Network Standard

Document No.
NS200

Title:
Major Substations Ventilation Design Standard

Approved Date	20/08/2026	Revision		3	
Lifecycle Stage	Design	Internal Use	☒	External Use	☒
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Revision

No	Date	Description	Technical Approver	Authorised By
3	20/08/2026	Update and conversion to the new template	Joseph Metti	Evan Riddell

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Scope

This Network Standard provides the requirements for natural and mechanical ventilation systems to be included in the design of major substations.

Other types of ventilation systems, specifically air conditioning and dehumidifiers, are also covered by this standard.

For new major substation buildings, the ventilation design shall comply with this Network Standard. For existing substations, the Designer shall assess each site individually and shall apply this Network Standard where it is reasonably practicable and cost-effective.

Refer to NS113 for the ventilation requirements associated with chamber substations.

Reference Documents

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards.

Ausgrid Documents

NS001 Glossary of Terms

Bush Fire Risk Management Plan

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

Other Standards and Documents

AS 1324.1 Air filters for use in air conditioning and ventilation: 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/NZS 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/NZS 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 Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings – Part 2: Sealed cells

AS 2865 Confined Spaces

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AS 3011.2 Electrical installations – Secondary batteries installed in buildings – Part 2: Sealed cells

AS 4254 Ductwork for air handling systems in buildings:

AS 4254.1 Part 1: Flexible Duct

AS 4254.2 Part 2: Rigid Duct

AS 4436 Guide for the selection of insulators in respect of polluted conditions

ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Standards and Guidelines

ENA Doc 001-2019 National Electricity Network Safety Code

ISSC 28 – Guideline for Enclosed Spaces in NSW Electricity Networks

National Construction Code Series (NCC)

Acts and Regulations

Electricity Supply (General) Regulation 2014 (NSW)

Electricity Supply (Safety and Network Management) Regulation 2014

Work Health and Safety Act 2011 and Regulation 2017

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Clause	Standard Requirements

1 General

1.1 The 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 elements;
- control the impact of environmental conditions, including humidity and airborne contaminants, to minimise condensation and associated corrosion risks to equipment;
- minimise the entry of dust and other airborne contaminants; and
- provide a supply of fresh air necessary to maintain satisfactory working conditions for personnel.

2 Functional requirements

2.1 General

2.1.1 To minimise unnecessary heat build-up inside substation buildings, the Designer shall investigate the overall building design and orientation, the selection of construction materials to be employed, and the louvre sizes to be used.

2.1.2 The ventilation system shall be designed to fully satisfy the equipment manufacturer's recommendations relating to air quality, humidity and temperature control for the equipment accommodation.

2.2 Default ventilation system

2.2.1 For reasons of reliability, simplicity and low maintenance, the use of natural ventilation shall take precedence over the use of mechanical ventilation systems.

2.2.2 Natural ventilation shall be adopted where a ventilation assessment demonstrates that the required temperature, humidity and air-quality limits can be maintained under the applicable site and equipment operating conditions. Refer to Clause 3.7.

2.2.3 In corrosive or heavy industrial environments, such as coastal regions, areas with high humidity, adjacent to coal mines etc., additional protection measures and/or alternative ventilation systems shall be assessed for design effectiveness. Refer to Clause 2.6.

2.2.4 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.

2.3 National Construction Code compliance

2.3.1 The National Construction Code (NCC) contains performance requirements for ventilation. These provisions apply to habitable and occupied spaces in a building and may not be applicable to electricity substations.

2.3.2 The NCC 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. From May 2012 a specific exemption applies for Class 8 electricity network substations, and this NCC requirement for ventilation no longer applies to major substations.

2.3.3 Rooms housing electrical equipment inside major substation buildings may also be granted other exemptions from the ventilation requirements of the NCC by the relevant certifying authorities.

2.4 Fire resistance and compartmentation

2.4.1 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.

2.4.2 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.

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2.4.3 The Fire Resistance Level (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.

2.4.4 External wall openings in buildings do not require protection by fire dampers or other means unless:

- protection is specifically required by the NCC (e.g. walls that are required to have an FRL and are within 3m of a side or rear boundary); or
- the protection relates to a defined fire hazard within the major substation (e.g. within 7m to 10m of an unprotected main transformer); or
- protection is specifically required by a bush fire risk assessment; or
- protection is required by other Network Standards at a specific location.

2.4.5 The protection of external wall openings against other, site specific, potential fire hazards, such as adjacent fuel storage facilities, significant traffic accidents etc. shall be subject to a formal risk assessment and the review and approval of Ausgrid Engineering.

2.4.6 Any additional fire protection measures (e.g. fire dampers) that may be required shall address only the identified risks that are deemed to be unacceptable for the major substation.

2.4.7 External wall openings that are later required to be sealed (e.g. for retrofit of air conditioning) shall be sealed with construction that achieves the same FRL as the associated wall. Any installed fire dampers shall be decommissioned or removed to avoid ongoing maintenance costs.

2.4.8 The requirements for FRL and compartmentation of major substation buildings shall be in accordance with NS187.

2.5 Overpressure

2.5.1 Overpressure requirements, where applicable, shall be assessed separately from ventilation requirements.

2.5.2 Where provision needs to be made for overpressure relief, any permanent openings that are provided primarily for building ventilation shall be included as part of the overpressure relief.

2.5.3 For external wall openings that are later sealed (e.g. for retrofit of air conditioning), the impact on overpressure relief for the building shall be re-assessed and modified vent area provisions made where required.

2.5.4 Overpressure relief panels shall be located clear of egress routes to reduce the risk of injury to personnel during evacuation.

2.5.5 Refer to NS185 and NS188 for details of the overpressure design requirements for substations.

2.5.6 Wherever practicable, any overpressure relief panels shall be located, designed and insulated to minimise the thermal load from the panels into the building. This will enable the resulting ventilation requirements to also be minimised.

2.6 Control of humidity, dust and contaminants

2.6.1 In corrosive or heavy industrial 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.

2.6.2 For rooms housing indoor electrical equipment, 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 greater where high humidity situations also exist inside the rooms.

2.6.3 The ventilation design in corrosive or heavy industrial environments shall assess suitable protection measures that may include:

- site specific vent filtration (e.g. HEPA filters to address coal dust);
- leeward facing vents;
- fully sealed equipment rooms; and

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- alternative design approaches including dehumidifiers, air conditioning and internal equipment heaters.

2.6.4 AS 4436 provides guidance on the evaluation of pollution severity for outdoor insulators including various site measurement methods. The Designer shall review AS 4436 as a potential technique in assessing the expected indoor air quality for dusty or contaminated environments, and as an input into the ventilation requirements for air insulated equipment.

2.6.5 ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) provides guidelines for data centres and electronic equipment operating environments. For corrosive or heavy industrial environments, the Designer shall review the relevant ASHRAE guidelines to assess allowable temperature and humidity ranges, including interpretation via the use of psychrometric charts.

2.7 Confined spaces

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

2.7.2 ISSC 28 contains information regarding the evaluation and classification of enclosed spaces in electricity networks and provides information on appropriate risk controls.

2.7.3 All confined spaces shall be managed in accordance with the requirements of AS 2865 and the Work Health and Safety Regulation 2017.

2.8 Recordkeeping in SAP

2.8.1 Information relating to the ventilation system shall be recorded and updated in Ausgrid's SAP system as an integral part of the installation process.

2.8.2 The key ventilation system details to be retained include, but are not limited to, the following items:

- Ausgrid contact to report system faults and alarms.
- Ausgrid key reference drawing(s).
- system details – manufacturer, installer, model, serial number.
- the location of system components that require routine inspection and maintenance (e.g. fan motors, fire dampers, filters, sensors etc.).
- SCADA interface details for mechanical equipment monitoring.
- the design thermostat set-point for air conditioning systems.

3 Design requirements

3.1 General

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

- natural ventilation;
- mechanical ventilation;
- air conditioning; and
- dehumidifying

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

3.2 Designer safety report

3.2.1 For plant, including machinery and equipment, the Work Health and Safety Regulation requires adequate information to be provided by the designer of the plant, or any part of the plant, to the person who commissioned the design. Ausgrid requires this information to form part of a Designer Safety Report.

3.2.2 The Designer Safety Report shall comply with the requirements of NS210 and shall be prepared at the completion of the design development process.

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3.3 Natural ventilation

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

3.3.2 As a result of the relatively small pressure differential, ventilation louvres and grilles shall be of a design that offers little resistance to air flow.

3.3.3 The Designer shall determine the location and orientation of natural ventilation openings based on the following:

- the site-specific environmental conditions, particularly in coastal regions and areas subject to high humidity or contaminants; and
- aiming to minimise the ingress of moisture and contaminants that may result in condensation and corrosion of equipment.

3.3.4 To harness the thermal effects and maximise the performance, the air inlet openings shall be located below the exhaust level, and the exhaust openings shall be as high as practicable.

3.3.5 The building configuration, equipment layout, control of dust and contaminants and the ventilation maintenance requirements shall be assessed as part of the location of ventilation openings.

3.3.6 Ventilation ducts, where required, 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.

3.3.7 Due to sensitivity to the direction of the prevailing wind, the location of natural ventilation openings on the external face of a building shall be selected to minimise negative effects. 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; and
- adopting the prevailing wind direction for the time of year that is expected to have the highest temperatures when locating natural ventilation openings.

3.4 Mechanical ventilation

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

3.4.2 Mechanical ventilation systems shall be designed in accordance with the requirements of AS 1668.2.

3.4.3 Mechanical ventilation systems shall incorporate one or more of the following components as required:

- a supply air fan;
- air filters;
- an exhaust fan; and
- supply air and exhaust ductwork to distribute the air throughout the space to be ventilated.

3.4.4 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 ventilated space.

3.4.5 The ventilation system shall be designed to provide a minimum +5Pa positive pressurisation to prevent dust and contaminant ingress.

3.4.6 The fan types adopted can be either axial or centrifugal, depending on the design air flowrate, the ventilation system resistance and the space available for ventilation plant.

3.4.7 Centrifugal fans are suited to higher pressures and flowrates and offer lower sound levels for an equivalent duty compared to an axial fan. Axial fans are lower cost and physically smaller but require multiple stages to generate higher pressures and are less efficient and noisier.

3.4.8 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. The design shall make allowance for the future

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inspection and maintenance requirements for any ventilation filters or other items associated with the air intakes.

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

3.4.10 The method of control for a mechanical ventilation system serving an area within a major substation shall be as follows:

- a fully adjustable 7-day time clock for automatic operation;
- a 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; and
- 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.

3.5 Air conditioning and dehumidifying

3.5.1 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.

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

3.5.3 Refer to Section 6 for the design requirements of air conditioning and dehumidifying systems.

3.6 Air quality, humidity and temperature control

3.6.1 The equipment manufacturer's recommendations relating to air quality, humidity and temperature control for equipment accommodation shall be assessed and adopted.

3.6.2 The substation switchroom / 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.

3.6.3 Alternative temperature range limits and/or the use of humidity control to meet specific mandated equipment requirements, shall be subject to the approval of Ausgrid Engineering.

3.6.4 The design of the ventilation system shall allow for both the heat load of the equipment housed in the building and the external heat loading on the building.

3.6.5 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.

3.7 Ventilation assessment

3.7.1 A ventilation assessment shall be carried out for each building / room as early as practicable during 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.

3.7.2 The ventilation assessment shall assess the minimum airflow requirements of the equipment, the internal and external heat loads, building insulation, thermal mass, air quality, humidity, temperature, local environmental issues, building constraints and safety aspects.

3.7.3 The Designer shall prepare a detailed ventilation assessment report to document and describe the following;

- building model inputs and assumptions;
- simulation and thermal modelling methodology;
- climatic data and weather file scenarios used for the analysis;
- thermal assessment results for each room under the various climatic scenarios;

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- the impact of alternative building designs and modelling assumptions on the thermal performance of the building; and
- preliminary system specifications for plant and equipment recommended by the report.

4 Ventilation requirements for specific rooms

4.1 General

Ventilation requirements have been determined for the following specific rooms within a major substation:

- cable basements
- switchrooms
- control rooms
- capacitor rooms
- battery accommodation
- indoor transformer bays

4.2 Cable basements

4.2.1 Cable basements for major substations are situated partly or entirely below ground level and pose a challenge with regard to natural ventilation to avoid creating a confined space.

4.2.2 For sloping sites and/or where there is adequate external wall area above ground level, the cable basement shall be naturally ventilated where site conditions and building layout allow.

4.2.3 Natural ventilation can be achieved by utilising fixed ventilation louvres at high level in the above ground walls to act as exhaust openings. These are supplemented by ventilation stacks or similar to provide inlet openings at low level.

4.2.4 To avoid confined space issues in naturally ventilated cable basements, ventilation openings up to 5% of the floor area shall be provided. The area provided by ventilation openings shall include all external doors within the security fence secured in the open position, to supplement other fixed ventilation.

4.2.5 For natural ventilation, additional warning signage shall be provided on external doors to the cable basement, notifying that all doors within the security fence are to be secured in the open position prior to entry, to ensure adequate ventilation and safe access conditions.

4.2.6 In CBD and fully underground locations where natural ventilation is not possible due to building or other constraints, mechanical ventilation systems shall be adopted.

4.2.7 Mechanical ventilation systems shall incorporate one or more of the necessary system components as required, to distribute the air throughout the cable basement and to dilute or remove any hazardous gases present. Refer to Clause 3.4.3.

4.2.8 Where mechanical ventilation is provided, mechanical supply and/or exhaust fans shall be interlocked with the cable basement light switch to automatically operate in accordance with Clause 3.4.10.

4.2.9 Where the cable basement is the lowest level in the substation, the exhaust ventilation system shall be provided with droppers to exhaust at both high level and low level.

4.2.10 Cable conduit penetrations into the cable basement from external areas shall be sealed to reduce both water ingress and the associated humidity levels within the substation building.

4.3 Switchrooms and control rooms

4.3.1 The ventilation requirements for a switchroom or control room are determined by:

- heat loss from the switchgear and cabling (for a switchroom);
- heat loss from the equipment, control panels, battery chargers etc. (for a control room);
- heat gain through the building fabric;

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- thermal mass of the building components;
- 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.

4.3.2 Additional site-specific requirements include the minimisation of dust entry to the room and the impact of corrosive or heavy industrial external environments on equipment within the room.

4.3.3 For locations where there is adequate external wall area above ground level, the use of natural ventilation for a switchroom or control room shall take precedence. Refer to Clause 2.2.

4.3.4 In corrosive or heavy industrial environments, such as coastal regions, areas with high humidity, adjacent to coal mines etc., the use of alternative ventilation systems shall be based on a site-specific ventilation assessment and shall be subject to the approval of Ausgrid Engineering. Refer to Clauses 2.6 and 3.7.

4.3.5 For a room 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 electrical equipment is in the range of:

- 1% to 1.5% of the floor area for a switchroom; or
- 1% of the floor area for a control room.

4.3.6 The actual open area required for natural ventilation shall be verified for each location based on the building construction adopted and the heat loss from the equipment used.

4.3.7 Any overpressure requirements associated with the equipment used shall be addressed separately from the ventilation requirements. Refer to Clause 2.5.

4.3.8 In CBD and other locations where natural ventilation may not be practicable, mechanical ventilation systems shall be adopted.

4.3.9 Mechanical ventilation systems shall incorporate one or more of the necessary system components as required, to distribute the air throughout the room. Refer to Clause 3.4.3.

4.3.10 Where GIS equipment is installed in a switchroom, the exhaust system ductwork shall be provided with droppers to exhaust at both high and low level.

4.4 Capacitor rooms

4.4.1 The ventilation requirements for a capacitor room are determined by:

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

4.4.2 Additional site-specific requirements include the minimisation of dust entry to the room and the impact of corrosive or heavy industrial external environments on equipment within the room.

4.4.3 For locations where there is adequate external wall area above ground level, the use of natural ventilation for a capacitor room shall take precedence. Refer to Clause 2.2.

4.4.4 The design approaches for capacitor rooms include the following:

- concrete or masonry construction with concrete or well insulated ceilings to minimise the heat that enters the room; or
- the use of well insulated lightweight building construction throughout that provides an equivalent thermal performance, subject to the written approval of Ausgrid Engineering.

4.4.5 The capacitor room design shall enable ventilation openings to be made as small as practicable to minimise dust and contaminant entry.

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4.4.6 The open area required for natural ventilation shall be determined on a site-specific basis due to the variability in the layout of capacitor rooms, and the difference in the operation of the capacitors between city and suburban substations.

4.4.7 The open area for natural ventilation at each location shall be based on the building construction adopted and heat loss from the equipment used.

4.4.8 Any overpressure requirements associated with the equipment used shall be addressed separately from the ventilation requirements. Refer to Clause 2.5.

4.4.9 In CBD and other locations where natural ventilation may not be practicable, mechanical ventilation systems shall be adopted.

4.4.10 Mechanical ventilation systems shall incorporate one or more of the necessary system components as required, to distribute the air throughout the capacitor room. Refer to Clause 3.4.3.

4.5 Battery accommodation

4.5.1 For new major substations, NS185 requires that batteries shall be installed in metal cabinet-type accommodation within the control room or switchroom.

4.5.2 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.

4.5.3 The use of natural ventilation for battery enclosures shall take precedence. Refer to Clause 2.2.

4.5.4 The ventilation discharge louvres used for battery enclosures shall be a vertical blade type, to avoid the accumulation of hydrogen.

4.5.5 Refer to the following Ausgrid drawings for battery enclosure requirements:

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

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

4.6 Indoor transformer bays

4.6.1 The heat dissipated by a transformer is the result of electrical losses which increase the temperature of the windings and core. The heat from the windings is transferred to the surrounding insulating medium, then to the heat exchangers, and finally to the ambient air.

4.6.2 The ventilation and cooling requirements for an indoor transformer bay are determined by:

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

4.6.3 The heat gain through the building fabric is relatively minor compared to the heat dissipated by the transformer.

4.6.4 The life of a transformer, at rated load, is dependent on both temperature effects and time.

4.6.5 Indoor transformers shall be provided with adequate cooling such that they operate within predetermined temperature limits, both during normal operation and under conditions of emergency operation.

4.6.6 The use of natural ventilation shall take precedence for the ventilation and cooling of an indoor transformer bay. For design calculations, a worst case ambient outside temperature of 45^0C shall be used.

4.6.7 The use of mechanical ventilation systems for indoor transformer bays shall be subject to the approval of Ausgrid Engineering, to ensure adequate thermal protection of the transformer and the long-term reliability of supply.

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4.6.8 Where a mechanical ventilation system is installed, normal operation of the transformer during periods of ventilation maintenance shall be assessed as part of the system design. The design may require the provision of duty and stand-by fans, duplication of controls and other measures.

4.6.9 The design of a mechanical ventilation system shall also investigate the potential impacts of a major transformer fire. This includes the need to efficiently exhaust heat and smoke from the building in order to limit damage to the building structure and other electrical equipment.

5 Ventilation system components

5.1 General

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

- Ductwork.
- Fire dampers.
- Air filters.
- Louvres and grilles.
- Vermin screens.
- Bush fire ember guards.

5.1.2 Refer to Annexure A for the design requirements of the main ventilation system components.

5.1.3 The key details of ventilation systems shall be recorded in Ausgrid's SAP system as an integral part of the installation process. Refer to Clause 2.8.

6 Air conditioning and dehumidifying

6.1 General

6.1.1 The need for an air conditioning and/or dehumidifying system shall be based on a site-specific ventilation assessment (Clause 3.7) and shall be subject to the approval of Ausgrid Engineering.

6.1.2 Air conditioning and dehumidifying systems shall only be adopted 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.

6.1.3 Alternative design approaches shall be investigated to demonstrate that the required equipment temperature and/or air quality criteria cannot be otherwise satisfied. This shall include an options assessment using the following design alternatives:

- 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

6.1.4 It is expected that only those sites which experience one or more of the following conditions will require an air conditioning or dehumidifying system:

- extended periods of hot weather;
- corrosive or heavy industrial environments (moist, salt laden or dusty air);
- compact equipment enclosures (e.g. modular equipment rooms).

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

6.2 Key design criteria

6.2.1 The system design shall 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.

6.2.2 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 impacts on critical electrical equipment only.
3) A heating cycle is not required for most locations, except with the written approval of Ausgrid Engineering.
4) For colder climates, a ventilation assessment (Clause 3.7) shall be used to investigate potential building materials, a heating cycle if required (subject to approval) and other options for temperature control, based on a Life Cycle Cost analysis.
5) Filtered fresh air shall be incorporated where required.
6) Ductwork shall be provided to distribute conditioned air if required.
7) Ductwork, fan coil units and other equipment shall not be located above major electrical equipment or enclosures. Refer to Clause A2.
8) Condensate trays and drains shall not be located above electrical equipment.
9) All condensates shall be drained by gravity to an external location, or to an internal sewer connection if available.
10) Plant and equipment shall be located to allow for ready access.
11) All penetrations through fire rated construction shall maintain the required fire rating of building elements, with reasonable access provided for future inspection and maintenance. Refer to Clause A3 for access to fire dampers.
12) Internal and external temperature monitoring, including alarms, together with system status, differential pressure across filters and other critical data, shall be provided (as data only) via the data communications network.
13) Remote system access for interrogation, reporting and alarms, shall be provided via the data communications network.
14) Fully adjustable thermostatic control shall be provided for automatic operation.
15) A manual over-ride function shall be provided for up to 8 hours operation (Clause 6.4.3).

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

6.3 Main system components

6.3.1 For Ausgrid applications, air conditioning and dehumidifying systems shall consist of one or more split ducted air-cooled refrigeration systems, except where an alternate design is approved by Ausgrid Engineering.

6.3.2 Installed systems shall provide conditioned air only to the selected and approved locations within the substation.

6.3.3 Individual split systems shall be sized and designed to meet the specific requirements of individual rooms. Where “multi-head” systems with one outdoor unit and multiple indoor units are proposed, the reliability and maintenance issues associated with a single outdoor unit shall be addressed.

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6.3.4 The use of single outdoor units, without redundancy, may not be suitable for critical locations containing equipment that is highly sensitive to temperature fluctuations. Where system redundancy is deemed to be essential for reliability, the Designer shall investigate alternate configurations, including the use of 3 x 50% or 2 x 100% units to provide the required standby capacity.

6.3.5 The main system components of a 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, or to an internal sewer connection.
- power and control cabling including separate temperature sensor(s).
- suitable fire rated seals / collars for all penetrations through fire rated building elements.
- self-contained unit control and safety systems with remote access.

6.3.6 Ductwork shall be provided to distribute the conditioned air throughout the space.

6.3.7 Where required, an outside fresh air component shall be introduced to ensure a nominal positive airflow pressure within the conditioned space.

6.3.8 Supply air systems drawing outside fresh air shall be provided with filters to minimise the amount of dust that is allowed to enter the conditioned space. Associated ducting shall be provided to the indoor fan-coil unit.

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

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

6.4 System control and over-ride

6.4.1 The method of control for air conditioning and dehumidifying systems serving a substation area shall be via a fully adjustable thermostatic control for automatic operation, with a manual over-ride to initiate a system start for a particular area.

6.4.2 Automatic temperature control shall be provided such that temperature is maintained within three degrees of the thermostat set-point. The temperature control shall be such that access to changing the set-point is limited to restricted personnel only, via a password or similar.

6.4.3 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 the unit will not continue to operate unnecessarily, and control will revert to automatic mode after the set time has elapsed.

6.5 System signage

6.5.1 The air conditioning and dehumidifying system shall be provided with clear signage located adjacent to the system control panel. As a minimum, the signage shall provide the following system details:

- the system design thermostat set-point.
- the operation of the manual over-ride function.
- instructions to RESET the system when exiting the substation.
- Ausgrid contact to report system faults and alarms.
- Ausgrid key reference drawing(s).
- system details – manufacturer, installer, model, serial number.

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6.5.2 The signage shall highlight the system design parameters, ensure that staff can readily RESET the system upon exit, and facilitate the reporting of any faults and alarms.

6.6 System commissioning and documentation

6.6.1 The air conditioning and dehumidifying system shall be correctly installed and fully commissioned on site with a minimum 12 months defects liability period to ensure effective long-term operation of the system.

6.6.2 Electronic copies of design drawings and specifications shall be provided in Ausgrid compatible format. “As-Built” drawings shall be provided within 4 weeks of completion of construction in the same format.

6.6.3 The system maintenance procedures and operating manuals shall:

- be submitted to Ausgrid for review and approval prior to an application being submitted for Practical Completion;
- include recommended procedures for all maintenance and operation activities;
- ensure that the specified Design Life is achieved to comply with Life Cycle Costing requirements;
- include information regarding operation and replacement instructions for items which have been amended during installation;
- comply with the relevant requirements of NS210 and NS212; and
- be in a format and structure that is suitable for uploading into the Ausgrid record management system.

6.6.4 Within 4 weeks of Practical Completion, the final maintenance procedures and operating manuals detailing all the inspection, maintenance and operational requirements shall be provided.

6.6.5 Certification shall be provided stating the air conditioning and dehumidifying system has been designed by appropriately qualified personnel in accordance with the Ausgrid design brief, all relevant Network Standards, the relevant Australian Standards and accepted standards of practice prior to approval or acceptance of the design.

6.6.6 Certification of the as-installed works shall be provided in accordance with the Ausgrid design documentation and shall be provided to Ausgrid as part of the building Final Occupation Certificate process.

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Annexure A: Ventilation system components

A1 General

This Annexure provides the design requirements for the main ventilation system components used in major substations.

A2 Ductwork

A2.1 All ductwork, and any composite material employed in the construction of ductwork, shall conform with the requirements of AS 4254.

A2.2 The materials used for the construction of ductwork shall have a smoke developed index not greater than three, and a spread of flame index not greater than zero, when separately tested in accordance with AS 1530.3.

A2.3 Flexible connections having a minimum width of 150mm shall be provided at the intake and discharge connections of all fans. Flexible connections shall be manufactured from heavy duty, waterproof, fire retardant material in accordance with AS 1668.1 and shall be airtight.

A2.4 Sheet metal ductwork and fittings shall be fabricated from steel, machine bent and free from waves and buckles. All burrs and sharp edges shall be removed.

A2.5 The material for sheet metal ductwork, either galvanised steel or stainless steel, shall be selected to suit the application and conditions on site.

A2.6 The thickness of ductwork shall be suitable for the pressure class in accordance with AS 4254.

A2.7 Rectangular sheet metal ductwork shall be reinforced in accordance with the requirements of AS 4254.

A2.8 All joints in ductwork shall be sealed and airtight. All bends shall be fitted with approved turning vanes.

A2.9 Fire dampers shall be installed where ductwork passes through fire rated construction. Where fire dampers are installed, suitable access panels shall be provided to allow access for inspection and servicing.

A2.10 Ductwork shall not be located above major electrical equipment or enclosures. Where this is not reasonably practicable, insulated ductwork or other measures shall be used to eliminate the risk of condensation falling onto electrical equipment.

A3 Fire dampers

A3.1 Fire dampers shall be manufactured in accordance with AS 1682 and shall be installed in all openings provided for the passage of air or ductwork through fire rated construction.

A3.2 Fire dampers shall be of the multi-blade type, using steel blades housed in a welded steel frame, suitable for the application. Damper blades shall pivot on stainless steel shafts in self-aligning bearings and shall be held in the open position by a fusible link arranged to lock on closure.

A3.3 Curtain type fire dampers shall not be used.

A3.4 The material for the fire damper, either galvanised steel or stainless steel, shall be selected to suit the application and conditions on site.

A3.5 Fire dampers shall have a free area of not less than 85% of the face area of the damper and shall be installed in accordance with AS 1668 and the manufacturer's instructions.

A3.6 Fusible links shall be marked with the maximum working load, year of manufacture and the manufacturer's name or identifying symbol and shall comply with the requirements of AS 1890.

A3.7 The load applied to fusible links in service shall not exceed the marked working load of the link and shall account for the dynamic loading due to airflow.

A3.8 Fusible links shall be manufactured by Archer, Elsie or an Ausgrid approved equivalent.

A3.9 Where ductwork is installed, or access to the fire damper is via a fire rated ceiling, suitable access panels shall be provided to allow inspection and servicing of the bearings, blades and fusible link.

A4 Air filters

A4.1 Supply air ventilation systems shall be provided with fabric type, disposable air filters manufactured in accordance with AS 1324.1.

A4.2 Filters shall be of the pleated panel type having a thickness not less than 25mm and supported by a wire grid. All filters shall be housed within a supporting frame and sealed to prevent air leakage using gaskets and spring type fasteners.

A4.3 All filters shall be located to comply with AS 1668.1 and the filter media approved in compliance with AS 1530.

A4.4 All filter media shall have a minimum performance rating of F5 when tested in accordance with AS 1324.1.

A4.5 The control of dust and contaminants in corrosive or heavy industrial environments may require the use of alternative air filter types. The Designer shall assess alternative air filters on a site-specific basis, and may include the use of:

- HEPA type filters (e.g. for coal dust); or
- reusable type air filters where frequent filter replacement is expected.

A4.6 Alternative air filter types shall be subject to the written approval of Ausgrid Engineering.

A5 Weatherproof louvres

A5.1 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 shall be discharged to the weather side.

A5.2 Weatherproof louvres shall meet the following requirements:

- be manufactured from extruded aluminium using extruded aluminium blades in an extruded aluminium frame;
- each set of blades shall be nominally 100mm depth and incorporate a minimum of two rain traps in the blade extrusion;
- the louvre finish shall be anodised aluminium, baked enamel or powder coating as required;
- the free area of the louvre shall not be less than 55% of the face area; and
- all louvres shall incorporate vermin mesh screens.

A5.3 For very exposed locations, storm-resistant weather louvres may be required and shall be assessed by the Designer on a site-specific basis. Alternative designs include the use of double stage louvres for exposed south facing locations.

A5.4 Alternative louvre types shall be subject to the written approval of Ausgrid Engineering.

A5.5 Intruder resistant security measures may be required for some louvre locations, depending on the sill height and any surrounding climb aids. Refer to NS185 for details.

A6 Supply air diffusers

Supply air diffusers shall be of the horizontal blade type and shall meet the following requirements:

- air diffusers shall use extruded aluminium blades in an extruded aluminium frame;
- the frame shall form a border with neatly mitred corners and shall incorporate concealed fixings;
- the air diffuser finish shall be anodised aluminium, baked enamel or powder coating as required; and
- air diffusers shall be adjusted to give the required air flowrate without the introduction of excessive noise.

A7 Inlet and exhaust grilles

Inlet and exhaust air grilles installed inside the building shall meet the following requirements:

- air grilles 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;
- the air grille finish shall be anodised aluminium, baked enamel or powder coating as required; and
- all inlet and exhaust grilles shall be fitted with vermin screens.

A8 Relief air grilles

Relief air grilles shall be of the horizontal blade type and shall meet the following requirements:

- air grilles shall use extruded aluminium blades in an extruded aluminium frame;
- the frame shall form a border with neatly mitred corners and shall incorporate concealed fixings;
- the air grille finish shall be anodised aluminium, baked enamel or powder coating as required;
- the air grille shall have a minimum free area of 80% of the face area; and
- all relief air grilles shall be fitted with vermin screens.

A9 Vermin screens

Vermin screens shall meet the following requirements:

- screens shall be installed at the rear of each inlet, relief or exhaust grille and on all weatherproof louvres; and
- screens shall be of grade 316 stainless steel welded mesh, 12.7mm pitch, with a wire diameter of 1.2mm minimum.

A10 Bush fire ember guards

A10.1 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.

A10.2 Ember guards shall be close fitting such that any gaps between the steel wire mesh and the ventilation opening does not exceed 2mm.

A10.3 The use of alternative aperture sizes for the ember guards shall be subject to a detailed site-specific assessment of the substation fire risk. For larger aperture sizes the Designer shall assess the relevant risk factors including:

- the exposed combustible materials (e.g. cable sheaths);
- the risk of ember build-up; and
- the consequences of fire propagation and loss of supply.

A10.4 Alternative aperture sizes for ember guards shall be subject to the written approval of Ausgrid Engineering.

A11 Noise

A11.1 The ventilation fan plant room walls and sections of ventilation ductwork shall be acoustically lined, where necessary, to reduce noise to acceptable levels. Silencers shall be used where required.

A11.2 The final sound pressure level of the completed installation shall be in accordance with AS/NZS 2107 and also with the recommendations of any acoustic studies undertaken for the site.

A12 Alternative materials

A12.1 The Designer may investigate the use of alternative materials for ventilation louvres and grilles that are exposed to high pollution or corrosive environments such as moist, salt laden air.

A12.2 Alternatives shall be assessed on a site-specific basis and may include the use of stainless steel components to reduce the ongoing costs of maintenance and replacement at exposed locations.

A12.3 Alternative materials for ventilation louvres and grilles shall be subject to the written approval of Ausgrid Engineering.