MINIMUM ENERGY PERFORMANCE STANDARDS

FOR

NEW CAPITAL WORKS PROJECTS

Cairns Regional Council

Buildings & Facilities Management

DOCUMENT CONTROL SHEET

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Contents

1 Introduction

1.1 Application

This document is to be read in conjunction with, and forms part of, the project specification and/or tender document to which it is appended to. The form attached to this document in Appendix A shall accompany all tenders and shall be duly completed by tenderers to indicate the extent of compliance with and incorporation of the recommendations of this document. Where specific technologies are deemed to be unsuitable for the particular project, Appendix A shall be completed accordingly.

Where the recommended Ecologically Sustainable Design (ESD) initiatives are not offered, the specific purpose for omitting the use of identified ESD shall be advised in the schedule, (Appendix B), and submitted in the form of an ESD report to be included with the tender submission.

The initiatives outlined in this document do not relieve the contractor from meeting compliance with all relevant codes and standards applicable to the works.

All supplied plant, equipment, fixtures, fittings and associated parts thereof; must comply with relevant Australian standards in design and manufacture for distribution within/to Australia.

1.2 Purpose

The purpose of this document is to define energy efficient technologies, systems and products required to be incorporated into new capital works projects undertaken on behalf of Cairns Regional Council. The aim is to implement Council's Sustainable Buildings Design Policy in a manner to ensure the practical and measurable reduction of energy consumption and consequential facility operating costs. This document provides guidance on the general suitability and application of specific technology for particular applications. It is expected that further revisions of this document will incorporate new and emerging technologies trialled by CRC for application on future projects as part of CRC's continuous improvement of energy efficiency in the built environment.

Review of the document will be on an annual basis ensuring applications meet best practice and are in-line with current legislative requirements.

1.3 Abbreviations

The following abbreviations are referenced within this document:

BMS	Building Management System
CRC	Cairns Regional Council
DX	Direct expansion, air conditioning systems utilising the expansion of refrigerant to release potential energy in a compressed refrigerant into thermal energy for cooling purposes
ESD	Ecologically Sustainable Design
HVAC	Heating, Ventilation & Air-Conditioning
kW(T)	Kilowatts of thermal energy (also referred to as kW(R) or refrigeration)

MEPS	Minimum Energy Performance Standards
PCOA	Pre-conditioned outside air system
PV	Photo-voltaic
UGR	Unified Glare Rating
TEHX	Total enthalpy heat exchanger
THD	Total harmonic distortion
VSD	Variable speed drive unit (also referred to as variable frequency drive or variable frequency drive unit)

1.4 Definitions

The following defined terms are referenced within this document. Where referenced, the following definitions shall be applied:

Lighting for Safe Access: Lighting for safe access refers to the parameters for safe access as defined in AS/NZS1680.0

Time switch: Where reference is made to time switch control, time switches shall be electronic fully programmable type pre-programmed as part of the commissioning process to disable normal operation on weekends and static public holidays and have the facility to omit additional days to suit variable public holidays. Time switches shall have a minimum 100hr battery reserve.

Photo-Electric Cell : A photo-electric cell (PE cell or PE switch) is a light sensitive device used for the control of electrical loads in response to the level of ambient daylight. PE cells may incorporate either electro-mechanical relays or solid state devices and are most widely used for controlling external lighting automatically. PE cells may also be used in indoor daylight harvesting applications by controlling the dimming levels of artificial lighting to that required in order to compensate for the contribution of natural light to achieve a pre-set service illuminance at the task area.

Micro Inverters : Micro inverters are devices for converting DC electrical energy derived from Photo-Voltaic (PV) panels to AC electrical energy and typically are used in applications where one inverter is dedicated to a single PV panel. Each panel is capable of 'grid matching' to the nominal supply voltage enabling a modular and scalable array to be incorporated into a project. Micro-inverter systems typically achieve higher system efficiencies than conventional PV systems since each panel is independent of the other. With conventional systems, the total system output is significantly reduced in the event of any portion of the array being shaded. With micro-inverter systems, any shading will generally only effect the output of the shaded panel, leaving the rest of the array unaffected. Micro inverters systems can have the ability to communicate their system status and diagnostics back to a PC for individual reporting of each panel's status.

VAV: Variable Air Volume air-conditioning units incorporate air throttling systems to reduce the flow of air to specific area when the heat load associated with that area is reduced. VAV systems can be included in DX systems and chilled water systems. VAV systems generally consist of either variable air volume diffusers or variable air volume boxes which throttle the flow of air to several air diffusers.

Air Compressors: Air Compressors are generally installed in industrial workshops for the production of compressed air for tooling, pumps and instrumentation. Industrial systems with free air delivery rates ranging from 1 – 12 L/s are generally oil lubricated reciprocating compressors rated at 12 L/s or greater being oil injected rotary scroll compressors. Air compressors generally require an air treatment system to remove moisture, filters to remove particulate matter and a receiver for storage of compressed air to reduce the number of starts required by the compressor. The air treatment systems required for tooling quality air are generally refrigerator dryers and can be integral to the air compressor or provided as a separate unit.

Compressed Air Reticulation: Compressed air reticulation systems generally comprise pipe work from the receiver tank to the points of use, air-line equipment and condensate removal points. Pipe work is generally copper, HDPE, galvanised steel or aluminium alloy composites. Pipe work can be installed below or above ground. Air-line equipment generally consists of filters, pressure regulators, isolation valves and lubricators. Condensate removal systems are generally drainage droppers to the pipe work with automatic or manually operated condensate drainage valves.

Cold Rooms: For the purpose of this document cold rooms shall generally comprise industrial type walk in cool rooms and freezers for food storage. Refrigeration systems generally consist of an condenser set, evaporator set(s) and cool room or freezer constructed of composite panels.

Boiling Water Units: Boiling water units are generally used for the production of hot water for domestic use. Boiling water units generally consist of a gas, electric, solar or heat pump heating system, insulated water storage tank and associated valves and fittings.

2 Internal Lighting

2.1.1 Occupancy Based Control

Mechanisms shall be incorporated into all new buildings to control the operation of internal lighting in response to the time of day and occupation of the building. The control system to be adopted shall incorporate the following control scenarios:

Security System Integration: Where a building security system is installed, all lighting throughout the building shall be globally enabled or disabled in response to the disarmed or armed status of the building security system respectively.

After Hours Control: On disarming of the building (or building sector) outside normal business hours, lighting within circulation zones (corridors, lobbies, etc) shall switch on to achieve lighting levels sufficient for safe movement. Where dimming control is provided for circulation area lighting, such lighting shall operate at minimum set-point required for safe movement. For buildings without building security systems, this function shall be achieved via a pushbutton at each building entry point.

On re-arming of the building (or building sector), all lighting within the building (or building sector) shall be automatically disabled after the expiry of an exit delay time pre-programmed into the security system. The exit delay time shall be set in consultation with the building owner's representative to provide sufficient time to safely exit the building. For buildings

without building security systems, building lighting outside normal business hours shall be limited to a 2 hour run period after the entry pushbutton has been activated. Such buildings shall also incorporate an 'all off' pushbutton at each building entry point to cancel the run-on lighting period.

Business Hours Control: Within business hours, lighting shall automatically switch on to designated areas only, via time switch control.

Individual Room Control: lighting within individual rooms including offices, meeting rooms, lunch rooms etc shall be controlled in response to occupancy sensors within the room. Provide a run-on timer control, adjustable between 0-10 minutes to delay the de-energisation of individual room lighting after detection of presence within the room. Within lunch rooms, tea rooms, amenities and the like, subject to frequent use, lighting levels shall set-back to a dimmed levels sufficient for safe access at times when presence is not detected within the rooms.

2.1.2 Daylight Harvesting

Perimeter Zones: Where rooms incorporate a zone with significant exposure to natural lighting due to their immediate proximity to perimeter glazing, lighting within the perimeter zone shall be grouped and dimmer controlled as appropriate to limit the contribution by artificial lighting to that required to compensate for natural day lighting in order to achieve the recommended task lighting levels as set out in AS/NZS1680. Dimming levels for the perimeter zone shall be controlled in response to a series of photo electric sensors mounted on the ceiling surface. Calibrate the lighting set-points at ceiling level using ceiling exitance as a proxy for lighting levels achieved at the working plane.

2.1.3 Efficient Light Sources & Fixtures

Preferred Systems: Preferred internal lighting fixtures for new applications employing troffer type lighting shall be either LED panel type fixtures or single tube T5 fluorescent.

Warranty on LED Luminaires: Where LED luminaires are employed; luminaires shall be backed by a minimum 5 year full replacement warranty, provided by a locally represented supplier, established for a minimum period of 10 years.

LED Systems: Where LED lighting systems are specified for internal room lighting applications, luminaires shall be provided as LED panel systems rated to meet the following minimum performance:

Lumen output (600mm x 600mm)	Minimum 2,600 lm
Lumen output (1200mm x 300mm)	Minimum 2,800 lm
Minimum light output ratio	85%
UGR	19
Minimum maintained luminance	70% @ 45,000 hrs
Minimum warranty	5 years full replacement

T5 Fluorescent Systems: Where T5 fluorescent troffers are employed, the following performance parameters shall be achieved:

Technical Criteria	**Requirement**

LOR (louvred)	≥ 77.5%
LOR (lensed)	≥ 70.0%
Glare index	≤ 16
Lamp	28W T5 ≥ 4000K
Initial Lamp Lumens	28W ≥ 2600 lm
Ballast type	A2, B1 (AS/NZS 4783.2)

Design Parameters: Lighting design calculations shall be based on the following technical parameters:

Design Parameter	**Design value**
Uniformity	0.7 minimum to average illuminance
Working plane	0.7m above floor level
Maintenance factor	≤ 0.8
Reflectance (ceiling)	70%
Reflectance (wall)	50%
Reflectance (floor)	30%

Downlight Applications : Where the use of downlights are appropriate, as either the main or supplementary source of lighting such as reception areas, boardrooms, etc, downlights shall be provided as LED type selected to meet the following minimum criteria:

LED manufacture	CREE or equivalent
Drivers	Thermally managed type

Acceptable Light Sources: Luminaires for external lighting applications for car parks, driveways, pathways or the like shall employ either metal halide or LED light sources. Irrespective of the light source employed, luminaires shall maintain a minimum 70% of initial light output at 50,000 hrs of operation.

Carpark & Driveway Lighting: Car park and driveway luminaires, irrespective of whether they employ metal halide or LED light sources, shall achieve asymmetric light distribution with zero tilt to achieve zero upward spill light above 90 degrees.

Distribution Patterns: Luminaires shall be available in a minimum of five (5) distinct distribution patters in order to comply with the performance requirements for all V category and P category lighting applications in a zero tilt arrangement.

Glare Control: The installed arrangement of luminaires shall limit glare to avoid the effects of visual discomfort to users of the subject property or adjacent properties.

LED luminaires: LED luminaires shall comprise a multi-layered single distribution pattern, such that in the event of failure of one or more individual LED's the overall lighting distribution pattern shall be maintained. LED luminaires shall comprise multiple replaceable LED modules and such that failure of any single module will not affect the overall distribution pattern of the fixture and will be allow in-situ replacement of the failed module to restore certified performance.

Warranty on LED Luminaires: Where LED luminaires are employed; luminaires shall be backed by a minimum 5 year full replacement warranty, provided by a locally represented supplier, established for a minimum period of 10 years.

External Security Lighting: External security lighting shall be designed to achieve responsive, event activated operation with time controlled manual over ride for emergency situations.

2.1.4 Emergency Lighting & Exit Signs

Manufacturer and Type: All emergency lighting and exit signage installed throughout any particular site shall be of the same manufacture throughout that site. Unless the specific application precludes it, all exit signage and emergency luminaires shall be of identical make and model throughout the site.

Exit Signs: Exit signs employed shall have pictograph legends and be available in either wall or ceiling mount whilst maintaining the same format, appearance and performance. Exit signs shall be maintained type employing 50,000 hr rated life replaceable LED lamp bar and shall incorporate switch-mode electronics, dual rate charger and high temperature nickel cadmium battery. The complete fixture shall be provided with a 3 year warranty.

Alternative fixtures employing cold-cathode lamps will be acceptable provided lamp wattage does not exceed 4W and lamps employed have a rated life of not less than 50,000 hrs.

Irrespective of which lamp type is used, the same type shall be employed throughout the building. Where multiple buildings are located on a single site, the same type of fixture shall be maintained throughout all buildings within the site.

Emergency Lighting: Emergency evacuation luminaires shall employ two (2) white high brightness LED's each with a luminous efficacy of not less than 85 lm/W. The fittings shall incorporate dual rate battery chargers and high temperature nickel cadmium batteries. Standby energy consumption shall be not more than 2.2 Watts. The complete fittings shall be covered by a 3 year warranty with the LED lamps covered by a lifetime warranty.

Testing Facilities: Testing facilities shall be provided at each switchboard supplying emergency lighting and/or exit signage in accordance with AS/NZS2293.1.

Computer Monitored Maintenance System: Computer monitored maintenance systems shall be adopted where the total aggregate floor area of buildings on a single site exceeds 2,000m^2, or is likely to exceed 2,000m^2 when fully developed.

2.2 External Lighting

2.2.1 Lighting Controls

Provide automatic Lighting controls for control of external lighting to car parks, driveways and pathways. Lighting operation shall be restricted to times when there is insufficient natural light available for safe vehicular and pedestrian movement through the use of photo-electric switches. Control switches shall be provided to bypass automatic controls for the purpose of daytime testing; however such bypass controls shall be provided with timer over-ride to revert to fully automatic operation after an adjustable period of 0-1 hr. Test circuits shall incorporate a cancel facility to immediately revert to automatic operation.

Dusk-til-dawn operation of external lighting shall be limited to lighting required for building security purposes only. All other lighting shall switch on at dusk (sensed via photo-electric switch) and switch off at a pre-set time agreed with the building owners representative.

Where the building incorporates a building security system, non-security external lighting (i.e. external access and car park lighting shall be disabled after the expiry of an adjustable exit delay period of 0-30 mins after arming of the building security system

2.2.2 Lighting Design & Performance

Design external lighting systems for car parks, driveways and pathways to meet the requirements of AS/NZS1158.3.1 as appropriate for the installation.

Provide RPEQ certified lighting design layouts clearly indicating the lighting levels achieved by the proposed lighting solution in the form of a gradient lighting contour plan with lighting contours at 5 lux increments. Lighting designs shall include a table indicating required lighting performance parameters and actual calculated performance to demonstrate required performance is achieved.

3 Air Conditioning

3.1 Occupancy Based Control

Central Ducted Systems: Central ducted air conditioning systems shall be controlled based on time of day and building occupancy. Time scheduling for operation of the plant shall be controlled via a building management system (for larger scale systems) or via a time switch integral with the mechanical services switchboard as appropriate. An after-hours shall function shall facilitate the operation of the air-conditioning systems for a period of 2 hours upon activation of an after-hours switch and shall have a manual off switch which shall turn the air-conditioning system off and reset the 2 hour after hours timer.

VAV Systems: VAV systems shall incorporate occupancy based control for individual rooms such as individual offices, lunchrooms, meeting rooms, training rooms and the like to revert to higher temperature set-points (no less that 2°C higher than the room set point) when the rooms are unoccupied for more than 20 minutes.

Where occupancy sensors are installed for the control of the room lighting, the air-conditioning system shall also be controlled by the same occupancy sensors.

Individual DX Split Systems, DX Split Multi Systems and VRV Split Systems: Split systems shall be controlled by time of day and building occupancy. Time scheduling shall be controlled via BMS where installed or a proprietary controller. Split systems installed to individual rooms or partitioned spaces shall incorporate occupancy based control to revert to higher temperature set points (no less that 2°C higher than the room set point) when the space is unoccupied for more than 20 minutes.

Where split systems are installed as a supplementary unit to a base building central air-conditioning system, the unit shall deactivate if the space is unoccupied for more than 20 minutes. An after-hours function shall facilitate the operation of the air-conditioning systems for a period of 2 hours upon activation of an after-hours switch and shall have a manual off switch which shall turn the air-conditioning system off and reset the 2 hour after hours timer.

3.2 Minimum Set-Point Temperatures

In addition to the provision of user operable controls, facility shall be provided to restrict the minimum set-point temperature for each zone to a pre-set minimum. Over-riding minimum temperature set-point controls shall be located where accessible to authorised personnel only.

The minimum set point for open plan spaces with constant volume air-conditioning systems shall be 23°C. Air-conditioning systems serving open plan spaces, incorporating VAV boxes shall have a minimum set point of no less than 21° C.

The minimum set point for multiple compartmentalised spaces or multiple rooms served by a constant volume system shall be no less than 21° C.

If ceiling sweep fans are used in conjunction with air-conditioning systems, the minimum set point shall be increased by 1 - 2° C.

3.3 Plant Selection

The selection of air-conditioning plant and equipment shall be appropriate to the application, considering:

- Zoning of building based on solar exposure, time of use and type of occupancy;
- Safe access to plant and equipment for regular plant servicing and maintenance
- Longevity of plant and equipment for the specific application
- System performance including flexibility, zoning, energy efficiency and duty.
- Environmental factors such as corrosive atmospheres or the like (as required in swimming pools and dry chemical stores)
- Specific critical temperature and humidity requirements such as in libraries or dry chemical stores.
- Space constraints often experienced in retro-fitted buildings or heritage protected buildings.

3.4 Zoning

Where the room floor area exceeds 250 m², each external aspect, incorporating glazing, shall be on a separate air-conditioned zone. The maximum perimeter zone depth shall be 4 meters. Each zone shall be served by separate air-conditioning unit(s) or VAV system(s).

Where specific areas of a building require critical humidity and/or temperature control, they should be zoned separately and thermally isolated from the remainder of the facility.

3.5 Air-Conditioning Fan Efficiency

As well as achieving MEPS and BCA compliance, all fans associated with air conditioning systems shall satisfy the following performance guidelines:

- Fans shall achieve a minimum of 77% efficiency at the commissioned operating point.
- Fan Motors shall achieve “high” efficiency standard as defined in AS1359.5.

- Air transport efficiency characteristics shall be greater than or equal to 5.5 based on the following formula:

  Air Transport Factor = $\frac{\text{(Space Sensible Heat Removable) kW}}{\text{(Supply + Return Fan(s) Power Input) kW}}$

3.6 Air Diffusion

Air diffuser layout shall be designed and installed to provide a Air Diffusion Performance Index (ADPI) of no less than 0.8 under all operating conditions. Air distribution shall be draught free and as even as possible. Air movement shall be between 0.1 and 0.25 m/s in occupied spaces measured 1.0m to 1.5m above floor level.

Where possible all air registers shall be fitted with plenum boxes, insulated to provide the same thermal performance as the adjoining ductwork. Noise associated with air registers shall not exceed 45 dBa at 1.5m from the register.

3.7 Temperature Sensors and Control

Where possible a combination of room and return air duct mounted sensors shall be provided. Where DX VAV systems are employed, the staging of compressors shall be controlled via a high select configuration from the individual zone temperature sensors. Where a ducted DX system is employed without VAV control, staging of the compressors shall be controlled via an averaging configuration of the individual zone temperature sensors.

Air-conditioning systems employing zone based electric reheat shall not be considered. Air-conditioning systems which rely on mixing of heated and cooled air streams throughout their operation for temperature control shall not be considered. Air-conditioning systems that employ waste heat for reheat are acceptable where dehumidification is achieved through the use of the refrigeration system.

3.8 DX Air-Conditioning Systems

3.8.1 Refrigeration System

Refrigerant used within DX packaged plant shall have a zero ozone depletion potential (ODP). DX packaged plant with a cooling capacity greater than 25 kW shall incorporate staged, multiple refrigeration circuits.

Refrigeration circuits shall incorporate head pressure control via the condenser fans and shall incorporate hot gas bypass. Where available, mulit-stage refrigeration systems shall incorporate a 1/3 – 2/3 split evaporator coil with the first stage of cooling through the 1/3 coil the second stage through the 2/3 coil and the third stage through both the 1/3 and 2/3 coil. Evaporative cooling systems shall be avoided where possible. Where available electronic commutated fans shall be used for both condenser fans and evaporator fans (plug fans).

Where split systems are installed both liquid and suction lines shall be insulated and vapour sealed throughout. Minimum thermal performance of the insulation shall be to the requirements of the BCA.

3.8.2 *Externally Mounted Plant*

Refrigerant condensers shall be mounted to allow for a clear air flow path to the intake and the discharge of the condenser fan. Horizontally mounted condenser fans shall have a minimum clearance of 1500 mm from the fan discharge. Vertical discharge condenser fans shall not have any obstructions to the discharge air path. Where obstructions are present and can not be removed, discharge ducts shall be installed to direct the air to a horizontal discharge configuration.

The intake of any condenser plant shall not be located within 6 meters of any direct heat source. Not with-standing the above, condenser units shall be installed to the manufacturer's recommendations.

3.8.3 *DX Non-Ducted Split Systems*

Individual DX systems shall be used where supplementary air-conditioning is required to a base building system or where a single isolated room requires cooling. All DX split systems shall comply with the Minimum Energy Performance Standards (MEPS)requirements. DX split systems shall be inverter type systems unless no inverter unit is available at the required capacity.

Where the split system in consideration has been nominated a minimum appliance star rating, it shall be no less than 3 stars. Where a minimum appliance star rating has not been applied, it shall achieve a COP no less than 2.7 in cooling mode

3.8.4 *Variable Refrigerant Volume (VRV or VRF) DX Split Systems*

VRV split systems shall be in the form of several ducted and/or non-ducted split systems connected to a single or multiple, modular outdoor variable refrigerant volume condenser units. Where heat pump systems are considered, VRV systems shall incorporate heat recovery. Careful consideration shall be taken to ensure the maximum volume of refrigerant within the systems meets the requirements of AS/NZS 1677.

Gas Powered Split Systems shall only be considered where VRF systems are to be installed with the total cooling capacity is no less than 85 kW and the onsite peak hot water demand is no less than 10 kL per day. Onsite hot water storage should also be considered when incorporating gas powered air-conditioning units.

3.8.5 *VAV Systems*

The preferred system arrangement for central plant systems is variable air volume (VAV) systems employing variable speed supply air fans and damper controlled supply air registers and/or VAV boxed servicing each cooling zone. VAV systems shall be employed for all ducted DX systems. Where variable speed supply air fans are unable to maintain a minimum of velocity of 1.6 m/s across the evaporator coil, a return air dump back shall be incorporated in conjunction with the variable speed supply air fan.

Where VAV systems are employed, each stage of the refrigeration system must incorporate hot gas bypass or shall be a VRV system. VAV diffusers shall be pressure independent type or a Thermafuser or equivalent delivery point VAV terminal.

Where VRV boxes are employed, fixed supply air register selection shall consider the minimum and maximum throws over the range of air flows to ensure a minimum of 0.8 ADPI is achieved

at varying air flows. Fan assisted VAV boxes shall only be considered if the fan performance characteristics of the air-conditioning system, as a whole, meets the air transport factor limits outlined in section 3.5. VAV boxes shall throttle the maximum design air flow by no more than 30%.

3.9 Chilled Water Air-Conditioning Systems

Chilled water central plant systems shall be considered for all new buildings where the total cooling capacity for the building exceeds 350 kW(T) due to the systems flexibility and ability to accommodate building adds, moves and changes (churn).

3.9.1 Chiller Capacity Increments

Each chiller within the chilled water system shall be capable of a minimum of 25% load capacity increments. Where possible each chiller shall have a minimum of two off compressors. Where a single compressor is employed the compressor shall be capable of a minimum of 25% load capacity increments. Where possible variable speed, magnetic bearing type chillers should be considered.

3.9.2 Full Load and Part Load Efficiency

Chillers shall have a full load efficiency (COP) of no less than 5.5. Chillers shall have an Integrated Part Load Value (IPLV or NPLV) COP of no less than 8 to the requirements of ASHRAE 90.1-2010.

3.9.3 Air Cooled Systems Vs Water Cooled Systems

Generally, the use of air cooled vs water cooled shall be considered based on the following table:

Type of Chiller Plant	Min Threshold	Maximum
Air Cooled	350 kW	1,000 kW
Water Cooled	750 kW*	unlimited

*While water cooled chilled water systems may be employed for systems of comparable size to air cooled systems, consideration should be given to the increased maintenance cost of water quality monitoring and chemical treatments and these costs balanced against the improved energy savings available with water cooled systems.

3.9.4 Air Cooled Chillers

Air cooled chillers shall be either remotely installed or packaged systems. Air cooled chillers shall incorporate multiple condenser fans, operated via an on board control system. Where available, condenser fans shall be electronic commutated and shall incorporate variable speed drives.

Air cooled chillers shall be installed to maintain a free air path for a minimum of 3 meters directly in front of the fan discharge.

3.9.5 Water Cooled Chillers

Cooling towers shall incorporate variable speed drives to cooler tower fans to modulate the fan speed in response to the condenser water leaving temperature. All cooling towers shall be

fitted with suitable drift eliminators to reduce drift losses to no more than 2.5% of the condenser water flow.

Condenser water pumps shall be fitted with variable speed drives and shall be modulated between the maximum and minimum condenser water flow rate (as stated by the chiller manufacturer) to maintain the required condenser water entering temperature to the chiller.

3.9.6 Chilled water and Condenser Water Pumps

As well as achieving compliance with the requirements of the BCA, chilled water and condenser water pumps shall achieve the following minimum energy efficiency performance guidelines:

- Pump motor efficiency shall achieve the "High" efficiency standard as defined in AS1359.5.
- Pumps must achieve a total minimum efficiency of 75% at the commissioned operating point.
- Pumps shall achieve a water transport efficiency factor of no less than 30 for chilled water and 40 for condenser water based on the following formula:

$$\text{Water transport factor} = \frac{\text{(Sensible Heat Change in the Circulating Water) kW}}{\text{(Pump Power Input) kW}}$$

3.9.7 Life Cycle Cost Analysis

For all systems above 350kW, the system selection shall be substantiated via a life cycle cost analysis of DX, Air cooled chilled water ad water cooled chilled water.

3.9.8 Waste Heat Recovery:

Waste heat recovery from air conditioning central plant should be considered when there is a demonstrated need for a large quantity of hot water on the same premises. Waste heat recovery from the condenser water or through de-superheater should be considered. Where additional pumps are required to distribute water through the waste heat recovery system with total pump input power (kWe) greater than 60% of the heat recovered (kWt), a waste heat system should not be considered.

3.10 UV Cooling Coil Treatment

Exposure of air conditioning cooling coils to ultra violet irradiation has found to be an effective treatment in the elimination of microbiological fouling and hence improves coil performance by improving the effectiveness of heat transfer. The elimination of microbiological growth reduces pressure drop through the coil, maintains design airflow and improves indoor air quality. Steril-Aire UVC emitters are pre-approved for use of Cairns Regional Council projects, however equivalent products may be approved providing specifications provided are at least equivalent to Steril-Aire and alternative products are locally represented.

UV coil treatment systems shall be considered for all new building projects employing ducted air conditioning systems of either DX or chilled water type, cooling coils of all air handling units and fan coil units shall be provided with UV coil irradiation systems selected to achieve a 99% effective kill rate of microbiological growth.

3.11 Under Floor Air Diffusion (UFAD) – Displacement Air-Conditioning Systems

Displacement type air-conditioning systems shall be considered for facilities where space for services beneath the finished floor level is available for the installation of supply air duct work and where air diffusers can be mounted at floor level in the form of either vertically discharging floor mounted diffusers or horizontal discharge (side blow) diffusers without being at risk of damage.

UFAD systems area form of displacement type air diffusion and generally consist of air diffusion systems via an underfloor cavity which is generally used as a plenum to establish the even distribution of supply air to the space above . Displacement type air-conditioning systems generally consist of side blow type diffusers mounted at floor level, connected to duct work within an underfloor or wall cavity.

Displacement type air-conditioning systems shall only be considered where the floor to ceiling height is no less than 3m. The supply air temperature shall not be below 18°C. This can be achieved by recirculating and mixing room air with the supply air and/or a waste heat reheat system, whilst still maintaining the required amount of dehumidification (50 – 69% RH). Alternatively, an ancillary dehumidification unit could be used to provide the required humidity level whilst the air conditioning evaporator coil provides the space dry bulb condition.

3.11.1 Run-Around Coil Configuration

The air handling system shall incorporate a DX or chilled water wet coil, capable of providing the required amount of dehumidification to maintain the required space condition by reducing the supply air temperature to approximately 12-14°C. The air handling system shall incorporate a run-around coil system to transfer heat from the upstream side of the cooling coil to the downstream side, therefore providing reheat of the air stream.

3.11.2 Dehumidification Unit

A desiccant dehumidification unit shall be installed to remove moisture from the supply air prior to the air handling system which shall incorporate a DX or chilled water coil capable of reducing the supply air temperature to no less than 18°C.

3.12 Total Enthalpy Rotary and Counter Flow Heat Exchangers

In all air conditioned applications, the use of total enthalpy rotary or counter flow heat exchangers shall be considered for the purpose of energy recovery and for the pre-treatment of outside air introduced to conditioned areas. The heat load applied to conditioned spaces in the tropics as a result of the introduction of hot humid air is a significant factor is the selection and sizing of air conditioning plant. Significant opportunities exist for the reduction of energy consumption by the pre-treatment of introduced outside air through the capture and re-use of embodied energy within the conditioned air displaced by the introduction of new fresh air. Hence the two main advantages of using TEHX's include:

1. Reduction in refrigeration capacity and therefore energy savings by reducing the net heat load on the conditioned space; and
2. Reduction in relative humidity of fresh air introduced to conditioned spaces, improving the temperature control and removing moisture from fresh air prior to introduction to the building envelope.

Application: The use of heat exchangers shall be employed in the following applications:

- Meeting rooms, conference rooms, theatres and training rooms and similarly densely populated spaces where a high density of occupants is likely;
- Applications where a high rate of outside air introduction is required for improved air quality;

Total enthalpy rotary heat exchangers shall be used where sufficient space is available. The heat exchanger shall achieve a sensible efficiency of no less than 82% and an enthalpy efficiency of no less than 87% when both the return and exhaust air flows are equal in magnitude. Toilet exhaust may be applied through the heat exchanger only where a purge cycle is incorporated into the heat wheel.

Total enthalpy counter flow heat exchangers shall only be substituted for rotary type systems where space constraints exist. The heat exchanger shall achieve a sensible and enthalpy efficiency of no less than 75% when both the return air and the exhaust air flows are equal in magnitude. Toilet exhaust air shall not be applied through enthalpy type counter flow heat exchangers.

3.13 Fresh Air Preconditioning Systems

Fresh air preconditioning systems shall be utilised where the fresh air supply exceeds 300 L/s and it is not viable to install a rotary wheel or counter flow heat exchanger to pre-treat the fresh air supply, due to pressurisation requirements or the removal of contaminants from the conditioned space.

Fresh air preconditioning systems shall incorporate a wet coil (DX or chilled water) with waste heat recovery in the form of a run-around coil or a total enthalpy heat exchanger.

3.14 Air Movement

3.14.1 Use of Ceiling Fans

The use of ceiling fans shall be considered for all new building applications as a means of providing an enhanced degree of comfort cooling at times of restricted air conditioning use and to supplement the use of temperature control alone to meet acceptable comfort conditions. Ceiling fans shall be considered where the ceiling height is at or above 3m.

The design principle behind the incorporation of ceiling fans into the design of an internal space is to enable higher temperature set-points to be achieved without impacting comfort conditions for personnel working within the space. Global fan speed control in this application shall be set by the automatic building controls to ensure consistent air movement and temperature control is achieved, appropriate to the time of use of the space (i.e. business hours vs after hours use).

Type of Ceiling Fans: Ceiling fans shall be designed for low speed operation (80-160rpm) to provide high airflow for cooling with low turbulence and minimal wind noise. Maximum fan motor rating shall not exceed 35 Watts.

In industrial facilities such as workshops, warehouses or areas with high ceilings (>4 m), High Volume Low Speed (HVLS) fans shall be considered.

Speed Control: Speed control of ceiling fans in open plan office areas shall be automatically pre-set via a single control system for all fans. The control system shall employ the proprietary fan speed control device supplied by the fan manufacturer, interfaced with group controls to enable speed selection of all fans via a single controller. Fan speed control shall be arranged as follows:

Normal Business Hours	Low speed (80rpm)
After hours	High speed (160rpm)

Facilities shall be made within the air conditioning system design to manually adjust the temperature set-point to achieve optimum assisted cooling when the ceiling fans are in use.

HVLS fans shall include a switch panel with multiple speed settings (high, medium and low as a minimum).

3.15 Air-Conditioning Duct Work

All air conditioning duct work conveying conditioned air shall be insulated to the requirements of the BCA. Conditioned air includes air that has been treated by a heat exchanger. Where necessary, duct work conveying unconditioned air shall also be insulated to ensure the space noise rating does not exceed 45 dBa (measured at 1.5m above finished floor level). Flexible duct lengths shall not exceed 6m in length and shall be insulated to the requirements of the BCA. Prefabricated composite panel plenum boxes and duct work shall only be used where the thermal performance meets the performance requirements of the BCA. Where internal insulation is used it shall be perforated foil faced. All internal surfaces visible through grilles and diffusers shall be painted matt black.

4 Ventilation Systems

4.1 Demand Based Fresh Air Supply

Open planned air-conditioned spaces that are ≥ 200 m² shall incorporate carbon dioxide sensors that monitor the level of carbon dioxide within the occupied zone (approximately 1800 mm above the finished floor level) and vary the volume of fresh air introduced into the space to maintain a carbon dioxide concentration of no more than 800 ppm. Ventilation fans shall incorporate VSD's to vary the volume of fresh air and exhaust air (where enthalpy heat exchangers are installed) in response to carbon dioxide levels.

4.2 Demand Based Carpark Ventilation

Enclosed car-parks that require an exhaust ventilation system to meet the requirements of AS 1668.2, shall incorporate carbon monoxide sensors installed at a height of 1.5-1.8 m above finished with single or multiple car-park exhaust fans fitted with variable speed drives. The sensors shall have a detection range of 1 – 100 ppm. When the carbon monoxide level exceeds 8 ppm for no less than 4 minutes, the respective exhaust fan shall activate to low speed. If the concentration level continues to rise to no less than 24 ppm the fan shall activate to high speed. When the concentration level falls below 4 ppm the fan shall switch to low speed and shall operate at low speed for a further 10 minutes before deactivation. Sensor layout shall be as per the manufacturers requirements.

5 Electric Motors

5.1.1 Use of Premium Efficiency Motors

Premium Efficiency Motors: All motor drives throughout the installation rated at 0.75kW or above, shall be premium efficiency type complying with AS1359 and MEPS 2006 requirements.

All motors shall comprise high grade cast iron frames to ensure high thermal reserve offering low temperature rise characteristics when operating at reduced speed applications. Motor insulation shall be Class 'F'.

For noise sensitive applications, motors shall incorporate low noise fans and acoustic fan covers, and shall incorporate sealed for life over-size bearings for applications up to frame size D132.

Refer also to Explanatory Notes in Appendix A for further considerations when employing VSD's for motor drive applications.

6 Variable Speed Drives

VSD Applications : For all applications involving motor drives where the applied load may be subject to fluctuation or the duty to be performed by the motor drive could manually varied, the use of VSD's shall be incorporated. For variable duties, the VSD shall be arranged such that the operating speed of the motor drive is automatically selected by reference to a set-point derived from the performance conditions the motor drive is required to meet (i.e. constant pressure, constant temperature, water level, etc). Speed control shall be automatically achieved through closed PID loop control.

7 Appliance Selection

Energy Rating Labels (ERL's): Where appliances are required to be supplied as part of the building contract, the following minimum star ratings for specific appliances shall be achieved.

Appliance	Standard	Minimum Star Rating
Air Conditioners	AS/NZS 3823.2	4.0
Clothes Dryers	AS/NZS 2442.2	5.5
Clothes Washers	AS/NZS 2040.2	4.5
Dishwashers	AS/NZS 2007.2	4.0
Upright Refrigerator	AS/NZS 4474.2	2.5
Upright Refrigerator / Freezer	AS/NZS 4474.2	3.5
Upright Freezer	AS/NZS 4474.2	3.5
Chest Freezer	AS/NZS 4474.2	2.5
Televisions	AS/NZS 62087.2.2	8.0

Where higher performance appliances are specified in accompanying document, the higher rating will apply.

Boiling Water Units (BWU's): Where under bench boiling water units are specified, the unit shall incorporate the following minimum energy efficiency features:

- Insulated holding tank;

- Variable energy control to element to maintain temperature control;
- Sleep control to shut off supply after 2 hours of inactivity;

Wall Mounted BWU's: Where wall mounted (over sink) units are specified, BWU's shall incorporate the above minimum features and also include a light level sensor to active sleep mode after hours.

Single Point Hot Water Units: The selection of hot water units shall be determined on the merits of the specific application. Unless specified otherwise in project documentation, where hot water is required for supply to a single sink or basin fixture, a stand-alone 5 or 10L (max) instantaneous under-bench or above-bench unit may be adopted, provided the energy saving features described above for boiling water units are incorporated into the unit.

Reticulated Hot Water Systems: For installations where hot water supply is required at multiple locations throughout a building, hot water generation shall be via heat pump(s).

8 Metering

Application: In addition to the requirement for separate metering as required by Appendix J of the National Construction Code, i.e.:

- Lighting
- General Power
- Air Conditioning
- Substantive Loads

Normalised Energy Reporting: Facility shall be included to identify energy consumption during business hours and after hours to provide a normalised baseline for future building energy performance comparison and benchmarking.

BMS: Where a BMS is provided, energy metering shall incorporate pulsed or high level serial output and logged to the BMS system.

Renewables: Energy contribution by renewables shall be separately metered and logged.

9 Renewables

9.1.1 Photo-Voltaic Generation

Application: Photo-voltaic power generation shall be incorporated into all projects where it is specifically required in the project terms of reference. In all other cases, facilities shall be incorporated to enable the retro-fit of PV systems without cost penalty due to abortive works.

Type of System: The preferred system type shall incorporate a micro-inverter associated with each individual panel (APS Micro or approved equal) to provide a scalable and future proof solution capable of accepting any panel type. Micro inverters shall be provided with 15 year manufacturer's warranty.

Micro-Inverters: Micro-Inverters shall incorporate the following as a minimum:

- Conversion efficiency shall be no less than 93.5% CEC.

- Decoupled control of active and reactive power.
- Over-current and anti-islanding protection.
- Galvanic protection between the panel and the grid.

Roof Design: Roof structures for all new buildings shall be designed to be suitable for the addition of PV without cost penalty (i.e. incorporate fall arrest, access provisions).

Switchboard Design: The design of new main switchboards and/or building main distribution boards shall be designed for the addition of supply from PV systems and all building 'as constructed' drawings shall include details of the provisions incorporated for the subsequent installation of PV.

10 Power Generation

10.1.1 On-Load Testing Facilities

For sites requiring standby power generation facilities, it is recommend practice to test run generator sets for a minimum of two (2) hours per month. As most manufacturers do not recommend operation at typically less than 30% rated capacity due to long term detrimental effects on the engine, the use of load banks are historically used to provide some artificial loading of gensets while test running.

For all new buildings where standby power generation is proposed, facility shall be provided for an auto-synchronising make before break changeover switch to be provide to facilitate on-load seamless transfer of designated test load from mains to generator supply and back to mains supply.

11 Cold Rooms

11.1 Refrigeration System

Cold rooms shall only use refrigerants with a zero ODP. Externally mounted condenser sets shall not be located in direct sunlight and shall not be located within less than 2 meters of any direct sources of heat. Condenser fan discharge shall not have any obstructions to the air path for a minimum of 3 meters.

11.2 Cold Room Construction

Cold room walls and ceilings shall be constructed of PIR composite panels, vapour sealed throughout. Minimum panel thickness shall be as follows:

Coldroom Temp.	Volume ≤ 45 m³	Volume > 45 m³
≥ 0°C	100 mm	150 mm
< 0°C	150 mm	200 mm

All penetrations shall be vapour sealed and shall incorporate escutcheons.

Cold room floors shall incorporate 100 mm thick polyurethane insulation panels with a 75mm thick insitu concrete wearing surface.

12 Appendix A - Explanatory Notes

12.1 Notes on the use of Variable Speed Dives

In most applications, the use of variable speed drives in lieu of fixed speed drives has the ability to offer significant energy savings. Often motor drives are rated to suit the maximum duty for a particular application which may occur for only a relatively small percentage of the time the drive is required to operate. Typically, in most applications employing fans and pumps within buildings, the actual duty applied to the fan or pump at any point is time may be in the order of 75% of its rated maximum capacity. In the case of centrifugal pumps, motors are often rated to be non-overloading under all conditions of operation. The maximum load in the pump is likely to be under an open discharge or 'pipe burst' condition when the pump is doing the most work, whereas under normal operation the pump will operate at a duty point where it will quite often absorb power equivalent to around 75% of the motor maximum continuous rating.

When operating a motor at 75% speed, the power drawn by the motor is around 50% as the power is reduced to the cube of the speed plus approximately 5% for reduced efficiency at part load (i.e. 0.75^3 + 5% = 47%). In order to realise this potential saving, the motor drive needs to select its speed based on tracking a performance set-point rather than run at 100% fixed speed at all times the motor is required to operate.

Some caution needs to be exercised when adopting variable speed drives including the introduction of harmonic distortion in the power supply. Harmonic filters can be applied to the drives to reduce the magnitude of harmonic distortion to ensure THD applied will not affect other more sensitive equipment within the installation. Consideration also needs to be given to the impact on any power factor correction equipment which can be adversely affected by the introduction of harmonics. A harmonic study considering the effects of introduction of VSD's shall be undertaken as part of the design process.

12.2 Motors with Variable Speed Drives

Where electric motors are intended for operation with variable speed drives (VSD's) consideration must be given to the reduced cooling effect of the motors integral cooling fan at low speed operation.

With the exception of applications where motors are fitted with separate forced fan-cooling provisions, motors operating at reduced speeds must have their outputs de-rated to allow generated heat to be adequately dissipated. Particular importance must be paid to applications where motors are operating at very low speed but still subject to constant torque at low speed operation.

The output voltage waveform from VSD's is non-sinusoidal and is often a Pulse Width Modulated (PWM) or 'chopped' waveform, which often effects both motor torque capability and the motors thermal characteristics. The selection of appropriate drive motors for these applications must take these factors in to account by de-rating the motor output accordingly to avoid the following typical consequences of inappropriate motor section:

- Reduced Insulation life due to dv/dt effects as well as increased voltage levels at the motor terminals due to reflected waves
- Increased noise levels – especially at low speed (frequency) operation
- Reduced bearing life through Electric Discharge Machining (EDM) effects.
- Motor over-heating due to harmonics in PWM waveform
- Possibility of generating shaft currents

In selecting the most appropriate motor drive for a specific application, the following must be considered:

- Type of Load / Application (e.g. Conveyor/Fan/Pump/Mixer etc)
- KW and Torque required in the required speed range
- Supply Voltage and Frequency with their tolerances
- Environmental Conditions (Temperature/Hazardous Area etc)
- Cable length from VSD to the motor

12.3 Appendix B – Compliance Schedule

Ref	ESD Initiative	Compliance			Comment
		Yes	No	N/A	
	Lighting				
1.	Internal lighting operation integrated with security system				
2.	Time of day lighting control during business hours				
3.	Occupancy based lighting control				
4.	After hours lighting control				
5.	Daylight harvesting to perimeter zones				
6.	LED or single tube T5 lighting				
7.	LED or cold cathode Exit signage				
8.	LED emergency lighting				
9.	Computer monitored maintenance system (emergency lighting)				
10.	External lighting operation integrated with security system				
11.	Daytime operation of external lighting inhibited (except for testing purposes)				
12.	Carpark lighting design RPEQ certified to AS/NZS1158.3.1				
13.	Carpark & driveway lighting either metal halide or LED				
14.	Carpark & driveway lighting zero tilt				
15.	Minimum 5 year warranty provided on LED lighting				
	Air-Conditioning				
16.	Ducted AC plant time scheduled operation				
17.	Occupancy based control				
18.	Minimum set point temperatures				
19.	Zoning Configuration				
20.	Air-Conditioning Fan Efficiency				
21.	Air diffusion				
22.	Temperature sensors and control strategy				
23.	DX refrigeration system				
24	Externally mounted DX plant configuration				

Ref	ESD Initiative	Compliance			Comment
		Yes	No	N/A	
25.	DX non-Ducted systems				
26.	VRV Split Systems				
27.	VAV systems				
28.	Chiller Capacity Increments				
29.	Chiller full load and part load efficiency				
30.	Air cooled Versus Water Cooled Chillers				
31.	Chilled water and condenser water pumps				
32.	DX Vs Chilled Water life cycle cost analysis				
33.	Waste heat recovery				
34.	UV cooling coil treatment				
35.	Displacement type air-conditioning systems				
36.	Total enthalpy rotary and/or counter flow heat exchanger				
37.	Fresh air preconditioning system				
38.	Air movement				
39.	Duct work				
	Ventilation				
40.	Demand based fresh air supply				
41.	Demand based car park exhaust ventilation				
	Electric Motors				
42.	Premium Efficiency Motors				
43.	Variable speed drives				
	Appliance Selection				
44.	Energy rating Labels				
45.	Boiling Water Units				
	Metering				

Ref	ESD Initiative	Compliance			Comment
		Yes	No	N/A	
46.	Normalised Energy reporting				
47.	BMS				
48.	Metering Renewable Energy Generation				
	Renewables				
49.	Photovoltaic energy generation				
50.	Power Generation				
	Cold Rooms				
51.	Refrigeration systems				
52.	Cold room Construction				