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Appendix 10 – Electrical Report

Cairns Performing Arts Centre

Concept Design Report
Electrical, ICT, Vertical Transportation and Lighting

Document Revision and Status

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Disclaimers and Caveats:

Table of Contents

1 Executive Summary

This concept design report has been prepared to highlight the Electrical services and master-planning principles associated specifically with the lighting, vertical transport and electrical building services systems to service the proposed Cairns Performing Arts Centre (CPAC).

Building services generally relate to human physiological needs, special environmental condition requirements and building functionality issues.

It is important to identify and state clearly that the overriding priority of the project is for a practical and cost-effective facility for the performing arts in cairns. All engineering systems have been developed with this as the primary goal with the following issues integral to the success of the project:

- Cost effectiveness – both in use and for construction
- Regional/ Climatic suitability – system/ equipment selection and specification
- ESD - Sustainability/ Energy
- Health and Safety
- Compliance
- Architectural Integrity

With these tenets in mind, a number of options have been assessed with the key ingredients to get right at the outset are cost, system selection and spatial requirements. The report provides this information for the following services:

- Site Diversions
- Power supply, protection and distribution
- Communications systems including NBN
- Lighting
- Electronic security
- Vertical transportation (lifts)

Control and monitoring systems will provide automatic control of systems as well as monitoring for energy analysis and the like.

The electrical services comprises of a new substation and new communications connections. Demolition and diversion of existing underground and aboveground site services are necessary. Discussions are to be commenced with Ergon and Ports north regarding High Voltage diversions and New Substation arrangement. The electrical services also comprise of modern telecommunications and security systems which are also closely coordinated with the acoustic and performance theatre design requirements.

The communication services to the new facility will be provided by a new lead-in from Telstra. Currently there are no plans to options of linking the new facility to the convention.

Lighting will support the architectural principles, relate to the openness and transparency of the building and reflect the geometry and core principles of the Architecture. Light is an integral element, tailored to suit the character of the building. Forming an integrated part of the building, light sources and lighting systems will be incorporated and concealed within the architecture.

Natural light of the foyers will inform the interior lighting which allow connection to the outside and balance the surfaces' brightness with the incoming daylight, mainly through up-lighting and lighting of vertical surfaces.

2 Introduction

The Cairns Performing Arts Centre (CPAC) will be developed in various stages which are to be further developed and confirmed by the Architect. The facility will contain:

- A 1,000+ seat auditorium and a
- A 500 seat auditorium
- Expansion of Cairns Convention Centre

This report provides the outline description of the design solutions for the lighting, electrical and vertical transportation services that will serve the new development. The report discusses the various systems that will be required in the new development and the links required to the new buildings. The report also provides brief information on the existing services affected by the project.

Due to the early stage of the design a number of issues will need to be further addressed in more detail as progress takes place in order to guarantee appropriate and responsible implementation of solutions to meet the functional and environmental expectations of the project. The intent of this report is to provide a document that will be endorsed by Cairns Regional Council to enable the design team to progress into more detailed design stages using the principles defined here as a basis.

3 Design Principles

3.1 Project Priorities

It is important to identify and state clearly that the overriding priority of the project is for a practical and cost-effective facility for the performing arts in cairns Centre of international standard. All engineering systems should be designed with this as the primary goal. Other considerations such as energy and budget, whilst extremely important must remain secondary to the project's purpose and its functional requirements. This principle has been and shall be used in all decision making processes and selection of options.

The building and engineering requirements described here aim to provide a well-engineered project which is economical to build, operate and maintain, has the requisite quality for image and function and provides a practical level of adaptability for future changes and possible expansion. In particular a number of key design objectives shall be considered:

Safety	Installations which produce suitable conditions, particularly in terms of health, containment performance and occupational use
Environmental (external)	The achievement, or betterment, of environmental policy requirements for emissions from the building, including the provision of energy and water conservation features where practical and cost effective
Cost	A value for money approach over the total life of the project. The capital cost, operational costs, maintenance and support costs are all to be considered in the design development
Co-ordination	The design and layout of engineering services and passive elements shall be carried out in a manner that co-ordinates with and complements the building and structural design and satisfies operation requirements of the space
Maintenance	The production of specifications and system layouts/designs that will include features for safety, accessibility, reliability and ease of replacement
Flexibility	Decisions regarding designs will be taken in a manner which includes the need for future adaptability/flexibility where these are highlighted and cost parameters allow. All specified electrical systems will have spare capacity in accordance with best practice principals and to cater for minor alterations to the systems in the future.
Acoustic	Treatment and considerations play an important role in the electrical design solutions.

3.2 Regional / Climatic Appropriateness

One main priority for the project is to ensure that the solutions provided are appropriate with regards to the local climate and the support (skills/ parts etc) available to maintain efficient and effective operation of the systems installed.

Whereas a number of options have been assessed and alternative/ more sophisticated solutions may be proposed, the concept design has been formulated to provide a robust, sustainable and appropriate outcome for many successful years of operation.

The concept design has taken into consideration local approaches to system selection, tried and tested

componentry (albeit in some instances this has been configured in an innovative way), local weather considerations (moisture, temperature, diurnal ranges, solar intensity/ radiation, winds and the like) as well as material behaviours (with regard to weather and atmospheric properties.

All equipment shall be readily and adequately supported in the local region. Adequate spares for important equipment shall be available in Cairns/ Australia and all equipment shall be fully supported by the equipment manufacturers and suppliers. Installations and plant room layouts shall allow for appropriate and easy access for the purpose of operations, maintenance, repair, and replacement of major components.

The building should also incorporate airlocks and vapour sealing to minimise corrosion/ energy/ condensation and internal environmental problems. It is suggested that the building also is placed under building pressurisation tests during construction to adhere to more stringent construction detailing and techniques to provide longevity in this regard.

The suggested systems are proposed as being elegant and intuitively suitable for the project.

3.3 Policies And Codes

The development shall generally be designed in accordance with Statutory Regulations, CPAC specific recommendations, the recommendations of the National Construction Code (NCC/BCA) and Fire Engineering Consultants.

The current National Construction Code and amendments shall be applied to the building services systems.

Statutory requirements shall be acknowledged for all areas via published regulations such as Noise Control Act, and Occupational Health and Safety Act. Australian Standards and Fire Brigade requirements shall be acknowledge through the NCC/BCA and Fire Engineering Consultant.

3.4 Documented Reference Material

There are numerous publications and guidance documents, which cover the environmental conditions and specific design issues for cultural facilities. It is not intended within this briefing document to regurgitate the different recommendations or scientific research results, however, relevant publications that reflect a selection of appropriate guidance for an international standard facility which the engineering services design will reference have been utilised in the Concept Design.

The design of the facility will be developed taking into consideration the relevant code requirements and standards.

3.5 Master plan Issues

The initial design of the buildings and the major supply infrastructure/ energy plant shall take into consideration system integration to initial, future expansion/ master planning issues where this is economically viable at this stage. An indicative services plan for future connection/ growth and use shall be developed in parallel with that of the site during developed design (i.e. consideration will be given to the Staging of works), this shall then be utilised to assess the impact on the major services supply infrastructure with a preference that allowances shall be made to cater for this expansion in the initial stage. It is not expected that all equipment will be provided initially, however, a plan shall be developed to allow for this expansion in a logical form.

The spare capacity for each of the relevant electrical services such as the substation, mains, switchboards and communication nodes shall be determined during the design phase.

3.6 Safety In Design

The NCC/BCA and Australian Standards are not always up to date in respect to best practises when it comes to *safety in design*. There are always illegal procedures in construction and servicing of plant and even as close as next door. These 'innovative' access solutions sometimes are a result of poor design and management decisions. They can lead to injury and death and in most cases result in unsustainable buildings as the plant is not simply unmaintainable. This applies to all services not just Mechanical thus a coordinated approach to Safety needs to be considered.

This is where engineers and designers are responsible for better safety in design. That's right a simple decision we make during design period can have a major affect and impact on the life of the building and the life of another human. Thus that makes us legally and ethically accountable.

Steensen Varming recommends that the Building and Building Services design review includes a Safety and Design assessment or session to address safety, maintainability and hazard mitigation. These sessions are usually chaired by the lead consultant, project manager or a specialist OHS consultant. They include all the relevant stakeholders including the client representatives who will be responsible to maintain the building and its plant.

There are a number of review tools available including the Consult Australia OHS Guide and the 'CHAIR' (Construction Hazard Assessment Implication Review) Document.

The process should address the various phases in the procurement and life of a building and its plant such as;

1. Design
2. Construction
3. Maintenance
4. Disposal

The benefits of implementing a safety in design approach in the procurement of buildings, and plant results in economic and social benefits, such as;

- improving the construction, operation and maintenance of buildings, structures or plant;
- helping to eliminate and reduce injury, death and disease;
- promoting healthier and safer workplaces, public facilities and infrastructure;
- increasing efficiency, capabilities and productivity in the workplace;
- reducing costs throughout all lifecycle phases of a building, structure or plant;
- allowing designers to better predict and manage the production and operational costs over the whole lifecycle of a building, structure or plant;
- enhancing critical thinking and innovation, in that safe design continually demands new knowledge and capabilities to be researched, understood and implemented.

A part of the Detailed Design process Steensen Varming will address the requirements of Safety in Design as one of the primary considerations in system selection and design. Internal QA guidelines and watch points will be followed to ensure that all system selections adhere to the highest requirements of Safety in Design.

Some of the items that will be addressed during detailed design will include;

- Adequate space be provided for servicing of equipment and parts in plantrooms and the general areas.
- Equipment shall be installed to ensure adequate serviceability without the need for unsafe work practices. Reference should be made to:
    - Manufacturer's installation instructions
    - Workcover requirements

- Australian Standards

In particular all moving and/or dangerous and/or hazardous parts of machinery are to be guarded, fenced or enclosed to the complete satisfaction of the Department of Industrial Relations and the Superintendent as part of this contract.

Areas that require special consideration by others with regard to Safety in Design include;

- Dangerous Goods
- Risk Assessments

4 Electrical

4.1 General

The following provides an overview of the proposed systems and electrical services. These will need to be carefully coordinated with the theatre consultant requirements during the next stage of design. The following provides an overview of the proposed systems and electrical services.

4.2 Design Principles

A number of essential design objectives have been set down by Steensen Varming to ensure the success of the Cairns Performing Arts Centre (CPAC) project from an electrical point of view:

- safety and reliability
- properly designed and appropriately sized to allow the full and proper functioning of all equipment, plant and fittings
- facilitates the operational requirements of the specific equipment, materials, processes and functions in the building
- arranged and routed in an organised and systematic manner and be accessible for operations and maintenance
- provided with necessary flexibility and versatility to allow isolation, shutdown and removal of equipment and systems as required for maintenance and extension
- compatibility with other services and systems in the facility
- labelled and colour coded for ease of identification and operation, to suit semi-skilled operation
- designed and installed to all relevant legislation, standards, codes and guidance that are appropriate and relevant to the type of electrical installation or equipment
- Acoustic Considerations
  Noise generated by electrical equipment and services can be of concern as they contain pure tones, to which the ears are very sensitive. Small control gear transformers, relays and ballasts can also generate noise that is annoying to performers and the audience members. These sounds may also be dedicated by sensitive recording equipment.

  While electronic gear appears to be less of a concern the final selection and design of systems needs to consider the acoustic requirements. The electric noise and the structural integrity of the fixtures are also important to avoid vibration.

  Openings within walls affect the integrity of acoustic ratings and thus outlets and cable penetrations must be carefully considered.

4.3 Codes & Standards

All works must be in accordance with this specification and the current Australian Standards and standards detailed within.

Electrical:

SAA Wiring Rule AS/NZS 3000:2007

Selection of Cables AS/NZS 3008:2009

AS/NZS1367:2007 : Coaxial cable and optical fibre systems for the RF distribution of analog and digital television and sound signals in single and multiple dwelling installations

Australian Communications Media Authority (ACMA) Installation Requirement for Customer Wiring AS3080, AS3084, AS/NZS 3085, AS/NZS 3087

AS/ACIF S008 and AS/ACIF S009

Sound Systems and Intercom Systems for Emergency Purposes AS1670.4: 2004

Emergency and Exit Lighting AS/NZS2293.1-2005

MEPS AS/NZS 4783.2 and AS/NZS 4782.2

4.4 Site Diversions

The new facility is proposed to be developed on the existing Ports North Administration Site. The presence of existing unknown In-ground Services in this site during Construction can have a significant impact on the development of Cairns Performance Arts Complex. Although preliminary investigations via DBYG have identified several underground services on the existing site, any other unknown services and latent conditions can affect the budget, program and also affect the functional operations of the surrounding facilities.

Ergon has a 22kV supply to this property which is the metering point for other Ports North assets. This Ports North office site supplies power to other Ports North Head Office property along the waterfront area.

As part of early works these Ergon assets will have to be relocated / diverted to clear the site for new development. The attached section in Appendix-B highlights the existing Ergon and Ports assets that require relocation/removal.

Detailed discussions should commence at the earliest with Ports North and Ergon do determine the diversions requirements.

4.5 Power Supply

The calculated energy power maximum demand of an electrical installation shall be determined, taking account of the capacity, physical distribution and intended use of electrical equipment in the installation.

The Maximum Demand is the largest current that the will exist in the electrical infrastructure at any one time. The maximum demand figures shall be calculated for each individual section of infrastructure. The calculations shall be completed in accordance with AS/NZS3000 Table C2. The initial figures shall be based on After Diversity Maximum Demand (ADMD) and then by detailed calculations once all the loads have been confirmed.

The maximum demand or the electrical supply capacity for the building shall be 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 ADMD comparison at the early stage will be based on VA/m^2 rate on similar buildings with similar construction, services and use. The spare capacity requirements will be added to the figure

Based on the briefed areas and required back of house areas the preliminary Planning Maximum Demand assessed load is in the order of 1.64 MVA total. These are based on individual VA/m2 for each type of space with the facility. The VA/m2 also includes load for Mechanical, Hydraulic and fire services. In the final sizing of the

substation and supply in the next design stage, consideration shall be given to redundancy and spare capacity. The maximum demand calculation based on VA/m2 is attached as appendix to this report.

The Maximum Demand is the largest current that the will exist in the electrical infrastructure at any one time. The above maximum demand is calculated based on VA/m^2, maximum demand figures shall be calculated for each individual section of infrastructure. The calculations shall be completed in accordance with AS/NZS3000 Table C2. The initial figures shall be based on After Diversity Maximum Demand (ADMD) and then by detailed calculations once all the loads have been confirmed.

4.6 Substation

The power supply to site will be provided by having a chamber substation on site .The preferred method would be for the facility to be a low voltage customer fed from Ergon Energy Network. The main advantage of being a low voltage customer is the savings in costs associated with the maintenance and responsibility compared to being a high voltage customer.

Based on the maximum demand of 1.54 MVA the following are main points related to the susbtation

1. Facility shall have an indoor substation with 2 x 1000 KVA transformer to be installed on the proposed site. The exact location of the substation is to be determined in the next design stage and shall comply with Ergon Energy's Indoor Distribution Substation Design Standards. The substation shall have access for heavy equipment and personal.
2. An external cable pit shall be provided for Ergon HV cable entry. The pit shall be designed with acceptable bending radii and stress load bearing capacity.
3. A 3m wide cable shared cable easement shall be provided for the HV and LV cables. 3 x 125mm HV and 2 x 80 mm LV conduits shall be provided in the easement.LV conduits to be installed near the property side.
4. The arrangement of the transformers shall be as indicated in the figure with HV switchgear on the southern wall and LV switchgear on the northern wall.

The general layout of an Ergon Indoor substation with 2 x 1000 KVA transformers is provided in the Appendix. Detailed co-ordination and formal approval would be required on the size, location and layout of the substation arrangement.

4.7 Generator

The facility will not be provided with a standby generator system. Provision will be made in the main switchboard to facilitate connection of mobile generator system.

4.8 Uninterruptible Power Supplies

An uninterruptable power supply unit will be provided. The UPS will be located in a dedicated UPS room in the facility.

Uninterruptible power supplies will be provided with 10 minutes battery autonomy and be adequately sized to accommodate the electrical capacity of the following:

- Computer Servers
- Electronic security system head end equipment.
- BMCS

The electrical reticulation associated with each UPS will be designed and installed to incorporate an external

maintenance bypass to allow removal of the UPS (for maintenance if required) without compromising the integrity of the power supply to the items of equipment listed above.

The Emergency lighting will have separate integrated battery systems and will not be connected to the UPS system.

All UPSs will be sized to suit the load requirements of the equipment to be served and be equal to American Power Conversions type or similar and incorporate surge protection on both the line and load side of each UPS.

Uninterruptible power systems
AS 62040.1.1-2003 - Uninterruptible power systems (UPS) - - General and safety requirements for UPS used in operator access areas
AS 62040.1.2-2003 - Uninterruptible power systems (UPS) - - General and safety requirements for UPS used in restricted access locations
AS 62040.2-2008 - Uninterruptible power systems (UPS) - Electromagnetic compatibility (EMC) requirements

4.9 Earthing

The earthing system shall be an MEN earthing system for this installation as detailed in AS/NZS 3000.

4.10 Technical Earth / Clean Earth

A clean earth system will be provided according to Theatre Design requirements for specialised equipment: The details and arrangement of clean earth systems shall be considered further during the design development stage of the project.

Dedicated power supplies shall be provided for audio equipment and be wired from separate switchboard to those supplying other building services.

4.11 ESD

The ESD initiatives for Electrical services shall be as per relevant ESD report.

4.12 Lightning Protection

A lightning protection risk assessment will be undertaken in accordance with AS 1768 2007. Based on the assessment, the new building will be provided with a dedicated lightning protection system as required.

A system incorporating traditional and/or a type Early Streamer Emission (ESE) system shall be provided in accordance with AS1768 (2007) and industry standards.

Lightning protection shall also consist of surge protection on the telecommunications systems, main switchboard and distribution boards which shall be provided throughout the installation in accordance with the relevant Australian Standards.

4.13 Main Switchboard

A new main switchboard will be provided in the main switchroom to be located in accordance with the Spatial Planning requirements provided in the appendix.

The main switchroom is sized to accommodate the main switchboard, distribution required metering, power factor correction equipment, distribution boards, records and framed/laminated single line diagrams and drawings of the installation.

The location of the switchboard switch board has taken the following into consideration.

- Electromagnetic Interference on adjacent environment
- Access for maintenance and emergency personnel
- Large or double doors for maintenance equipment access
- Passive fire protection to code and a limit on wet fire sprinklers
- Above recorded flood zones and away from hazardous areas

The main switchboard consists of all the instruments, bus-bars, cable zones, circuit protection devices and labelling. All of which, shall be of an appropriate type, size and configured to accommodate the code requirements together with the functional and maintenance criteria.

The configuration of the Main Switchboard shall be determined by the following;

- Prospective short-circuit current at switchboard (based on substation rating from Supply Authority)
- Maximum demand and load characteristics
- Specific load requirements and dedicated supplies
- Metering and possible BMS remote control and monitoring
- Redundancy and spare capacity
- Required standby power connection
- Maintenance and emergency services isolation
- A balance of the insulation protection versus the temperature rise
- Other factors such as cable sizes, fault-loop impedance and ability of protective devices to electrically discriminate with each other.

The main switchboard shall be custom made. The preference is an industry standard custom made main switchboard of Form 3B.

The maintenance of switchboards requires due consideration. Typically the board should be designed to limit the ability of a person to work “live”. This includes the installation of isolators for relevant sections of the board thus reducing the need to isolate the complete board to carry out regular maintenance or modifications. This also helps to reduce the number of main switches which can assist emergency personnel in quickly isolating the relevant sections of the switchboard. The provision of a main isolator for the complete supply behind tooled covers shall also be considered to limit the future Supply Authority costs in switching power on and off as required.

There is need for specialist maintenance personnel to carry out work on a live switchboard such as completing thermo graphic scans. To address this issue the switchboard will be complete with rotary switch handles for all outgoing supplies however the interlocks shall be ‘defeat able’ by a special means and have Perspex covers.

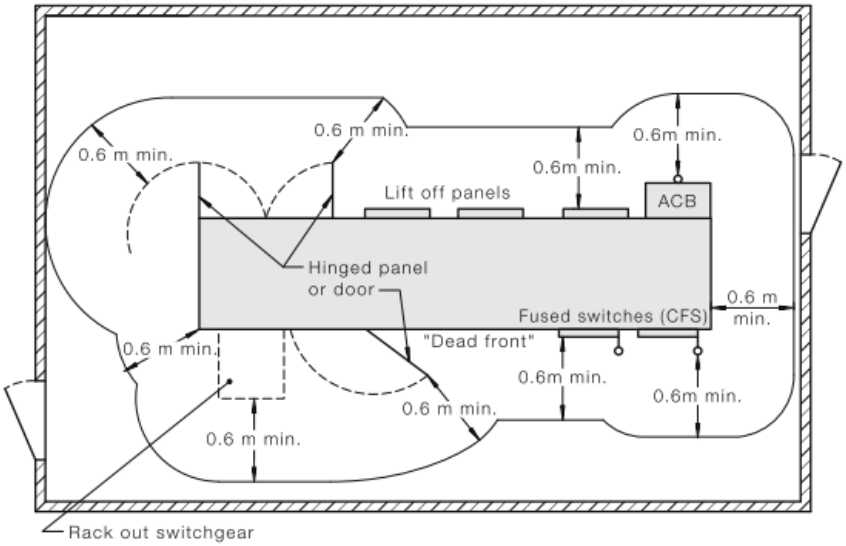


FIGURE 2.15 ACCESS TO SWITCHBOARDS—FREESTANDING SWITCHBOARD WITH RACK-OUT SWITCHGEAR

Image Source AS3000.

4.14 Distribution Boards

The design criteria for the Distribution Boards (DBs) shall generally be as detailed for the main switchboard. They shall supply all outlets and lighting for their respective levels. Distribution boards shall be provided to allow the separation of Lighting and Power supplies.

Distribution boards shall be provided in each level inside electrical cupboards.

These distribution boards will be installed to form part of the vertically aligned electrical riser which serves all floors of the building.

The DB cupboards shall be complete with reduced sized ‘as built’ laminated electrical plans and lighting plans indicating circuiting and switching arrangements. This will assist in the maintenance and operation of the facility and is additional to the required standard electrical DB typed circuit schedules.

It is proposed that the Distribution Boards shall be proprietary type Form 2 construction

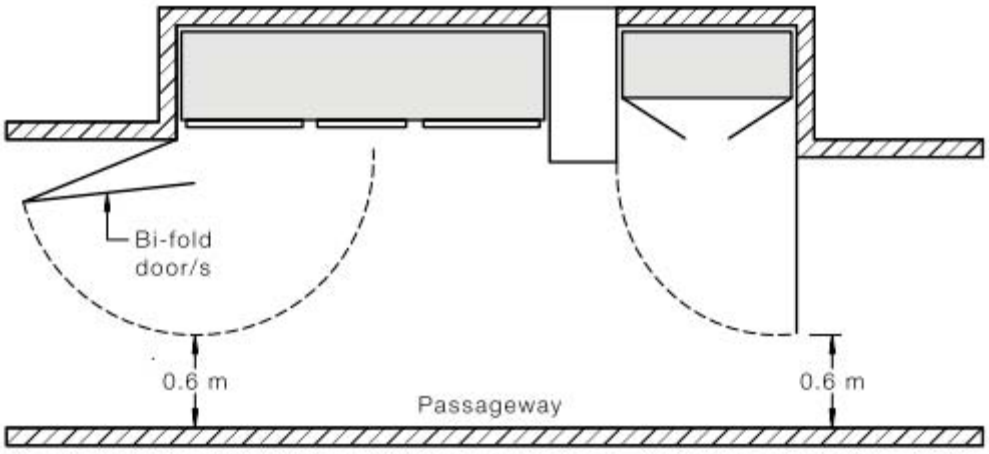


FIGURE 2.18 ACCESS TO SWITCHBOARDS—
SWITCHBOARDS WITH DOORS THAT OPEN INTO
ACCESSWAYS OR NARROW PASSAGEWAYS

Typical Electrical Switchboard Cupboard.

4.15 Metering

The main switchboard and the metering facilities shall be arranged to enable tariff selection changes without the need to modify the switchboard busbar system. The metering shall also be arranged to allow for authority meters for individual installations downstream of the main switchboard for possible cafe or restaurant.

Ergon meters shall be located in accordance with Local Supply Authority requirements. It is proposed that authority meters be located within the main switch room and these meters be digital with remote read facility.

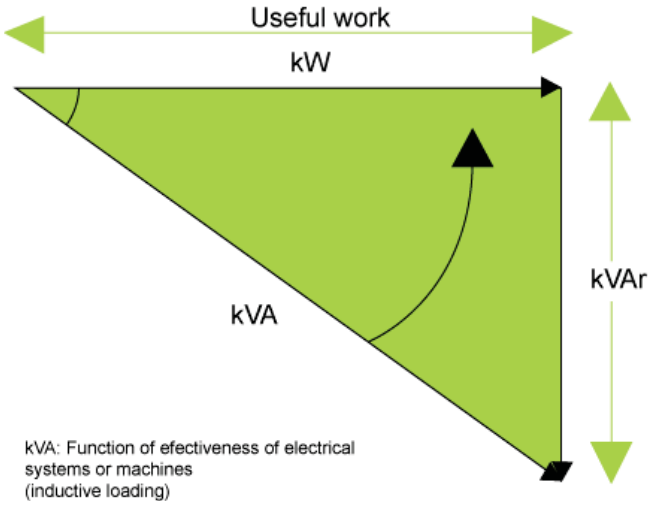
Private metering consisting power monitors shall be positioned on the main supplies and on selected loads in

compliance with current NCC/BCA standards. This will include separate metering of lighting & power and metering of major plant items. The microprocessor based 3 phase power monitors that shall communicate with BMCS / metering system and shall display and transmit selected data such as:

- voltage
- current (each phase)
- frequency
- kilowatts
- kVA maximum demand (15 min. cycle)
- kilowatt hours
- kVA
- power factor
- THD including the details on the neutral conductor

4.16 Power Factor Correction

The new main switchboard shall be provided with its own power factor correction unit to correct power factor to 0.98 and in accordance with Electrical Utilities.



4.17 Electromagnetic Compatibility & EMI / EMF

A lot of electrical equipment relies on receiving and transmitting of electromagnetic radiation (EMR). Electromagnetic Compatibility (EMC) is the ability of the electronic equipment to co-exist with its electromagnetic environment. All electrical equipment shall be Electro-Magnetic Compatible. The equipment shall not cause interference to other equipment and shall comply with the limits set in the relevant AS/NZS 61000 series of standards

The building services installation shall be designed to minimise the impact of EMI in accordance with the recommendations and guidelines of the following:

- Ergon Energy
- Guidelines for the Management of 50Hz Magnetic Fields in Office Buildings Owned and Managed by

the Queensland Department of Public Works

- ENA Guidance on Electrical Installation Practices to Reduce EMF from Low Voltage Wiring.

To reduce the likelihood of stray fields from cable installations, they shall be laid in trefoil configuration.

The position of large power nodes shall be located away from sensitive equipment and personnel workspaces.

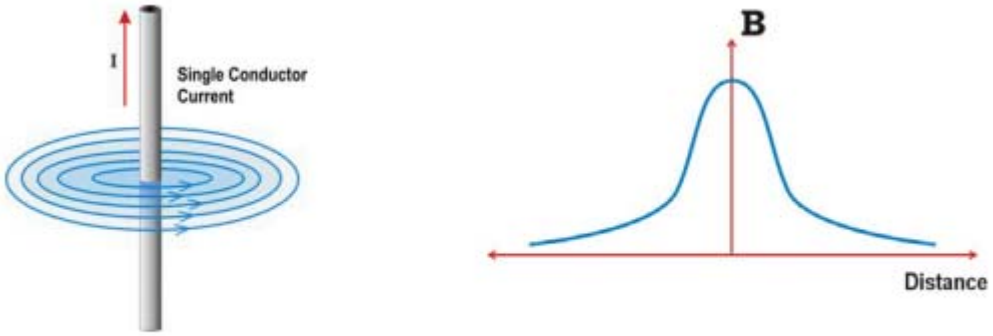


Figure 1. Reduction of magnetic field strength, B, with distance from conductor source

Images Source: Energy Networks Association

4.18 Submains and Reticulation

Cabling and reticulation consists of submains, cable trays, conduits, and ducting systems and shall be designed in accordance with AS/NZS 3008.1. All electrical cabling and reticulation shall be integrated into the architectural design of the building.

All new submain cabling shall generally be reticulated from the main switchboard on dedicated cable trays/cable risers and shall be accessible. Where submain cabling reticulates in ceiling spaces, they shall be reticulated along corridors as much as possible so as to minimise electromagnetic interference to adjacent working spaces.

Submains shall be provided to all required power supplies. Some loads will require dedicated supplies due to the type of load and its size. All cabling shall be designed and installed to allow for derating in accordance with AS3008.1.All loads connected to essential distribution boards will utilise fire rated cabling.

Submains may be reticulated on exposed cable tray within plant room spaces and within services risers. It is proposed that cable trays are sized to incorporate spare space and submains are sized to incorporate spare capacity for future expansion.

It is proposed that sub circuit cabling shall also be reticulated within accessible ceiling space, wall mounted skirting duct, or within dry walls to access socket outlet locations. It is proposed that sub circuits be loaded to provide spare capacity for future expansion.

All cabling conductors shall be multi strand copper and cable trays and supports shall be of appropriate

material to withstand long term use and comply with relevant standards.

4.19 Power for Theatre Equipment and Lighting

Dedicated submain supplies shall be provided at the stage and technical positions to accommodate the power loads for lighting and stage equipment. These Stage lighting and power systems will be designed to have sufficient capacity to meet the demands of major theatrical productions.

4.20 Theatre Performance Cabling

The outlets and equipment for the theatre performance systems form part of the theatre trade works. However, the cabling (to Theatre Consultant Specification) between the equipment and outlets shall form part of the electrical trade.

The specialist theatre services shall be provided with power supplies at the relevant locations. The electrical services trade will provide the following:

1. Outlets where required to supply the theatre services including rigging hoists, dimmers and light bars
2. All cabling required by the theatre design
3. Containment and reticulation for all cables required by the theatre design.

Dimmers patch panels and hoists shall be documented by the theatre consultant. Final termination of all theatre cabling shall be done by the theatre contractor.

4.21 Performance Lighting

While the stage lighting and performance dimmer systems and controls are part of the theatre trade, the outlets and cabling shall be provided for the performance Lighting systems shall be by the electrical trade. Cabling between the equipment and outlets do form part of the electrical scope.

4.22 Accessories

Accessories include the power outlets, switch plates, and floor boxes/ducting. The number of accessories will be as per the future room data sheets.

Power socket outlets shall be provided throughout the building to satisfy the functional requirements of the building and for cleaning purposes. Final arrangement of the power socket outlets shall be determined during the design development stage of the project. Consideration will be given to the use of soft-wiring within the office area or traditional fixed wired point.

Flexibility shall be provided in the outlet arrangement. Any rooms that are required to have all outlets on the standby supply or vice versa, all outlets on non-essential supply, outlets of the other type shall be provided so that if maintenance is carried out on one power system, some power still remains usable in these spaces.

Outlets for the wet areas shall have adequate IP protection in accordance with AS/NZS3000. RCD safety device protection shall be provided on all final sub-circuits. Outlets within any hazardous zones shall comply with the relevant Australian Standards.

Light switches shall be mounted at height of 1100mm AFFL. Generally, power outlets and communications points shall be 600mm AFFL and in some cases above bench / desk height to facilitate easy access to portable laptops and notebooks. The final location and arrangement of accessories will require close coordination with the architecture.

Typical Recessed Floor Box.

4.23 AUDIO VISUAL – Miscellaneous Systems

For areas other than the performance spaces, such as meeting rooms the Audio Visual services forms part the electrical trade works.

Each ceiling projector shall be provided with interconnected ceiling mounted and wall mounted or desk mounted outlets.

The Audio Visual Services shall be in accordance with the following standards and guidelines;

- AS/NZS 60065:2003/Amdt 1:2008 Audio, video and similar electronic apparatus - Safety requirements (IEC 60065:2001, MOD)
- AS/NZS 14496.series Information technology - Coding of audio-visual objects
- BSRIA Power Quality Guide AG2/2000
- Guide for Audiovisual Systems Design and Coordination Processes. American National Standards Institute (ANSI) ANSI/INFOCOMM 2M-2010
- AS/NZS 2107:2000 Acoustics – Recommended design sound levels and reverberation times for building interiors;
- AS 2533-2002 Acoustics - Preferred frequencies and band centre frequencies
- AS/NZS ISO 717.1:2004 Acoustics – Rating of sound insulation in buildings and of building elements. Part 1: Airborne sound insulation
- TEFMA Tertiary Education Facilities Management Association
- AETM (Association of Educational Technology Managers) papers
- Digital Video and Audio Broadcasting Technology – A Practical Engineering Guide W Fischer.
- AS/NZS1367:2007 :Coaxial cable and optical fibre systems for the RF distribution of analog and digital television and sound signals in single and multiple dwelling installations
- Australian Communications Media Authority (ACMA) Installation Requirement for Customer Wiring AS3080, AS3084, AS/NZS 3085, AS/NZS 3087
- AS/ACIF S008 and AS/ACIF S009
- National Construction Code (NCC/BCA)

4.23.1 Public Address System to Foyer and Non Performance Spaces

The Public address system with zone selection facility will be provided at designated locations within the building. The system will include the following functions and features:

- Zoned ceiling mounted PA speakers
- Multi-channel mixer amplifier, microphone, music deck and pre-recorded announcements.
- Selector switch
- Volume controller
- Automatic anti feedback

An automatic override switch shall be provided to interface with the Building Emergency Warning Intercom System. Further details of the PA system are to be determined during the design development stage of the project.

Audio Speech Intelligibility
At all places within the relevant areas where ambient noise figures are less than 85 dB(A), the speech transmission index (STI) shall be ≥0.5. The rating of speech intelligibility shall be in accordance with the common intelligibility scale (CIS) method of AS 60849, measured in accordance with Appendix A. The average speech SPL shall not exceed 110 dB(A). Exact details to Acoustic Engineer's specification.

Consideration may be given to incorporating the PA function from the EWIS.

4.23.2 Acoustic requirements

All acoustic rating of plant rooms and service areas shall comply with Acoustic Engineer's specification. Detailed co-ordination will be done with the Acoustic consultant during the next design phase on the system compliance with Acoustic specification.

4.23.3 Security

It is understood that the buildings will not be occupied by Security Staff after hours.

The security for the building consists of physical and active systems. The active systems (Electronic Security Systems) which form part of this report will be closely coordinated with the physical systems as detailed by the architect.

An electronic security system shall be provided throughout the building to assist in providing a safe environment for all building users. Final details of the electronic security system shall be determined during detailed design, however, it is anticipated that the electronic security system shall incorporate the following system elements:

- Access Control
- Intercom System
- Intruder detection
- CCTV System
- Duress Alarms

The CCTV system shall be an IP based system. CCTV monitoring points shall be provided. CCTVs shall be provided in the following areas

- Car Park Entry and Exit
- Car Park Bay
- Studio
- Loading Dock
- Foyer Area
- Building Entry
- Corridors
- External Areas

4.23.4 Codes and Guidelines

Security and CCTV will be provided throughout the building in accordance with the following guidelines and standards.

- The National Construction Code
- Security Intruder Alarm System AS2201

4.23.5 Access control

The Access control system will incorporate sufficient door reader modules, electronic strikes (fail safe), electromagnetic locks (fail safe), proximity card readers and door release pushbuttons as required to serve the nominated locations. Typical locations may be the entry to the following areas:

- Administration Offices and Back of House Areas
- Lifts
- Plant rooms
- Stores

- Communication room
- Security and Staff Entries
- Studio

All access control points to the facility will be secure, with the exception of the main entry which will be unsecured during normal opening hours. After hours entry to the building via the main entry will be secured by card access.

All external perimeter doors will be manually locked to prevent unauthorised access and complete with Reed Switches unless otherwise stated.

The access control system will be linked to the fire system

4.23.6 Intruder Detection

An intruder detection and alarm system will be provided to monitor perimeter doors and incorporate zone expanders, door reed switches and passive infrared movement detectors to nominated locations as required.

All external doors will have reed switches and local sounders.

The intruder alarm system shall be controlled from a central security location. Duress alarms will also be linked to the intruder alarm system to utilise secure lines of transmissions.

The response to alarms will be dependent on the location of the area in alarm in relation to the location of, security staff. All alarms will report to the central security room and be automatically sent via the paging system to the security staff as a text message.

4.23.7 Intercoms

Audio intercoms will be used at selected areas such as car park, loading dock and main entry.

4.23.8 Closed circuit television

CCTV network and cameras shall be a full IP CCTV system with open protocols system such as LENEL allowing various manufacturers and camera types to be installed.

The system shall be used for

(a) Public awareness, crime watch (vulnerable areas monitored more actively to allay public concern about safety and enable a swift response to incidents).
(b) Improved staff and visitor safety.
(c) Reduction in theft and crime.

A surveillance system shall be designed to be a deterrent to illegal activity as well as providing the ability to review incidents after the event. It is not intended for the CCTV system to be monitored at all times as incidents will be recorded automatically.

5 Telecommunications

5.1 General

The new development will provided with a new communication services connection. The communications services for the new building will be linked via new lead in connections from Telstra. The development will be serviced from a single lead in from Telstra to a main communication room within the building. The remaining development shall be subsequently serviced from the Main Communication Cabinet. Discussions are to be commenced with Telstra on this basis.

The telecommunications systems for the building shall consist of following and will be carefully coordinated with the Performing Arts Brief and Scope.

- Intercom system(s)
- Structured Cabling System
- PABX
- Wireless network
- PA - Public Address system(s)
- PayTV/MATV signal distribution system(s).
- NBN

It is important to ensure that the overall ICT infrastructure supports both the short and long term requirements of a practical and cost effective facility.

It is important that the core network infrastructure, equipment and the servers are identified at an early stage. Each of these may have a direct impact on the design of the building, including:

- Supply of suitable power to nominated areas (type and capacity)
- Inclusion of multiple paths for cabling infrastructure, to allow for sufficient cabling via diverse pathways
- Main Computer / Server room
- Telecommunication rooms and cupboards to be sized to accommodate racks for cabling and network equipment
- The number and location of voice and data outlets
- UPS and back-up power supply

The Network Infrastructure must consider:

- Management (fault and performance indicators)
- Network virtualisation (VLANs)
- High availability (path redundancy, device redundancy)
- Security (access control lists, wireless intrusion detection and prevention system)
- Scalability
- Wireless (convergence of wired/wireless infrastructure, VPNs/VLANS)
- Voice and multimedia (Power of Ethernet (PoE)

The Facility shall be cabled to provide real-time network technology for the integrated transport and routing of multi-channel 3G/HD/SD-SDI, video, multi-channel audio, Inter-communications, control and data.

Structured cabling pathways shall be provided throughout the facility to provide initial and future cabling requirements in accordance with the theatre performance brief requirements.

The installation shall comprise of both high speed optical fibre and copper cabling systems.

lT technical systems will use OS1 Single-mode Fibre and Multi Mode Fibre as the primary transport medium and venues will be connected via a redundant ring of multi-core and Single-mode Fibre.

Single-mode and Multi mode Fibre network will form the core cabling technology for the Centre.

As per the theatre consultant requirements 'Zero Water Peak OS1 Single-mode Fibre' shall be the standard used to maximise the useable spectrum (bandwidth) of the fibre.

The designed cabling topology shall be implemented to help minimise no single point failures.

The adoption of Coarse Wavelength Division Multiplexing (CWDM) will increase channel capacity while keeping the number of fibre cables to a manageable level. Cabling within venues will comprise of OS1 Single-mode Fibre and Category 6A Shielded copper cable thus ensuring high speed and wide bandwidth transport is maintained to every connection point.

Distributed Node Rooms will be established at strategic points throughout the Centre to service the venues. The Distributed Node Rooms will be built to telecommunication carrier standards i.e. redundant environmental control, power and security. A fundamental part of the distributed design will ensure that in the unlikely event of failure of one or more Node Rooms, catastrophic Centre failure will not occur.

Interface to outside communities will be achieved through the National Broadband Network (NBN) thus enabling all Australians with high-speed and wide bandwidth interaction to the Performing Arts Centre. Connection to the NBN will be via redundant links. This is considered essential and the venue is not only for the city of Cairns but also the benefit of the wider community.

5.2 Codes and Guidelines

Communication services will be provided in the new building in accordance with the following guidelines and standards.

IEEE 802.3	Ethernet
IEEE 802.5	Token Ring
TS 001 – 011	ACA/ACA Technical design briefs
CPCM	ACA/AUSTELL customer premises cabling manual.
AS/NZS 1768	Lightning Protection
AS 2834	Computer Accommodation
AS/NZS 3000	AS Wiring Rules, Electrical – Buildings, structures and premises.
AS/NZS 3594	Information Processing Systems – Interface Connector and Contact
ISO/IES 8877	Assignments for ISDN basic interface located at reference points S & T.
Code of Practice	Issued by Telecom and ESAA for Earth Potential Rise
AS/ACIF S008:2006	Requirements for Customer Cabling Products
AS/ACIF S009:2006	Installation requirements for Customer Cabling (Wiring Rules)
AS/NZS 1049.1:2008	Telecommunication cables – Installation, sheath and jacket – Material
AS 1049.2:2008	Telecommunications cables – Installation, sheath and jacket – Test Methods

AS/NZS 3080:2003	Telecommunications installations – Generic cabling for commercial premises (ISO/IEC 11801:2002, MOD)
AS/NZS 3080:2003/ Amdt1:2009	Telecommunications Installations – Generic cabling for commercial premises (ISO/IEC 11801:2002, MOD)
AS/NZS 3084:2003	Telecommunications installations – Telecommunications pathways and spaces for commercial buildings
AS/NZS 3084:2003/ Amdt1:2007	Telecommunications installations – Telecommunications pathways and spaces for commercial buildings
AS/NZS 3085.1:2004	Telecommunications installations – Administration of communications cabling systems – Basic requirements
AS/NZS ISO/IEC 15018:2005	Information Technology – Generic cabling for homes
AS/NZS IEC 61935.1:2006	Testing of balanced communication in accordance with ISO/IEC 11801 – Installed cabling
AS/NZS IEC 61935.2:2006	Testing of balanced communication in accordance with ISO/IEC 11801 – Patch cords and work area
AS/NZS ISO/IEC 14763-3:2007	Telecommunications installations – Implementation and operation of customer premises cabling – testing of optical fibre cabling
AS/NZS 2967:2010	Optical fibre communication cabling systems safety
AS/NZS 3835.1:2006	Earth potential rise – Protection of telecommunications network users, personnel and plant – code of practice
AS/NZS 3835.2:2006	Earth potential rise – Protection of telecommunications network users, personnel and plant – Application guide
HB 100-2000 (CJC 4)	Coordination of power and telecommunications – Manual for the establishment

5.2.1 Rooms & Risers

The system shall comprise of a Campus Distributor (CD) and star and ring topology from this single point, to large campus facilities comprising the CD, BDs (Building Distributor) and FDs (Floor Distributor).

The backbone cabling shall provide functional interconnection between the distributors CD, BD and FD comprising the cabling system.

The backbone wiring shall use a hierarchical star topology with redundancy loops.

Communications structured cabling equipment shall be enclosed within the communications rooms. The Main communication room is provided near the ground floor which would also house the security equipment.

The communications riser which is to be vertically aligned wherever possible and located directly adjacent to the communications rooms to ensure a cost effective installation and provide minimal life cycle costs are located directly adjacent to the communications rooms. With the risers vertically aligned this will help to ensure that ceiling heights are maximised and coordination between structure and other services is possible.

The communications rooms will not have a raised floor but rather a grid of cable trays above the communications racks.

The rooms shall have air conditioning and will be backed up with standby power supply. The rooms will also have

no ceiling, be painted and have anti-static flooring to architectural details.

The rooms shall be the service nodes for:

- Voice and Data Structured Cabling
- Security
- MATV

The services within the communications room shall either be supported by a central UPS or rack mounted UPS units.

5.3 Communications

The provision of containment and cabling infrastructure shall be developed during the design development stage of the project.

The new communication systems will include a Cat 6A structured cabling system capable of handling voice and data systems throughout the building. Cabling to meet the requirements for extended warranty.

All telecommunication nodes shall be linked via multimode 12 OM3 optical fibre as well as being linked back to building main communication room. Single Mode optical fibre cabling shall be utilised where it is deemed necessary. These links to the existing rooms shall be further established during detail design.

Final arrangement of the communications outlets shall be determined during the design stages of the project.

Generally the detailed brief of the telecommunications services shall be developed further in conjunction with the client and their requirements. The following should be considered by the stakeholders in providing the telecommunications for the building;

- Topology and system architecture
- Voice and data Requirements
- Functional requirements for voice and data
- Security
- Cable type and performance capacity
- Redundancy
- Spare Capacity
- Interfaces to other facilities

All labelling shall be in accordance with industry standards.

5.4 Optical Fibre Backbone Network

Optical fibre backbone cabling shall be a minimum of 12-core single mode OS1. Consideration shall be made to installation methods due to environmental factors.

Installation methods shall be such that compliance with IEC 60794-2 and IEC 60794-3 are achieved. Special consideration shall be given to ensure that subterranean cables are fit for purpose.

Multi-mode fibre may be installed only in facilities that require this and will generally be 12 core micron multi-mode optical fibre.

Additional cores and cables shall be installed subject to a bandwidth analysis of the system.

Lengths of channels shall not exceed those as specified by AS/NZS 3080.

5.5 Horizontal Cabling – Cable Type

Fibre-optic horizontal cabling is to be is to be provided to outlets only to locations as required by the facility and equipment.

The horizontal wiring is the portion of the telecommunications wiring system that connects the voice and data outlets in the work area. These shall be Cat 6A specification.

5.6 Wireless

Wireless Access Points (WAP) are to be incorporated in all services facilities to provide network access internally and at nominated exterior locations including the public domain.

Consideration must be made to the location of the outlets to ensure coverage is provided to 100% of the interior of the facility excluding lifts and fire passageways. Bandwidth requirements shall be discussed with the facility to ensure that the minimum spacing of the WAPs are sufficient to provide this.

Discussions with the principal are to be undertaken to ascertain the IEEE 802.11standard equipment to be installed. Ensure minimum signal levels are achieved at all required locations to this standard.

Some equipment contained within the facility may be susceptible to electromagnetic interference (EMI). It is a requirement that the designer locates WAPs coordinated with this sensitive equipment to ensure interference is within the tolerance levels as specified by the equipment manufacturer. Areas that are not covered by wireless services due to this are to be discussed with the principal or their representative prior to complete design.

At this stage of the design it is understood that the WiFi and WAP will use Power over Ethernet (PoE).

5.7 MATV

The building shall be provided with an MATV system to receive free to air digital television.

5.8 IT and PABX equipment

The exact requirements for the new IT equipment and PABX shall be determined in the next stage of design.

The active equipment may utilise a traditional PABX or a VoIP system.

Active equipment such as telephone handsets, network switches, wireless access points etc to support the building, shall be provided. These devices shall be specified in close consultation with the principal. Handsets shall be provided in maintenance areas, including major plant rooms.

6 Vertical Transportation

6.1 General

The vertical transportation system will incorporate the following:

- Lifts must be safe and comply with all Queensland and national relevant codes and standards.
- Lifts must be easily maintained by multiple (other than the original manufacturer) lift maintenance contractors
- Lifts are to be as flexible and versatile in operation as possible
- Lifts must have a proven (10 year) local history of reliability
- Lifts must be environmentally friendly as well as being both economical to operate and maintain.
- Lifts must be energy efficient with minimal electrical power consumption to meet or exceed the building's ABGR rating and design intent.
- Lifts must meet the minimum requirements for use of persons with disabilities as defined by the lift code AS1735.12.

Where vertical transportation system interconnects to other building services such as fire and security services, an interface will be provided that achieves optimum functionality, performance and reliability.

Low level interfaces shall comprise of a set of electrical contacts controlled via s signal from the lift control system, as listed below.

System to be Interfaced	Interface Type	Interface Responsibility
Fire	Low level	Fire
Access Control	Low Level	Security
BMCS	Low Level	Mechanical

6.2 Design Principles

The building is proposed to have several lifts at different locations as per the architectural plans.

6.3 Codes And Guidelines

The lifts shall be designed, manufactured, installed and tested in accordance with Australian and AS/NZ Standards or with other approved standards where the Australian Standards are not applicable.

All works must be in accordance with this specification and the current Australian Standards and codes detailed within.

BUILDING CODE OF AUTRALIA (BCA/NCC) 2011

AS 1735.1:2001(EN81)	Aust. Lift Code - General Requirements
AS 1735.2:2001	Aust. Lift Code - Passenger & Goods Lifts – Electric
AS 1735.3-2002	Lifts, Escalators And Moving Walks - Passenger And Goods Lifts - Electrohydraulic
AS 1735.4 : 1986	Aust. Lift Code – Service Lifts – Power Operated
AS 1735.5:2003	Lifts, Escalators And Moving Walks
AS 1735.10:1998	Lifts, Escalators And Moving Walks - Tests

AS 1735.12:1999	Aust. Lift Code - Facilities For Persons With Disabilities
AS 1735.14-1998 :	Lifts, Escalators And Moving Walks - Low-Rise Platforms For Passengers
AS 1428.2:1992	Design For Access And Mobility - Enhanced And Additional Requirements - Buildings And Facilities
AS/NZS 3000:2000	Wiring Rules
AS/NZS ISO 10012:2004	Measurement Management Systems - Requirements For Measurement Processes And Measuring Equipment
AS 1657:1992	Stairways, Ladders And Platforms
AS 1170.4:1993	Minimum Design Loads On Structures - Earthquake Loads

Workcover Authority

The Workcover Authority regulates the implementation of the Lift Code AS1735. The NCC/BCAalso refers to AS 1735. This standard deals with the detail design of the lifts. The Authority will not inspect the installation however may audit the installation in the future or when there is an accident. The lifts however will need to be registered with Workcover by the Contractor.

Access Provisions – DDA

Disabled access is required to be provided to the retail sections of the building in accordance with the NCC/ BCAand DDA. The code has requirements that refer to control panel heights, handrails, door sensing devices and minimum car sizes and openings.

E3.6 – when a passenger lift is provided in a building required to be accessible, it must be suitable for use by occupants with disabilities. (this relates to the lift complying with the requirements of AS1735.12).

The minimum car size is 1.1m x 1.4m deep, with 0.9m clear doors. Lift landings should have adequate space as detailed in Section D of the NCC/BCA.

AS1735.12 – Facilities for Persons with Disabilities

Compliance with this standard is most likely to be a condition in the DA. Compliance with the standard includes the need for appropriate Audio and Visual indication, higher light levels and minor alterations or restrictions of car finishes and panels. It also will have an effect on
the door closing times of the lifts.

AS1428.2 – Enhanced and Building Requirements

Usually an Access Consultant or Architect with consideration to the Disability Discrimination Act (DDA) would advise on the need to comply with this standard. Compliance with the standard in relation to Lifts includes the need for larger lift cars than stated in AS1735.12. ie. Minimum size for disabled access is 1.4m wide x 1.7m deep.

It is noted that the minimal car size in the pending draft NCC/BCA 2011 is 1400mm x 1600mm.

Stretcher Facility shall be provided where required by the NCC/BA.

7 Lighting

7.1 General

Light has direct influence on the perception of the space and the visual performance and comfort of its users. There has been considerable research on lighting and its impact on the visual comfort, and health for people within the built environment.

An important issue that should be considered in designing lighting is the visual comfort of visitors and staff. Light should create a comfortable, varied, inviting and interesting atmosphere and support the intention and design of the architectural design.

7.2 Design principles

The lighting system for the performing arts centre seeks to address the following key issues:

- The provision of a lighting and lighting control system that provides operational and functional lighting to the auditorium with a high degree of flexibility.
- The creation of a humane and engaging interior that provides both comfort and "excitement". A warm colour temperature and good colour rendering are regarded as key requirements.
- Use of light to define qualities of surfaces (colour, form and texture).
- Lighting quality with respect to light distribution and illuminance levels.

  Australian Standard AS/NZS 1680 should be used as guidance for illuminance levels. However, the lit atmosphere and surface brightness should be used as design parameters rather than solely illuminance levels.
- High quality lighting characteristics in terms of dimmability. For the theatre spaces, smooth dimming from 0-100% is critical.
- An approach that enhances and reinforces the architect's vision and identity of the building and that is fully integrated into the architectural design.
- Designing lighting atmosphere (in terms of colour temperature, colour rendering properties, illumination intensity etc.) to suit best to the architectural context and the uses of the building.
- Provision of operational and functional lighting to the various spaces to fulfil visual task requirements without glare or discomfort.
- Lighting used to draw people to particular areas or down certain routes (orientation/ way finding).
- Energy efficient lamps, luminaries and control gear shall be used at all times, considering efficacy, light output ratio and suitable light distribution.
- Use of time controls, light sensors and occupancy sensors to control lighting when appropriate.
- The provision of an intelligent lighting control system and consideration of lighting control strategies to provide flexibility of operation and reduce energy consumption.
- The selection of light sources and control aims to minimise maintenance where possible. Lamp types will be standardised for ease of maintenance.
- All lighting fixtures and equipment need to be located to enable access and maintenance.
- Flexibility for the various usages, functions and future requirements as part of the design.
- Integration and coordination with other services and systems.
- Consideration of daylight in order to supplement and balance incoming daylight with electric lighting.
- Minimisation of energy consumption and environmentally sustainable initiatives as part of the design.

- As part of the energy efficiency measures, the design is required to comply with the National Construction CodePart J6, which restricts the power consumption of lighting in form of maximum illumination power densities. It is noted that the NCC/BCA part J assessment need to consider the entire building rather as a whole than individual areas.

7.3 Codes and Guidelines

Whilst lighting will be designed to achieve the aesthetic and comfort required and be guided by the architectural principles, it will be designed in accordance with the intent of the following guidelines and standards:

- Interior Lighting AS1680
- Control of the Obtrusive Effects of Outdoor Lighting AS 4282:1997
- Pedestrian Area Lighting AS/NZS 1158.3.1:2005
- Emergency and Exit Lighting: to AS/NZS 2293.1-2005
- Structural design requirements for utility services poles (for lighting poles) AS/NZS 4676:2000
- Energy Consumption – NCC/BCA Part J6
- Aisle Lighting – AS1680.2.3: 2008 and NCC/BCA Part H1.7

7.4 Light Quality

The appearance of colour, both in terms of chromaticity (Correlated Colour Temperature) and colour rendition (Colour Rendering Index) are important for the overall feeling, comfort and visual performance within the space:

- Colour rendering

The colour rendering index (CRI) describes the effect of a light source on the colour appearance of objects by comparison with their colour appearance under a reference source.

Incandescent light sources have a continuous spectrum and attain a CRI value of 100.

It is recommended that the light sources applied in the foyer and auditorium spaces should have a minimum CRI of 85.

- Correlated colour temperature

Colour temperature is a characteristic of visible light that influences the perception and atmosphere of a space. The colour temperature of a light source is the temperature of a black-body radiator that radiates light of comparable hue to that light source. The black-body radiator gives a reference by which the whiteness of light sources is judged. The temperature is conventionally stated in units of temperature in Kelvin (K).

Higher colour temperatures (5,000 K or more) are perceived as cool, lower colour temperatures (2,700–3,000 K) as warm colours. Incandescent/ halogen lamps which are traditionally used in theatres, have warm white light output with a colour temperature of around 2700-3000K and become warmer when dimmed.

Generally, a neutral white colour will blend in with the natural light entering the spaces and contribute to balancing the incoming daylight.

A warm light colour is recommended for the auditorium space to create a warm and inviting atmosphere.

7.5 General Lighting Philosophy

Light is a powerful means for communication and plays an essential role in realizing and sharing the

architectural vision of the project. For this communication to be "total", lighting needs to embrace natural and artificial sources and their interaction with forms, surfaces and colours.

The concept will be developed to best suit to the architectural design and the use of the building. Lighting will support the architectural principles of openness and transparency and reflect the geometry and core principles of the design.

Natural lighting plays a major part in the architectural design and as a key factor for the spatial quality as well as peoples' alertness, comfort and well-being. Natural light and the transparency during the daytime will inform the interior lighting. Internal lighting should be designed to allow connection and views to outside and to balance the surfaces' brightness with the incoming daylight, mainly through uplighting and lighting of vertical surfaces.

Lighting underlines the architectural form and enhances the appreciation of height and openness. Through lighting, the vertical surfaces become illuminants, creating focal points, facilitating orientation and guiding movement. The main surface materials and their qualities will be enhanced through light.

Light is an integral element, tailored to suit the character of the building. Forming an integrated part of the building, light sources and lighting systems should be concealed within the architecture.

The design involves illuminance variations in order to compliment the architecture and highlight features and focal points. Highlighting certain areas or surfaces draws people to particular areas or down certain routes.

At night, lighting treats the building as a sculpture enhancing its meaning within its surroundings and reflecting the layers and shapes of the roof/ canopies and the arrangements of internal spaces.

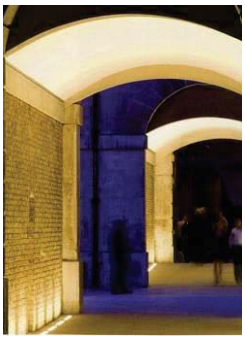
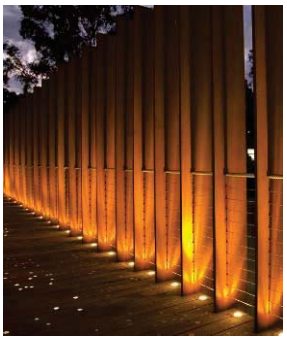
Lighting to internal and external landscape elements such as trees and plants strengthens the architectural concept of creating a strong connection to the nature and enhances the appreciation and enjoyment of the external environment.

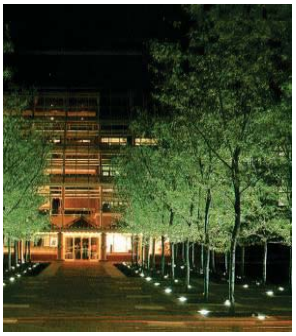


Concealed uplighting and lighting of vertical surfaces



Lighting of materials and surface finishes



Lighting of external elements at night-time, creating focal points and a balance between light and shade



Lighting of trees and landscape elements

7.6 Performing Arts Space Lighting

7.6.1 Principles

In the performing art spaces, Lighting has to fulfill task and functional requirements, integrate into the architectural design and contribute to the creation of an environment that enhances the theatregoer's senses in preparation for the performance to come.

The lighting design concept will follow the architectural concept and will be based on seamless integration of the lighting into the architecture. Through lighting the architectural geometry and surfaces, the concept will aim to maximise the experience and comfort within the space.

The proposed solution should address the hierarchy of seeing: The gathering audience is considered the priority and the architectural envelope the next within the visual hierarchy.

Dimming holds a key position within performing arts spaces; it informs the viewers to settle down, end conversations and direct the attention towards the performance area.

The lamps used for auditorium lighting need to smoothly dimmable from 0% to 100% and require instant start and re-strike.

It is noted that lighting for maintenance and cleaning does not require dimming and instant start/ re-strike capabilities.

Aisle lighting along stepped or inclined surfaces shall be incorporated into the seating or steps, providing subtle guidance during performances without being obtrusive or distracting.

7.6.2 Illuminance Guidelines

Australian and International standards are used to form the basis of the illuminance advice.

The following recommendations from various standards refer to auditorium house lighting:

- AS/ NZS 1680.2.3 – 2008 refers to educational and training facilities and recommends 160 lux for an auditorium when used as assembly hall and 80 lux for social activity.
- As part of the recommendations for Public and Educational Buildings, AS1680.2.0 – 1990 recommends an average illuminance of 80 - 160 lux for foyers and auditoriums of Assembly and Concert Halls.
- The AS1680.2.0 – 1990 recommendation for cinemas is for 80 lux for foyers and 40 lux for Auditoriums during intermissions.

Lighting will be designed to achieve an overall illuminance of 80 lux average at the seating area for pre- and post-entertainment sessions and intermissions. The lighting system will be dimmable to vary light levels, depending on the task requirements.

For safety and orientation, the steps must be seen clearly:

AS/ NZS 1680.2.3 – 2008 recommends to install aisle lighting if floors are sloped at greater than 1 in 12, or are stepped and that each step should be defined by producing contrast between the step and its riser.

To make the steps evident is considered a matter of contrast. A combination of appropriate illumination as well as the material selection will enhance the discrimination of steps and provide safe circulation.

7.7 Exterior Lighting

7.7.1 Principles

Landscape lighting within the foyer and plaza improves the aesthetical quality of the environment at night time, emphasizing feature elements and creating a harmonious balance between light and shade, void and solid. Tree and leaf shadows, usually perceived as a natural effect from sunlight, can be considered to bring natural elements into the spaces and to strengthen the building's connection to the landscape.

The lit night-time environment will include lighting of trees and landscape features as well as lighting of facade

elements and the roof canopies, creating an inviting and welcoming environment and night.

7.7.2 Illuminance Guidelines

Exterior, façade, and plaza lighting will be provided throughout the complex in accordance with the following guidelines and standards.

- AS/NZS 1158 Lighting for Roads and Public Spaces
- AS/NZS 4282 Control of Obtrusive Effects of Outdoor Lighting

Detailed calculations shall be done during the detail design stage to address issues related to any light spills on neighbouring properties.

7.8 ESD Considerations

Energy efficiency and sustainability form part of the lighting design philosophy and will be considered throughout the design process.

The solutions implemented in the lighting design need to take into account environmental impacts by means of balancing a number of issues. Lighting encompasses display, architectural, ambient, access, task and security lighting, therefore needing to address several key issues one of which is the associated environmental impact.

The first priority is to be given to the creation of the required visual environment and compatibility with the architectural philosophy, performance and exhibition design requirements. Visual performance, visual comfort and an enjoyable atmosphere for visitors and staff are to be achieved by reflecting and enhancing architectural design intentions. In some cases, the solution may not have energy efficiency as the primary driver, but it will be balanced out in other areas and other modes in order to achieve an excellent overall energy efficiency, economy and environmental responsibility.

ESD objectives associated with the lighting design take into account the following issues:

- Where spaces are designed to embrace natural lighting, they promote a natural and comfortable visual environment and enable a connection to the outer environment. Maximization of daylight reduces the need for electric lighting.
- The design of the room surfaces has a considerable influence on the quality of the lighting including light distribution, general lighting levels, the degree of glare and space/ object perception. Light coloured and non-glossy surfaces improve the light distribution by multiple reflections and contribute to achieving required light levels (eventually less luminaires/ lamp wattage required) while limiting contrast glare.
- An appropriate and flexible lighting control system is a key requirement for a sustainable lighting installation. Time switches, occupancy sensors and photo sensors are suggested to be used to control lighting when and where appropriate.
- Appropriate luminaire types and light sources will be chosen to minimize energy consumption, maximize efficiency and obtain low maintenance expenses.

  However, the quality of the light is considered being the first priority and lamps will be chosen with consideration to the nature of the exhibited objects, the health and well-being of the occupants and to their qualitative spectral properties. LED sources will be considered as the main source of lighting.

7.9 Lighting Control

Lighting comprises of auditorium house lighting, display lighting, architectural lighting and lighting for orientation and way finding; all of which functions need to have the ability to be separate controlled.

Lighting needs to be changeable and support multiple uses within the performing arts space and the foyer spaces:

- Different settings before, during and after performance
- Different lighting atmospheres and configurations for different performances
- Adaptability and flexibility for future changes and requirements
- Various exhibition layouts and types of displayed objects

Flexible control groups, programmable control and dimmability are key requirement for the lighting operation, especially as the space will house a variety of events, shows, displays and changing exhibitions. The control system needs to allow for adaptability to cater for various uses and exhibition layouts.

Pre-programmed scenes shall be recalled to create a different atmosphere and to cater for the various requirements. The settings can be changed for different types of events and usages, e.g. allowing for functions within the foyer spaces.

7.10 Exit and Emergency Lighting

Emergency and Exit lighting will be provided throughout the building in accordance with the following guidelines and standards.

- AS/NZS 2293 Emergency escape lighting and exit signs for buildings
- Building Code Of Australia

Emergency lighting and emergency exit lighting is an essential part of the building lighting. The system should consist of luminaries and exit signs that identify an escape route.

A computer monitored emergency lighting and emergency exit lighting system will be provided in accordance with the Building Code of Australia, AS/NZS 2293 and comprise of self-contained emergency exit and emergency luminaries.

The fittings require regularly scheduled maintenance testing in accordance with the requirements of AS/NZS 2293. The maintenance testing of the emergency lighting system shall have the capacity for automatic testing, generate test reports, colour graphic display and be capable of remote monitoring (testing, report generation).

The style and type of emergency fittings will be selected to suit the area in which it is located and to match the particular requirements for each area. Generally, the emergency lighting equipment will be an integral part of the design and mainly concealed or unobtrusive. In line with this principle, emergency lighting will be integrated within general luminaries where possible or provided through dedicated recessed LED emergency fittings complete with self-contained battery and charger.

8 Appendix A – Electrical Plant Requirements

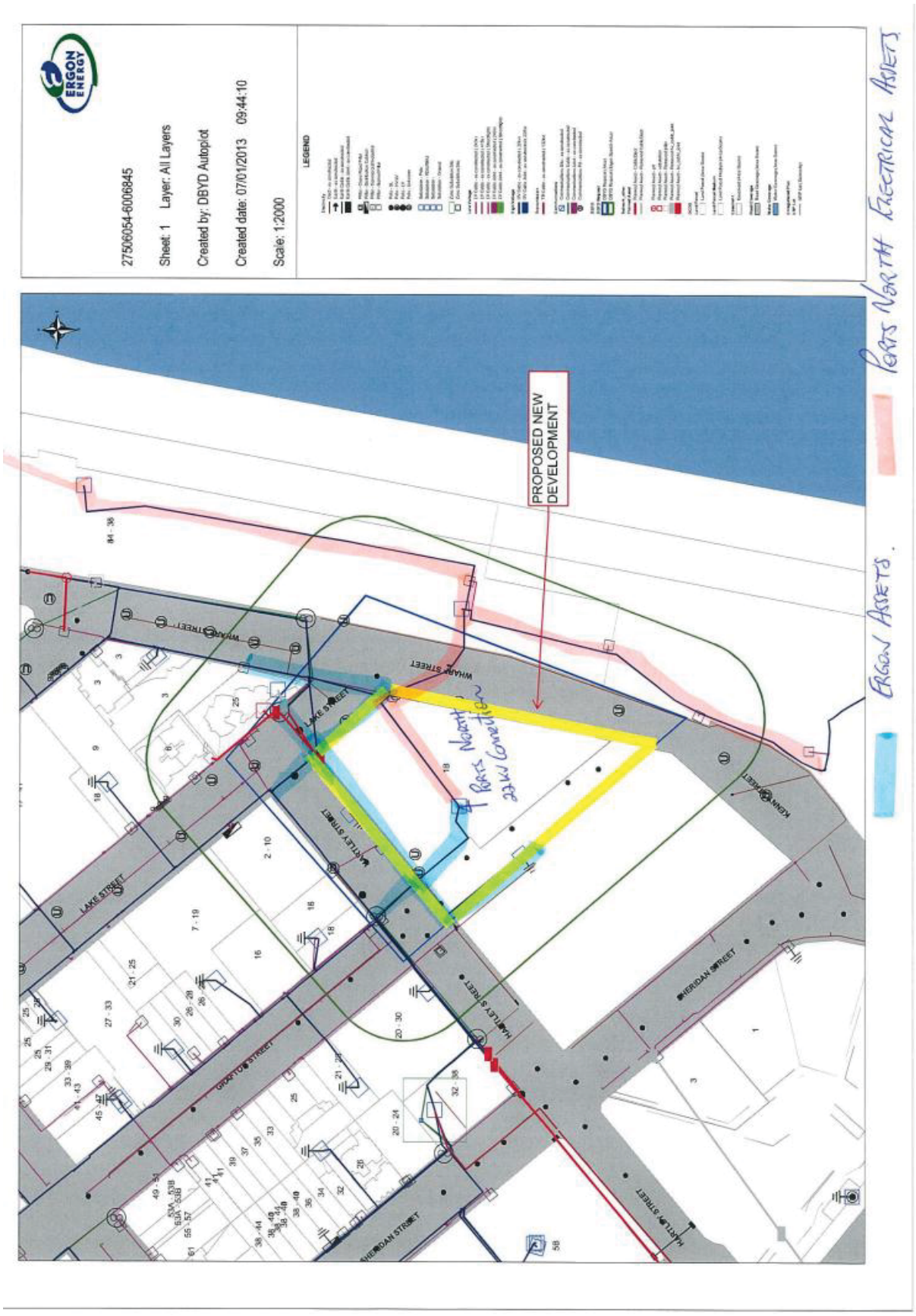
The spatial requirements shall be read in conjunction with the spatial drawings issued to COX on 05.02.2013

STEENSEN VARMING

Project	**Cairns Performing Arts Centre**	**Project No.**	**11794**
ELECTRICAL SERVICES SPATIAL PLANT REQUIREMENTS		**Date**	**12/12/17 MH**
Stage:	**Preliminary**	**Revision**	**1**

Item	Description	Area	Comments	Additional Specific Notes
E1	Chamber Type Substation Option for theatre and Museum	**10m x 7.3m x 3.5m**	Several planning requirements such as fire rating, ventilation clearances, vehicle access and EMI. Refer to attached Document Version 1 from Ergon Allow for larger substation at this stage. No allowance is included for future development	In addition Ergon require substations to be installed at not less than Q100+300 to the bottom of their equipment, and a separation of min 5.5m from a substation to any habitable room.
E2	*Generator - EXCLUDED AT THIS STAGE*	*11m x 5m x 4.5m ceiling Large doors to allow access for equipment. Two forms of egress.*	*Allow for exhaust flue to top of building at least 1m above roof line. Make allowance for ventilation and vehicle access. Need to consider Acoustic requirements and ventilation and Located @ Q100+300*	*Based on an estimated ~1200kWe. The actual standby power requirement to the building needs to be confirmed . The requirement for standby power in this building is more to do with the commercial reasons rather than statutory reasons.*
E3	UPS - Central	6m x 3m x 2.7m	Located near Main Switchroom	
E4	*Co-generation option*	*EXCLUDED AT THIS STAGE*	*Not provided*	
E5	Main Switchboard	16m x 4m x 2.7-3m height Double door to allow access for equipment. Two forms of egress.	Located in lower right hand corner of Building 1. Located as part of electrical risers. Close to main mech AC load and substation 120/120/120 fire rating. Ventilation required. Smoke seals etc. to be in accordance with BCA clause D2.7 . Located @ Q100+300	Generally require 1200-1350 in front of the switchboard and 600mm around other sections of the board. More space is required if island type board (rear connect). Weight - ~ one tonne /m length. Ventilation 100 l/s per 1000kva.- extra for PFC. Refer to design guide.
	Cable Runs and Risers		To be located away from habitable spaces and theatres	
E6	Electrical Distribution Boards (EDB)	2.4m x 0.6m (each) located on each level and positioned coverage of ~30m radius Vertically aligned. Located off corridor or access areas. (2.4m high doors). Each EDB to be complete with a minimum of 3 off 600mm x 100mm penetrations	Smoke seals etc. to be in accordance with BCA clause D2.7. Subman cables are also required to be 2hr fire rated to be in accordance with rules set out in the BCA	Distribution boards to be sized to provided desired spare capacity. Consolidation of EDB may be possible pending exact building forms and cable routes.
E7	Main Communications Equipment Room and MDF / Building Distributor	3.2m x 6m x 2.7m high	Located on upper level not more than one level above ground . Located as part of communications risers. Located @ Q100+300.	The size is based on the installation of X x 38RU racks. Exact size to be confirmed once more detailed data/phone/AV requirements are specified.
E8	Telecommunications Closets (TC) Floor Distributors	Allow rooms at 4m x 3m located throughout the building positioned to provide coverage of ~65m radius. Located off corridor or access areas. 2.4m high doors. No Ceiling required.	Smoke seals etc. to be in accordance with BCA clause D2.7	
E9	Communications Riser Location	800mm x 200mm riser. Fully accessible with access door. To be ideally position with TCs such that they are vertically on top of one another.	Smoke seals etc. to be in accordance with BCA clause D2.7	
E10	Security Room	3m x 10m - Also kitchenette and WC.	A security room is required and will contain a number of systems and may also be occupied by security personel	
E11	Fire Control Room	Hydraulic Fire Consultant to Advise		
	FIP & Warning System	1500mm high x 800mm wide x 300mm deep	Should be located in close vicinity to the main entrance	
E12	Maintennace Store Room	*12m x 3m*	General Store for lamps, and maintenace gear.	
T13	Solar Power System	*TBC*	Roof Mounted.- Maintenance Access Required	

9 Appendix B – Existing Ergon /Ports North Assets



10 Appendix C - Maximum Demand Calculations

Preliminary Electrical Maximum Demand

Project Name: Cairns Performance Arts Complex

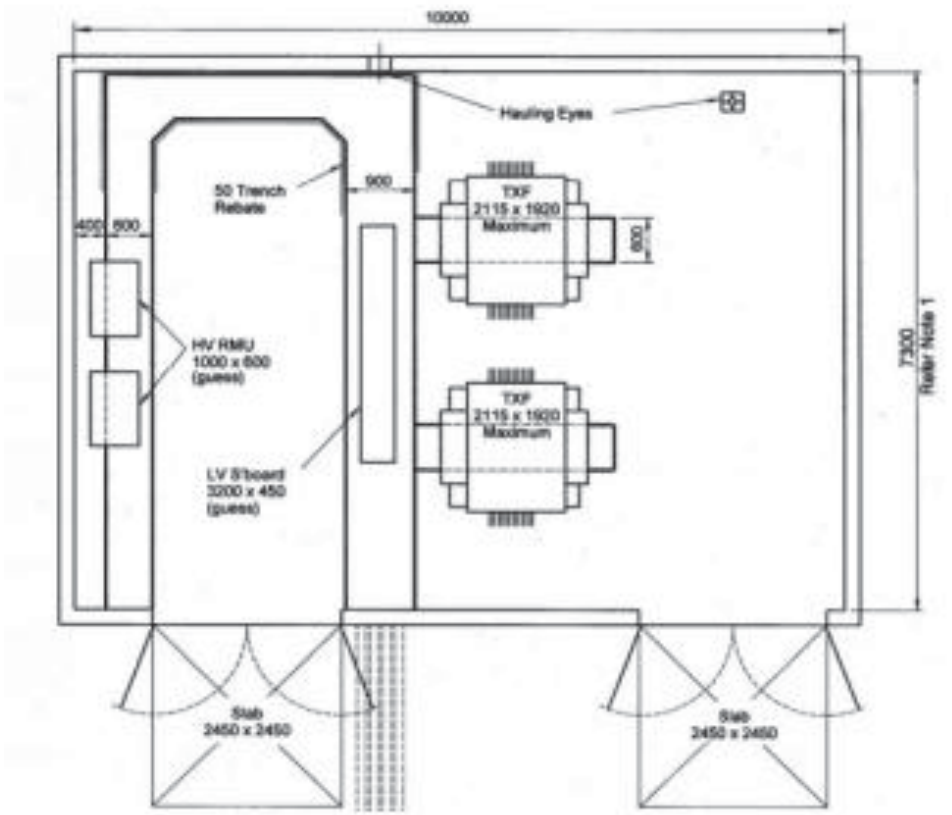
Job Number	11794
Date	16.01.13
Revison	5
Author	SK
Checked	

Room Name	VA/m^2	Area (m^2)	Total kVA
Level 0			
Auditorium (Substage)	130	640	83.2
Car Park	30	2860	86
Back of house	130	100	13
Plant	130	200	26
Level A			
Auditorium (Stage)	130	360	46.8
Flexible Theatre	130	780	101.4
Foyers	130	1780	231.4
Back of house	130	1080	140.4
Plaza	110	550	60.5
Loading	70	290	20.3
Plant	130	80	10.4
Level B			
Auditorium (rear stalls)	130	740	96.2
Foyer	130	190	24.7
Level C			
Rear of flexible theatre	130	270	35.1
Foyers	130	1230	159.9
Back of house	130	1100	143
Level D			
Foyers	130	170	22.1
Auditorium (Balcony)	130	380	49.4
STAGE			
Grid	130	860	111.8
Plant	130	630	81.9
	TOTALS	**14290**	**1543.3**

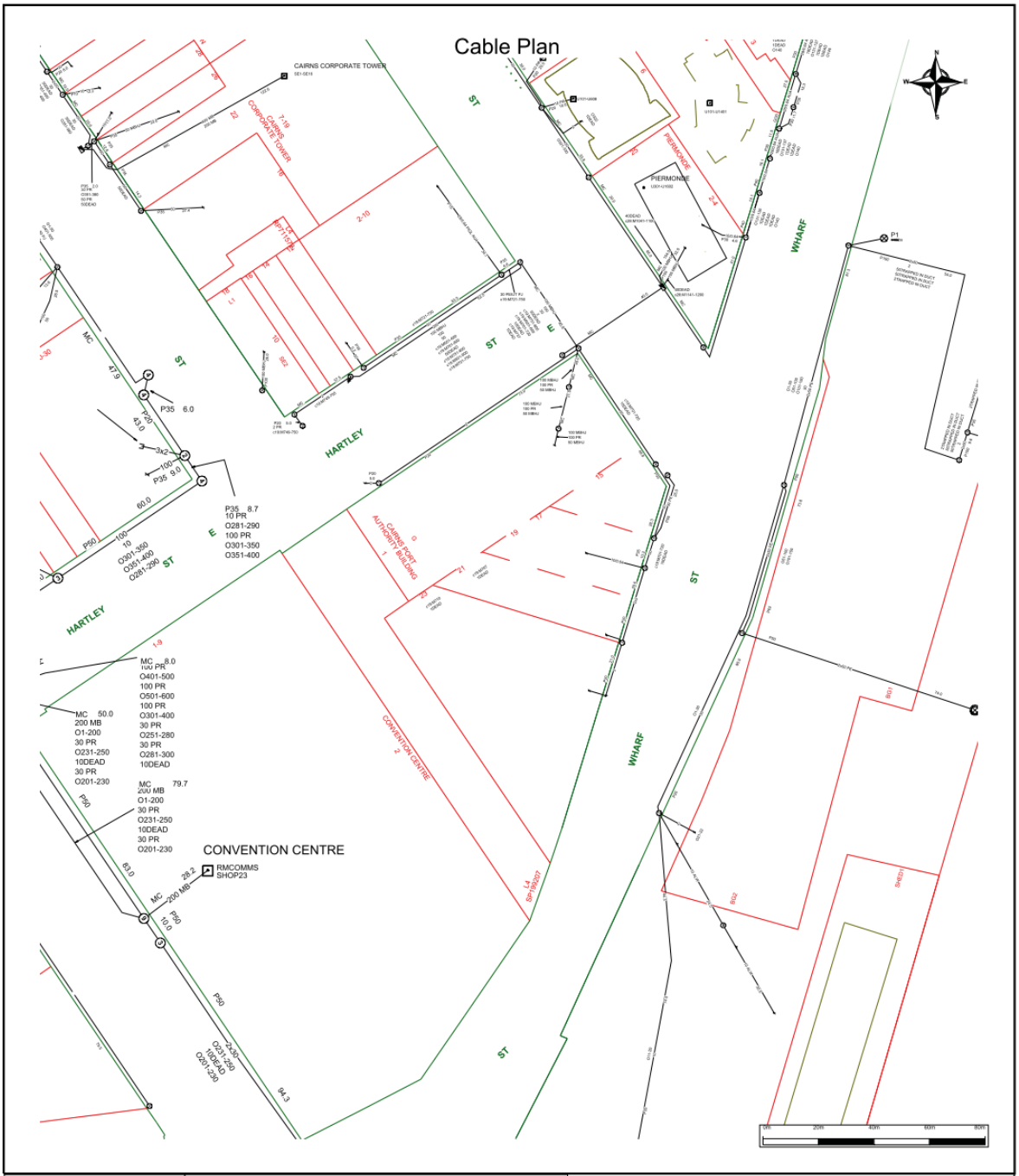
	Current Per Phase (A)	**2145.19**

QA Ref: emd.09 rev 1

11 Appendix D- Ergon Indoor Substation Arrangement



12 Appendix E – Telstra Dial Before You Dig Plans



Telstra	For all Telstra DBYD plan enquiries - email - Telstra.Plans@team.telstra.com For urgent onsite contact only - ph 1800 653 935 (bus hrs)	Sequence Number: 27506055
TELSTRA CORPORATION LIMITED A.C.N. 051 775 556		CAUTION: Fibre optic and/ or major network present in plot area. Please read the Duty of Care and contact Telstra Plan Services should you require any assistance.
Generated On 07/01/2013 10:48:13		

The above plan must be viewed in conjunction with the Mains Cable Plan on the following page

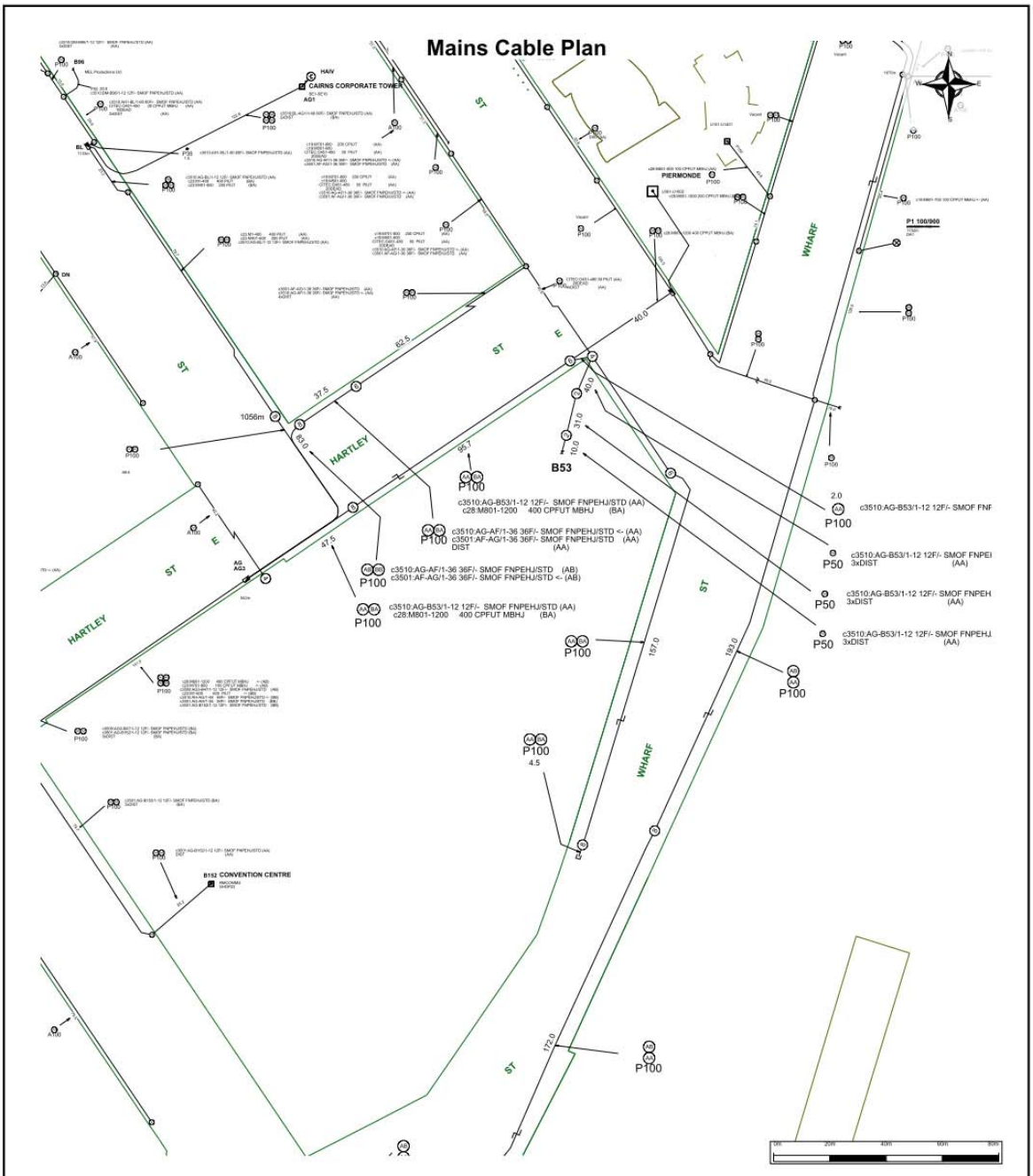
WARNING - Due to the nature of Telstra underground plant and the age of some cables and records, it is impossible to ascertain the precise location of all Telstra plant from Telstra's plans. The accuracy and/or completeness of the information supplied can not be guaranteed as property boundaries, depths and other natural landscape features may change over time, and accordingly the plans are indicative only. Telstra does not warrant or hold out that its plans are accurate and accepts no responsibility for any inaccuracy shown on the plans.

It is your responsibility to locate Telstra's underground plant by careful hand pot-holing prior to any excavation in the vicinity and to exercise due care during that excavation.

Please read and understand the information supplied in the duty of care statement attached with the Telstra plans. TELSTRA WILL SEEK COMPENSATION FOR LOSS CAUSED BY DAMAGE TO ITS PLANT.

Telstra plans and information supplied are valid for 60 days from the date of issue. If this timeframe has elapsed, please reapply for plans.

Page 1 of 2



Telstra For all Telstra DBYD plan enquiries - email - Telstra.Plans@team.telstra.com For urgent onsite contact only - ph 1800 653 935 (bus hrs)	Sequence Number: 27506055
TELSTRA CORPORATION LIMITED A.C.N. 051 775 556	CAUTION: Fibre optic and/ or major network present in plot area. Please read the Duty of Care and contact Telstra Plan Services should you require any assistance.
Generated On 07/01/2013 10:48:23	

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Page 2 of 2

13 Preliminary Budget

11794 Electrical Budget Rev 3

STEENSEN VARMING

Project	**CAIRNS PERFORMANCE ARTS COMPLEX**	**Project No.**	**11794**
ELECTRICAL SERVICES OPINION OF PROBABLE COST		**Date**	**08.02.13**
Stage:	**Preliminary**	**Author**	**SK**
		Checked	**MH**
		Revision	**04**

Item	Description	Unit	$ Rate	$ Cost (Building)	Note
1	Electrical Services			$2,861,550	
2	Lighting Services			$3,185,750	
3	Substation			$400,000	
4	Communications Services - Lead in			$150,000	
5	Site Diversions			$600,000	
	Contingency			$150,000	
Total	**Building Cost**			**$7,347,300**	
	Floor Area (Approx)			14,290	
	$/sqm			**$514.16**	
5	**Vertical Transportation**				
	Lift -1			$300,000	
	Lift -2			$300,000	
	Lift -3			$200,000	
				$800,000	

Exclusions

GST
Carbon and Emission Taxes
Latent Conditions
Shielding and Acoustic Treatment
General Builders work (Penetrations, plant enclosures etc.)
Trenching and making good
BMCS
Standard Contingencies and profits
Site preliminary's
Statutory fees and charges
Design Fees
Documentation for Certification of Rating Schemes such as NABERS, Green Star

Basis of Calculations

This opinion of probable cost was calculated based on the following:
1 Steensen Varming rates for recent projects
2 Refer Steensen Varming Scope of Works document

Disclaimer

1 The order of costs provided are based on historical data. Contingencies should be allowed for changes in labour and equipment costs, such as the volatile copper and steel prices.
2 The figures are order of cost estimates only and are provided to assist in cost planning. The client needs to make their own judgement and employ a professional cost
3 The costs presented are based on the information available at the time. Unless we are commissioned separately to complete a detailed site survey of the existing services then we rely only on the client information provided and thus latent conditions may exist.

QA RefL EOCS.09.rev2