



# 0001c Design Checklist - Power System

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# 00 Design Principles

## 0.01 Main Considerations

It is a requirement to undertake the [00 PLANNING AND DESIGN/ 0001R - DESIGN REFERENCE](#) and [GLOSSARY OF TERMS](#) information into all aspects of design, detailing and delivery when developing the content here within. Clear demonstration of adherence to these requirements is part of the services and will be called upon at key points in the project and during at the discretion of the Department of Education (DoE).

### Introduction

The Power System includes a complete distributed system of low voltage power which is to be provided throughout the school for connection of portable equipment, via socket outlets and fixed equipment.

All power circuits are to be run from a general distribution boards fed via appropriately sized circuit breakers. Circuits are to be wired in radial format.

The general small power installation is to comprise multi core, thermoplastic insulated (TPI) cables running from the final circuit distribution boards that serve the respective area.

Final circuit wiring is to be based upon radial topologies dependent upon circuit requirements.

The completed installation is to meet the requirements of the National Construction Code, and the associated relevant standards, including AS/NZS 3000.

The design of the power system and the selection of materials and fittings is to be undertaken based on a Whole of Life approach to ensure that the completed system provides:

- Value for Money
- Fit for purpose
- Long term reliability
- Minimal maintenance requirements
- Low maintenance costs

Specifically, power equipment must be accessible, serviceable and easy to maintain with minimal impact on school use when maintenance is being performed

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## 0.02 Socket Outlets

General **socket outlets** are to be protected by 20A circuit breakers.

In some situations, this may require the use of final subcircuit wiring larger than 2.5mm<sup>2</sup>.

Socket outlets are generally used for the connection of low power consumption devices such as digital projectors, computers, television sets, portable music equipment etc. The maximum number of socket outlets per 20A circuit is:

**Critical items of equipment** such as: **1**

- Refrigerators
  - Freezers
  - Animal life support systems
- High consumption device areas** such as: **6**
- Main Staff Common Room
  - Canteen

**Other areas:** 12 Double socket outlets are to be considered as 2 and triple outlets as 3 in application of the above.

### Socket Outlet Positions

Socket are to be positioned to suit the application and intended use, as follows:

- Positioned to suit specific items of equipment, the exact position is to be co-ordinated with the selected item of equipment.
- General use socket, positioned on the wall generally 300mm above floor level for general use of the occupants. At least 20% of these sockets and at least one per classroom, are to be positioned to enable access for disabled persons in accordance with the requirements of AS1428. This will require sockets to be positioned at least 500mm from internal corners and between 600mm and 1100mm above the floor.
- Specific task sockets could be positioned above work benches or sink benches. The position of the socket is to be identified on construction documentation drawings.
- General maintenance sockets, positioned in general walkways and the like at regular intervals for use by cleaning and maintenance staff.

Where the socket is to be positioned in wet areas or close to sinks and other water sources, as required by the standards, the socket is to be noted as weather proof or hose proof. These sockets should be rated as IP65.

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**Label** each socket outlet with the switchboard and circuit number. Labelling to be machine engraved and paint filled or hot stamped into the plate or into an insert fixed into the plate.

Use only plates that require the **use of a tool** to remove the cover.

Refer to individual rooms and spaces pages for equipment that is to be provided in each space.

## 0.03 Socket Outlet Protection

### Residual Current Device (RCD) Protection

Residual current device (RCD) protection is required on final sub circuits containing socket outlets, lighting outlets and three phase outlets, including socket outlets dedicated to specific appliances, except fixed electric cooking appliances.

RCD protection is to be via 30mA units incorporated in each final sub-circuit circuit breaker. RCD protection shared between final sub-circuits is not permitted.

Panel cut outs for test buttons and labelling is to be included on each switchboard and instruction sheets are to be provided with residual current device (RCD) circuit breakers.

Label RCD protected circuit breakers, and where the circuit breaker test button is not labelled by the manufacturer, install a suitable label adjacent to the test button reading "TEST".

Mount an instruction sheet adjacent to the circuit schedule with wording based on the following:

#### **RCD PROTECTION**

If an RCD circuit has tripped (toggle in off position or half way between off and on), an earth fault may have occurred.

#### **TO RESET**

- A. Turn toggle to off position and then turn to on position.
- B. If it trips again, disconnect all appliances on that circuit (see schedule) and try again.
- C. If it trips again, turn off the circuit breaker and have wiring checked by an electrician.

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D. If it does not trip, add appliances one by one. If circuit breaker trips after any one appliance, disconnect that appliance and have it checked. Reset the circuit breaker.

E. If it does not trip immediately after all appliances have been reconnected, it may trip after a short duration. This indicates the circuit may be overloaded. Disconnect non-essential appliances or connect them to alternative circuits and reset the breaker.

F. If a problem remains or a defective appliance is found, have it checked by an electrician.

#### TO TEST

A. Press test button.

B. Circuit breaker should trip.

C. If tripped, reset breaker.

D. If not tripped, have checked by an electrician.

## Surge Protection

Refer to: [00 PLANNING AND DESIGN/ 0001c DESIGN CHECKLIST – COMMUNICATIONS](#) and [00 PLANNING AND DESIGN/ 0001c DESIGN CHECKLIST - SECURITY](#)

Provide surge protection as recommended by AS1768 to limit power surges to protect equipment from lightning. In addition to this, provide individual surge protection to final sub-circuits containing socket outlets which provide power to critical equipment which includes communications equipment, computers or microprocessor-controlled appliances.

Generally, this will apply to final subcircuits containing socket outlets:

- Supplying structured cabling system CDs and BDs
- Supplying the telephone system
- Supplying the WAN router
- Supplying the AV equipment
- Supplying electronic security equipment
- Supplying automatic lighting controller
- In the Administration Block (all outlets except in the corridors, tea room, clinic and store rooms.)
- In the communications room and audio-visual workroom

- In staff studies
- In computer learning spaces and laboratories
- In the library computer space and office

Note: In the above areas, however, this requirement will not apply to socket outlets for specific appliances such as water heaters, boiling water units, room heaters and refrigerators that do not require surge protection.

Select surge protection appropriate for the location of the school, the circuit loading and the equipment to be protected. Provide confirmation from the manufacturer or supplier of the surge protection.

Where surge protection units are within switchboards, provide DIN rail mounted, that have LED status indication visible from outside the switchboard, series connection, minimum 20A rated, cut-off frequency (-3dB at full load) of less than 1kHz, peak let through voltage (3kA active-neutral) of no greater than 800V and minimum surge current (8/20us) of 25kA.

Where the physical size of individual surge protection units would result in a large switchboard, a co-ordinated surge protection installation may be used. Use a combination of surge protection at the MSB and/or incoming lines to the EDB in conjunction with surge protection at each nominated final subcircuit. Select components from the one supplier using sound engineering principles and in accordance with the manufacturer's data to achieve an equal level of protection to all nominated areas.

Distinguish socket outlets that are connected to surge protected circuits, for example by a blue coloured insert fixed in the plate or coloured switch toggles.

## 0.04 Ceiling Duct and Overhead Power Support System

These systems are used in some of the specialised Materials Technology spaces to provide increased flexibility when relocating pendant socket outlets, and also as a connection point for task or supplementary lighting.

Provide pendant socket outlets as noted in the EFSG, and locate as shown in the typical drawing. Provide a continuous cable way, fixed to the underside of the ceiling adjacent to the pendant supports, for connection of the pendant socket outlets to the permanent wiring. Install pendant socket outlets clear of ceiling fans.

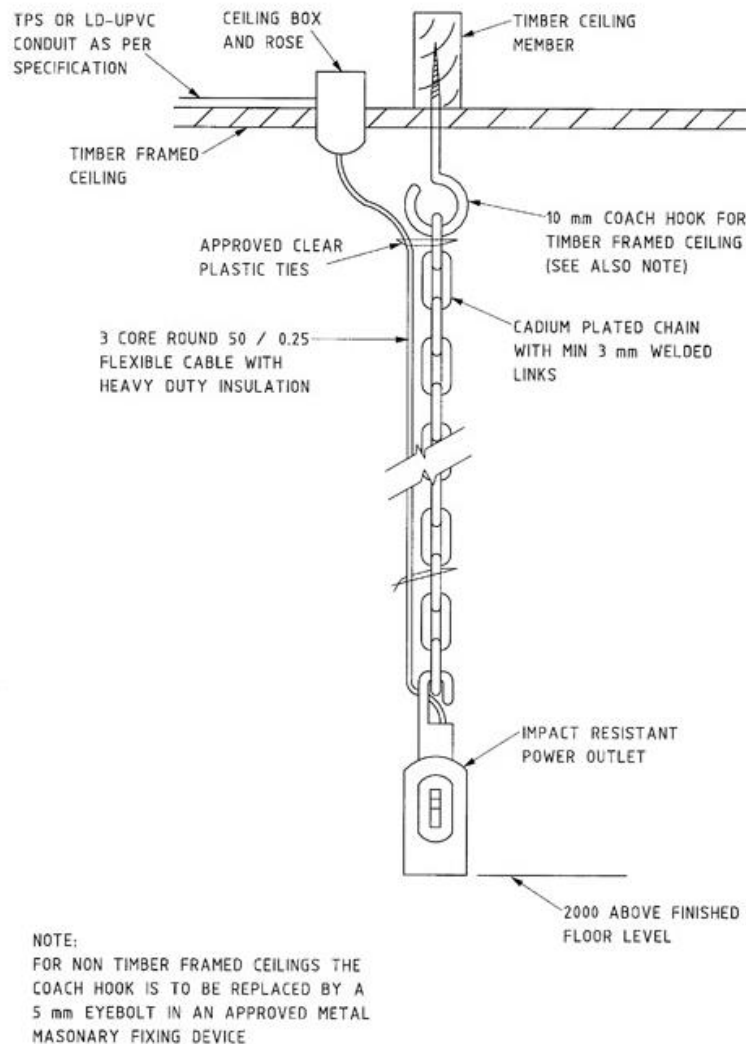
The cable-way must meet the following:

- 20A minimum rating, single-phase, neutral and earth



- Provide either a standard track system, as used for display lighting, or a normal plug-in busway
- Maximum number of Socket outlets per circuit to be as nominated in DG / POWER / SOCKET OUTLETS
- Connection of pendant to cable way to be via proprietary type “take-off” plugs/modules which must have a minimum rating equal to the rating of the pendant Socket outlets
- It must be possible to relocate the power take-off point in steps no more than 1 metre long, without needing any electrical expertise

**Figure 01: Schools Generally Pendant Outlet**



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## 0.05 Electrical Supply for Specific Purposes

In addition to socket outlets, dedicated electrical supply is required for specific purposes in schools.

Provide dedicated circuits to similar equipment or operation. Limitation on number of equipment on circuits should be assessed based on current overloading and leakage current.

Examples of typical circuits of this nature may include the following:

- Fridges
- Comms Room GPO's for general maintenance
- Security Equipment
- Cleaner's outlets

Hardwired connections and three phase circuits are to be provided with a dedicated circuit.

For the preferred position for plug sockets and isolating switches in each space refer to the individual Rooms and Spaces technical data.

All outlets are to be co-ordinated and position with reference to the architectural furniture layout and wall finishes. Refer to -- / POWER / SOCKET OUTLETS.

In Food Technology Learning Spaces, include a neon pilot light in stove isolating switches. Locate the switches so that the pilot light is clearly visible.

Provide welding bay control panels for each welding bay as approved and as indicated on Rooms and Spaces pages.

## 0.06 Ceiling Fans

Provide ceiling fans together with fan speed controllers from a recognised and approved supplier that offers equipment that has been assessed as suitable for school use.

Ceiling fans are to be quiet in operation.

Install ceiling fans where indicated in the Rooms and Spaces data table and as determined in the project cooling strategy except in:

- Rooms less than 12 sqm. (Provide a wall fan in lieu of the ceiling fan)
- Food service units
- Small rooms where lighting flicker effect from the blades may occur

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- Where dust nuisance could be exacerbated (E.g. over woodworking machine bays)
  - Over bandsaws or disc sanders in Materials (Wood) Technology
  - Close to fume cupboards in science laboratories and science preparation rooms
  - Ceiling spaces subject to ball damage (E.g. Gymnasiums)
  - Spaces with ceiling heights of less than 2700 mm (Provide a wall fan in lieu of the ceiling fan)

The installation of ceiling fans in some Materials Technology spaces is potentially dangerous due to the materials being handled and locations must be carefully considered to reduce the risk of impact.

Ceiling Fan Locations: Refer to ceiling mounted fan standard drawing for further information on ceiling fan clearance requirements.

Generally, provide ceiling fans:

- **At a rate equal to one** 1420 mm diameter fan per 25 sqm of floor area. (or larger fan to larger area)
- **Evenly distributed** throughout that space.
- **Positioned** to suit the lighting layouts and building features while providing adequate ventilation.

In rooms of between 13 sqm. and 25 sqm., install one ceiling fan in the centre of the room and arrange the lighting to suit.

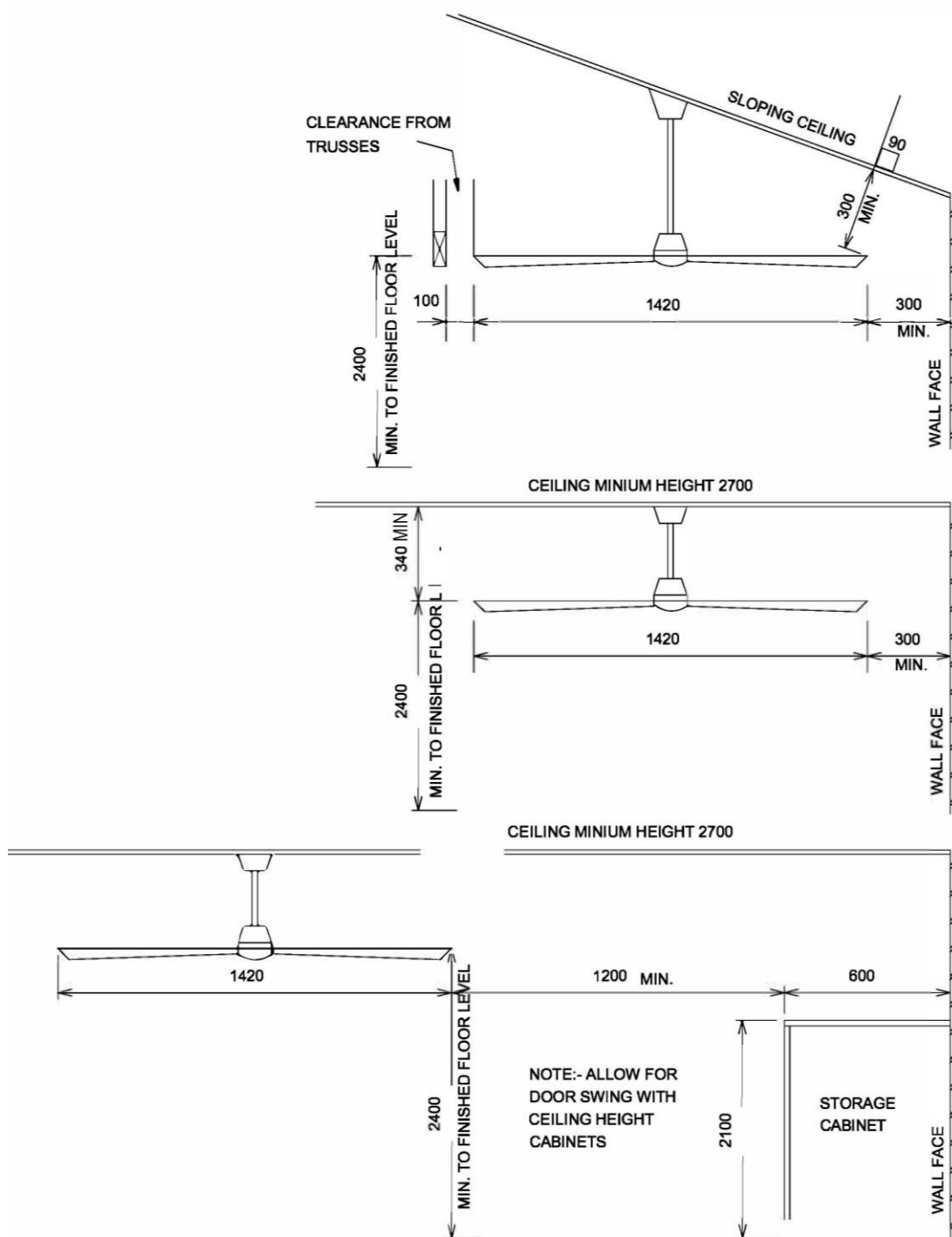
Locate ceiling fans with respect to luminaires to avoid reflections and stroboscopic effect. Do not mount ceiling fans where the top of the blades is less than 2.4m from the floor or less than 300mm from a (sloping) ceiling.

In rooms where natural-lighting strips or rooflights are provided, position the fan to avoid flicker.

Where only one luminaire can be installed, provide a wall fan in lieu of the ceiling fan.

Maintain adequate clearances from ceilings, cupboards, other structures and personnel. Forcing air movement close to fixtures can create noise, and operable walls could impact with blades.

**Figure 02: Ceiling Mounted Fan Clearances**



## Ceiling Fan Controls

- 3 hour local timed switch/fan speed controller
- Do not mount controllers on stainless steel switch plates

- Use “reduced maximum speed” controllers where fan blades are less than 3.0 m above floor
- Connect no more than 4 ceiling fans to the one controller
- Adjust the “minimum speed” setting of the speed controllers so that no fan remains stationary when first turned on

Locate the ceiling fan controller with the lighting control switches for the particular space. The requirements for the switch panels are contained in 0951 LIGHTING.

Use the gimbal type mounting bracket supplied with the ceiling fan to mount on either flat or sloping ceilings, provided the slope is within the capacity of the bracket. Connect the final subcircuit wiring at the terminal strip incorporated in the bracket.

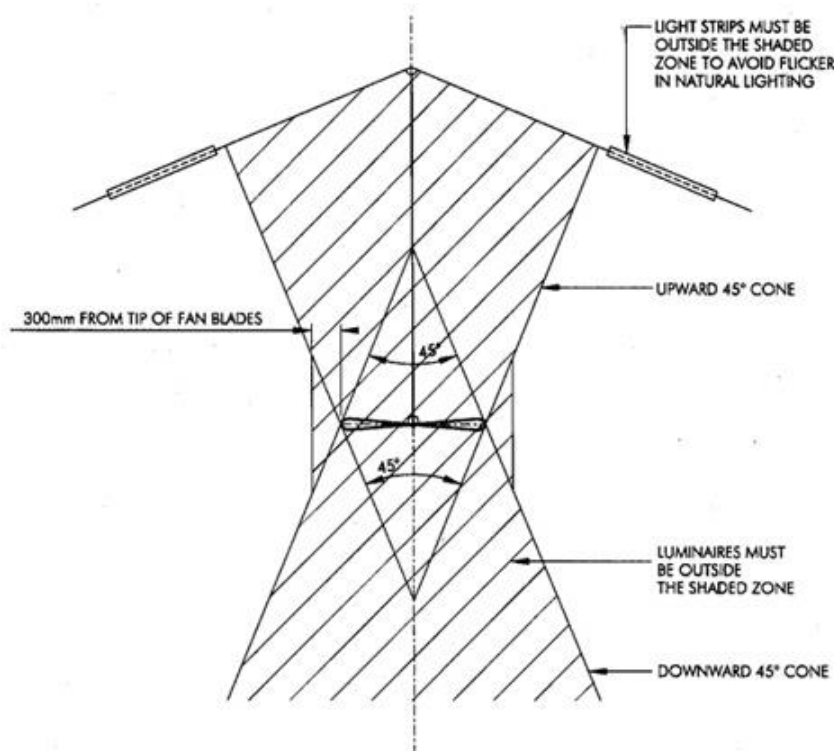
Specify the fan with either the standard short or optional long rod for gimbal mounting.

Use the optional ceiling hook mounting and fabricated rod assembly with either steeply sloping ceiling and/or a rod longer than standard. With the hook type bracket use a 3-pin plug top/socket outlet connection between the flexible cord and the fixed wiring.

Rigidly mount into solid backing framing. Mount any gimbal bracket with the opening on the high side.

To limit fan wobble, adjust the blades so they are equidistant from the floor.

**Figure 03: Ceiling Fan Locations in Schools**



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## 0.07 Wall Fans

Provide wall fans only where circulating fans as indicated in the Rooms and Spaces pages and where it is not possible to install a ceiling fan.

Fans are to be 10A 3 speed, oscillating with 400mm dia. blades, and a remote ON/OFF switch located at a convenient height. Wall fans are to be quiet in operation.

Install wall fans by rigidly fixing into backing framing. Use a standard 3 pin flat pin plug/socket connection to enable replacement and servicing

## 0.08 Electric Heating - General

Electric heating may be considered subject to the department approval and as identified in the Heating strategy developed for the project.

Generally, gas heating will be used in areas where natural or town gas is available.

In areas where natural or town gas is not available obtain the following information from the relevant electricity retailer as part of the Whole of Life Analysis in the development of the project heating strategy.

- The price of the on-demand rate
- The type of off-peak rates available and associated prices
- The time bands that the off-peak rates are available

Refer to [00 PLANNING AND DESIGN/ 0001r DESIGN REFERENCE](#) and [00 PLANNING AND DESIGN/ 0001c DESIGN CHECKLIST - MECHANICAL](#)

The types of electric heating that can be used are:

Off peak:

- Heat banks

On demand:

- High-mounted fan heaters in laboratories
- Both high-mounted and low-mounted fan heaters in offices
- Radiant strip heaters
- Under floor heating and supplementary heating for Severe [Support] Unit

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Run timers are required for on-demand electric heating other than in severe (support) units. Locate heater controls in a flushplate matching the lighting switchpanel under or beside the heater at switch height. Label as HEAT with switch/es to both turn the heater on and off. The time delay unit may be in the switchplate or the switchboard. The run time is stated for the heater types.

Provide an isolation switch at each heater which may be in the form of a 10A or 15A switched socket outlet for heaters up to 3kW and an isolator in the fixed wiring for larger heaters. Label the isolation switch as HEATER and locate beside the heater.

## 0.09 Off Peak Electric Heating – Heat Banks

Rarely used - Use only when approved as part of the project heating strategy.

## 0.10 On-Demand Electric Heating – Fan Heaters

Use only where approved as part of the project heating strategy after heating options study is completed.

Generally, rooms that are to receive on-demand electric heating are identified in the Rooms and Spaces Data pages. On-demand electric fan heating **could be considered for** the following areas:

- In high use offices where furniture layouts preclude the use of gas space heaters or off-peak electric heat banks
- In Science Laboratories and Preparation Rooms
- In Materials Technology workshops, Learning Spaces, Technology Bays, Art Rooms
- In schools where gas heating or off-peak electric heating is not available or cost effective
- When required as a supplement to other forms of heating.

Determine the sizing and location of the fan heaters in conjunction with the mechanical engineer, project architect and the architectural furniture layouts.

Heater noise is a particular problem in all areas of the school. Select heaters that are **quiet** in operation.

## High Mount Fan Heaters in Laboratories and TAS Spaces

**A zone map** divides the state into four climatic zones each of which has different requirements for this type of heating installation.

- Laboratory heating is not normally provided in Zone A, though this is to be assessed for each project as part of the Project Heating Strategy.



- Single line diagrams for Zone B, C and D are included.

Install and control high mount laboratory type fan heaters in laboratories and other areas as identified in the Rooms and Spaces technical data table.

**Control any supplementary on-demand heating** by a thermostat set 2°C below temperature set for the heat banks. Provide a run timer to switch heater/s off after 2 hours. If supplementary on-demand heating is installed for night time use provide an overriding time switch for the circuit which will prevent use during the daytime school hours.

**Figure 04: Heating Zones for Laboratories and TAS spaces.**



## High Mount Office Type Fan Heating

Due to restrictions imposed by furniture layouts, ECH - high-mount office type fan heaters may be considered for office areas. Generally, rooms that are to receive fan heaters are



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identified in the Rooms and Spaces Technical Data tables. Provide individual on/off controls with run timers to switch heater off after an adjustable 0 to 3 hours. In addition, control each heater by an individual thermostat within the heater or external at 1800mm.

When called for, provide high-mount office type fan heaters in Severe [Support] Units, as supplementary heating to the under-floor heating system. Control by timed switches separate from the under-floor system.

## Wall Mounted Fan Heaters (Low Mount Style)

Wall mounted fan heaters may be considered for high use office and teaching spaces where gas or off-peak electric heating is not available or practical. Use a heater with built-in start/stop switch, adjustable 0 to 3 hours timer, high temperature cut-out and thermostat control. Do not use external controls. Mount these heaters within 100mm of the floor.

Exercise care where heaters are located beneath windows so that there is sufficient height for the heater and its clearance above the finished floor level, to ensure that adjacent elements such as blinds, curtains or blind control cords will not overheat melt or burn. Also heaters should be located where there will be minimal obstruction to the flow of heated air about the space.

## 0.11 On-Demand Electric Heating – Radiant Heaters

Use only where approved as part of the project heating strategy after heating options study is completed.

Radiant heaters may be considered for areas where use is of short duration, quick response is desired and where heating of the entire space would be uneconomic ie. where convection heating would be lost through vents, windows, shutters, etc.

Generally, **rooms that are to receive radiant heaters** are identified in the Rooms and Spaces Technical Data tables.

When providing heating in the **disabled person's toilet/shower** via ceiling mounted infrared heating lamps, mount in a housing suitable for use in damp areas.

### Control of radiant heating

- Provide individual on/off control with a run timer to switch heater off after a maximum of one hour.
- Where electric radiant heaters are provided in communal areas or multi-purpose halls, group control the heaters in two banks, each with an on/off controls on the hall switchpanel and an adjustable 0 to 3 hours timer in the hall switchboard.

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## 0.12 On-Demand Electric Heating – Under Floor Heating

Use only where approved as part of the project heating strategy after heating options study is completed.

### In Severe [Support Unit]

Children spend substantial periods of time in contact with the floor surface undergoing therapy or instruction. These children may be unable to regulate their body heat as efficiently as others; or communicate discomfort readily; or lack sensations of heat or cold.

When providing under floor heating in these areas:

- Embedding MIMS heating cable in the concrete slab to manufacturer's recommendations, and to Rule 4.3.8 of AS/NZS 3000. Design of this heating method shall be only by the manufacturer or his agent. Advise the Architect/Structural Engineer of the slab requirements.
- In existing installations, lay the cable on top of the existing slab and apply concrete screed to adequately cover the cable. Provide heating under both vinyl and carpet covered areas of the Home Base and Practical Activities Areas, but not Laundry/Bathrooms and Withdrawal Areas.
- Provide a centrally located time switch / programmable timer, to ensure an adequate floor surface temperature when classes begin in the morning. Override by a non-timed switch in each building / room, mounted at a minimum height of 1800 above finished floor level.
- In addition, provide control in each room by embedded ON/OFF thermostats to maintain floor temperatures in the range 20-22°C.
- Floor heating is in addition to the high mounted fan heaters.

Refer proposed floor heating for suspended concrete or timber floors to the Project Manager.

Alternatives to in-slab heating are to be considered, which may include the use of heating mats in small areas or hydronic heating. Seek advice from the Project manager, design team and the Department.

### High Mounted Fan Heaters

- High mounted fan heaters are required in addition to the underfloor heaters.
- Provide thermostat control of these heaters separate from than installed for the under-floor heating to maintain temperatures in the range 20-22°C.

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- Do not install undersized fan heating on the basis of the floor heating.

## 0.13 Mechanical Ventilation / Heating / Cooling

Provide supply to these installations as required.

Refer to [00 PLANNING AND DESIGN/ 0001c DESIGN CHECKLIST - MECHANICAL](#) and [00 PLANNING AND DESIGN/ 0001c DESIGN CHECKLIST - SUSTAINABILITY](#)

### Mechanical Electrical Service Interface

**The point of interface** between services depends on whether the mechanical plant is supplied from dedicated Mechanical Services Switchboards or from the local Electrical Distribution Switchboards.

- If there are Mechanical Services Switchboards it is recommended that the electrical services trade provide appropriate submains for termination on the mechanical board from which point responsibility for the installation passes to mechanical services trade.
- If the mechanical plant is supplied directly from the local electrical distribution board then it is recommended that the electrical services trade provide appropriate supplies to the relevant items of equipment terminated in isolating switches adjacent to such equipment.

The installation of all such cabling is to be as specified in the electrical services documentation.

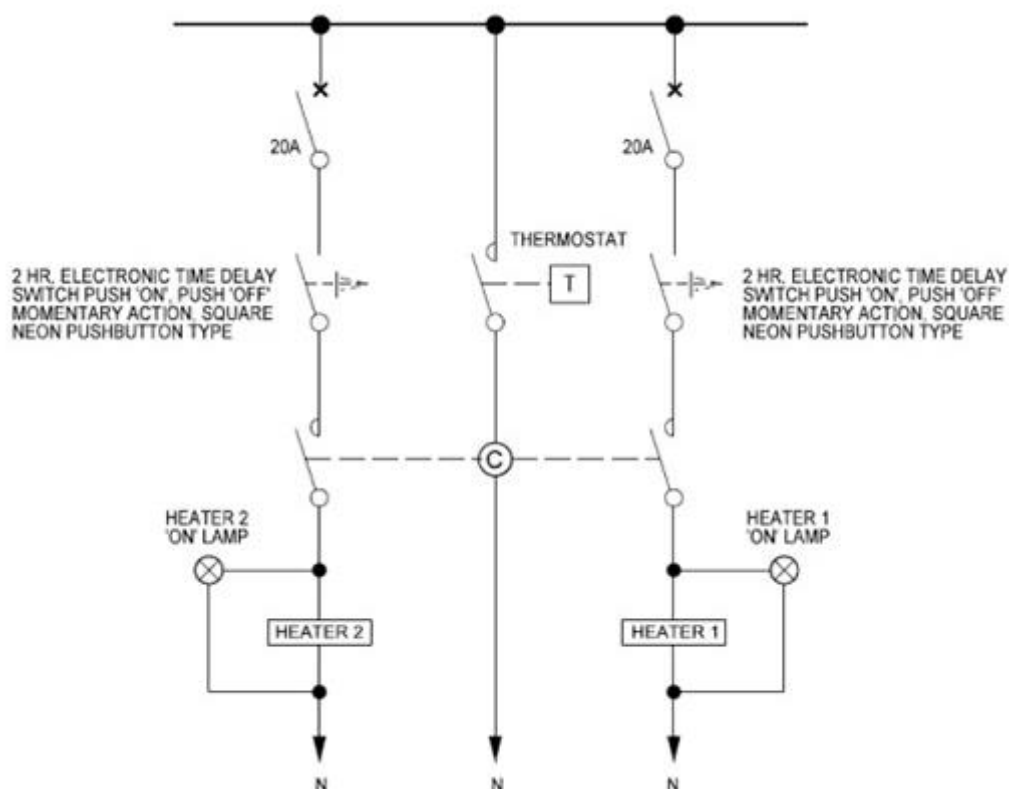
Where external switches are used for external mechanical plant, provide an isolating switch capable of being locked in both the ON and the OFF position. Provide weather proof outlets, with a minimum of IP56 rating.

As a minimum, rate the socket outlet and light switch in the dust-extraction room at IP50, and the luminaire is to be vandal proof, to reduce hazards when dust collects. Use a higher rating if required by the mechanical services trade.

Where flued radiant gas radiant heaters are provided in Communal Halls, Gymnasiums and Movement Studios, supply heaters fitted with electronic ignition, individually controlled by a selectable 0-3hr electronic time delay switches.

Check with the mechanical engineer whether electric supply is required at gas heater locations, e.g. for fans or ignition.

**Figure 05: Flued Radiant Gas Heaters Single Line Diagram**



## 0.14 Master Switch

The Education Facilities Standards and Guidelines (EFSG) require a “Master Switch” in certain rooms such as the Computer Learning Space. This item allows authorised staff to control power supply to all outlets by a suitably located key-switch. Each room must be able to be isolated without affecting any other room. Leave one outlet uncontrolled, for use by cleaners.

Where the size of the load or number of circuits is too great for direct switching, locate a contactor within the distribution board enclosure from which the circuits originate and with an independent circuit breaker to feed the control circuit through the master switch.

## 0.15 Master Control (Emergency Off)

This term means an overall control, similar to the Master Switch, but also fitted with a large headed mushroom button for emergency use, within areas such as workshops, laboratories, kitchen, etc as indicated in the Rooms and Spaces Technical Data tables.

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When a room is supplied from more than one EDB, the operation of any master control in the room is to isolate all power outlets in that room, if needed in an emergency situation.

This overall isolation requirement does not apply to Master Switches.

Use mushroom head type push buttons with the following design features:

- Minimum head diameter of 35mm
- Contact normally closed in the ON position
- Push button to lock into the OFF position when pushed button requires a keyed release back to the on position
- Key removable in both the on and off positions
- Robust and tamper proof suitable for flush mounting unless otherwise specified

Install a label above each push button with the following wording:

"Electric Power Isolator"

## 0.16 Other Equipment

Refer to the Rooms and Spaces Technical Data tables and equipment schedules to determine items of equipment to be included. The schedules will also note equipment requiring safety switches and/or master isolating switches.

## 0.17 Kiln Outlets

In Secondary schools: normally 20A, three-phase 5-pin switched socket outlet with all terminals cabled.

In Primary schools: minimum 20A, single-phase switched socket outlet, or another outlet for a specific kiln.

To avoid nuisance tripping do not provide RCD protection to the kiln final subcircuits unless it is deemed mandatory under AS/NZS 3000.

## 0.18 Boiling / Chilled Water Units

Power supply to boiling and chilled water units must be controlled by a time switch as set out in BCA requirements. Confirm details with Hydraulic consultant if in-built time switch is provided in equipment.