3. ELECTRICAL SERVICES

Electrical Performance Outcomes

3.1.00. OBJECTIVES

To provide electrical services that deliver safe, reliable and flexible energy sources within the facility that provide the expected lighting levels for comfort and functionality, using cost effective solutions that achieve an optimal balance between capital, operating and maintenance costs over the life of the service.

3.1.05. OUTCOME STATEMENT:

Achieve objective through the use of energy efficient building and services design, low whole-of-life costs while meeting OH&S requirements and achieving occupant satisfaction with the internal environment.

Components	Performance Outcomes	Performance Criteria	Measurement Mechanism
General power and lighting energy usage	Minimise energy consumption	Energy input per square metre of floor area per annum Average 120 kWH/m^2 pa Clinical Areas 140 kWH/m^2 pa Administration 65 kWH/m^2 pa Wards 95 kWH/m^2 pa	Energy used in functional areas and the whole building
Power distribution flexibility	Spare capacity for future load changes	Spare capacity provision in mains and switchboards Consumers Mains: Matched to maximum capacity of transformers Submains light & power: 30% Switchboards: 30% spare poles Mechanical Plantroom S/B's: X%	Spare capacity as supplied on installed equipment
Communications system flexibility	Spare capacity for future change	Structural Cabling: Copper 50% Optical Fibre 50% Comms Cupboards & hub equip: 50%	
Lighting efficiency	Maximise the lumens output per watt of energy used in lamp selection Maximise luminaire efficiency Minimise luminaire energy consumption	Lumens per watt for lamp selection General lamps >50 lumens/watt Luminaire Light Output Ratio>70% <4.0 Watts/m2/100 lux generally <6.0 Watts/m2/100lux for wards	Lumens output for lamp selection.
Lamp life/Maintenance	Maximise lamp life and minimise luminaire maintenance costs	Lamp life – Linear Fluorescent tubes >15,000 hrs PLC Lamps > 5000 hrs	

Occupant comfort	Occupant satisfaction with lighting conditions in occupied spaces	80% satisfaction rating	
	Maintain lighting levels and colour rendering in functional areas to agreed levels	In accordance with AS/NZS 1680 and other directives	Actual quantities measured against AS/NZS 1680 requirements
Whole of life costs	Lowest system cost over it's operating life considering: capital cost; operating cost; and maintenance and replacement costs	Life cycle costing analysis	Life cycle costing analysis complying with AS 4536
Infection control	Prevent intrusion of dust in operating theatres and other defined clinical areas through lighting fittings. Minimise dust collecting surfaces in general		
Ecological Sustainability			

Introduction

3.2.00. GENERAL

The cost of lighting installation and power distribution cabling systems are major contributors to the cost of electrical services and are significant items in the overall engineering services cost for the refurbishment or construction of new health facilities.

There is a perception in the health industry that the current design practice is not as efficient as it should be and consequently over-design and over-provision for unsupported future requirements are seen to be prevailing.

Significant aspects of the electrical services design are governed by statutory requirements contained principally in the following codes and standards:-

- BCA (Building Code of Australia)
- AS/NZS 3000:2000 Electrical Installations

These regulations together with the referenced Australian Standards cover the following major elements of electrical services for hospital buildings:

- Power supply and distribution systems
- Wiring for all electrical equipment
- Emergency lighting and exit signs and
- Emergency warning and intercom systems.

It is recognised that approval for departures from the statutory requirements is difficult and time-consuming to achieve. Notwithstanding, this document identifies some areas of the statutory regulations which should be challenged and modifications to suit hospital projects be sought by NSW Health.

There are, however, other aspects of the electrical design which are not subject to regulations and are normally carried out in accordance with the following criteria:

- Recommendations of Australian Standards
- Requests by hospital user groups and
- Designer's office design practice.

This document is primarily targeted at those areas where opportunities exist for cost efficiency improvements.

3.2.05. OBJECTIVES

The primary objectives of the design guidelines for electrical services are to:

- Focus on areas where cost efficiency in design could yield construction cost savings;
- Provide better defined design parameters and future provision requirements in the selected areas for designers to achieve industry-wide cost efficiency, and energy savings;
- Provide a catalyst for further improvements and individual design innovation;
- Ensure important electrical services design issues which have significant impact on the building design are properly addressed with appropriate solutions adopted at the early scheme design stage of the project development; and
- Ensure cost reduction measures do not reduce the level of required servicing and safety standards.

3.2.10. APPLICATION

This document will be used for the design of electrical services for all Health Care buildings.

The following selected, cost-significant items of electrical services have the greatest potential for capital and recurrent cost savings:

- Mains supply provision;
- Mains and sub-mains;
- Power distribution equipment;
- Emergency supply provision;
- Interior lighting provisions; and
- Protected wiring systems in patient treatment areas.

Main Electrical Supply Requirement

3.3.00. GENERAL

The mains electricity supply capacity is normally assessed jointly by the designer and the supply authority based on the calculated value of the maximum demand of the new electrical installation, adjusted (normally) downwards to an assessed value comparable to the recorded values of similar installations.

The method of determining maximum demand on the electrical installation and therefore on the consumers' mains is prescribed in AS/NZS 3000

Assessment of maximum demand using AS/NZS 3000 may be conservative and therefore may result in a gross over-design of supply systems.

However, the opportunity for over-design and therefore ineffective provisions lies in the following areas:

- Assessment of spare capacity for future requirements, and
- Provision of dual supplies which does not maintain true supply integrity because of non-automatic changeover operations and/or lack of full capacity on the standby feeder.

This document addresses these areas.

Electrical Supply Demand

3.4.00 PRESENT REQUIREMENT

The assessment of electricity supply demand for the purpose of determining the capacity of the substation or supply service shall be carried out in accordance with the following procedures:

- Calculate maximum demand of the various load groups of the new electrical installation in accordance with AS/NZS 3000 or other relevant demand assessment basis.
- Forward the calculated maximum demand together with the following information to the Supply Authority for a joint assessment of the demand requirement.
- When initially communicating with the Supply Authority, known and established w/m2 figures instead of SAA calculations should be used as the number of socket outlets and 3 phase outlets (which we regard as largely irrelevant to the maximum demand calculation) are not usually known when initially talking to the Supply Authority.
- The gross area of the new or refurbished building,
- The supply demand of the existing electricity installation proposed to be de-commissioned as part of the refurbishment project.
- The number of GPOs and three-phase outlets allowed for in the calculations and their likely usage rate (loading diversity factor).
- The number of standby equipment/motors and their loading requirements. Note: Supply demands of these standby motors are to be excluded from the demand calculations. Details of loadings are to be given to the Supply Authority for their information only.
- The number of lifts and their individual supply demand, and
- Actual supply demands of similar installations and their locality for fine-tuning of the demand assessment by cross-referencing.

3.4.05 PLANNED SPARE CAPACITY

Consideration shall be given to the appropriate allowance for the space / capacity (either in equipment or accommodation space) for additional requirements of future budgeted new equipment or budgeted new building development being planned for implementation in the near-term (within 5 years).

No planned spare capacity shall be provided unless the future new development is included in the budget.

When appropriate, the planned spare capacity shall be assessed based on the anticipated power requirement of the future development. However if the information is not readily available then the capacity shall be assessed based on the following per unit area allowance.

Building Categories:	VA per sq.m	kVA per sq.m.
Air-conditioned with non-electric heating	100	0.10
Air-conditioned with electric heating	120	0.12
Air-conditioned (Reverse Cycle)	110	0.11
Electric heating with no cooling	100	0.10
Non-electric heating with no cooling	60	0.06

3.4.10. CONTINGENT SPARE CAPACITY

In the absence of any known future requirements, a contingent spare capacity of not more than the following allowances shall be included:

Air-conditioned buildings: 20%
Non-air-conditioned buildings: 35%

3.4.15. TRANSFORMER AND CAPACITY

The transformer capacity shall be sized to include the assessed present requirement and the planned spare capacity or the contingent spare capacity (Refer to Electrical Supply Demand), whichever is greater. The supply authority will normally determine the size of the transformers where it owns and supplies the transformers.

As far as possible, one transformer shall be provided for the required aggregate capacity subject to maximum transformer size available from the relevant supply authority.

Provision of a spare transformer or a second transformer to improve supply availability is not required unless specifically requested and funded by the supply authority.

For medium capacity requirements (e.g. up to 750 kVA), pad-mounted outdoor kiosk-type transformers (substations) are preferred subject to supply authority availability and access requirements. Multiple pad-mounted kiosk-type substations are preferred over indoor substations where available.

Where chamber (indoor) type substations are required, they shall be in a fire-rated enclosure within the main building or in an outbuilding.

3.4.20. SUBSTATION ROOM

The substation room shall be sized to accommodate the required number of transformers and the associated switchgear to satisfy the present supply requirement.

Spare space in the substation room for additional transformers will not be required except when the aggregate (present plus spare) capacity is equal to or greater than:

- 1000 kVA for a single transformer installation, or

- 75% of the total capacity of a multiple transformer installation.

Priority planning consideration should be given to the provision of more space for substitution of the initial transformer(s) by larger size transformer(s) than for additional transformers.

3.4.25 HIGH VOLTAGE SUPPLY

It should be anticipated that even in the most reliable situations a loss of the electricity supply can occur. Given also the current trend to minimise maintenance costs on the external infrastructure, the risk of loss of supply is increased. Therefore do not rely on external energy sources only.

Where hospitals cannot function for a time with loss of the external supply, standby power generation regardless of the form of the normal power supply shall be provided.

In considering the provision of dual supplies to ensure electricity supply reliability, consider the following factors:

- Large teaching hospitals and hospitals spread over large campus areas will have multiple high voltage power supplies and preference should be given to ring main reticulation from separate power supplies where practical. Automatic transfer switched should be employed.

- Hospitals with multiple transformer installations with immediate access to ring main feeders at the site boundary should be connected to form a ring main supply connection. Such connections allow for routine maintenance of the equipment, and loss of supply on one feeder due to environmental conditions such as lightning strikes, bush fires, motor vehicle accidents and fault trip conditions. The cost benefit should be weighed in regard to automatic transfer switching versus manual switching of the ring main feeders including consideration of any standby emergency generation capacity.

- Where practical, feeders should emanate from two independent network circuits and from two different street reticulation routes.

- Ring main dual supplies should not be considered for small hospitals and generally not for single transformer sites where the supply is considered highly reliable.

- Where dual supplies to hospitals are not readily available and are subject to substantial costs, provide single HV site connections (spur connection).

- Whether automatic transfer from the duty feeder to the standby feeder is permitted by the Electricity Distributor.

- Whether the street reticulation systems are prone to interruptions due to inclement weather conditions or prevailing vandal problems.

- Where spur connections to hospitals are being considered and the reliability of supplies are known to be questionable, a cost benefit study should be carried out on either moving to dual supplies or increasing the capacity of standby emergency generation.

- Where a standby supply feeder does not have full capacity available, a cost benefit study should be carried out on either utilizing the standby feeder with a standby generator or using only a standby emergency generator of increased capacity. In such cases manual switching between the HV supplies will be necessary and site switching of hospital loads will be necessary to reduce the connected load and co-ordinate the loads connected to the emergency generator.

- The total life cycle cost (i.e. initial capacity cost of the installation, authority charges and recurrent standby charges if applicable).

3.4.30. TARIFF SELECTION

Detailed analysis of the likely demand and consumption of the new electrical installation shall be carried out to determine the most cost-effective tariff.

The health building user shall carry out a further tariff study approximately 12 to 18 months post-occupancy to verify the tariff selection.

The main switchboard and the metering facilities shall be designed to enable tariff selection changes without the need to modify the switchboard busbar system.

In general, Three Part Time-Of-Day low voltage demand tariff (if available) is the most cost effective option particularly where high power consumption is envisaged during weekends and night hours from 10:00 p.m. to 7:00 a.m.

Subject to detailed analysis of the demand and consumption, Three Part Time-of-Day High Voltage Demand may be suitable provided that the extra over capital cost of the substation equipment can be off set by energy cost savings in not more than 3 years.

For installations subject to kVA demand charges, power factor correction equipment shall be provided to improve the power factor of the electrical installation to 0.98 or better to minimise the demand charge.

Standby Power

3.5.00 GENERAL

In accordance with the Building Code of Australia (BCA) requirements, the provision of emergency supply for the following services is mandatory:

- Emergency evacuation lighting,
- Fire alarm system, and
- Emergency warning and intercom system.

Provision of battery supply as emergency supply is deemed to satisfy.

In addition, the BCA. also requires that emergency supply be provided for a lift installation comprising two or more lift cars but only when standby generator supply is already available.

Apart from the above, there are no other statutory requirements for emergency supply.

The need for emergency supply for other essential services and critical care areas and the extent of its reticulation shall be evaluated for the hospital taking into account the following factors:

- The procedures which are regularly undertaken and which involve patients that are susceptible to interruption of the electrical supply,
- The frequency at which such procedures are undertaken,
- the frequency at which areas are used for their designated function,
- The availability of battery-operated or gas-operated equipment,(including lighting) to continue critical procedures or to resuscitate a patient,

Most hospitals will require an emergency power supply regardless of the nature of the normal electricity supply.

Once the need for an emergency supply is established for the hospital, the preferred supply source is a standby generating plant comprising one or more diesel-fuelled, engine-driven generator(s) with automatic start and changeover. Alternatively, where piped natural gas is available to the site, natural gas engines may be considered.

AS/NZ 3009 does not require that standby driven generators be fuelled from site stored fuel supplies where the electricity supply on the site (normal and standby) is available from dual offsite energy sources (i.e. electricity and natural gas).

Where co-generation using waste heat from natural gas fuelled engines running normal plant is a design consideration, the engine may be used in a dual operating mode to run a standby generator during loss of electricity supply to the site.

This guideline covers the extent of provision that should be included.

3.5.05 EMERGENCY SERVICES

The following services shall be provided with emergency electrical supply from a diesel generating plant in accordance with the recommendations of AS 3009 and as modified herein. Lighting or power provided with less than 100% supply may be distributed through the department in any pattern to suit Departmental needs. (See Clause 3.10.35).

Area/Facility	Lighting	Power
Angiographic Laboratory - Angio Equipment	100%	100% 100%
Blood bank refrigerators	30%	100%
Blood bank type and cross matching areas	30%	100%
Cardiac catheterisation room - Cath Lab equipment	100%	100% 100%
Computer Centre Cooling Systems	100%	100% Policy decision
Coronary Care Unit • Acute beds • Elsewhere	 100% 50%	 All GPOs per bed Note1 50% GPOs
Critical Care Areas (see DP14)	50%	100%
Diagnostic laboratories	30%	30%
Emergency department treatment rooms	100%	All GPOs per bed Note1
Food preparation (Cooking)	30%	30%
Intensive Care Unit • Beds • Elsewhere • Ventilation	 100% 50%	All GPOs per bed Note 1 50% GPOs Ventilation System
Labour and delivery suite	30%	All GPOs
Nurses station and work area	30%	NIL
Obstetrical recovery rooms	30%	All GPOs
Post-operative recovery room	50%	All GPOs
Renal units	30%	100%
Specialist neonatal	50%	100%
Surgical suite - Operating Rooms - Anaesthetic Rooms - Elsewhere - Ventilation System	 100% 100% 30%	 All GPOs All GPOs Nil Full ventilation
Inpatient Beds Isolation Rooms – Negatively Pressurised	25%	All GPOs per bed Exhaust Fans
High dependency beds	50%	All GPOs
Inpatient treatment rooms	30%	30%
Lifts	NIL	One car in each node Note 2
Smoke exhaust fans	NIL	Nil
Essential communications facilities	30%	100%
Fire alarm system	NIL	Nil
Security alarm system	NIL	Nil
Medical suction and air system	NIL	100%
Offices	30%	Nil
Toilets/bathrooms	30%	Nil
Change rooms	30%	Nil
Therapy rooms	30%	Nil
Reception/Waiting	30%	Nil
Dirty Utility	30%	Nil
Clean Utility	30%	Nil
Tutorial Room	30%	Nil
Consultation Room	30%	Nil
Engineering Workshop	30%	30%
Air Conditioning Refrigeration Plants	Nil	Nil
General Corridors	25%	Nil

Note 1:
The quantity of power outlets to be connected to the emergency supply system has negligible impact on the generator capacity requirement. However the wiring for power outlets will be simplified significantly and hence cost-reduced if all outlets are on the same system.

Note 2:
Power will be made available to bring all lift cars down to the ground level sequentially. When all cars are brought down, only one selected car will be provided will standby power.

3.5.10 SYSTEM CAPACITY

The capacity of the standby generating plant shall be sized to match the diversified demand of the connected loads using the calculation method as per AS/NZ 3000 and as modified herein. Note utilising the AS/NZ 3000 calculation methods will result in over sizing of capacity as it is too conservative:

- The loading diversity factor for mechanical ventilation equipment is to be 100%, the diversified demand of general purpose power outlets is to be 40 watts each; and

- The diversified demand of 3 phase outlets is to be the actual rating of the equipment or appliance connected to the outlet.

No spare capacity is to be added to the assessed capacity.

Unless it can be justified on the basis of clinical or supply reliability needs, the standby generating plant capacity must not exceed 30% of the total normal mains supply demand requirement.

Should the assessed generating plant capacity exceed the prescribed limit, the extent of essential services loads proposed to be connected to the emergency supply system must be reduced to suit.

The generating plant capacity may exceed the prescribed limit, where:

- In upgrading a facility to incorporate a new generator, the cost to modify a main switchboard to split the load between normal and emergency load exceeds the cost of providing 100% standby capacity, then the higher capacity plant should be incorporated
- Studies have been undertaken to compare the advantages and disadvantages between dual power supplies and higher capacity emergency supply plant and this has favoured increased generator capacities, then the higher capacity plant should be incorporated
- The normal electricity supply is known to have reliability problems and a decision has been made to increase the capacity of the emergency generator plant to improve the hospital power supply, then higher capacity plant should be incorporated.

The generating plant selection should meet the following criteria:

- Generators should be rated for continuous duty
- Load should not exceed 80% of the set's capacity
- Generators should be able to meet the lighting and general power load on start up without stalling
- Motor loads should incorporate delay start up where necessary to diversify the start up currents over time in lieu of a peak current condition to allow the set to reach satisfactory operating conditions without stalling.

3.5.15 PLANT CONFIGURATION

When the assessed generating plant capacity approaches or exceeds 750 kVA, the configuration of the generating plant will depend on the load diversity, such that large generating plant is not required to provide supply to small hospital loads.

Plant configuration should be assessed on capital and recurrent east considerations as well as diversity of range of output. Generally, one generating set is preferred.

Where load diversity, set size or other justifiable considerations determine the need for multiple generating sets, the sets shall operate in synchronous mode.

Sets should generally be of equal size, but mixed sizes are permissible, if existing plant is reused or load diversity has justification.

3.5.20 SYSTEM CONTROL REGIME

The operation of the standby generator(s) shall be automatic upon mains supply failure. Consideration should be given to the sequential connection of essential services motor loads to the standby supply system to avoid stalling of the generator engines.

3.5.25 LOAD TESTING OF GENERATORS

The power distribution system shall be designed to permit testing of the generators on load without the need for dummy loads (heat banks).

The preferred method of load testing generators subject to approval of the supply authority is to use the emergency/essential hospital load as the test load and to connect and disconnect the load by synchronising the generator(s) with the normal electricity supply.

The essential supply distribution system shall be arranged to permit the operating of mechanical services equipment on standby generator supply without disturbing the lighting and general purpose power circuits of the building.

The operation of the mechanical services (ventilation only) equipment may not provide adequate load.

Emergency generation plant should be regularly tested to a scheduled testing program that checks the system for maintenance or fault problems such that the system is in readiness for use in the event of an electricity supply failure.

At regular intervals, not exceeding an annual event, the electricity supply to the hospital should be turned off and the emergency generation plant tested under an actual supply failure condition to verify its readiness to satisfactorily work.

Where such events are considered unsatisfactory due to risks to patients, then emergency generation plant should be designed for synchronous operation with the mains power supply.

3.5.30 FUEL STORAGE

The diesel fuel storage capacity for the standby generating plant shall be assessed by the designer taking into consideration the following factors:

- Full load fuel consumption rate of the generating plant;
- Locality of the hospital and its proximity to a fuel supply depot *(time needed to refill tank*);
- The role of the hospital as a medical service provider in the region, and
- Average fuel level in the tank prior to tank refill; and
- Quantity of fuel stored in the tank and its turnover time (diesel fuel stored for long periods of time 'goes off').

Generally, a fuel storage capacity based on 12 hours of full load operation will be sufficient. Larger storage capacity may be provided based on justifiable clinical needs or local factors as noted above.

3.5.35 EARTHQUAKE PROTECTION

The design and installation of the diesel generating plant including any remote engine cooling plant shall comply with the seismic constraint requirements in accordance with the AS 1170.4 - Earthquake loads.

3.5.40 CONNECTION OF MOBILE GENERATOR

For hospitals without the provision of a permanent diesel generating plant, consideration shall be given to the provision of a quick connection facility (i.e. 'socket outlet connection or busbar cable connection facility) for linking the emergency services loads to a temporary (mobile) generator set, should the need arise.

3.5.45 UNINTERRUPTIBLE POWER SUPPLY (UPS)

UPS is generally not required. However, should UPS be considered necessary for a particular computer system or medical diagnostic or treatment system, the provision for the UPS system shall be funded from the special equipment budget.

However, where a number of SOCKET OUTLETS are required to be connected to a UPS requiring a distributed wiring system, then consideration should be given to the provision of a central UPS with final sub circuit wired to the outlets.

Submains

3.6.00. GENERAL

The method of determining the maximum demand and therefore the capacity of submains is prescribed in the AS/NZS 3000 Electrical Installations. The prescribed calculation method accounts for all items of electrical equipment connected to the submain circuits together with the appropriate diversity factors for different types of loads.
This method of assessment is generally used by designers and normally yields a cost-effective result. Alternative maximum demand methods based on hospital design experience is also acceptable.

Maximum demand in a submain can also be determined by assessment or by limitation. However these methods are not practical and not normally applicable to the electrical services loadings in hospital buildings.

Notwithstanding, the opportunity for over-design and therefore ineffective provisions lies in the following areas:

- Assessment of spare capacity for future requirements, and
- Type of conductors for different types of electrical services.

This document covers these two aspects of submain selection.

3.6.05 TYPES OF SUBMAINS

The types of submains for distribution of electricity supply from the main switchboard to light and power distribution boards and building services switchboards in various parts of a hospital building can broadly be categorised into the following groups:

Group A - Essential Services (SAA defined)
Group B - Critical Care Services (Health Department defined)
Group C - General Services (Remainder)

3.6.10 GROUP A – ESSENTIAL SERVICES

The AS/NZS 3000 Electrical Installations define essential services, some or all of which will be required in the hospital design. Submains for the essential services require special provisions to ensure integrity of supply in fire and other building emergency situations.

Examples of essential services include;

- fire hydrant booster pumps, automatic fire sprinkler pumps, fire detection and alarm system, air handling equipment for control of spread of fire and smoke;
- emergency warning and intercom system (inter-fire zone cabling);
- centralised battery supply system for emergency evacuation lighting; and
- lifts.

Submains for the above SAA defined essential equipment shall have fire and mechanical protection ratings as specified in the respective Australian Standard having jurisdiction over the system or installation.

3.6.15 GROUP B – CRITICAL CARE SERVICES

Standby lighting and power systems to AS/NZS 3009 shall be provided in critical care areas.

Submains for lighting and general purpose power outlets in critical care areas require special consideration to ensure continuous availability of power supply.
As defined by NSW Health, critical care areas are those areas where acute resuscitation procedures occur on a regular basis. These areas include:

- Resuscitation bays in the emergency department,
- Treatment bays in the emergency department in Level 5 and 6 facilities,
- Operating rooms, anaesthetic bays and recovery area,
- Day procedures rooms,
- Coronary care unit
- Intensive care unit
- Neonatal intensive care unit
- Cardiac catheterisation rooms and
- Selected areas of medical imaging unit.

Light and general purpose power outlets in critical care areas shall have dedicated submains originating from the main switchboard. The switchboard and submains shall be configured to ensure continuous availability of electrical supply by means of an essential section on the switchboard.

Two dedicated submains circuits shall be provided for each critical care area. At least one of the circuits shall be connected to the emergency generator supply where installed. Critical care submains cables are not required to be fire rated. Protection against mechanical damage shall be provided.

Emergency power shall be connected to all critical patient equipment involved in invasive subcutaneous procedures. This will allow clinical personnel time to complete or finalise an invasive procedure without risk to the patient.

3.6.20 GROUP C – GENERAL SERVICES

The remaining submains for services and equipment not listed in group A and B comprise the following:

- General light and power throughout the buildings
- Mechanical services systems
- Medical imaging system
- Computer (main frame) system and
- Hydraulic services system.

Light and power submains for non-critical care areas may either be dedicated or shared circuits via suitably protected tee-offs.

Light and power submains to be provided with emergency generator supply shall be separate from the normal supply submains. They may be either dedicated or shared circuits.

Submains for small mechanical and hydraulic services plants may either be dedicated or shared circuits via suitably fused tee-offs. Submains for major mechanical plants should be dedicated.

Submains for main frame computer system and medical imaging system shall be dedicated. They may be used for lighting and general purpose power sub circuits in the same department.

All of the above submains need not have fire and mechanical protection ratings. The least cost cable type is to be selected.

3.6.25 ASSESSMENT OF SUBMAIN CAPACITIES

The submain capacities shall be assessed in accordance with the permitted methods as prescribed by AS/NZS 3000 Electrical Installations.

Submains for mechanical service, fire services and lifts shall be sized to match the rated duties of the equipment. No spare capacity is required to be allowed for these submains.

Submains for lighting and general purpose power circuits shall be assessed by calculation method using the permitted diversity factors in accordance with AS/NZS 3000 Electrical Installations (Note).

In addition to the assessed capacity for the present requirement, normal (mains) supply submains for light and power circuits shall include spare capacities not exceeding the following percentages:

Circuit Designation	Dedicated Circuit	Shared Circuit
Pathology Light and Power	50%	25%
Kitchen Power	30%	15%
Imaging Light and Power	50%	25%
Inpatient Wards	30%	15%
Administration	30%	15%
I.C.U.	30%	-
C.C.U.	30%	-
Operating Suite	30%	-
Other areas	15%	10%

Note:
The permitted diversified loading for power outlets are 1000 watt for first outlet and 100 watt for each additional outlet. In many areas of the hospital, high concentrations of power outlets are provided for clinical reasons. The loading requirement for outlets would average to much less than 100 watt each. According to the present assessment criterion, the capacity of submains would be higher than needed.

This is one area of the statutory regulations that should be challenged and modifications be sought by NSW Health.

3.6.30 SWITHCHBOARDS

Switchboards (main and main and distribution boards) shall be provided for the submains as described above.

For light and power submains at least one distribution board shall be provided for each fire compartment to minimise the number of small penetrations through the fire wall.

Distribution boards shall be fitted with circuit breakers and RCDs where required for all final subcircuits to be fed from them. In addition to the present circuit requirement, distribution boards shall be sized to allow space for connection of future circuits as follows:

- Normal supply distribution boards – 30%
- Emergency supply distribution boards – 30%

3.6.35 EARTHQUAKE PROTECTION FOR SWITCHBOARDS

The main electrical switchboard and distribution switchboards design and installation shall comply with AS 1170.4 – Earthquake loads, for seismic constraint requirements.

Lighting

3.7.00. GENERAL

Design of interior lighting for hospital buildings is generally carried out based primarily on the recommendations of the following Australian Standards with AS/NZS 1680 as the principal reference document.

AS/NZS 1680.1 – General principles and recommendations
AS/NZS 1680.2.5 – Hospital and medical tasks

The recommendations contained in these standards are not mandatory. However they are generally accepted as codes of good practice. In particular AS/NZS 1680 is being referenced in draft Occupational Health and Safety Regulations for Safe Work Places.

AS/NZS 1680.2.5 provides the recommended illuminance (lighting levels) for specific tasks and interiors.

The recommended values contained therein are generally slightly less than those expressed in the previous standard. However the new values assume that designers will make due allowance for light losses in service during the period in-between lamp replacements.

This document focuses on the following areas where cost efficiency could be achieved:

- Identify areas where the recommended illuminance could be further reduced
- Design parameters for illumination calculations and use of energy efficient light source.

Maintenance Illuminance

3.8.00 GENERAL

The recommended maintenance illuminance for a range of tasks contained in AS/NZS 1680 are as follows:

CLASS OF TASK	**RECOMMENDED MAINTENANCE ILLUMINANCE Lux**
Movement in orientation	40
Rough intermittent	80
Simple task	160
Ordinary or moderately easy task	240
Moderately difficult task	400
Difficult task	600
Very difficult task	800
Extremely difficult	1200
Exceptionally difficult	1600

The normal ranges of visual tasks in work places fall between simple to very difficult requiring illuminance between 160 lux to 800 lux.

Workplaces within a hospital building generally would involve visual tasks from simple to moderately difficult requiring illuminance between 160 lux to 400 lux.

Notwithstanding the general requirements, in selected clinical areas supplementary examination lights are deployed to satisfy clinical needs.

In addition, the general (ambient) illuminance in operating rooms is required to be sufficiently high as to reduce the contrast between the high intensity light source from the surgical lights and the ambient illuminance. This document recommends 800 lux instead of 1200 lux as

recommended by AS 2502 – The Lighting of Operating Rooms.(superseded)

Examples of related activities within a hospital building for the various classes of visual tasks are summarised as follows:

3.8.05 VISUAL TASKS AND RELATED ACTIVITIES

(a) Movement and Orientation (40 lux)
- corridors and walkways
- stairwells

(b) Rough Intermittent (80 lux)
- staff change rooms and locker rooms
- storage of bulky materials
- loading bays

I Simple Task (160 lux)
- waiting rooms
- occasional reading for short periods
- staff rest rooms
- staff cafeteria
- clean and dirty utility rooms

(d) Ordinary and Moderately Easy Task (240 lux)
- moderately easy visual tasks with high contrasts or large detail
- food preparation
- reception counters
- consulting rooms (with examination lights)
- staff stations
- seminar rooms

(e) Moderately Difficult Task (400 lux)
- moderately difficult with small detail or with low contrast
- clinical procedure rooms
- routine office work
- laboratory testing work

(f) Difficult Task (600 lux)
- visual tasks with very small detail or with very low contrast
- drawing offices
- proof reading
- fine machine work
- fine painting and finishing

Most of the work-related activities within a hospital would fall in between simple and moderately difficult tasks.

For areas where regular clinical procedures or routine office works are carried out the recommended illuminance is 400 lux.

For areas where non-routine office work is carried out and where visual tasks with medium contrast or medium detail are involved, the recommended illuminance is 300 lux. These areas would include offices for clinical staff and managers.

The remaining work areas should have illuminance between 160 to 240, appropriate to the class of pre-dominant visual tasks being carried out in the area.

Design Parameters

3.9.00 GENERAL

The illuminance recommended in the AS/NZS 1680 and as above are not design values. For

design purposes, it will be necessary to select an initial illuminance and to allow for light loss factor as outlined in the standard. The design factors to be used are as required by AS/NZS 1680.

3.9.05 COLOUR RENDERING

The colour rendering properties of a light source are dependent upon its special energy distribution. The desired colour appearance of an illuminated object will only be obtained if the light source contains all necessary special components in suitable proportion.

Colour rendering index of a light source is a measure of the degree to which the perceived colours of objects illuminated by the source conform to those of the same objects illuminated by a reference light source. The index is expressed on a scale of up to 100.

The higher the index number, the better the colour matching properties the light source possesses.

Australian Standard AS/NZS 1680.2.5 deals with 'Light Service Colour' i.e. dealing with visual task requiring discrimination of colours. The standard gives three examples:

- Examination of patient's skin condition to detect conditions such as cyanosis and jaundice
- General examination for dermatological conditions
- Colour based diagnostic tests.

For cyanosis observation, special lamps meeting AS/NZS 1680.2.5 are required. The standard suggests that medical staff decide upon those areas where provision should be made for the usual detection of cyanosis. Hospital designers are to seek advice from health care teams as to what areas are to be designed for cyanosis detection.

For the other areas and usual tasks, the standard recommends a colour measuring index of at least 85 with continuos spectral energy distribution.

This document recommends where colour rendering of light sources is required and the type of fluorescent lamps is to be used.

3.9.10 LOCATIONS WHERE SPECIAL COLOUR RENDERING IS REQUIRED

As recommended by AS/NZS 1680.2.5, the following are examples of areas in which the requirement for special colour rendering apply.

- Intensive care Units
- Observation Units
- Anaesthetic Rooms
- Operating Rooms
- Recovery Units
- Resuscitation areas
- Pathology departments
- Patient investigative imaging areas
- Emergency Department Treatment Rooms
- Birthing and Obstetric Rooms
- General and Paediatric Inpatient Units
- Corridors and lifts used for the transfer of patients between the operating rooms, emergency department and inpatient units.

The requirements also apply to areas such as pathology laboratories where observations of biological solutions and pathological specimens take place.

This document recommends that all patient remedial or diagnostic treatment and accommodation areas are to be illuminated with good quality light source having a high colour rendering index.

Standard high efficiency fluorescent lamps with a rendering index between 60 and 80 are to be used in offices and industrial type functional areas within the hospital.

Notwithstanding, the same special colour rendering lamps for the patient areas could be extended to the remaining areas if demonstrated to be more cost effective over the life cycle of the building.

3.9.15 ACCEPTABLE LIGHT SOURCE

Australian Standard AS/NZS 1680.2. 5 sets out specific design parameters for lamps required to usually detect cyanosis. Only lamps meeting these criteria are to be used in areas nominated by the medical staff.

In accordance with the requirements of AS 1765 (superseded), the colour temperature and colour rendering of the light source shall lie within those recommended limits.

For other areas requiring usual identification of medical conditions, lamps shall have a colour rendering index of at least 85. The standard also recommends a substantial continuous spectral energy distribution.

With respect to the few fluorescent tubes which comply with both the colour temperature and colour rendering requirements, the light output of these lamps is significantly lower than the standard tubes (approximately 66% of the normal output). Therefore, to achieve the same required illuminance, significantly more luminaries are required. Because of the high lamp replacement cost, these special lamps also impact on recurrent costs.

To avoid the high capital and recurrent costs of complying with the Standard's Colour Temperature and Colour Rendering requirement, NSW Health has adopted the fluorescent tube TLD 84 (or equivalent) as their standard. The characteristics of this type of tubes are as follows:

- Colour Temperature: 4000 degrees Kelvin
- Colour Rendering: 85

The colour rendering properties of TLD 84 tubes do not quite comply with AS/NZS 1680.2.5 in their continuous spectral energy distribution.

The colour rendering properties of TLD 84 tubes do not quite comply with AS/NZS 1680.2.5 in their continuous spectral energy distribution.

Nonetheless, the performance of TLD 84 has been generally found satisfactory except for cyanosis discernment.

The TLD 84 (or equivalent) lamps are very energy efficient. Therefore lighting systems utilising this type of light source would yield good quality performance at reasonable initial capital costs.

This document recommends the use of TLD 84 (or equivalent) lamps for all patient treatment and accommodation areas where cyanosis discernment conditions are not required.

Note: New lamp types meeting AS/NZS 1680.2.5 for hospital use are in their initial stages of release. When available they are to be assessed to the TL84 lamp and if favourable be the preferred lamp.

3.9.20 NIGHT LIGHTING

Night lights shall be installed in all patient care areas and exit passages where normal lighting levels will decrease at night. Night lights shall be mounted at a low level and shall be low intensity and diffused. Night light levels shall not interfere with patients' sleep.

3.9.25 CLINICAL LIGHTING

A clinical observation light shall be provided where clinical observation is required. A patient reading light shall be mounted at each bed head. If the clinical observation light is not required to be colour-corrected, clinical observation lighting and patient reading lighting can be

incorporated into one fitting

Patient Electrical Protection Systems (Body and Cardiac Patient Areas)

3.10.00 GENERAL

Patient treatment areas where electro-medical equipment may be used for procedures classified as either body-type or cardiac-type as defined by AS/NZS 3003, shall have electrical installations installed to comply with AS/NZS 3003 'Electrical installations – patient treatment areas of hospitals and medical and dental practices'.

AS/NZS 2500 provides the guide to the safe use of electricity in patient care areas. It outlines the different protected wiring systems recommended for various types of medical procedures to be carried out in patient treatment areas.

Areas where cardiac protection systems are required are usually nominated by user groups.

3.10.05 LIST OF AREAS TO BE PROVIDED WITH BODY PROTECTED WIRING SYSTEM

All patient-occupied areas are to be provided with a minimum Body Protected Wiring System.

3.10.10 LIST OF AREAS TO BE PROVIDED WITH CARDIAC PROTECTED WIRING SYSTEM

Definition: Cardiac-Type Procedure

A patient is considered as undergoing a cardiac-type procedure when an electrical conductor is placed within the heart or is likely to come into contact with the heart and such conductor is accessible outside the patient's body. In this context an electrical conductor includes electrical wires such as cardiac pacing electrodes, intracardiac ECG electrodes, intracardiac catheters or insulated tubes filled with conducting fluids.

Department	**Location**
All Departments	Critical Care Areas as defined in 2.10 00. Only where cardiac procedures are to be undertaken.
Emergency	Resuscitation bays and critical care areas. Only where cardiac procedures are to be undertaken.
Imaging	Vascular Angiography Cardiology Angiography Screening rooms where cardiac invasive procedures are to be performed.
ICU / CCU	Beds only when cardiac invasive procedures are carried out.
Operating Suite	Operating Rooms, Anaesthetic Bays, Recovery Bays only where cardiac procedures are to be performed.

3.10.15 PROTECTION FOR BODY AND CARDIAC PROCEDURES

Body and cardiac procedures are to be carried out in areas specially wired for the procedure or where medical equipment is designed to type BF or CF to be used without the need for special wiring.

AS/NZS 3003 requires all patient areas to be wired to minimum body protected standards.

3.10.20. PROTECTIVE DEVICES

In accordance with AS/NZS 3003 , the wiring to power outlets and electrical equipment within the cardiac or body protected patient areas must be protected by either:

- Residual Current Devices (RCDS) or
- Isolation transformer and Line Isolation Monitors

RCDs (previously referred to as ELCBs) are more cost effective than the alternative transformer isolated supplies. Therefore they shall be used for all listed body and cardiac protected areas.

Transformer isolated supplies may be used in selected cardiac protected areas provided that it can be justified on the basis of clinical needs.

3.10.25. WIRING SYSTEM TO GPO CIRCUITS

AS/NZS 3000 currently require the installation of 30mA RCDs on all final sub-circuits in residential type areas of hospital buildings.

Ward Areas generally
All final sub-circuits in hospital ward areas shall be wired to body protected standards. to body protection wiring standards.
Where areas are wired to AS/NZS 3003 no 30mA 30 mA RCDs's (as per AS/NZS 3000) are required in the local electrical distribution switchboard for the BP circuits for the BP circuits, the 10mA 10 mA RCDs being installed in the protected area.

The residential area shall apply to the whole ward area and includes bed area, bathrooms, en suites, lounge, office and service areas.

Remaining Hospital Areas
The AS/NZS 3000 residential area requirement for RCDs does not apply to the remainder of the hospital. AS/NZS 3000 requires that 30mA RCDs be installed where there is considered an increased risk of electrical shock to the users.

AS/NZS 3003 requirements would generally apply to significant medical treatment areas in the remainder of the hospital i.e. operating theatres, ICU, CCU, birthing areas. RCDs should only be installed in areas where there is considered an increased risk of electrical shock.

3.10.30. PROTECTION OF WET AREAS AND TRADE AREAS

30mA RCDs should be installed where users function in a wet area or trade areas in the repair of electrical equipment. Wet areas would generally comprise laboratories where electrical and conductive fluids exists, in x-ray dark rooms, kitchen and mortuary areas.

Trade areas would generally comprise biomedical engineering, electrical and mechanical maintenance areas.

3.10.35 E6.8 ELECTRICITY SOURCE TO POWER OUTLETS IN PATIENT AREAS

Two general practices currently apply from designers in sourcing power to socket outlet circuits in patient areas - either the majority of outlets are connected to the emergency power circuit or an even mix of outlets is connected to the emergency and normal power circuits.

The rationale for the latter is a 'belt and braces'approach, i.e. if one of the circuits fails then there is a significant number of outlets available on the other circuit to enable functionality to continue whilst the failed power supply is repaired and returned to use. This approach is in consideration of a fault occurring in the supply of electricity to the patient area.

The objective of the design should be to minimise the cost in the provision of power outlets and to provide a reliable source of supply to the functional areas.

Mixed supplies to every patient bed or point of service, which is dual electricity supplies (emergency plus normal supply circuits), cannot be supported on the basis of cost as it requires duplicate circuits and RCD devices. A cost-neutral design whereby normal and emergency power circuits in body protected areas are spread over several beds may be acceptable or where the number of power points at a bed location requires two circuits (outlets exceeding 12 in numbers). In cardiac protected circuits, the circuit must be confined to the one patient location.

The Area Facility Table 3.5.05 indicates the number of socket outlets that should be connected to the emergency circuit. The mix of circuits over emergency and normal supplies affects the recommendations of this table. Generally, mixed circuits should not be provided and all socket outlets be provided from the one power circuit.

As background, emergency supply generators are being provided solely on the basis of a standby power supply in the event of a failure to the hospital's normal power supply from the supply authority. The emergency generators do not act as a backup power source to a failure of equipment within the hospital electrical distribution system. The cost and complexity to control generators for internal equipment failure is not supported in this document.

This document has set guidance that critical care areas shall generally be supplied by separate submains from the main switchboard or main distribution board for the building, thereby limiting the effect of other circuits and areas in the building from disconnecting the supply to the critical care area. Accordingly, submains to critical care areas should be conservatively designed to eliminate loss of supply from overloads or minor faults and maintenance should be regular to avoid the occurrence of faults from poorly maintained equipment and cable connections. The loss of a submain in normal service is a very rare occurrence and should not be a reason for duplication of supply to circuits in patient care areas.

The purpose of providing emergency power to outlets is to provide power in the circumstances of loss of power to the hospital site and to maximise the available outlets usable in this circumstance.

Provision of Power Points

3.11.00. INTRODUCTION

A frequent excessive cost is the number of general purpose outlets requested by the users. In many instances these requirements far exceed the normal needs of the room and are subsequently left untouched in every day use.

3.11.05. POWER POINTS

Scales of provision of socket outlets should be in accordance with the Room Data Sheets in the NSW HFGs (Health Facility Guidelines) and the end users must be required to justify each additional socket outlet with a corresponding item of equipment. This exercise should be carried out for each room.

Outlets & Switches

3.12.00. All RCD protected outlets provided under AS/NZS 3003 shall be identified and labelled in accordance with the Standard. All other outlets and switches shall be labelled in accordance with AS/NZS 3000 and colour coded to AS/NZS 3003.

Outlets in nurseries and children's wards shall be fitted with safety shutters.

Security

3.13.00. Health care facilities need to provide a safe and secure environment for staff, patients and visitors. Health facility planners and hospital staff are to identify security risk areas and environments requiring the provision of security and central access systems.

Where staff, patients or visitors within health care facilities are considered vulnerable to security risks, designers are to give consideration to the provision of a secure environment by providing satisfactory security lighting, central access to identified environments and access systems that allow identification of people seeking entry into the facility, particularly during night hours, i.e. CCTV, intercoms, electronic security doors, fixed and personnel duress alarms. In high risk areas staff motion detection may need to be provided as well as internal access control and duress systems i.e. Mental Health Facilities.

3.13.05 DESIGN REQUIREMENTS

NSW Health has a security guideline for health care facilities. Designers are to adhere to the guidelines in the design of security and access control systems.

3.14.00. COMPLIANCE

Departures from the above are to be justified on an objective basis. Security shall be agreed with user groups and others such as Hospital Watch. Changes to planning and operational policies can often minimise the need for active security systems.

Battery Back-up

3.15.00 Battery back-up is required to provide a standby power source to mains power equipment considered to provide essential, or to important services within the hospital environment should main power fail and which cannot tolerate the loss of power during the start-up period of any emergency generation plant.

Generally non-fixed equipment provided will include, or be supplied with, standby power sources such as battery back up or UPS systems.

Designers will need to provide standby power sources for fixed equipment identified or requiring standby power. Examples of equipment or systems requiring battery back up are:

- Essential Services:
  - Fire systems and EWIS (AS/NZS 3000 defined)
  - Emergency and evacuation lighting
- Operating Theatres Shadow-less Lighting Systems
- PABX Telephone Systems (usually provide as part of the PABX system)

Clocks

3.16.00 Clocks in health care facilities take two forms:

- Individual battery operated clocks or
- Master clock systems.

Master clock systems comprise slave clocks in functional areas hardwired back to the master clock. Generally these clock systems are expensive to install and are only to be used in limited areas of the hospital.

Individual battery-operated clocks are highly reliable and relatively inexpensive and are the preferred clock option.

Master/Slave clocks are only to be installed in areas where access to clocks is difficult or where time - for legal reasons - is required to be accurate over a number of similar rooms and where individual battery-operate clocks are considered unsatisfactory. Examples of such areas are operating suites and delivery rooms.