1. DIPL MINIMUM DESIGN GUIDELINES – MECHANICAL

1.1 GENERAL

The purpose of this minimum design standard is to set out Northern Territory Government (NTG) minimum requirements for the design of Mechanical Services for projects.

The Heating, Ventilation and Air Conditioning (HVAC) system must provide proper air flow, heating, and cooling to each area in an efficient and economical manner. When dealing with humidity control and ventilation, occupant health must always take precedence over energy issues.

Any design aspects not specifically addressed by this minimum design standard shall be identified by the designer and brought to the attention of the Department of Infrastructure, Planning and Logistics (DIPL) 'Manager Projects Engineer Mechanical' for resolution during the design process.

It is expected that the design and installation of mechanical services and equipment in buildings generally comply with all current statutory requirements and current applicable Australian Standards; hence these are not specifically referenced as part of this document.

For the purpose of this minimum design standard, whenever reference is made to NTG or DIPL it means the nominated DIPL representative for the project.

In all instances the Mechanical Services shall be designed in consultation with the designated DIPL representative and the client.

Heat load calculations must be carried out using the ACADS-BSG CAMEL software package or similar and approved.

For designs associated with existing assets, the design engineer and the drafter must visit the site and determine the available ceiling space, switchboard capacity (inspection by authorised personnel only), existing plant capacity etc. prior to submitting the fee offer.

Direct Digital Control (DDC) control systems must be of the same manufacturer for each site.

Split system air conditioning units are generally not recommended in Class 2 to Class 9 buildings as prime systems, however, if the client has a particular need that suits this type of air conditioning then a properly engineered system may be considered. Where a client specifically requests split systems, the designer shall provide the client and DIPL with pros and cons of both split systems and an alternative such as a Packaged Air Conditioner (PAC) unit. It is imperative that the client forms an informed decision. Fresh air at the Building Code of Australia (BCA) prescribed level must be provided in all situations.

1.2 MECHANICAL SERVICES

1.2.1 Relevant Sections of this Brief

Read this section in conjunction with all other sections of this minimum design standard.

1.2.2 Design Policy

Design Mechanical Services systems in full consultation with the DIPL to ensure compliance with policy guidelines on system components and for their ongoing operation and maintenance. This shall be achieved by means of a written briefing by the Project Manager which must be documented by the designer in a return brief to DIPL for verification and acceptance.

In addition to the return brief, submit a report detailing the proposed future peak load capacity of the thermal plant, the peak load capacity required at the completion of the current stage of works and the proposed final thermal plant configuration.

On completion of design works, along with all required documentation for tender, submit all supporting heat load calculation reports and program data files.

1.2.3 Design Compliance

The design and installation of mechanical systems shall comply with the following:

- Current applicable Australian Standards
- Building Code of Australia (BCA)
- Local Council Regulations
- State and/or Federal Regulations
- PowerWater Corporation Rules
- NT Work Safe Health and Safety Regulations
- Environment Protection Authority Regulations
- Any other relevant Acts or Regulations

1.2.4 Client Objectives

Design the works in accordance with the following Client objectives;

- Project purpose
- Project/System life cycle
- Flexibility of performance
- Indoor environment quality
- Process environment
- Fire and life safety
- Durability
- Energy efficiency
- Greenhouse emissions
- Maintenance repairs

1.3 AIR CONDITIONING SYSTEMS

During the design phase the design engineer must incorporate energy efficient systems that are in keeping with the Northern Territory Governments policies towards sustainable development.

The design phase will be required to assess all layers of functionality of the air conditioning system and its relationship to other building systems. As a part of the preliminary design development report provide a full risk matrix identifying responsible duplication of plant.

The overall concept of system design, based on all relevant standards and specific user information, shall be presented in a return brief for preliminary discussion with DIPL.

Air handling systems will be required to be contained entirely within the smoke zone and fire zones they are serving. Design methodologies for plant location must ensure the majority of maintenance obligations are kept within plant room spaces, away from the principal functional activities of the building.

1.3.1 General

Design air conditioning systems for ease of maintenance, including good accessibility to all items of plant. External noise levels from plant rooms, cooling towers and condensing units must be assessed with respect to the occupied areas and the site boundary, to ensure sound pressure levels are within that nominated by the Australian Standards and these Guidelines.

Where air handling units are located in walkways, the minimum height to the underside of the platform frame must be 2.4m.

Design air conditioning systems to meet the requirements of AS 1668 Parts 1 and 2 and AS 3666. The use of “openable windows” clause of BCA to achieve a concession with regard to outside air when air conditioned is disallowed. The Clause shall be interpreted as providing outside air through openable windows for spaces that are to be naturally ventilated only. Where a space is to be naturally ventilated then minimum 5% (of floor area) open area on an external wall or roof shall be provided. Natural ventilation implies that no air conditioning shall be provided.

1.3.2 Split Systems

The use of split systems is to be restricted to supplementary air systems only, and only with the approval of the DIPL representative.

Use inverter type condensing units to ensure that the cooling coil is active at low loads. Single occupant office is exempt from this rule.

In latitudes south of Katherine, ensure split systems are reverse-cycle capable to provide heating during winter.

Do not use multi-headed and/or variable refrigerant volume split systems.

The condensers shall be selected for continuous operation at peak ambient conditions and peak demand with consideration to specific placement.

Provide interlocks with any outside air system associated with the split system. Interlocks shall have delay timers, with adjustable timing (initially set to 10 minutes) to allow for the split system to cool the space before starting the outside air system.

All refrigerant pipe work shall be fully insulated and vapour sealed with ends and joints of insulation taped and/or glued. Cover all external pipe work and wiring with metal capping, and supported with saddle clips. Provide fully weatherproof units and electrical controls etc., suitable for outdoor operation under tropical conditions.

Generally, all equipment shall be suitable for operation, without deterioration, in the following conditions:

- High humidity levels
- Ingress of wind driven rain
- High ultra violet light levels
- Termite/ant infestation

1.3.3 Evaporative Air Cooling Systems

The use of evaporative air cooling systems will be subject to approval of the DIPL representative, and shall only be considered in latitudes south of Katherine, and only where the ambient operating conditions exist below 23 ℃ wet bulb for long enough periods of time for evaporative cooling to be economically viable.

Do not use evaporative air cooling systems in areas where water availability is scarce, or where poor water supply quality will lead to excessive mineral and scale build-up.

Optimise the system configuration based on the design requirements of the space:

- Residential installation: Direct evaporative
- Commercial or large-scale installation: Indirect or two-stage evaporative, as the primary cooling system or pre-cooling stage to refrigerant-based plant

Primary evaporative cooling systems shall achieve the following internal design conditions:

- Maximum internal conditions 27.4 ℃ dry bulb, relative humidity (RH) no more than 80%
- Air change rate of 20 – 40 air changes per hour (ACH)
- Achieve relief/exhaust air for the space through non-mechanical means

Use control and water quality systems that are automatic with continuous water quality monitoring. Use robust, low maintenance components for controls and sensors. To reduce water consumption, do not use water quality systems that use continuous water bleed or periodic dumping methods.

Interlock the operation of the unit with ambient enthalpy sensors for:

- Economy cycle – where the water circuit can be disabled and the fan permitted to run to provide ventilation when ambient conditions equal the target internal temperatures
- Extreme ambient conditions – where the system can be disabled when it cannot achieve target internal conditions. Set to automatically change over to refrigeration-based plant in this condition.

1.3.4 Minimum HVAC System Features

The air conditioning systems design must include the following features:

Generally, provide air conditioning systems:

- That is effective in delivering the required conditions for optimum comfort to each thermal zone and application.
- That are flexible and capable of cost-effective modification should there be a change in the function of the building or occupied space at a later stage.
- That provides ease of maintenance, including adequate accessibility and circulation space to all items of plant. Avoid locating plant on roofs or in ceiling spaces, and allow for plant maintenance to occur at ground level.
- That provides a healthy internal environment, ensuring optimum air quality and providing safe and comfortable working conditions. Provide a design opportunity for a controlled space environment which manages both dry bulb and absolute humidity upper limits within all functional areas. Strategies associated with this will be required to be energy efficient with clear definition of any associated parasitic energy consumption. Provide a section within a design development report which as a minimum identifies the lifecycle assessment of the system design consistent with the Shaw method of air conditioning. The assessment will be required to consider and depict consequences comparing a controlled space environment with a conventionally designed dry bulb regulated system which explores the potential for control of internal space environments that could affect both the building fabric and occupant satisfaction and wellbeing.
- That includes a cost-effective outside air economy cycle.
- That includes demand based ventilation such by CO_2 level sensing and/or minimum fresh air at plant start up.
- That enables an economic after hours operation for individual areas of the building.
- That provides a minimum air change rate of 8.5 ACH/hr.

- That provides sub-metering to all major items of plant.
- That interlocks operation of toilet exhaust systems with the HVAC system.
- That provides adequate building pressurisation to minimise infiltration of outside air. Provide 0.5 air changes per hour net positive airflow into the building (account for building exhaust systems such as toilet exhausts, kitchen exhausts, fume cupboards and the like).
- That allows for complete, unimpeded removal of all mechanical plant components. Design isolation points on connecting pipework and ancillaries to allow dismounting of pipework to permit plant removal and installation.

In addition, the following design considerations must be implemented into the proposed design:

- All chilled water air handling units to have minimum 6 row deep main coils, and minimum 6 row deep coils associated with dedicated chilled water outside-air pre-cooling units. The use of air to air heat exchangers and desiccant-based dehumidification is not permitted.
- If the site has significant after hours usage, utilize low-load chilled water generation in the form of a low load chiller
- For the proposed DDC control system, the chilled water plant controls shall be separate from the field (air handler) controls. Limit communications between the two control groups to call-for-cooling only. Select control hardware and communications protocols that are open industry standards, and all controls intellectual property ownership is to be transferred to the Northern Territory Government.
- Limit ductwork velocity to no more than 5 m/s. Ensure all return air paths to the air handlers are via dedicated ductwork. Limit the use of room-to-room return air transfer ducts.
- Air handlers shall have fully ducted return and outside air reticulation to all air handling units. Do not rely on plant rooms to act as mixing plenums.
- Provide tempered air conditions inside all mechanical plant rooms. Target design conditions for plantrooms shall be no more than 28℃ and 60% RH.

Where heating systems are required other than those incorporating reverse cycle direct expansion packaged plant, the following design considerations must be implemented into the proposed design:

- All heating coils to be selected for the flow temperatures of less than 40oC with a temperature differential of not greater than 8oC, suitable for the incorporation of secondary energy recovery systems.
- If the site has significant after-hours usage, incorporate low load active thermal inertia storage tanks.
- Incorporate low level return air grilles where ceiling heights are greater than 2.7m.

1.3.5 General Chiller Plant Design Considerations

The new thermal plant must have considerations for the following:

- If existing thermal plant is to be reused in the proposed design, submit to DIPL a dilapidation report of the existing plant. Approval must be given by DIPL prior to using existing plant in new designs.
- Within the design development report, identify the optimum thermal plant configuration (air-cooled or water cooled, primary loop or primary-secondary loop configuration), from a practicality, capital cost and whole-of-life cost perspective.
- Nominally configure the system with a two-chiller base load arrangement, with any one chiller capable of handling up to 70% of the total site-wide, non-diversity adjusted load.
- Chilled water circuit design shall implement an active thermal inertia tank in the return chilled water path. The primary pumps in primary loop configurations, and the secondary pumps in primary-secondary loop configurations, shall have full n+1 redundancy on all pumping components.

- All common chilled water and condenser water plant (headers, expansion tanks and the like) shall be sized for the full future system capacity and have all future expansion provisions in place. For the condenser water loop, ensure that the future expansion provisions are designed to prevent biological growth whilst not in use.
- Consideration must be made to material selections, with regards to corrosion (i.e. if the site is in close proximity to salt water).

1.3.6 General Heating Water Plant Design Considerations

The new thermal plant must have considerations for the following:

- If existing thermal plant is to be reused in the proposed design, submit to DIPL a dilapidation report of the existing plant. Approval must be given by DIPL prior to using existing plant in new designs.
- Within the design development report:
  - Identify the optimum combustion fuel resource from an availability, practicality, and whole-of-life cost perspective.
  - Identify the optimum heating water thermal plant configuration (condensing boiler or heat pump, solar collector pre-heaters, primary loop or primary-secondary loop configuration), from a practicality, capital cost and whole-of-life cost perspective.
- Nominally configure the system with a two boiler base load arrangement, with any one boiler capable of handling up to 70% of the total site-wide, non-diversity adjusted load.
- Thermal plant shall incorporate electronic automatic ignitors and full modulation of fuel and combustion airflow above 20% of the rated capacity.
- Heating water circuit design shall implement an active thermal inertia tank in the return heating water path. The primary pumps in primary loop configurations, and the secondary pumps in primary-secondary loop configurations, shall have full n+1 redundancy on all pumping components.
- All common heating water plant (headers, expansion tanks and the like) shall be sized for the full future system capacity and have all future expansion provisions in place.
- Thermal plant shall be installed within and adequately ventilated weatherproof enclosure. The ventilation rate shall be designed to satisfy combustion air requirements and dissipation of radiated heat to ensure a safe worker environment. Combustion gas flues shall be constructed from non-corroding materials.

1.3.7 Design Conditions

In general terms, the system will need to perform to achieve the imperatives of design consistent with the following:

Summer Conditions (Darwin):

- Outside: 34.6 ℃ DB 27.2 ℃ WB
- Inside: 24 ℃ (set point) DB 60% RH (max)

Summer Conditions (Katherine):

- Outside: 39.3℃ DB 27.9℃ WB
- Inside: 24 ℃ (set point) DB 60% RH (max)

Summer Conditions (Alice Springs):

- Outside: 40.7℃ DB 22.9 ℃ WB
- Inside: 24 ℃ (set point) DB 60% RH (max)

Winter Conditions (Alice Springs):

- Outside: 1.1℃ DB
- Inside: 22℃ DB 50% RH (max)

The above set points apply to office, laboratory, classroom, patient care areas, lecture theatres etc unless other specific conditions are stipulated by the Brief. All set points for temperature control are to be adjustable over the range of 18℃ to 28℃. Minimum temperature for cooling shall be 22℃. The set point is to be determined by DIPL. An adjustable dead band of at least 2℃ shall be provided across the set point.

Due consideration will need to be depicted within preliminary design reports indicating consequences of abnormal ambient conditions for extremes separately of dry bulb temperature and absolute humidity, with consideration to recent trends in frequency of occurrence of abnormal extremes and projected future abnormal extremes.

Katherine and its surrounds have no requirements for winter heating for items of plant operating for 10 hours or less daily.

It is a requirement to specifically assess and provide options for upper limit humidity control in the design development report.

Chilled Water Temperatures – For design purposes the following chilled temperatures may be assumed as the general design criteria:

- Supply Water Temperature 7℃
- Return Water Temperature 13℃

The selected heat exchangers for air handling systems must be able to achieve peak load responsibility at elevated chilled water temperatures to improve chiller energy efficiency.

Larger coil splits must be used for long chiller water loops to reduce the pipe and pump sizes. Use primary/secondary loops with variable speed secondary pumps. Ensure 0.5℃ lower ΔT in the primary loop to maintain a higher water flow than the secondary to avoid reverse flow issues.

1.3.8 Population Densities

Where no specific occupancy rates have been nominated, use Table D1.1 of the BCA.

1.3.9 Hours of Operation

Unless specifically requested, it can be assumed that the plant shall operate Monday to Friday from 0800 to 1630 excluding public holidays through a time switch incorporating a 365 day calendar function. For schools the programming must exclude all school holidays. Unless specifically requested otherwise, after hours push button time delay shall be 2 hours.

Liaise with the other disciplines to ensure the building structure and all services co-ordinated, including any 24-hour operational requirements of the building, and including full vapour barrier detailing.

1.3.10 Noise Levels

Noise level contribution to the background levels from HVAC equipment shall be minimised based on the building usage and occupant type.

Comply generally with Australian Standards AS 2107 unless otherwise noted.

Specifically comply with:

Type of occupancy/activity	Design sound level ($L_{Aeq,t}$) range
Executive office	35 – 40
Open plan office	40 – 45
Board / conference rooms	30 – 40
Video/audio conference rooms	30 – 40
Consultation / surgeries / treatment / procedure rooms	40 – 45
Ward bedrooms	35 – 40
Teaching spaces (single classroom)	35 – 40
Lecture theatres	30 – 40
Interview / counselling rooms	40 – 45
Library – general areas	40 – 50
Library – reading areas	40 – 45
Corridors and lobbies	45 – 50

Note: The project specifications and/or room data sheets may require lower design sound levels than those specified in this table and AS2107. Defer to the lower of the two specified sound levels.

Ensure that the measured background levels are not exceeded at the boundary of any adjacent building or dwelling. Background level shall be measured generally in accordance with AS1055 using the statistically averaged L_{Aeq} dB(A) for 90% exceedance level. The level must be determined for a sufficiently long time to be representative of the background at the time of noise impact. The minimum period is 10minutes.

As an alternative to site measurement, the following “estimated” levels may be used:

- Single Dwelling (SD) /Multiple Dwelling (MD) residential: 50 L_{Aeq} dBA from 7 am to 10 pm and 40 L_{Aeq} dBA from 10 pm to 7 am.
- Medium Density (MR) residential: 55 L_{Aeq} dBA from 7 am to 10 pm and 45 L_{Aeq} dBA from 10 pm to 7 am.

A penalty of 5 decibels applies if there is modulation or tonality in the noise source and 10 decibels if both modulation and tonality are present.

The sound pressure level contribution from HVAC or associated equipment at any specific external activity area within the site such as play areas, sports areas, walkways, designated work areas etc shall not increase the background noise levels by more than 3dB(A).

1.3.11 Speech Privacy

Where speech privacy between lightweight constructed rooms is required ensure that the Ceiling Attenuation Class (CAC) is at least 35 and the Dw is at least 45dB. Liaise with the architect, acoustic engineers and other building services designers to select and implement appropriate wall construction types to achieve the target design sound insulation.

1.3.12 Piping, Valves & Fittings

Specify all pipework to be of Type B Copper except condensate drains, which shall be class 12 PVC.

Pipework within the building must be run in service ducts, risers or ceiling spaces. Pipework must be easily accessible for maintenance or modifications.

For pipework in walkways the minimum height to the underside of the pipework and its support structures must be no less than 2.4m.

Valves shall be of approved manufacture to conform to AS MP52 and must be located in easily accessible positions. Provide ceiling markers to easily identify the location of equipment above ceilings.

Specify all underground pipework to have a minimum of 600mm cover to topmost surface of pipe or pipes. Pipes must be laid to the requirements of AS 3500. Pipes must be laid side by side and not one above the other. Pipes laid in the same trench as electrical or data conduits must be separated in accordance with the requirements of AS 3000 and AS 3500. All underground pipework must be identified by laying continuous PVC detectable warning tape not less than 300mm above the pipe. Specify trenches to be backfilled only with selected fill and compacted in layers not exceeding 200mm to a relative density of 90%. All valves must be accessible in concrete pits which shall be drained. All bolts, washers etc must be 316 stainless steel. Thrust brackets in pits must be hot dipped galvanised. Pipes must be sleeved where they pass through the pit wall. Identify all valve pits on the surface by a pre-cast concrete pillar with recess for reflective ‘V’ marker plate.

Specify ball or resilient seat valves be used throughout except where throttling for flow measurement is required in which case ‘Tour and Anderson’ STAT and ‘STAD’ or approved equal valves must be specified. Valves must be butterfly lever action less than 150mm DIA and geared action 150 mm DIA and above.

All valves must have extended shafts to accommodate complete insulation of the pipework. Valve actuators must have a “reserve” torque capacity of 25% from that nominated by the valve manufacturer.

Incoming mains and main distribution pipes must be installed of a size adequate to permit connection of future buildings or any expansion. The requirements are to be discussed with the DIPL representative and generally follow the site master plan if available.

For pipes that pass through floors or walls specify sleeves filled with appropriate insulation or fire rated material to suit the application.

Specify suitably sized pipework risers within the building to service every building level. Provide dirt legs and drains at the bottom of each riser, fitted with hose cocks. Pipework risers must incorporate dedicated isolating valves at every building level take-off and at all other significant sub branch pipework runs. It must be possible to isolate each building level and sub branch without disrupting the chilled water service to other levels and sub-branches. Provide drains at the lowest points in the chilled water system on each building level. Automatic air bleeds complete with isolation valve and drains to the nearest waste shall be provided at the highest point of any piping system.

All screwed valves and fittings must have unions for easy removal without cutting the pipework.

Fit ‘Binda’ cocks to all air-handling units, fan coil units, pumps etc. These must extend a minimum of 15mm beyond the outside surface of the insulation. ‘Binda’ cocks must be located next to all DDC sensors for calibration and test purposes.

Chilled water thermal inertia tanks must allow for stratification and incorporate a well-designed diffuser for charging and discharging. Ensure that the Froude number is less than 0.5. Tanks must be able to withstand the full pump head.

1.3.13 Ductwork & Registers

Use Standard Specification for Major Building Works (NATSPEC BASIC)

Main supply ducts must be capable of handling an increase of 15% in air quantity. Fans and motors should be selected with this in mind.

Ductwork, solid and flexible, must be constructed an installed in accordance with AS 4254. Flexible ductwork must be supported by packaging straps, buckles and gutter guard saddles to suit the duct diameter and shall be not less than 300mm long. Provide locking quadrants to all adjustable dampers including spigot and butterfly dampers.

Insulation to air conditioning ductwork must be applied to the internal surfaces of the duct for areas north of Tennant Creek. External insulation of ductwork shall only be installed with the prior approval of the DIPL representative.

Where ductwork is exposed to view in occupied spaces, all ductwork whether insulated, or uninsulated, must be spiral wound circular or oval duct. Where ductwork is exposed to weather, it must be profiled to shed water. Ductwork exposed above roofline excluding fume exhausts must be constructed from 'Colorbond' sheet steel to match the roof colour. External ducts must be graded to prevent ponding and all joints must be sealed with a sealant.

Special consideration must be made to ductwork exclusively serving evaporative cooling plant. Subject to the approval of the DIPL representative, ductwork hidden from view may be externally insulated, and ductwork exposed to view may be uninsulated. Acoustics and noise transfer from evaporative plant through ductwork must be carefully assessed where evaporative plant is used.

Specify all longitudinal joints to be the Pittsburgh type with a smooth interior finish.

Use TDF/ TDC (Transverse Duct flanges or Transverse Duct Connectors) for joining ductwork. Do not use slip joints.

Duct supports must not be used to support piping, ceiling and any other loads additional to the ductwork.

The Installation of Duct Liners must comply with the requirements of AS 4254.2 and the BCA:

- The insulating performance of the duct liner shall comply with the requirements of the BCA.
- The liner surface designated to be exposed shall face the airstream.
- The liner shall be adequately retained within the duct by use of pins.
- The liner shall be neatly butted without gaps at transverse joints.
- The liner shall be folded and compressed in the corners of rectangular duct sections or shall be cut and fitted to ensure butted edge overlapping
- Longitudinal joints in duct liners shall not occur except at the corners of ducts, unless the size of the duct and the standard liner's product dimensions make them necessary.

Provide duct access panels in the risers at each floor and in each branch or sub-branch for cleaning purposes. Duct access panels must not be more than 10 metres apart. Duct access panels minimum size 300 x 200mm may be 'Bullock' brand and the location of access panels above ceilings must be coordinated with the ceiling grid, light fittings and equipment layout. Where these access panels are visible they must be fitted with 'Larkspur' catches.

Ceiling registers must be of the square louvers-faced type of 'Bradford', Holyoake', 'Dragon' or other approved manufacture with removable cores. The interior of ductwork behind registers should be painted black.

Wall registers must be of the adjustable blade type with the front set of blades horizontal. Maximum blade spacing shall be 20mm.

All exhaust and return air grilles must be square or rectangular one-way Louvre faced type grilles similar in appearance to the general ceiling registers, and with removable cores unless required for aesthetic reasons.

Ductwork penetrations to walls and floors must be packed with an approved insulation (fire rated in a fire rated wall or floor) and must be flanged on both sides of the penetrations. Flexible ducts must be sleeved where they penetrate full height walls.

Where required, provide details for all duct penetrations and cushion heads passing through walls and ceilings with special requirements (such as fire rated security walls and ceilings). Outside air intakes must be provided with easily removable media filters to pre-filter the air before it enters the unit(s). Outside air grilles shall be anodised aluminium, minimum 20 microns, to match the exterior colour scheme of the building (no 'Colorbond'). Provide removable vermin mesh behind all external louvers. Outside air ductwork located in conditioned space must be insulated externally to avoid condensation.

Secure areas will have special requirements. Check the brief and consult the project manager to obtain the specific design requirements.

All air handlers and fan coil units must have adequate insulation thickness to avoid condensation on the external surfaces at all times.

Nominate drip trays with adequate length to catch all airborne condensate or use a low face velocity. Face velocity must not exceed 2.5m/s for all coils.

Cooling coil fins/m must not exceed 350. The finned height must not exceed 950mm.

Corrosion protection must be provided for all condenser coils within the Darwin and the coastal areas.

Filters	Details
Built-up air-handling units and packaged type	'Pyracube' or 'Four Peak"
Unitary fan coil units	'Email SP' series panel filter or similar
Grease filters	'Email' Type GW or similar

1.3.14 Insulation to Pipework

Use Standard Specification for Major Building Works (NATSPEC BASIC)

Factory pre-insulated pipework systems are preferred to ensure uniform thickness of insulation and to avoid voids within.

Where factory pre-insulated pipework systems are unavailable, chilled water pipework must be insulated with preformed, polystyrene insulation in accordance with AS 1366 Part 3, complete with vapour seal. Insulation shall be factory faced with 'Sisalation 450' (extra heavy duty grade) and shall be glued to the pipework and between all mating surfaces using 'Fosters 252WB' adhesive and further secured with nylon straps. Oversized sections shall not be used. All joints shall be overlapped and sealed using 'Precision 493' (or approved equal) foil tape. Insulation valves, flanges and fittings shall be arranged for easy removal for maintenance purposes and shall have hinged and clipped (not screw fixed) casings.

Insulation thickness to chilled water pipework generally:

- 25mm for pipe up to 25mm diameter
- 38mm for pipe 32mm and 40mm diameter
- 50mm for pipes 50mm diameter or larger

Chilled water pipes which are run underground can be direct buried but must have a 'HDPE' outer layer. Pipework exposed to the weather shall be clad with galvanised steel sheathing and painted where exposed to view.

Condensate drains must be continuously insulated with approved elastomeric closed cell insulation, minimum 19mm wall thickness equivalent to 'Armaflex'. All joints must be glued with approved adhesive in accordance with the manufacturer's recommendation.

Where future buildings are planned, provide valved take-offs located in service pits for future connection. Service pits must be located adjacent future building sites. Pipework must be sized to accommodate future buildings as indicated on the site master plan and anticipated natural expansion.

1.3.15 Pumps

Pumps must be close coupled Back-End-Pull-Out type wherever possible, 'Ajax 2000 Series' or 'Southern Cross'. Impellers must be bronze, casings gunmetal and shafts etc stainless steel. Chilled water pump selection must be based on suitability to the duty. The pump casing and electric motor must be sized to accommodate an impellor two standard sizes larger than selected. Stainless steel drip trays are to be mounted on concrete inertia bases complete with spring mounts.

In all cases, dual pumps must be provided complete with variable speed drives (VSD) for balancing or controlling purposes. Each secondary/tertiary chilled water pump shall be sized to accommodate 100% of the required design water flow.

1.3.16 Motors

Motors must be totally enclosed fan cooled and normally be limited to 1450 rpm maximum. Motors shall have an IP56 rating. Belts, pulleys and couplings must be protected by the use of easily removable and replaceable guards. Motors rated at more that 10kW must be provided with a lifting eye. All motors rated at 5.5kw and above must be of the Premium Efficiency type ('TECO Max-E2' or equivalent).

1.3.17 Heater Banks

Do not use electric heater banks. Where reheat is required for humidity control, consider the use of heat recovery from chillers and other cogeneration options.

1.4 EXHAUST AIR SYSTEMS

Exhausted air presents numerous problems to buildings in terms of energy losses, humidity problems and human comfort issues, and must be designed with the Australian Standards, Building Code of Australia, associated air conditioning plant, design briefs, and Northern Territory Government sustainable development policies in mind.

1.4.1 General

Design exhaust air systems in compliance with AS1668 part 1 and 2. Provide mechanical exhaust ventilation in all circumstances where make-up air is to be sourced from air-conditioned spaces or where natural ventilation will create a public nuisance or hazard.

Select exhaust fans based on expected duty, serviceability, efficiency and acoustics. Allow for fan selections which will have minimal in-duct and breakout noise to comply with the interior space acoustic levels specified in AS2107, with minimal additional acoustic insulation required.

For fans capable of 100 litres per second and above, provide speed controllers to allow for exhaust air flow rate balancing.

Where mechanical exhaust fans have make up air sourced from air-conditioned spaces, ensure that the main air handling systems maintain overall building pressurisation when the exhausts are active, particularly when the exhaust system is constantly operating. Generally provide make up air through transfer ducts.

Any specialist exhaust air systems (e.g. Physical Containment laboratories, negative pressure wards) shall be designed strictly in accordance with the Australian Standards and applicable statutory authorities, and commissioned via a specialist NATA accredited agent.

Do not use air-to-air energy recovery units to recover energy from exhausted air.

1.4.2 Toilet Exhausts

Natural ventilation (Subject to BCA clause F4.6) as ablution exhaust is only permitted where there will be sufficient natural cross-flow ventilation through the building, such as standalone toilet blocks and the like. Coordinate with architects and other services to ensure that any airflow from naturally ventilated toilets cannot permeate adjacent occupied spaces.

Interlock toilet exhausts with light switches and/or motion sensors where provided.

All fans are to have 15 minute run-on timers to allow for any remaining odours to be ventilated from the space.

For multiple fans attached to a single exhaust stack arrangements, provide backdraft dampers on each fan to prevent exhausted air from pushing back into adjacent spaces. Ensure each fan has enough static pressure to drive exhaust air through the common duct when all fans are active.

Attempt to locate fans in easily accessible areas and avoid locating access panels and plant in socially and/or culturally sensitive areas.

1.4.3 Kitchen Exhausts

All commercial kitchen exhaust hoods are to be of the compensating type with filtered outside air make up.

Use of proprietary commercial kitchen hoods shall be subject to approval by DIPL, and prior to design, supply the manufacturer's letter of compliance to AS1668.2.

Do not use inline ducted fans for kitchen exhaust. Use roof mounted high temperature vertical discharge fans only.

Use a minimum ratio of 20% air-conditioned spill air, 80% filtered outside air to compensate for exhausted kitchen air. Do not use less than 20% air-conditioned spill air.

For exhaust ductwork, comply with the duct design requirements of AS1668.1 and AS1668.2, particularly with respect to duct service hatch and horizontal duct fall requirements. Ensure the duct design does not allow for grease to pool and create a fire hazard.

Do not allow for direct line-of-sight noise emitted from the exhaust fan to enter the kitchen space. Either design for two or more duct bends before the fan, or provide kitchen exhaust specific in-duct attenuators.

1.4.4 Fume Cupboards

Generally comply with AS2243.8, and dependant on the facility usage and design brief, the ventilation requirements in AS/NZS 2243.1 for Physical Containment level facilities, and/or the Australian Government Department of Agriculture and Water Resources – Requirements for Operating Approved Arrangements.