators is finally transferred to the ambient air.

The ventilation and cooling for an indoor transformer bay are mainly required for the following:

- heat loss from the transformer for a particular set of outdoor conditions, and
- ventilation requirements for maintenance personnel servicing the equipment.

The heat gain through the building fabric is typically only minor compared to the heat dissipated by the transformer.

The life of a transformer, at rated load, is dependent on both temperature effects and time. Hence, it is essential that transformers be provided with adequate cooling such that they operate within predetermined temperature limits both during normal operation and under conditions of emergency operation.

Natural ventilation is the preferred method for ventilation and cooling of an indoor transformer bay. For calculations, a worst case ambient outside temperature of 45^0C shall be used.

For long term reliability of supply the use of mechanical ventilation systems should be avoided. If a mechanical ventilation system is installed then transformer operation during periods of ventilation system maintenance needs to be considered in the design of the system. This may require the provision of duty and stand-by fans, duplication of controls and other aspects.

7 VENTILATION SYSTEM COMPONENTS

7.1 General

The main components of ventilation systems used in major substations include the following:

- Ductwork
- Fire Dampers
- Air Filters
- Louvres and Grills

7.2 Ductwork

All ductwork and any composite material employed in the construction of ductwork shall conform with the requirements of AS 4254.

The materials used for the construction of ductwork are to have a smoke developed index not greater than three (3) and a spread of flame index not greater than zero (0) when separately tested in accordance with AS 1530.3.

Flexible connections having a minimum width of 150mm are to be provided at the intake and discharge connections of all fans. Flexible connections are to be manufactured from heavy duty, waterproof, fire retardant material in accordance with AS 1668.1 and are to be airtight.

Sheet metal ductwork and fittings are to be fabricated from steel, machine bent and free from waves and buckles. All burrs and sharp edges are to be removed.

The material for sheet metal ductwork, either galvanised steel or stainless steel, is to be selected to suit the particular application and conditions on site.

The thickness of ductwork is to be suitable for the pressure class in accordance with AS 4254.

Rectangular sheet metal ductwork is to be reinforced in accordance with the requirements of AS 4254.

All joints in ductwork shall be sealed and airtight.

Fire dampers shall be installed where ductwork passes through fire rated construction. Where fire dampers are installed, suitable access panels are to be provided, where necessary, to allow access for inspection and servicing.

All bends are to be fitted with approved turning vanes.

7.3 Fire Dampers

Fire dampers shall be manufactured in accordance with AS 1682 and shall be installed in all openings provided for the passage of air or ducts through fire rated construction.

Fire dampers shall be of the multi-blade type, steel blades housed in a welded steel frame, suitable for the particular application. Damper blades shall pivot on stainless steel shafts in self aligning bearings and be held in the open position by a fusible link arranged to lock on closure.

Curtain type fire dampers shall not be used.

The material for the fire damper, either galvanised steel or stainless steel, shall be selected to suit the particular application and conditions on site.

Fire dampers are to have a free area of not less than 85% of the face area of the damper and are to be installed in accordance with AS 1668 and the manufacturer's instructions.

Fusible links are to be marked with the maximum working load, year of manufacture and the manufacturer's name or identifying symbol and fully comply with the requirements described in AS 1890. The load applied in service is not to exceed the marked working load of the link and is to take into account the dynamic loading due to airflow.

Fusible links shall be as manufactured by Archer, Elsie or other approved equivalent.

Where ductwork is installed or access to the fire damper is via a fire rated ceiling, suitable access panels are to be provided to allow inspection and servicing of the bearings, blades and fusible link.

7.4 Air Filters

Supply air ventilation systems shall be provided with fabric type, disposable air filters manufactured in accordance with AS 1324.1.

Filters are to be of the pleated panel type having a thickness not less than 25mm and be supported by a wire grid. All filters are to be housed within a supporting frame and suitably sealed to prevent air leakage using gaskets and spring type fasteners.

All filters shall be located to comply with AS 1668.1 with filter media approved in compliance with AS 1530.

All filter media shall have a minimum performance rating of F5 when tested in accordance with AS 1324.1.

7.5 Ventilation Louvres and Grilles

7.5.1 Weatherproof Louvres

Weatherproof louvres shall be of the fixed horizontal blade type designed to prevent the ingress of rain under varying wind and rain conditions. All rainwater collected by the louvre is to be discharged to the weather side.

The louvres shall be manufactured from extruded aluminium using extruded aluminium blades in an extruded aluminium frame. Each set of blades is to be nominally 100mm depth and incorporate a minimum of two (2) rain traps in the blade extrusion. Louvre finish is to be anodised aluminium, baked enamel or powder coating as required.

All louvres are to incorporate vermin mesh screens.

The free area of the louvre must not be less than 55% of the face area.

7.5.2 Supply Air Diffusers

Supply air diffusers shall be of the horizontal blade type, extruded aluminium blades in an extruded aluminium frame. The frame shall form a border with neatly mitred corners and shall incorporate concealed fixings.

Supply air diffuser finish is to be anodised aluminium, baked enamel or powder coating as required.

Supply air diffusers are to be properly adjusted to give the required air flowrate without the introduction of excessive noise.

7.5.3 Inlet and Exhaust Grilles

Inlet and exhaust air grilles installed inside the building shall consist of a 12mm x 12mm grid, 12mm deep, egg crate type aluminium core fixed in an extruded aluminium frame. The frame shall form a border with neatly mitred corners and shall incorporate concealed fixings. Finish is to be anodised aluminium, baked enamel or powder coating as required.

Inlet and exhaust grilles are to be fitted with vermin screens.

7.5.4 Relief Air Grilles

Relief air grilles shall be of the horizontal blade type, extruded aluminium blades in an extruded aluminium frame. The frame shall form a border with neatly mitred corners and shall incorporate concealed fixings. Finish is to be anodised aluminium, baked enamel or powder coating as required.

Relief air grilles are to have a minimum free area of 80% of the face area.

Relief air grilles are to be fitted with vermin screens.

7.5.5 Vermin Screens

Vermin screens shall be installed at the rear of each inlet, relief or exhaust grille and on all weatherproof louvres.

Vermin screens are to be of grade 316 stainless steel welded mesh, 12.7mm pitch, wire diameter 1.2mm minimum.

7.5.6 Bush Fire Ember Guards

In bush fire prone areas all ventilation openings shall be fitted with ember guards made from stainless steel wire mesh having a maximum aperture size of 2mm.

Ember guards shall be close fitting such that any gaps between the steel wire mesh and the ventilation opening does not exceed 2mm.

7.5.7 Noise

The ventilation fan plant room walls, and sections of ventilation ductwork shall be acoustically lined, where necessary, to reduce noise to acceptable levels. Silencers are to be used where required.

The final sound pressure level of the completed installation is to be in accordance with AS 2107 and also with the recommendations of any acoustic studies undertaken for the site.

8 AIR CONDITIONING AND DEHUMIDIFYING

8.1 General

The need for an air conditioning and/or dehumidifying system shall be based on a site specific ventilation assessment and shall be subject to the approval of Ausgrid.

Air conditioning and dehumidifying systems shall only be adopted as a last resort where adequate control of temperature and/or air quality cannot be achieved cost effectively by any other means and is essential for the equipment as specified.

Alternative design approaches shall be considered to demonstrate that the required equipment design criteria cannot be otherwise satisfied. This should include an options assessment typically using the following hierarchy:

- Natural ventilation
- Mechanical ventilation
- Additional building insulation and thermal mass
- Strategic vent positioning and protection
- Alternative vent filtration methods
- Local protection of critical equipment components
- Alternative equipment design
- Planned refurbishment / replacement of affected equipment
- Other aspects.

It is anticipated that only those sites which experience extended periods of hot weather and/or are located in aggressive environments (moist, salt laden or dusty air) will require an air conditioning or dehumidifying system.

All proposals for installation of an air conditioning and dehumidifying system shall include a Life Cycle Cost analysis based on the capital and operating costs, expected site conditions and the Design Life of the substation.

8.2 Key Design Criteria

The system shall aim to maintain the internal temperature within the acceptable limits for the equipment specified and/or stabilise the humidity at a required level to address any condensation issues.

The key design criteria for air conditioning systems shall incorporate the following aspects;

1. Temperature control to maintain the room within the range +5^{0}C to +40^{0}C unless specific equipment requirements mandate otherwise.
2. Relative humidity controlled to the level required to address condensation.
3. A heating cycle is not required.
4. Filtered fresh air to be incorporated where required.
5. Ductwork to be provided to distribute conditioned air if required.
6. Ductwork, plant and equipment not to be located above major electrical equipment or enclosures.
7. Condensate trays and drains not to be located above electrical equipment.
8. All condensate to be drained by gravity to an external location.
9. Plant and equipment to be located to allow for ready access.

10. Suitable treatment for all penetrations to maintain fire rating of building elements.
11. Internal and external (data only) temperature monitoring, including alarms, via the data communications network.
12. Remote system access for interrogation, reporting and alarms via the data communications network.
13. Fully adjustable thermostatic control for automatic operation.
14. Manual over-ride function for up to 8 hours operation.

Dehumidifying systems shall have the same design criteria but without the requirement for significant cooling of the space. In this case, temperature control shall be maintained by other means to the requirements of this standard.

8.3 Main System Components

For most Ausgrid applications, air conditioning and dehumidifying systems are expected to consist of a split ducted air cooled refrigeration system. All systems installed shall provide conditioned air only to selected and approved locations within the substation.

Individual split systems shall be sized and designed to meet the separate requirements of individual rooms. Alternatively, “multi-head” systems with one outdoor unit and multiple indoor units can be used provided that reliability and maintenance issues associated with a single unit are addressed.

The main system components of a typical split ducted air cooled system are as follows:

- Indoor fan coil unit(s)
- Outdoor condensing unit(s) with anti corrosion treatment for the coils
- Galvanised metal ductwork, hangers, supports, anti-vibration mountings and air grilles
- Interconnecting refrigeration pipework (to outdoor unit)
- Safety tray and condensate gravity drain to outside
- Power and control cabling including separate temperature sensor(s)
- Self contained unit control and safety systems with remote access

Suitable ductwork shall be provided to distribute the conditioned air throughout the space. Internal ductwork and fan coil units shall not be located directly above major electrical equipment or control cabinets.

Where required, an outside fresh air component can be introduced to ensure a nominal positive airflow pressure within the conditioned space. Supply air systems draw fresh air from outside and shall be provided with filters to minimise the amount of dust that is allowed to enter the conditioned space. Associated ducting is to be provided to the indoor fan-coil unit.

Fresh air intakes shall be leeward facing where practicable and located clear of exhaust openings or other sources of pollution that may reduce the quality of the air entering the system.

Fresh air intake plenums and ducts shall be maintained dry in service. Provision should also be made for inspection and cleaning of the internal surfaces.

8.4 System Control and Over-ride

The preferred method of control for a typical air conditioning and dehumidifying system serving a substation area is a fully adjustable thermostatic control for automatic operation, with a manual over-ride to initiate a system start for a particular area.

The manual over-ride function shall be limited to up to 8 hours operation by an adjustable timer so that if the system is left on for an extended period of time the unit will not continue to operate unnecessarily and control will revert to automatic mode after the set time has elapsed.

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