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Energy and Demand Management Standards for the Design Process
Version 1.02 – 1st December 2006

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VERSION CONTROL SYSTEM

Section Modified	Description of Modification	Version	Organisation	Representative	Date
Throughout	UOW Logo added to headers	1.02	Asset Technologies Pacific	Tom Poyner	28/11/06
10.2	Add risk assessment activity to conceptual design process.	1.02	Asset Technologies Pacific	Tom Poyner	1/12/06
10.4	Insert OH&S reference link	1.02	Asset Technologies Pacific	Tom Poyner	1/12/06

10. ENERGY AND DEMAND MANAGEMENT

Energy management is a part of UOW's overall environmental management policy. The principals of efficient energy management must be implemented throughout the life of the building system, service or structure.

This standard focuses on the design phase of the equipment's life cycle. The objective is to nominate appropriate energy management guidelines that if implemented will result in acceptable space conditions whilst consuming minimum energy.

Demand management is a subset of energy management and should also be implemented throughout the operational life of the building system, service or structure. Demand management involves the reduction of peak loads through load shedding, efficient scheduling or implementing alternate energy sources during peak energy usage periods.

10.1 OVERVIEW

The purpose of this standard is to provide guidance for the integration of energy and demand management principals into the design process.

The designer responsible for specifying electrical, mechanical or building elements shall use this standard in conjunction with the specific design standard appropriate for the system, service or structural element being designed.

The equipment specified in the individual design standards is considered energy efficient when compared to other comparable equipment. Therefore, the make and model of specific equipment has not been repeated in this standard.

For each project it is incumbent upon the designer to ensure that the design satisfies site specific operational, logistical and performance requirements and there is not a significant functional or performance trade off from implementing energy efficient design practices.

In determining the most appropriate equipment for a particular installation, the designer shall consider the long-term energy efficiency, maintenance implications, operational efficiency and life cycle costs as well as the initial capital costs.

10.2 ENERGY PERFORMANCE DESIGN PROCESS

Following is an outline of the energy performance design process:

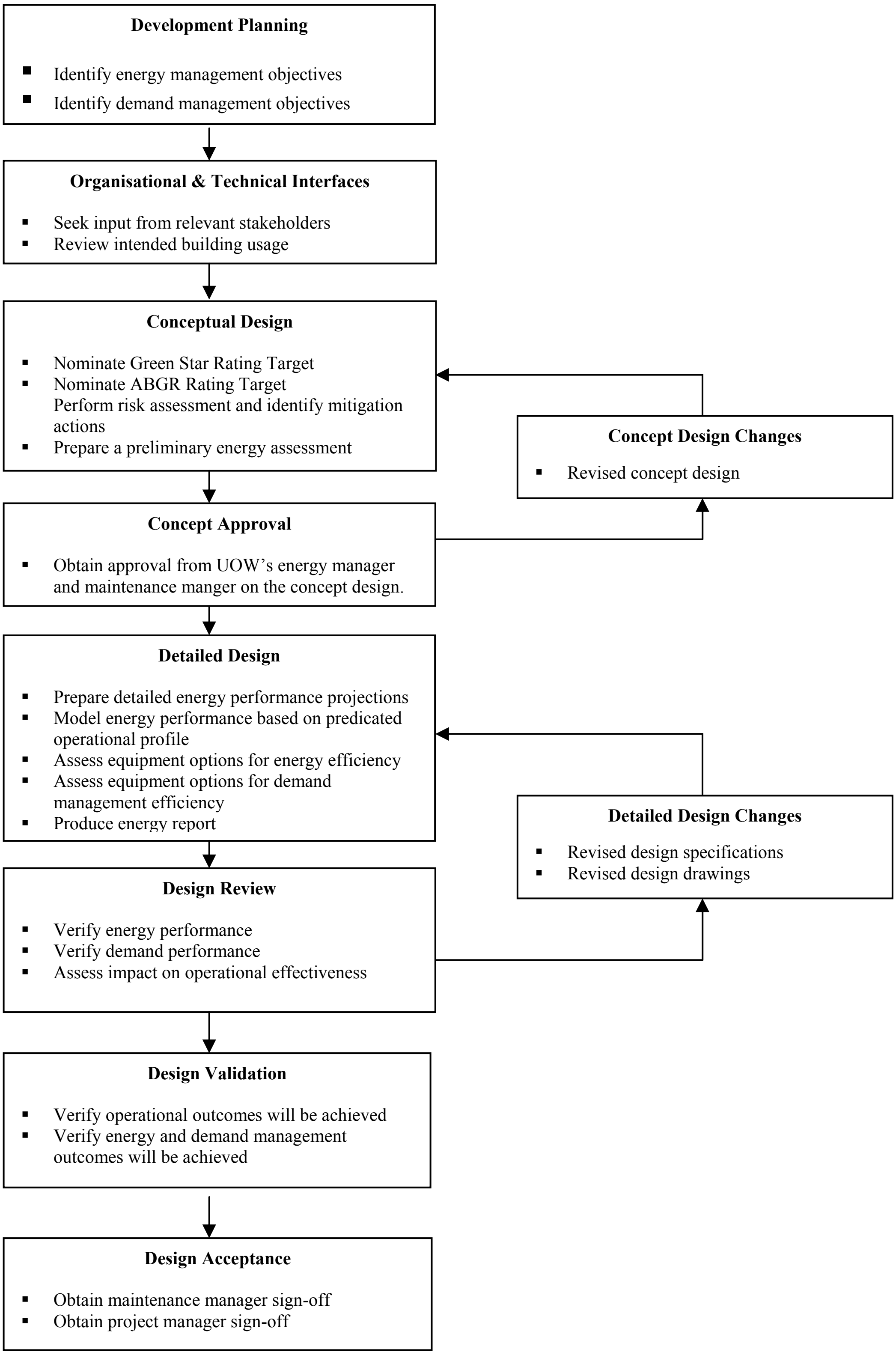

Figure 10.1 - Process Flow

10.3 ENERGY PERFORMANCE

10.3.1 General

Energy performance is the measure of energy consumed to provide space conditions or to operate electrical or mechanical equipment. Efficient energy management design principals will minimise consumption during all operational periods.

Efficient demand management design principals will reduce consumption during peak demand periods. For UOW, the peak demand periods are from 12:00 Midday to 3:00 PM Monday to Friday during February.

10.3.2 ABGR

The New South Wales Department of Energy, Utilities and Sustainability (DEUS) administer the Australian Building and Greenhouse Rating (ABGR) scheme nationally.

The ABGR scheme is a voluntary rating scheme and is used to rate a building according to its actual performance, using 12 months energy data.

Although primarily a management tool to measure ongoing energy management in commercial buildings, a design process modelled on the ABGR has been developed and can be used as part of the Green Star Rating for all buildings (refer section 10.3.3 Green Star).

The designer shall also comply with the Energy provisions of the Building Code of Australia.

It is important that the electrical or mechanical designer adopts the correct design approach to enable a favourable rating to be achieved on an ongoing basis for any commercial building and as part of the design projections for all buildings.

There are three types of ratings for ABGR and they are:

- Tenancy – for office space within a building, covering the tenant's use of light and power;
- Base building – covering central services and common areas of the building;
- Whole building – a combination of above.

The ABGR scheme rates buildings from one to five stars with five stars representing exceptional greenhouse performance. The table below defines the star ratings for ABGR.

Number of Stars	Definition
1	Poor – Poor management or outdated systems
2	Good – Average building performance
3	Very Good – Current market practice
4	Excellent – Strong performance
5	Exceptional – Best building performance

Table 10.1 – Australian Building Greenhouse Rating Scheme

Whilst it may not always be appropriate to specify an ABGR performance standard, UOW's objective is to design a building that will produce an ABGR rating of four stars or higher for all three types of ratings.

10.3.3 Green Star

The Green Council of Australia administers the Green Star rating. Green Star is a voluntary rating system and is used to rate a building's environmentally sustainability for its design, construction and operational phases.

Green Star is rated across the following nine categories:

Category	Definition
Management	This category assesses management's adoption of sustainable development principles from project conception through design, construction, commissioning, tuning and operation.
IEQ	This category assesses the environmental impact, occupant wellbeing and project performance.
Energy	This category assesses the greenhouse emissions, energy consumption and use and sources of energy for the operation of the building.
Transport	This category assesses the type of transportation used to gain access to the site.
Water	This category assesses water consumption and use, efficient design of building services and water sources.
Materials	This category assesses energy efficiency of the material selected.
Land use and ecology	This category assesses the projects impact on its immediate ecosystem.
Emissions	This category assesses the point source pollution from building and building services to the atmosphere, watercourse and local ecosystems.
Innovation	This category assesses innovations used to make it a sustainable building.

Table 10.2 – Green Star Categories

Green Star rates buildings from one to six stars. The Green Council of Australia only certifies buildings that achieve a rating of four stars or higher. Following are the rating definitions of the Green Star system:

Number of Stars	Definition
1	Not eligible for certification
2	Not eligible for certification
3	Not eligible for certification
4	Eligible for certification that recognises/rewards best practice
5	Eligible for certification that recognises/rewards Australian excellence
6	Eligible for certification that recognises/rewards world leader

Table 10.3 – Australian Building Greenhouse Rating Scheme

UOW's objective is to design a building that will produce a rating of five stars or higher.

10.3.4 NSW Greenhouse Gas Abatement Scheme

To reduce greenhouse gas emissions in New South Wales, the NSW State Government legislated to make it mandatory for NSW electricity retailers to reduce the greenhouse gas emissions associated with the electricity that they sell. Retailers may meet their reduction target by purchasing and surrendering certificates, called NSW Greenhouse Gas Abatement Certificates (NGACs).

When UOW implements an eligible project that reduces electricity consumption and greenhouse gas emissions, NGACs can be created. One NGAC represents one tonne of greenhouse gas emission abated by the activity in respect of which it was created. The NGAC can then be traded for an agreed amount either through a third party or directly with the energy retailer.

UOW's participation in this scheme requires detailed documentation to be prepared for each project and appropriate record keeping processes be implemented. The designer shall ensure that design specifications require certificates with the necessary documentation to be produced for each relevant project at Practical Completion.

The creation, submission and keeping of records shall comply with UOW's procedures that are current at the tim and may involve a commitment of a third party contracted to maintain the records.

10.3.5 Demand Side Abatement Systems

UOW has established a system for the monitoring and recording of demand side abatement records. The designer shall ensure that design specifications require this system to updated as part of the practical completion process for all new systems, services and structures that produce a peak demand saving.

Where abatement certificates must be completed and submitted to the relevant regulatory agencies, the Designer shall ensure that a process is specified that outlines the UOW's requirement for the completion of certificates and record keeping.

10.3.6 Monitoring and Control Process

As part of the design process the designer shall specify the method for monitoring energy usage. This method may involve electrical sub-meters installed to meter the electrical consumption of major plant or a specific operational area such as a kitchen.

As a guide the following shall be provided with sub-metering:

a. Mechanical Services Switchboards

b. Retail Outlets

c. Swimming Pool Equipment

d. Industrial Plant

e. Scientific/Experimental Equipment (100 kW or higher)

Where energy metres are specified, they shall connect to data logging equipment to enable energy performance trends to be captured. Alternatively they may be connected to the Building Management and Control System (BMCS) or to anther similar management system.

The BMCS may be also used to monitor lighting, air-condition or other electrical or mechanical services directly.

Where the BMCS is to be used for energy monitoring, sensors shall be provided to record the following:

- Equipment status;
- Actual energy consumption;
- Equipment run times;
- Load factors;
- Operating times;
- Sequencing strategies (trending).

10.4 STANDARDS

The design shall comply with all relevant codes and standards. Table 10.3 below contains a list of the relevant codes and standards.

Issuing Body	Document Number	Title
Australian Building codes Board	BCA - 2006	Building Code of Australia
Australia / New Zealand Standards	AS/NZS ISO 14001:2004	Environmental Management System - Requirements with Guidance for Use
Australia / New Zealand Standards	AS/NZS ISO 14004:2004	Environmental Management System - General Guidelines on Principles, Systems and Support Techniques
Standards Australia	AS 2725-1984	Guidelines For Reporting Energy Use as Part of the Energy Audit
Standards Australia	AS 3595-1990	Energy Management Programs - Guidelines for Financial Evaluation of a Project
Standards Australia	AS 3596-1996	Energy Management Programs - Guidelines for Definition and Analysis of Energy and Cost Savings
Standards Australia	AS 3598-1990	Energy Management Programs - Guidelines for the Preparation of an Energy Audit Brief
Standards Australia	AS 3598-2000	Energy Audits
UOW	OHS064	OH&S Consideration for Design (http://staff.uow.edu.au/workingsafely/design/OHS064-OHS_Design_Guidelines.pdf)

Table 10.4 - Codes and Standards

10.5 EQUIPMENT SELECTION GUIDLINES

10.5.1 Electrical Services

The designer shall perform the electrical design in accordance with the UOW Design Standards. This section is intended as a guide for the designer in determining the most energy efficient and operationally suitable equipment.

Where necessary, the advantages and disadvantages are listed to assist the designer with selecting equipment that is most appropriate for a particular application.

10.5.1.1 General Lighting

The purpose of general lighting is to provide adequate and appropriate lighting for functional spaces including lecture theatres, teaching rooms, common rooms, administration offices, passageways and hallways, bathrooms, storerooms, plant rooms and service areas.

An energy efficient approach to general lighting is to use single fluorescent triphosphor T5 lights with 28W lamps.

Following are the benefits of using the single fluorescent triphosphor T5 lights as compared to the commonly used single fluorescent triphosphor T8 lamps that use a 36W lamp.

a. The single fluorescent triphosphor T5 light that uses a 28W lamp is 23% more energy efficient than the single fluorescent triphosphor T8 light that uses a 36W lamp and produces the same amount of light. This greater energy efficiency results in energy cost savings for the operational life of the light.

b. The single fluorescent triphosphor T5 (28W) light has a greater radius of illumination than the single compact fluorescent light (13W) or the twin compact fluorescent light (26W). The greater light output means fewer lights are required, resulting in a lower capital cost.

c. The single fluorescent triphosphor T5 (28W) light has a lamp life that lasts 18% longer than the lamp life of the single fluorescent triphosphor T8 (36W) light, the single compact fluorescent light (13W) or the twin compact fluorescent light (26W). The longer lamp life means that less maintenance is required to change the lamps, resulting in a lower maintenance cost.

d. Where compatible with the light fitting, voltage reduction units may be used. These reduce consumption by approximately 20%.

10.5.1.2 Special Purpose Lighting

Special purpose lighting is used to provide direct lighting to highlight a specific area or function. These lights are generally used in the bathrooms, lifts, foyers and display areas.

An energy efficient approach to special purpose lighting is to use compact fluorescent downlights with 9W lamps.

The compact fluorescent downlight has the same appearance as the commonly used tungsten halogen dichroic low voltage lights with 20W lamps.

Following are the benefits of the compact fluorescent downlights (9W) as compared to tungsten halogen dichroic low voltage downlights:

a. The compact fluorescent downlights (9W) is 55% more energy efficient than the tungsten halogen dichroic low voltage downlight (20W) and produces a greater amount of light. The greater energy efficiency results in energy cost savings for the operational life of the light.

b. The compact fluorescent downlights (9W) produces more light than the tungsten halogen dichroic low voltage downlight (20W). The greater light output means fewer lights are required, resulting in a lower capital cost.

c. The compact fluorescent lamp lasts seven (7) times longer than the tungsten halogen dichroic low voltage downlight lamps. The longer lamp life means that less maintenance is required to change the lamps, resulting in a lower maintenance cost.

d. The tungsten halogen dichroic low voltage downlight requires a transformer to operate. These transformers have a life of 4,000 hours. The compact fluorescent light does not require transformers to operate, resulting in cost savings on the maintenance.

Following are the disadvantages of the compact fluorescent downlight (9W) as compared to the tungsten halogen dichroic low voltage downlight:

a. The compact fluorescent downlights are currently only available as a white light. The tungsten halogen dichroic lights are available as either a white light or warm (yellow) light.

b. The compact fluorescent downlights are not dimmable. Where as the tungsten halogen dichroic lights are dimmable.

c. The lamps for the compact fluorescent downlights cost more than the lamps for the tungsten halogen dichroic downlights.

10.5.1.3 External Lighting

The purpose of the external lighting is to provide adequate lighting to illuminate roads, car parks, exit and entry points to buildings and pedestrian pathways for staff, students and service providers and to provide lighting for security purposes.

An energy efficient approach to external lighting is to use metal halide high intensity discharge lights.

Following are the benefits of the metal halide high intensity discharge lights as compared to other comparable lights:

a. The high pressure sodium high intensity discharge light produces 40% more illumination than the equivalent metal halide high intensity discharge light. The greater light output means fewer lights are required, resulting in a lower capital cost and lower energy consumption.

b. The metal halide high intensity discharge light produces 60% more illumination than the equivalent mercury vapour high intensity discharge light. The greater light output means fewer lights are required, resulting in a lower capital cost and lower energy consumption.

c. The light produced by the metal halide high intensity discharge light is most suitable for situations where colour identification is important. Where as the light produced by the high pressure sodium high intensity discharge light yellows with age.

Following are the disadvantages of the metal halide high intensity discharge lights as compared to the comparable lights:

a. The metal halide high intensity discharge lamp has a life that is 15% shorter than the mercury vapour high intensity discharge lamp or the high pressure sodium lamp.

   The shorter lamp life means that the lamps will need to be replaced more frequently, resulting in a higher maintenance costs.

10.5.1.4 Low Intensity Lighting

Low intensity lighting can be used for special effects or to provide general lighting in areas where low levels are required. LED lighting is generally more energy efficient than other low intensity options such as low voltage lighting and should be considered for both internal and external usage.

10.5.1.5 Lighting Controls

The following lighting control technologies can be implemented to save energy through better switching of the lights.

a. Timer Controls

These are automatic switches that allow the lights to be turned on for a set period of time. This technology is best used to control outdoor lighting for open air car parks, outdoor security lighting and outdoor display lighting.

b. Occupancy Sensor Controls

This technology uses infrared or ultrasonic sensors to detect heat or movement and to automatically activate the lights when someone enters a room and turn off the light after the person leaves the room. This technology is best used in low occupancy areas such as staff bathrooms and storage areas.

c. Day-light Sensor Controls

This technology used photocells to detect the lux levels of ambient light and turn on/off or dim the lights to maintain constant light levels. This technology is best used to control high frequency fluorescent lights in areas where natural sunlight is available.

d. Compartmentalisation

An effective method to reduce the electricity consumed from lighting is to split the lighting of a large area into separate switching compartment so that each area is operated through its own switch. This results in only those areas that need to be lit at any time to be turned on, avoiding unnecessary lighting use.

10.5.1.6 Power Factor Correction

It is UOW's objective that all new facilities operate at near unity power factor. Therefore, where the energy analysis identifies that a new installation will operate at below 0.99 power factor, power factor correction equipment shall be installed.

10.5.2 Heating, Ventilation and Air Conditioning System

The heating, ventilation and air conditioning (HVAC) System shall provide space conditions to nominated areas. HVAC can be designed as either a centralised system or a distributed system.

A centralised system comprises central chiller plants, heating equipment and air handling units (AHU) designed to supply an entire building. A distributed system comprises packaged air conditioning units or individual room air conditioning units designed to supply discrete areas within a building.

The design objectives will determine whether a cental system or a distributed system or a combination of both is the most appropriate option for a specific application.

The following is intended as a guide for the designer in determining the most energy efficient and operationally suitable equipment.

10.5.2.1 Chillers

The four (4) common types of chillers available for central cooling purposes are the absorption chiller, centrifugal chiller, reciprocating chiller and the screw chiller.

New technologies are being developed and trailed that will produce cooling for HVAC purposes more efficiently than the chillers currently on the market. The designer should research new technologies prior to undertaking the conceptual design as a significant saving may be achieved through the use of an emerging technology.

At present the energy efficient approach to provide cooling is to use a screw chiller that is efficient at both high and low loads. Depending on the load profile, the screw chiller is between 20% and 60% more efficient than the other chillers.

10.5.2.2 Air Volume Units

Air volume units regulate the amount of conditioned air to that is supplied to specific zones. An energy efficient approach is to provide conditioned air through the use of variable air volume units.

The benefits of a variable air volume over constant air volume units are:

a. The variable air volume unit can vary the amount of air circulated in response to demand by varying the speed of the fans. Where as the constant air volume unit supply a constant amount of air and it's fan speed is constant.

   The variable air volume units ability to vary the speed of its fan means that it requires less energy to operate. This greater energy efficiency results in energy cost savings for the operational life of the light.

b. Variable air volume units ability to vary the load on the fan motors results in a longer life cycle for the fan motors. This longer life cycle results in maintenance cost savings, as the fan motors require less maintenance and replacement.

10.5.2.3 Space Heating

Following are the most common methods to provide space heating:

a. Electric duct heaters are electric coils that are located in the ducting of the air handling units or the air volume units. These units heat the air as it is moving through the ducts.

b. Electric boilers are large centralised plants that utilise electric elements to heat the water of the centralised air conditioning system.

c. Gas boilers are large centralised plants that utilise gas burners to heat the water of the centralised air conditioning system.

The most energy efficient approach to providing space heating is to use a gas fired boiler. The gas boiler is between 20% and 40% more efficient than the comparable heating methods.

10.5.2.4 Alternate Heating Options

An alternative to the traditional forms of heating is to use solar energy, heat pumps or to implement a cogeneration process where the waste heat from one process may be used to provide space heating.

Whilst these alternate technologies generally are not as cost effective as the traditional forms of heating for general use, they may be relatively cost effective for smaller installations or where the design criteria does not require rigid temperatures to be maintained at all times.

These applications include swimming pools that have a backup gas heating system or hot water units that can be used for domestic or HVAC purposes.

The designer shall consider alternate heating options during the conceptual design phase and analyse the feasibility of at least one alternate heating option during the energy assessment.

10.5.2.5 Cooling Towers

Cooling towers provide a means to reject the heat from the building. There are two common types of cooling towers, water cooled and air cooled. Water cooled cooling towers generally provide more cooling capacity than air cooled cooling towers and are more energy efficient.

10.5.2.6 Distributed Systems

A distributed system utilises air conditioning equipment to provide space conditions on a distributed basis across different levels or areas within a building.

A distributed approach can be the most efficient option when only a small area within a building requires cooling or heating. Used in conjunction with ceiling fans or other ventilation equipment, a packaged air conditioning unit may be an effective method of air conditioning.

10.5.3 Building Monitoring & Control System

The building monitoring and control system (BMCS) provides monitoring and control of mechanical, electrical and environmental services. The BMCS currently installed at UOW is the Siemens Apogee Insight System.

When new plant and equipment is installed the BMCS shall be extended through the provision of additional field processing units and field devices.

The BMCS shall be programmed to control plant and equipment efficiently. Following are basis control strategies that shall be implemented in conjunction with the control strategies specified in the BMCS design standard:

- The rate of change of the chilled water temperature, space temperatures etc shall be monitored. Where the rate of change is slowing, the BMCS shall be programmed to increase/decrease the set point by half a degree.

  The objective is to eliminate the need to enable additional plant, provided that the temperature does not change by more than half a degree.

- The BMCS shall be programmed to operate to the operational profile of the facility. Where a significant decrease in heat load is anticipated due to operational reasons such as students leaving an auditorium or an increased in lecture room vacancy, the BMCS shall be programmed to commence load shedding prior to the heat loads decreasing.

- Where the lighting is controlled through the BMCS or a similar automatic control system the general lighting shall be programmed to switch off automatically during after hours periods.

10.5.4 Building Structures

Where new facilities are constructed or extensions to existing facilities are undertaken, the designer shall model the thermal and lighting performance to ensure compliance with the Green Star Rating objectives.

The designer shall perform the modelling, taking into consideration the specifications outlined in the building element design standard. The final design shall be aesthetically pleasing, functional, low maintenance and energy efficient.

The design shall utilise natural light as much as possible and provide for effective insulation to minimise heat loss during winter and reduce the requirement for cooling during summer.

10.6 REFERENCES

The equipment listed in Section 10.5, Equipment Selection Guidelines can be referenced in the following documents:

Reference Document	Version
UOW - Electrical Services Design Standards	1.01
UOW - Mechanical Services Design Standards	1
UOW - Building Monitoring and Control Systems	1

Table 10.5 - Reference Documents

10.7 ENERGY PERFORMANCE COST ANALYSIS

The designer shall undertake an energy cost analysis as part of the detailed design process to help determine the most appropriate system, services or structural building element for a particular application.

The period of financial interest shall be in accordance with the equipment manufacturer's predicted life expectancy under normal operating conditions.

The cost analysis shall include the following for each option:

- Equipment supply cost;
- Installation cost;
- Maintenance cost;
- Cost of software support and regular upgrades;
- Licenses and statutory costs;
- Cost of third party support for interfaces;
- Annual energy cost over the life of the equipment.

Where the provision of a particular type of system, service or structure is to be cost justified through energy performance savings, the designer shall prepare a cost feasibility report containing the above costs and the cost benefits, payback period and internal rate of return.

Engineering calculations that are based on the specific equipment ratings, predicted load factors and operational times shall be prepared to support the cost benefit.