Technical Communication
There are many different ways of communicating ideas, information, instructions, requests, etc. They can be transmitted by signs or gestures, by word of mouth, in writing, or graphically. In an industrial context the graphical method is commonly used when formal communication is mostly conducted by means of technical and engineering drawings. If oral and or written communication only were used when dealing with technical matters, misunderstandings could arise, particularly in relation to shape and size etc.

The lack of a universal spoken language makes communication and understanding even more difficult because of the necessity to translate both words and meaning from one language to another. The universally accepted methods used in graphical communication through technical drawings, eliminate many of these difficulties and make it possible for drawings prepared by a designer to be correctly interpreted or “read” by a counterpart.

Equally important, the components shown on the drawings could be made by suitably skilled tradespersons of any nationality provided they can “read” a technical drawing.

Standardized technical, engineering and construction drawings provide the main means of communication between the client, the planner, designers and the tradespeople such electricians, machinist, fitters, metal fabricators etc. For the communication to be effective, everyone concerned must interpret the drawings in the same way. Only then will the finished product be exactly as the designer envisaged it. To achieve this result, standards and conventions must be followed.

Drawing Standards and conventions
There are internationally recognized standards used in most countries. The main standard body is:

- The International Standardization Organization (ISO).

The Australian Standards are typically based on ISO standards, and the principal standards for technical drawing are:

- AS 1100.101 Technical drawing –General principles
- AS 1101 Graphical symbols for general engineering
- AS/NZS 1102 (Set) Graphical symbols for Electrotechnology
- AS/NZS 4383 Preparation of documents used in Electrotechnology

In summary:
Drawings provide a clear and concise presentation of ideas and requirements. They are the primary means of formal communication between all of the key parties involved any construction project or manufacturing process etc. The drawings link the requirements of the client through the designer to the manufacturer or the tradespeople who will ultimately perform the tasks.
Note how the “pictorial” type drawing shown to the right is being used to illustrate the concept of power transfer from the generating source to the customer’s premises.
Uses of technical drawings in industry:

Communication
As detailed above, engineering and construction drawings are the main method of communication between all persons concerned with the design and manufacture of components, building and construction, and engineering projects.

Discussion
Technical drawings are the means by which ideas, strategies and theoretical development, are discussed between peers and colleagues. The evolution of ideas can be discussed and developed and possible problems with manufacture or construction can be overcome in the planning stage.

Records
Drawings are also used to record and register tasks undertaken and resources or materials used. Statutory authorities and local administration bodies require plans to be submitted before commencing construction or manufacture.

These drawings can also be referenced for:

- Costing of materials or components
- Purchasing
- Future reference for repeat or similar designs
- Recording specifications
- Recording of faults or difficulties with manufacture or design

Architectural Drawings
An architectural drawing is one that provides information primarily with buildings and their surrounding areas. The provide details of design, positioning or location, equipment, levels as well as incidental information such as building material types, finishes, colours etc.

When constructing a house, office building, large industrial construction site, or high-rise apartment block, etc, the communication process must not break down for any reason, if the project is to be completed as designed, within the time and costing parameters, as well as meet all legal and contracted standards.
The electrical tradesperson must be able to read plans to determine precisely what type of electrical installation is required. This applies to quoting/estimating for labour and materials, and to understand what is to be done and in what order. Information presented on drawings can provide specific detail of, the route of the consumer’s mains, position of the switchboards, location of and types of accessories / fittings, etc.

Any interruptions to the process will invariably be disruptive to other trades, resulting in costly delays to the time schedule if the electrician cannot interpret the plans correctly. Errors can prove very costly to the electrical contractor.

**Types of architectural drawings**
As with most types of drawings, architectural drawings are classified according to the information they are to represent. Each type of drawing should only contain information that is appropriate to its category. Below are common types of (architectural) drawings and a brief description of the information they may provide.

**Drawings at design stage**
Drawings intended to explain a scheme and to promote its merits. Drawings may include tones or hatches to emphasise different materials, but they are diagrams, not intended to appear realistic. Basic presentation drawings typically include people, vehicles and trees, taken from a library of such images, and are otherwise very similar in style to working drawings. Rendering is the art of adding surface textures and shadows to show the visual qualities of a building more realistically. An architectural illustrator or graphic designer may be employed to prepare specialist presentation images, usually perspectives or highly finished site plans, floor plans and elevations etc.

![Image of a house](image)

A development drawing is a design drawing which depicts the building and site as envisaged by the designer. It is from this that the production drawings are made. A “development drawing” moves the scheme to the next stage by
introducing broad parameters of scale etc. This stage enables the client to make some decisions about interior elevations, exterior details and finishes, floor plan choices, cabinet configurations, structural section drawings and roof plans. This stage is to ensure that the client understands and can visualize the type of construction they are getting for moving to the detailed stage.

**Drawings at production stage**

A “location drawing” is a drawing which enables users to:

- a) gain an overall picture of the layout and shape of the building;
- b) determine setting-out dimensions for the building as a whole;
- c) locate and identify the spaces and parts of the building, e.g. rooms, doors, cladding panels, drainage; and
- d) pick up references which lead to more specific information, particularly about junctions between the parts of buildings

Each group of “location drawings” will almost always include site plans, floor plans, elevations, sections and, very often, drainage plans, but there will be occasions when further categories, such as joist layouts, reflected ceiling plans or the enlargement of complex areas may be necessary.

- Component drawing – a drawing to show the information necessary for the manufacture and application of components. Information on basic sizes and system performance data are often also shown.
- Assembly drawing – a drawing to show in detail the construction of buildings and junctions in and between components.
Other documents that may be included in architectural drawings may be:

- Specification – a precise description of materials and workmanship required for a project or construction.
- Schedule – a table that provides information on a range of similar items differing in detail, such as doors, windows etc.
- Bill of quantities – a complete measure of the quantities of material, labour and other items required to complete a project or construction.

For electricians, the two main types of architectural drawings used are:

- Design drawings
- Working drawings

“Design drawings” are used to develop ideas and concepts;
- regarding room relationships
- Dimensions
- Stylistic concepts and development

This type of drawing more often assists in the communication between the architect and the client.

“Working drawings” display the finalised design, together with all necessary information that the contractor and other associated trades require to construct and complete the project. Working drawings are the drawings most commonly used by the tradesperson on the job.

The working drawings may include one or more of the following plans:

- Site plan,
- Floor plan
- Elevations (front, rear, side)
- Section views
- Detailed drawings

During the “construction phase” of a building an electrician will typically use each of the following drawing types:

- Site plans
- Floor plans
- Detailed drawings

NB: It is from the Floor plan that the Electrical layout or Electrical plan is evolved.

Terms used in architectural drawings.

- **Job datum** – a clearly defined and accessible marker which will be visible and not disturbed during the course of construction. This point is typically used as reference point for all other levels and survey points
• **Level** – the height or depth of an object or point related to the job datum.
• **Reflected plan** – the plan of the ceiling or similar, viewed from above

**Architectural drawings and interpretation**

**Using Architectural drawings**

To enable a tradesperson to be able to clearly read and discern the information detailed in architectural drawings the information must be presented in standard format using Australian Standard symbols.

The use of symbols allows information detail to be presented in graphical form, with scaled dimensions and little need for further detail. The following is an explanation of some of the common architectural drawing standard details.

AS/NZ1100.301_2008 Technical drawing - Architectural drawing

AS/NZ1102.111_1997 Graphical symbols for electrotechnology - Architectural and topographical installation plans and diagrams
Architectural Symbols
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing
Standard symbols are used to represent building components on architectural drawings. A clear understanding of these symbols assists in understanding the type of material and its use in the drawing.

Walls

(i) Cavity brick

(ii) Brick veneer

(iii) Timber stud

(iv) Showing structural material

(v)

(vi) or

Alternatives for (i), (iii) and (iii)

(b) Windows

(i)

In cavity wall

(ii)

In single wall

(c) Doors (swing)

(i)

Single

(ii)

Double

(d) Doors (sliding)

(i)

Into a pocket

(ii)

Exposed on wall

(e) Doors (folding)

(i)

Hinged

(ii)

Fabric

(f) Archways

(i)

To arch or lintel

(ii)

To top of the wall

(iii) Servant

Exposed on wall
## Architectural Symbols
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing

<table>
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<th>No.</th>
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<th>Elevation</th>
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<tr>
<td>1</td>
<td>Single sink, left hand drainer</td>
<td><img src="image1" alt="Plan" /></td>
<td><img src="image2" alt="Elevation" /></td>
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<tr>
<td>2</td>
<td>Double sink, left hand drainer</td>
<td><img src="image3" alt="Plan" /></td>
<td><img src="image4" alt="Elevation" /></td>
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<tr>
<td>3</td>
<td>Cleaner’s sink</td>
<td><img src="image5" alt="Plan" /></td>
<td><img src="image6" alt="Elevation" /></td>
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<tr>
<td>4</td>
<td>Laundry sink</td>
<td><img src="image7" alt="Plan" /></td>
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<tr>
<td>5</td>
<td>Washbasin</td>
<td><img src="image9" alt="Plan" /></td>
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<td>Industrial washing trough</td>
<td><img src="image11" alt="Plan" /></td>
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<td>Bath</td>
<td><img src="image13" alt="Plan" /></td>
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<td></td>
<td>A shower bath is indicated by the bath symbol with letters SHR superimposed</td>
<td><img src="image15" alt="Plan" /></td>
<td><img src="image16" alt="Elevation" /></td>
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<tr>
<td>8</td>
<td>Shower tray</td>
<td><img src="image17" alt="Plan" /></td>
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<td>Bidet</td>
<td><img src="image19" alt="Plan" /></td>
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<td>10</td>
<td>WC</td>
<td>![Plan Image]</td>
<td>![Elevation Image]</td>
</tr>
<tr>
<td>11</td>
<td>Urinal bowl</td>
<td>![Plan Image]</td>
<td>![Elevation Image]</td>
</tr>
<tr>
<td>12</td>
<td>Urinal stalls</td>
<td>![Plan Image]</td>
<td>![Elevation Image]</td>
</tr>
<tr>
<td>13</td>
<td>Vanity basin (Locate bowl as required)</td>
<td>![Plan Image]</td>
<td>![Elevation Image]</td>
</tr>
<tr>
<td>14</td>
<td>Spa bath (Indicate spa jets with marks on shape of bath)</td>
<td>![Plan Image]</td>
<td>![Elevation Image]</td>
</tr>
<tr>
<td>15</td>
<td>Drinking trough (Show number of fountains)</td>
<td>![Plan Image]</td>
<td>![Elevation Image]</td>
</tr>
<tr>
<td>16</td>
<td>Drinking fountain</td>
<td>![Plan Image]</td>
<td>![Elevation Image]</td>
</tr>
<tr>
<td>17</td>
<td>Cook top (Example configuration)</td>
<td>![Plan Image]</td>
<td></td>
</tr>
</tbody>
</table>

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**Legend:**

- SINGLE SWING DOOR
- SLIDING DOOR
- STAIRS
- RAMP
- VERTICALLY SLIDING SASHES
- HORIZONTAL SLIDING SASHES
- FLOOR SLIDE SHOWN WITH FLOOR DRAIN
- FOLDING DOOR OR PARTITION CENTRED ON TRACK
NB: Some CAD (computer aided drafting) programs may differ from these symbols however their representation is usually similar so that they can be recognised and used.

(a) Single swing door — $90^\circ$ swing  (b) Pair of double-acting doors

Stairs

Escalator
Building Types
There are three main categories of buildings:

- Domestic
  - Single domestic (homes or residences)
  - Multiple domestic (Town houses, home units or flats)
- Commercial
  - Shops
  - Offices
  - Recreational
  - Churches etc.
- Industrial
  - Factories
  - Ware houses
  - Industrial plant

Site plans
A site plan is a drawing that depicts where a building is located in relation to other major items on the block. These may include:

- Boundaries
- Easements
- Roads
- Or other buildings

They can also indicate other infrastructure that may be associated within and around the site such as landscaping, trees, water tanks, pathways and driveways. An example of a typical site drawing is depicted over the page. Site plans are generally the first plan to examine, particularly for large industrial construction projects. Obviously, the site plan for a single domestic dwelling will not be as complex, but is of equal importance because of the information that it details.

The details that are included on the site plan are as follows:

- Real estate property description street name/s location
- Surveyed spot levels (1 at the four corners, and two at kerb for suburban lots).
- Location of buildings (external walls shown solid; overhangs shown dashed)
- Clearances to boundaries and easements, dimensioned to the outermost projection such as walls or facia.

- **Services**, Route layout and location of connection points such as
  - Electricity,
  - Water
  - Gas
  - Telephone
  - Sewerage, location of any manholes and underground services.
- Scale of plan.
- North point (compass bearing)
- Driveway location and gradient
Other information that may be included
- Location of swimming pool, including fences and pump motor
- Location of water storage tanks, septic tanks, alternative sewerage systems and disposal trenches.
- Contours (sketched from levels).
- Extent of cut, fill and batters
- Location of existing fill if depth greater than 600 mm
- Location, type and maximum height of retaining walls
- Building platform levels, floor levels, maximum flood levels if applicable

Also contained in the site plan, or in a separate attached plan could be;
- Uncovered and covered car parking spaces on site.
- Location of trees which are to be protected and retained, or removed.
- External paved areas (if not shown on floor plan)
- Buildings on adjacent sites if within prescribed distances

**NB:** A site plan could be used to establish details of route length for the “consumer’s mains” for a building.

Examples of typical site plans are shown below.
Site plan

REAL PROPERTY DESCRIPTION
RESUB.16 of SUBDIVISION 24
PARISH of AMPERE
COUNTY of MAXWELL
/Area 871 m²/

Lot 132 Voltaire Street

DATE 8/4/2009 SCALE 1:200
Site plan for a residence
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing
Site plan for a commercial building
Ref: ASZN1100.301_2008 Technical drawing - Architectural drawing
Site plan for a factory building
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing
Floor plans
A floor plan represents the layout of a building (or section) at floor level. It may be as simple as a residential floor plan as shown on the right or a complex multi-storey commercial building showing multiple floor levels.

A floor plan contains the detailed layout and position of doors, windows and fixtures etc.

This plan is used by an electrical tradesperson to determine the position of conduits to be laid in a concrete slab for the purpose of feeding wall mounted socket outlets or island benches etc.

Commercial floor plans often show similar features to residential plans however there are generally other components such as elevators etc which are not normally found in residential floor plans.

There will be different floor plans for multistorey buildings if there are variations to the basic floor design.
A variation to the floor plan is a 3D drawing.

These are created through the use of complex computer programs to illustrate ‘what the floor plan may look like when furnished and occupied.

The image to the right shows a typical 3D drawing.

**Typical Floor Plan Details**
The following information may be included in floor plans.
(In multi floor buildings, there is typically a floor plan for each floor level.)

**Room layout** with nominal function shown (e.g. ‘bedroom 1, bedroom 2, Bathroom ’)

**Dimensions** (include: overall, internal, fittings, features and wall thickness)

**Windows** (with direction of opening, swing and or slide)

**Door openings** (with direction of door swing and or slide)

**Floor details:**
- Steps
- Falls
- Floor line over (if two story)

**Stairs and ramps**
- Directions up /down
- Widths
  - Extra detail may be provided for
    - Materials
    - Riser and tread dimensions
    - Winding stair details
- Built in furniture (vanity, robes, kitchen, etc.).
- Veranda posts
- External paved areas (if not shown in the site plan)
The following items may also be included on the floor plan, or in a separate specialized attached plan:

- Electrical fittings and fixtures such as socket outlets, luminaries, switching arrangements, fans, air conditioners, stoves, wall-ovens, hot plates, washing machines, refrigerators, TVs, telephone outlets, data outlets, smoke alarms etc.
- Meter box
- Electrical switch-boards
- Telecoms switch panels
- Water heater systems
- Air-conditioning systems
- Plumbing fixtures and floor wastes
- Gas cylinders
Floor plan for a residence
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing

NAME OF ORGANIZATION

PROPOSED RESIDENCE

FLOOR PLAN

DATE

JOB No.

ORG No.

SCALE 1:100

SHEET SIZE A4
Floor plan for a commercial building
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing
Floor plan for a commercial building
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing
Floor plan for a commercial building
**Detailed Plans**
In engineering drawings, special sections are sometimes used to illustrate the interior or unusual hidden features of an object. Following the same principles, architectural drawings often show interior views of rooms of a building, as well as details of building construction. Placement of features such as cupboards, built-in's, kitchen and bathroom fixtures, as well finishes can be conveniently shown by sections. Although a floor plan is essentially a section in the horizontal plane, the section in architectural drawings commonly refers to one made vertically through a building. A detailed section may be made through a wall to show the actual wall construction details.

**Detailed drawings are often drawn at larger scales than site and floor plans.**
They show details of specific parts of buildings, such as footings, structural steel frame assembly methods, electrical accessory fixing details, etc.

**Detailed drawing examples**

**Footings plans**
- Footing plans usually include the location of the footing system
- Width and depth of the footings
- Location and levels of drainage required.

**Wall sections:**
- Load baring sections
- Bracing details required

**Roof:**
- Roof line (showing over-hang or eaves)
- Layout (on floor plan or separate plan)
- Ridges, valleys, hips, verandas, overhang (as dashed lines)
- Roof and ceiling beams (with sizes and reference numbers)
- Pergolas and skylights

**Ceilings:**
- Type (cathedral or raked)
- Lower ceiling areas
- Bulkheads

**Elevations**
Elevations are the vertical views of the external walls. Elevations are most commonly titled according to their compass bearing. This drawing is used when establishing the height of features in a building.

Elevations show the:
- Size and shape of external walls
- Size and shape of openings
- External finishes
- New and old ground levels
- Floor and ceiling levels

**Detailed drawing for residential premises**

Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing
Elevation drawing for residential premises
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing

1 ELEVATION

2 SECTION

NOTES

NAME OF ORGANIZATION

JOB TITLE  PROPOSED RESIDENCE

DRAWING TITLE  ELEVATION & SECTION

DATE  JOB No.  ORG No.  C3

SCALE  1:100  SHEET SIZE  A4
Elevation drawing for commercial premises
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing

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**Notes**

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<td>DRAWING TITLE: ELEVATION</td>
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<td>DATE</td>
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**List of Abbreviations**

F - Fixed Glazing

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**Elevation**

- Precast Concrete Panels
- Roof
- FCL
- FEL
- Selected Shopfront Glazing
Section drawing for commercial premises
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing

LIST OF ABBREVIATIONS
F FIXED GLAZING

SECTION A-A

NAME OF ORGANIZATION

NOTES

JOB TITLE: PROPOSED COMMERCIAL BUILDING
DRAWING TITLE: SECTION A-A
DATE
JOB No.
DRG No.
SCALE 1:100
SHEET SIZE A4
Section drawing for commercial premises
Ref: ASNZ1100.301_2008 Technical drawing - Architectural drawing

2 SECTION

NOTES

NAME OF ORGANIZATION

JOB TITLE: PROPOSED INDUSTRIAL BUILDING
DRAWING TITLE: SECTION
DATE
JOB No.
DRG No.
SCALE 1:100
SHEET SIZE A4

4/5
The National Construction Code

The National Construction Code (NCC) is produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Australian Government and each State and Territory Government.

The NCC is a uniform set of technical provisions for building work and plumbing and drainage installations throughout Australia whilst allowing for variations in climate and geological or geographic conditions. The NCC comprises the Building Code of Australia (BCA), Volume One and Two; and the Plumbing Code of Australia (PCA), as Volume Three.

Administration

The National Construction Code (NCC) is given legal effect by relevant legislation in each State and Territory. This legislation prescribes or "calls up" the NCC to fulfil any technical requirements which have to be satisfied when undertaking building work or plumbing and drainage installations.

Each State's and Territory's legislation consists of an Act of Parliament and subordinate legislation which empowers the regulation of certain aspects of building work or plumbing and drainage installations, and contains the administrative provisions necessary to give effect to the legislation.

- Administrative provisions typically covered in the enabling or subordinate legislation include—
  - Plan submission and approval procedures
  - Issue of permits
  - Inspections and audits
  - Provision of evidentiary certificates
  - Issue of certificates
  - Review and enforcement of standards
  - Fees and charges

The NCC provides a dual approach to compliance, so that—

- if compliance is achieved with the Deemed-to-Satisfy Provisions, a proposal is deemed to have complied with the relevant volume of the NCC; or
- if a practitioner wants to take an alternative approach, they have the opportunity to do so – on the understanding that their proposal must meet the Performance Requirements.

The first step in using the performance-based system is to choose the means by which the proposal will achieve compliance. This will be by either—

- a deemed-to-satisfy solution;
- an Alternative Solution; or
- a mixture of deemed-to-satisfy and Alternative Solutions.
The Building Code of Australia (BCA)
The Building Code of Australia (BCA) is Volumes One and Two of the National Construction Code (NCC). The BCA is produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Australian Government and State and Territory Governments. The BCA has been given the status of building regulations by all States and Territories.

The Building Code of Australia (BCA) is Volumes One and Two of the National Construction Code (NCC). The BCA is produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Australian Government and State and Territory Governments. The BCA has been given the status of building regulations by all States and Territories.

The goal of the BCA is to enable the achievement of nationally consistent, minimum necessary standards of relevant, health, safety (including structural safety and safety from fire), amenity and sustainability objectives efficiently.

This goal is applied so—

- there is a rigorously tested rationale for the regulation;
- the regulation generates benefits to society greater than the costs (that is, net benefits);
- the competitive effects of the regulation have been considered and the regulation is no more restrictive than necessary in the public interest; and
- there is no regulatory or non-regulatory alternative that would generate higher net benefits.

Proposals to change the BCA are subjected, as applicable, to a Regulatory Impact Assessment process.

What does the BCA cover?
The BCA contains technical provisions for the design and construction of buildings and other structures, covering such matters as structure, fire resistance, access and egress, services and equipment, and energy efficiency as well as certain aspects of health and amenity.

Overview of Building Structures
An electrician should be familiar with the various building terms and phases of construction which will allow them to correctly interpret plans and to understand how the electrical system integrates with the overall construction.

Foundations
The foundation of a building is the actual ground on which it is constructed. The top soil is removed and the clay or rock is used to give support to the footings.

Footings
The footings of a building consist of all the concrete strips, stumps, slabs and brick walls that are built below the floor level of the building. Footings sit onto the foundation and support the building.

Stumped footings
In Queensland many older homes were built using timber stumps while more modern dwellings tend to have concrete stumps to raise them above the ground level. The length, number and size of the stumps are determined by the type and location of the building and the relevant Building Regulations.
An example of stumped footing is shown below:

**Strip footings**
Buildings with stumped footing sometimes may have a brick exterior finish (brick veneer). This outer brick wall is typically supported by a concrete base called a strip footing.
Concrete slab footings
A concrete slab footing is achieved by pouring concrete directly onto the ground. The slab is normally reinforced with steel bars and it provides both the footings for the building and also acts as the floor base. Currently it is the most common type of footing used in domestic homes in this area. The floor surface is typically tiled, or carpeted etc to provide a finished surface.

Note: If you are required to cut a hole in a concrete wall or floor, NEVER cut a reinforcing steel rod as this could severely weaken the structurally integrity of the building.

Low set or Highset Design
House designs are commonly categorized as being either “low-set” (one story with the floor approximately at ground level) or “high-set”. High-set can mean either a “two storey” (two floors) or one floor which is raised off-the-ground on stumps or a brick base etc..

Many older homes which are built on timber stumps, with timber flooring and open timber batten areas below are commonly referred to as Queenslanders.

Contemporary dwellings generally have concrete or steel stumps to raise them above the ground. The length, number and size of the stumps are determined by the type and location of the building and the relevant Building Regulations.

Unstable soil conditions may require new houses to be built in this manner, instead of the more common concrete slab type construction.

Floor Design
Timber floors
These were commonly used on older style brick veneer constructions or where the building is set on very sloping ground. It often requires the use of piers and stumps. In this form of construction, the brick external walls are continuous to ground level and have strip footings.
The process is to use timber (tongue and groove) floor boards or composite (particle board) sheets which are fixed to timber “floor joists” which are in turn fixed to larger timbers called “bearers”. The bearers rest on brick footings, stumps or piers. Note the “ant caps” are used to prevent white ant entering the main building structure.

The image above shows a low-set “off-the-ground”, brick veneer design with timber floor.
The image below shows a high set, brick veneer design with timber floor second storey

Concrete Floor
In buildings constructed using concrete slab footings, the slab is also used as the primary floor. The slab is designed to support the entire structure and the walls are secured directly to the concrete slab by bolts (sometimes set in place before the concrete sets). Suspended concrete slabs may also be used as a second storey floor. This design is common with home units and commercial buildings, but less common on houses.

Concrete slab
Suspended concrete floor

Walls
The building’s walls are classified as “internal walls”, which have both sides facing the inside the building, or “external walls”, which have one side facing the inside of the building and one side forming the outer wall of the building. The outer face is exposed to the weather.

Internal Walls
There are a number of different internal wall types used, depending on the type of building construction.

Framed walls
Framed walls are usually constructed from timber or steel. The wall frame consists of vertical pieces of material called “studs”, which are fixed to the “top” and “bottom” plates. The “plates” are horizontal supports that form the very top and bottom of the frame. Additional horizontal strengthening pieces called “noggings” are placed between the studs at about half frame height. The noggings prevent the studs from bowing under the weight of the roof. The studs and noggings support the wall cladding material. (eg. Plasterboard)
Where there is a door or window opening in a wall frame, a horizontal “lintel”, which is a thicker stronger piece of timber or steel, is included to ensure that the frame does not lose any structural strength. The wall frame is prevented from going out of square by diagonal pieces called “braces”. It is common nowadays to also fix sheets of “ply-wood” at the corners of the frame to provide additional strength.

**Timber framed walls**
The drawing below illustrates the key names for the parts of the frame. Note the names such as “facia” and “soffit” etc.
Ref: AS1684.2_2010 Residential timber-framed construction - Part 2
The most common cladding used for internal frame type walls is plasterboard. The electrical cables must pass through the plasterboard when fitting off the switches and socket outlets.

**INTERNAL TIMBER WALL FRAME**

**Internal brick walls**
In some constructions the internal walls may be constructed of brick. The finished wall will either be left as exposed brick (as a feature wall) or “cement rendered”, where a layer of cement mortar is applied over the brickwork. When the mortar is dry a thin layer of plaster is applied and the wall may then be painted.
NB: The “plasterer is the tradesperson who typically applies the cement render to the walls.

**Brick, Block and Masonry Construction**

Brick and blocks are used in many forms of construction. For large retaining walls the holes in the blocks are sometimes filled with concrete to give additional strength.

Bricks are bonded together in the wall with a cement based “mortar”: Each layer of brick is called a “course”. For example, we may refer to a point on a wall as “12 courses up”.

![Diagram of brick types and construction](image-url)
External Walls

Framed walls
External framed walls are constructed the same as internal framed walls with the exception of window openings, where required.

The inner face of the external wall is clad with the same material as other internal walls, while the outer face is clad with materials more suitable to exposure to the elements.

Typical cladding for external walls is materials such as brick, fibrous planking, chamfer board or weatherboard.

A typical weatherboard construction is show to the right.

Fibrocement Sheeting (commonly referred to as Fibro)
This type of sheeting is made from cellulose fibre and cement powder. It can be used for both external and internal walls. It is sometimes used as an external cladding where it is cut into sheets resembling weatherboard. It is a common cladding material for low-cost housing.

Warning: Early forms of this sheeting contained asbestos and this material can still be found in many older homes. This material is extremely hazardous. If you suspect that a building contains an “asbestos” product, immediately seek advice on the correct procedures. Typically it requires correct P.P.E. when cutting, drilling or disturbing it.

Brick veneer
The most common form of domestic construction is currently low-set, brick veneer. A timber wall frame is constructed and fixed to the concrete slab floor and this frame supports the roofing frame. The internal wall frames are separated from the external brick veneer by a narrow air space or “cavity”. 
The external wall is mostly “face” brickwork which is fixed onto the timber or steel frame using “wall-ties”. The wall footings are either the concrete strip footing or part of the concrete slab, depending on the construction.

There is a cavity between the outer brick wall and the inner wall frame. It is permissible to run electrical cables within this space.

**Typical brick veneer house construction**
Cavity brick construction
There are two independent walls with a spacing of approximately 50mm between them. This space is called a “cavity”. The cavity provides insulation against dampness, heat and cold etc. The walls are tied together with “wall ties”.

Tilt-Up Construction
Tilt-up, tilt-slab or tilt-wall is a type of building and a construction technique using pre-cast concrete. It is a cost-effective building technique and efficient construction method.

In this method concrete elements (i.e. walls, columns, structural supports, etc.) are formed on a concrete slab; usually the building floor, but sometimes a temporary concrete casting surface near the building footprint.

After the concrete has cured, the elements are tilted from horizontal to vertical with a crane and braced into position until the remaining building structural components (roofs, intermediate floors and walls) are secured.

Steel Framed Construction
Steel in the form of channels, girders or beams are fixed together to form a rigid continuous frame. Cladding sheets are then fixed to both outside and inside surfaces. Utility services are inserted inside the walls as per a timber framed building. The metal is white ant proof, but it can rust. The metal frame must be electrically earthed.
Fire Walls

Building Code of Australia definition: A “Fire wall” means a wall with an appropriate resistance to the spread of fire that divides a storey or building into fire compartments. A fire wall is not simply any wall having a fire-resistance level (FRL). The purpose of fire walls in the Building Code of Australia is:

- To separate different classifications; or
- To compartment buildings having large floor areas; or
- So that for the purpose of the BCA each part can be regarded as a separate building as per Clause C2.7 Separation by fire walls

Both concrete block and brick veneer when constructed in accordance with AS3600 and AS3700 respectively are assumed to meet the Deemed-to-Satisfy provisions of the BCA for the required FRL.

An electrician is required at times to install cables that penetrate through a firewall. To maintain the integrity of the firewall all of the free space around the cables must be filled in to prevent a fire from penetrating from one side of the wall or floor to the other.

AS/NZ3000:2007 Clause 3.9.9.3 Penetration of fire barriers

(a) Where a wiring system passes through elements of building construction, such as floors, walls, roofs, ceilings, partitions or cavity barriers that are required to be fire-rated—

(i) the opening shall be close-fitting to the wiring system and at least 50 mm from any other service opening; and
(ii) the cross-sectional area of the opening shall be not greater than 500 mm², i.e. if circular, 25 mm diameter; and

Exception: The cross-sectional area of the opening may be increased up to a maximum of 2000 mm² (50 mm diameter) for a single cable that leaves a gap of not more than 15 mm between the cable and the opening.

(iii) the fire-rating of structures shall be reinstated where openings remain after passage of the wiring system, in accordance with the relevant provisions of National Building Codes.

NOTES: Guidance on materials suitable for restoring fire-rated constructions is given in National Building Codes.

(b) Wiring systems, such as conduits, cable ducting, cable trunking, busbars or busbar trunking systems, and flush boxes that penetrate elements of building construction required to have a specified fire rating shall be internally sealed to the degree of fire-rating of the respective element before penetration and externally sealed as required by Item (a).

(c) Conduit and trunking systems of material complying with the flame propagation test of AS/NZS 2053 or AS/NZS 4296, as appropriate, and having
a maximum internal cross-sectioned area of 710 mm$^2$ i.e. 30 mm internal diameter, need not be internally sealed provided that—

(i) the system satisfies the degree of protection IP33; and
(ii) any termination of the system in one of the compartments separated by the building construction being penetrated satisfies the degree of protection IP33.

(d) All sealing arrangements used in accordance with Items (a) to (c) shall comply with the following requirements.
Sealing arrangements shall—
(i) be compatible with the materials of the wiring system with which they are in contact; and
(ii) permit thermal movement of the wiring system without reduction of the sealing quality; and
(iii) be of adequate mechanical stability to withstand the stresses that may arise through damage to the support of the wiring system because of fire.

NOTE: This requirement may be satisfied if— (a) either cable clamps or cable supports are installed within 750 mm of the seal, and are able to withstand the mechanical loads expected following the collapse of the supports on the fire side of the seal to the extent that no strain is transferred to the seal; or (b) the design of the sealing system provides adequate support.

(e) Sealing arrangements intended to satisfy Items (a) and (b) above shall resist external influences to the same degree as the wiring system with which they are used and, in addition, shall meet the following requirements:
(i) They shall be resistant to the products of combustion to the same extent as the elements of building construction that have been penetrated.
(ii) They shall provide the same degree of protection from water penetration as that required for the building construction element in which they have been installed.
(iii) The seal and the wiring system shall be protected from dripping water that may travel along the wiring system, or that may otherwise collect around the seal, unless the materials used in the seal are all resistant to moisture when finally assembled for use.

NOTE: Materials and installation methods used for sealing will require the use of certified sealing products and installation methods. There are many fire rated sealants on the market, the ones shown below are just examples.

Fire Rated Sealing Products
3M™ brand Fire Barrier Moldable Putty+ is designed for use as a one-part, 100% solids
intumescent firestop that restores the integrity of fire-rated building construction. It is ideal for construction gaps, cable, insulated pipe, electrical conduit and metal pipe.

Another product is the 3M brand Fire Barrier pillow or Fire Rated Wrap/Strip which is a self-contained, intumescent fire stop product for use in through-penetration situations. Compressing the pillow or wrap prior to insertion secures them in the opening achieving Fire Resistant Ratings of up to 3 hours.

**Roof Types**

There are many roof types and hybrids used for house construction. Some of the more common are show below. Note that the ceiling space is not readily accessible for “skillion” and “flat” roofs. Typically roofing tiles or sheets must be removed to gain access.
Roof Construction

The term roof covers that part of the structure intended to cover and give protection to the lower part of the building. Timber is the most commonly used material for the framework of residential roofs although steel framed houses are becoming more popular. Note: The “eaves” are that part of a roof that meets or overhang the walls of a building.
Truss Roof
The majority of roofs are currently constructed using prefabricated “pine” wood trusses. They are light, structurally very strong and cost less than a custom build roof. The truss is held together using flat “gang nails”.

Note: **Never** drill holes in any part of a truss as this can severely weaken its structural strength.

Roof Coverings
The main roof coverings in use include “concrete or terracotta tiles”, “treated steel sheet”, “galvanized steel”, “fibrous cement sheeting”, “slate or metal shingles” plus many others.

Common Building Materials
The building materials used for construction tasks in this state are continually evolving. Some of the more tradition are discussed below /

Concrete
Concrete is made by mixing sand (fine aggregate) and gravel (coarse aggregate) with cement powder and water. The proportions of each depend on where the concrete is to be used. It can either be mixed on-site or delivered (ready-mixed). Most concrete is reinforced with steel bars or mesh which are included when the concrete is poured. The reinforcement controls shrinkage and cracking and allows the concrete to carry higher loads.

Pre-stressed concrete is a specialised process that applies extra stress to the reinforcement. It allows greater loads to be carried with smaller sections of concrete. Pre-stressed concrete can be used for construction of items such as bridges, floor beams and pre-fabricated wall panels.

Concrete has a very good fire rating as it does not ignite when exposed to heat or direct flame. It will expand and shatter when exposed to extreme heat.
A masonry drill is typically used when drilling small holes in concrete. If the hole is to pass cables through you should ensure that there are no rough edges left to damage the cable. Preferably the cable should be run through a length of PVC conduit inserted in the hole. If the hole is for mounting or securing large equipment then the hole should be drilled to the recommended size for such fixing devices as “Dynabolts” or “Chemsets”. For small sized items, “Rawl plugs” are used for fixings. Larger holes can be made in concrete using jackhammers or impact chisel type power tools.

**Concrete Blockwork**

Concrete blocks (Commonly called Besser Blocks) are used for both structural and decorative purposes. They have a typical grey colour of all concrete products but can be coloured with pigments during manufacture. The standard size of a concrete block is 200mm wide x 200mm high x 400mm long. The most common blocks are hollow to reduce the weight and make them easier to handle. Reinforcement can be used in hollow blocks and the cores filled with concrete for retaining walls and structural walls.

Concrete blocks are strong, and walls can be erected quickly due to the size of the blocks. They are more awkward to handle than bricks and structural walls will need reinforcing. They will usually require further treatment once erected (sealing, painting, rendering, etc).

Holes can be made in concrete block work in the same way as for concrete.

**Brickwork**

Clay bricks are one of the oldest and most durable building materials. The size of a standard brick is 230mm x 110mm x 76mm, although these dimensions may vary slightly between manufacturers. Brickwork is used extensively for walls. The walls are constructed by laying down courses of brick, one course on top of the next. The bricks are held together by a bed of mortar in a similar way to concrete blocks. The bricks are constructed with a series of holes which allows the mortar to seep into the brickwork and provide more strength. Each course of bricks are staggered so that the bricks overlap each other to give the completed wall greater strength. They can be obtained in a wide range of colours and textured finishes depending on the type of appearance sought.

Bricks are hardy and can withstand extremes of heat and cold and will not burn. They have excellent sound/noise reduction properties and like concrete blockwork are not prone to insect attack. Also like concrete blockwork, bricks have good insulative properties and a good fire rating. They are generally more expensive material to build with than other materials such as timber or plaster board cladding. Holes in brickwork will also require the use of a masonry drill. Large holes (greater than one brick) should be avoided as it may weaken the wall.

**Steel**

Steel is a common building material used in all types of construction. It is produced in a large variety of shapes sizes and forms. Steel is also used as the
reinforcing in concrete. Square section steel is used as uprights and lintels in various constructions, while “U” and “C” section steel is used to construct steel framed houses. Corrugated “Zincalume” and “colour bond” sheeting are used extensively as roofing materials.

Advantages of steel as a building material is that it doesn’t warp when used as framing, and is not prone to insect or fungal attack like timber can be. It is very strong and thus smaller size beams can be used compared with timber. It is also non-flammable.

Disadvantages of steel are that it may corrode in the presence of moisture and salt environments. It can be difficult to work with and may need the use of specialised equipment such as welders or grinders. It expands and contracts with temperature change and can make a building “noisy”.

The most suitable way of making smaller size holes in steel is with standard high speed drills. Larger holes in thick steel may require the use of oxy-acetylene equipment while in smaller thickness steel (roofing), nibblers, jig saws and angle grinders may be used. Any holes through which cables may pass must be fitted with suitable PVC bushing to protect the cables.

Timber
Timber and timber products are used extensively in the construction industry. Timber can be broadly classified as hardwood or softwood. Hardwood timbers are often used for structural members such as wall framing, roof trusses, rafters, joists, decking and cladding. Because of it higher strength hardwood timbers can sustain greater loads than softwood timbers of similar cross sectional area. They have a higher fire resistance and generally resist termite attack better than softwood timber. They are however, more expensive than softwood timber.

Softwood timbers can also be used for the type of structural members listed for hardwood, but because of their lesser strength, larger cross sectional timbers are required for the same task. Also structural members need to be placed closer together thus reducing the span between supports. Some softwoods are suitable as flooring material but all have a lesser resistance to fire and termite attack and need to be treated as such. Softwoods are generally not suitable for use in areas exposed to sun or rain without further protection.

Smaller holes in timber are usually made by the use of drills or wood auger bits while larger holes can be made with such tools as jigsaws.

Timber Products
Particle board is made of small “chips” of wood pressed together in flat sheets, with the chips being held together with synthetic glues. It is commonly called “chipboard”. It is relatively cheap and can be veneered with plywood or laminates or used on its own. It provides a smooth surface and can be easily painted to a high quality finish. Some designs tend to absorb water rather easily and may swell and deteriorate if subjected to prolonged contact with water.
Plywood is made of an odd number of thin layers of wood glued together. The layers (or plys) are arranged so that the grain direction of each layer is at right angles to the layers next to it. Plywoods are rated according to the type of glue used to bond the plys. The type of glue used will determine the type of application to which the plywood can be used. Structural plywood is commonly used as a cheap alternative to timer flooring.

Hardboard is made from the waste woodchip fibres that are bonded together under pressure, using natural or synthetic glues. It is medium to dark brown in colour and can be smooth on both sides or have a smooth surface with a grid mesh texture on the back surface. It is commonly used for facing internal doors. Pegboard is a common example of hardboard material. It is harder and denser than plywood, but is still easy to cut. It doesn't hold screws or nails very well however.

**Sheeting**

Plasterboard is a sheet of gypsum plaster that is covered on each side with a thin layer of paper. It is commonly used as a lining for internal walls and ceilings. It is also made into a special curved strip called a cornice, which is used to cover the joints between wall and ceiling sheets. Sheets are generally manufactured in 10mm or 12mm thickness. It is easy to paint, gives a good surface finish and is easy to work with. It is prone to water damage but specially prepared plasterboard is available for use in wet areas such as bathrooms. Commonly referred to as “gyprock”, which is a trade name.

**Fibrocement sheeting** is made from cellulose fibre and cement powder. It was once used for both external and internal walls. It has largely been replaced by plasterboard for internal applications except in wet areas (bathrooms and laundries). Newer water resistant grades of plasterboard is seeing this application being reduced also. It is still used as an external cladding where it is cut into sheets resembling weatherboard. When used externally it is commonly referred to as “Hardiplank”.

Holes in both sheeting types can either be drilled or cut with jigsaws etc.

**Common Building Terms**

**Abutment** that part of a pier or wall either end of an arch, beam, or bridge which resists the pressure of a load.

**Access** approach or way in.

**Access door** allows access to concealed space or equipment.

**Acrow prop** is a strut which is light enough to be man-handled, often adjustable in length and used in scaffolding or to support beams temporarily.

**Aggregate** the crushed stone or alternative substance contained in concrete.

**Allotment** a building site

**Ant capping** termite barrier (shield), usually of galvanized iron, placed over piers and dwarf walls to control the entry of termites.

**Apex** the highest point of a gable.

**Arch** a structure of wedged shaped blocks, or square blocks with wedge
shaped joints, over an opening so disposed as to hold together when supported from the sides, and capable of carrying a load over the opening.

Architect a person who is qualified to design buildings and supervise their construction.

Architrave is a moulded section covering the joint between window and door frames and the wall lining. Used to disguise the gap between joinery and other work.

Area the measure of a plane surface within defined boundaries, eg land, buildings.

Art deco is a geometric style of home furnishings and architecture popular in the 1920s and 1930s.

Attic is the space above the ceiling floor and below the roofing material. This area may contain insulation, mechanical equipment, or stored items. Access to roof rafters and roof sheathing is gained in the attic area. The attic may or may not be accessible.

Australian standard approved standard for material, equipment, technique or procedure as set down by the Standards Association of Australia.

Backfill is the gravel or excavated earth replaced into the trench around and against a basement foundation. To “backfill” means to fill the earth, any remaining space after placing concrete, brickwork, timber, pipes etc in an excavation. Backfill: the replacement of excavated earth into a ditch around a basement or foundation wall.

Bagging a masonry process in which thin mortar is applied to the face of the work with some coarse material.

Bagging is a method of finishing brickwork involving the application of a thin mortar slurry using a hessian bag or sponge. Can be painted over or left to fade in an oxide finish. Usually completed by the bricklayer. Bagging varies in texture and colour greatly and is not uniform like render.

Balcony a platform, enclosed by a railing or balustrade, projecting from the face of either an inside or outside wall of a building (eg a gallery in a theatre).

Baluster a small post used to support a hand-rail.

Balustrade a series of balusters supporting a hand-rail.

Barge board the board covering the roof timbers on the gable or skillion end of a roof, fixed parallel to the roof slope. It is a timber or metal member fixed along the pitched edges of a gable to cover the ends of the roof members. It is similar to a fascia board but is parallel to rafters, on an angle at the skillion end of a gable.

Basement a room or rooms of a building, in part or wholly below ground level.

Batten: Narrow strips of wood or moulded steel screwed to the top chord of trusses to secure roofing iron or tiles or screwed to the underside of the bottom chord of trusses or ceiling joists to attach plasterboard/drywall to create a ceiling.

Bay window a window of varying shapes, projecting outward from the wall of a building, forming a recess in a room.

Bead is a moulding, generally of small size in cross section.

Beam a horizontal load-bearing structural member.

Bearer a member of floor framing, spanning piers and supporting joists.

Bevel an angle formed between two straight lines meeting at an angle other than 90°.
Bond pattern for laying bricks so that none of the perpends are in line in adjacent courses.

Bowing deformation of timber at right angles to its face.

Brace a member, usually a diagonal, which resists lateral loads and/or movements of a structure.

Brick construction a construction where the external and internal walls are built of brick.

Brick veneer framed construction with an outside skin of brickwork tied to the frame.

Brick veneer: a house where the walls consist of a layer of brick covering timber framework. The bricks have no structural role.

Brick(s) blocks of material moulded from clay or cement used for building or paving purposes. Usually bricks burnt in continuous kilns; used in general work.

Bricks (face) are best quality bricks used for face or external work, or for other special work.

Building trades are all trades which have a part in the construction of a building (eg carpentry, masonry, painting, plumbing, electricity, heating).

Butt hinge: a hinge where the pin is inserted into a round barrel. They are commonly used on swinging doors.

Camber is a convexity upon an upper surface (eg beam, bridge, lintel).

Cantilever a projecting beam supported at one end, or a large bracket for supporting a balcony or cornice. Two bracket like arms projecting toward each other from opposite piers or banks to form the span of a bridge making what is known as a cantilever bridge.

Carpentry is the trade of preparing, cutting and fixing timber in building construction.

Carport is a car shelter which is generally open at the sides.

Cavity wall is a hollow wall, usually consisting of two brick walls erected 40 to 50mm apart and joined together with ties of metal.

Cavity: is the common name given to the space between the outer brick wall and the inner timber frame on a brick veneer house:

CCA copper chrome arsenic salts are used in preservation of timber. (ie. The timber has as a greenish appearance) (NB: This chemical a toxic (poisonous) substance and special care should be taken when handling.)

Ceiling height is the overhead internal lining of a room. The height of a room measured from floor surface to ceiling, or, where there is no ceiling, to the underside of the rafters.

Ceiling joist a structural member which binds the wall and roof framing together and carries the mass of the ceiling sheeting.

Cement (portland) is obtained by crushing and burning limestone in kilns, the resulting clinker being finely ground with gypsum and with the addition of various aggregates is used for many purposes (eg concrete, mortar)

Cement rendering: is the application of a thin premixed surface of sand, cement and lime plaster to brick, cement, stone.

Chamfer to take off the edge of any material to a small depth at an angle of about 45°.

Chase means a rough groove or recess cut into a masonry wall for water pipes, conduit etc.

Civil engineering works refers to construction such as such as a dam, bridge,
road etc or an operation such as dredging, dewatering, soil stabilization etc. Not a building.

**Cladding** is any material used to face a building or structure. Cladding is a layer of material that protects the structural elements of a building. Metal, brick, timber and cement sheets are all common types of cladding.

**Clerk of works** supervisor of a building project, employed by the architect or the building owner, to ensure that the architect’s plans are followed accurately and that workmanship is of an appropriate quality.

**Coarse aggregate** is hard stone, basalt, dolerite, cracked river gravel greater than 4.75mm in diameter - a component of concrete.

**Colour bond roof** is a corrugated steel roof.

**Column** free standing is a vertical load bearing member.

**Concrete block** is a concrete building block.

**Concrete** is a mixture of cement, gravel, sand and water that is often used in construction.

**Construction joint**: where two successive placements of concrete meet, allowing for expansion and contraction.

**Construction** the process of assembling materials and erecting a structure. The medium in which a building is built (eg wood, steel or masonry).

**Contour line** is a line drawn on a site plan joining points of the same elevation.

**Contractor** is one who agrees by written agreement or contract to supply materials and perform certain types of work for a specified sum of money.

**Course** is a single row or layer of bricks.

**Cramp** is used to compress edgewise the boards of a floor.

**Crane** is any crosspiece which diverts, transmits, or resists the pressure of a load.

**Cross cutting** means cutting timber across the grain.

**Cul de sac** is an access street with a blind end usually in the form of a turning space for vehicles.

**Curing** means treatment of concrete or cement rendering to facilitate hardening.

**Dampcourse** is a waterproof membrane that protects brickwork or masonry from rising damp.

**Datum** is a predetermined level on a site from which all other levels are established.

**Dead load** is a permanent, inert load on a building or other structure due to the weight of its structural members and the fixed loads they carry, which impose definite stresses and strains upon the structure.

**Defect liability period** is the period of time specified in the contract in which
the builder is required to rectify defects (except for minor settlement or minor shrinkage).

**Defects** are work that is faulty or not to the level specified in the contract.

**Diagonal brace** is an oblique framing member securing wall framing lateral in vertical position.

**Dimension** is a measure of distance.

**Distributed load** is a load spread over a surface expressed in kilograms per square metre, or along a length of member expressed in kilograms per metre.

**Door frame** is a frame into which a door is fitted.

**Door head** is the upper part of the frame of a door.

**Door jambs** are the two vertical members of a door frame.

**Door leaves** in wide openings, a door may be made up into two or more individual sections or “leaves”, which are hinged together.

**Double glass** is also known as insulating glass. Two panes of glass are joined together with a pocket of air between them to reduce heat transfer.

**Dowel** is a wood or metal pin used to strengthen a joint by its insertion partly into each of the joined pieces.

**Dressed** timber is that which has passed through a planning machine to produce smooth surfaces.

**Drywall (gyprok)** is used for interior walls. Drywall usually comes in large panels and is made from gypsum, plywood or a similar material.

**Dumpy level** is an optical levelling instrument.

**Dust mask** is a device fitted over the nose and mouth to prevent inhalation of toxic dust or fumes.

**Dwarf wall** is a brick wall from footing level or underside of floor framing.

**Ear muff** is a shield worn over ears to protect against excessive noise.

**Ear plug** is a device fitted over the nose and mouth to prevent inhalation of toxic dust or fumes.

**Easement** are areas of land located above or around the equipment used for essential services such as pipes and electrical wires. Government authorities control use of this land.

**Easement**: is a right or privilege that one party has in the property of another that entitles the holder to a specific limited use of the property.

**Eaves** are the overhang at the lower edge of the roof that projects over the wall.

**Elevation** is a geometrical drawing of a facade of a building.

**Excavation** is a hole made by removing earth.

**Expansion joint** is a joint in a building to permit thermal movement or creep.

**Expansion strip** is a soft, resilient material used to fill the void provided for the expansion and contraction of any two adjacent substances.

**Fascia** is a board fixed horizontally to the lower ends of the rafters, to which guttering may be fixed. Also forms the outside board of a boxed eave.

**Fibre cement** is a product made of cellulose fibre, fillers, portland cement and water.

**Fibre optic cable** is a high-end data cable that can handle huge amounts of information.

**Fibreboard** is a type of wallboard in which wood chips or shavings are bonded together with resin and compressed into rigid sheets.

**First floor** is the floor which is next above the floor at ground level

**Fittings** are the items that can be removed from a property without damage,
such as ovens, baths and hot water systems.

**Fixed-price contract** is a contract in which the customer and contractor agree on a price that will not change, no matter what the project actually costs the contractor.

**Fixtures** are anything permanently attached to a house and regarded as part of the real property, such as cabinets and cupboards.

**Flashing** is a strip of impervious material used to prevent the ingress of water between two surfaces.

**Flush joint** is used to place two adjacent surfaces together in the same plane. To form an invisible joint between two such surfaces, eg sheets of plaster-board.

**Footing** is the construction whereby the weight of the structure is transferred from the base structure to the foundation.

**Form work** is a temporary structure, often a frame made of wood or steel, that keeps concrete in place while it is being poured and while it hardens.

**Foundation** is the ground upon which the footings of a building are constructed.

**Full brick** is a building where both the inside and outside walls are brick.

**Gable roof** is a roof shape consisting of two sloping surfaces.

**Gable** is the triangular end of a house formed at the end of a pitched roof, from eaves level to apex.

**Grain** is description of direction of growth of wood.

**Ground plan (floor)** is the plan view of a horizontal section of a building showing the layout of rooms on the ground floor.

**Grout** is the mortar used to fill the joints and cavities found between pieces of masonry or ceramics.

**Handrail** railing serves as a guard and which is intended to be grasped by the hand to serve as a support.

**Hanging beam** is a beam above the ceiling used to support ceiling joists.

**Hardboard** is a timber sheet product manufactured of compressed wood fibre.

**Hardwood** Regardless of weight or hardness, 'hardwoods', e.g. red cedar, are technically defined as those woods having vessels (pores), while 'softwoods', e.g. hoop pine, are defined as those not having vessels.

**Header** is a brick laid with its short end to the face of the wall.

**High gloss** is a lustrous, enamel like finish.

**Hip** is a slanting ridge formed by the intersection of two sloping roof surfaces at an external corner.

**Hipped roof** is a roof with an end roughly pyramidal in shape, with surfaces sloping upwards from all three eaves.

**Hoist** is any device or machine used in building for lifting materials.

**Horizontal line** is one that is a tangent to the curvature of the earth's surface. Eg at any given point it is parallel with the surface of still water.

**Hot dip galvanized** is a process by which iron or steel is immersed in molten zinc to provide protection against corrosion while in service.

**Housing recess** is cut across the face of a piece of timber to receive the end of another piece.

**Identification survey** is a survey which indicates whether a building is erected on the correct allotment and does not encroach on any of the side boundaries.

**Isolated pier** is a pier supporting floor framing at points not attached to dwarf walls.
Jamb is a vertical member that forms the side of a window or door frame.
Joinery refers to doors, windows, cupboards, manufactured in a joiner’s shop.
Joint is the area where the ends of two surfaces are joined together by some kind of fastener.
Joists ceiling are the timber members spanning between walls or other supports, to which the ceiling battens or ceiling is attached. Floor timber members to which the flooring is fixed.
Kerf is a cut or incision made by a saw or the like in a piece of material.
Kick back tendency is when a circular saw blade attempts to move back sharply when becoming jammed in the cut.
Kiln drying controlled seasoning of timber by use of kilns.
Laminated timber is layers of timber glued together to increase rigidity or create a multi-coloured effect.
Leveling instrument is a device consisting of a spirit level attached to a sighting tube and the whole mounted on a tripod and used for leveling a surface to a horizontal plane (eg dumpy level).
Line of sight is the straight line projected from the telescope of a dumpy level.
Lining is the internal covering to walls of framed construction.
Lintel is the structural member or beam carrying loads over an opening.
Live load is the load arising from the intended use or purpose of the building or structure, but excluding wind, snow and earthquake loads.
Load-bearing wall is a wall that supports weight from a floor or ceiling above it.
Louvre is a parallel slat in a window (usually adjustable) that allows air and light to enter a building while excluding rain.
Manhole is a large chamber or opening on a drain, sewer or equipment to permit access for inspection, testing or clearance if obstruction. It is also referred to the access hole into the space between the ceiling and the roof of a house.
Masonry brick, concrete, stone, artificial stone or terra cotta laid in mortar.
Master keying a system by which all locks within a building are capable of being operated by one key. Often there are a series of sub-masters.
Mastic is a waterproof adhesive plastic compound.
Mezzanine floor is the a partial story between two main stories of a building.
Milled timber is that has passed through a moulding machine and is of a specific profile.
Mitre is half the angle of a joint.
Mitre saw is a circular saw which can rotate on a swivel base for cutting timber at angles up to 45°.
Moisture barrier is material which is used to retard the flow of vapour or moisture into floor or walls.
Moisture content is the mass of water contained in timber expressed as a percentage of dry wood fibre.
Mortar a composition of lime and/or cement and sand mixed with water in various proportions.
Mortar joints types of joints in finishing the mortar in stone or brick work.
Mortise is a recess in a piece of wood to receive a tenon or lock.
Newels are posts placed at top and bottom of flights of stairs to secure handrails, strings.
Niche is a hollow recess or indent in a wall.
Nogging is a horizontal piece of timber fixed between studs in a framed wall.
Non-load-bearing partition or non–load-bearing wall is one which supports no vertical load except that of its own weight and merely defines spaces.

Off-site means in another place out of the building.

Orthogonal projection is a drawing of the various views or sections of a building, so the projecting lines are perpendicular to the place of projection.

Overhang (roof) is the section of a roof extending over the external wall (see eaves).

Overloading means placing too heavy a load on a beam, column or floor.

Owner-builder permit: in some states you must have this permit before you are allowed to carry out building work above a certain value by yourself.

Paint is usually a coloured liquid laid on the surface of building materials by a brush, roller or spray gun, drying as an impervious coat to protect the material covered from the effects of the atmosphere and also for decorative purposes.

Painter’s putty is a plastic substance composed of a mixture of whiting and linseed oil and sometimes including white lead, used for fixing panes of glass in window frames and to fill nail holes and defects in wood before applying paint or enamel.

Pane is a single piece of glass in a window or door.

Panel is an area on a wall, ceiling, raised above or sunk below the general surface; a piece of wood framed within four other pieces of wood, as in the styles and rails of a door, but often applied to the whole square frame and the sinking itself; in fencing, a section or infilling between two posts.

Parapet is a low wall at the edge of a roof, balcony, bridge or terrace.

Particle board is a plywood substitute made from coarse sawdust and resin pressed into sheets.

Particleboard is a manufactured material formed by bonding together flakes of wood and pressing them into a dense sheet.

Party wall is the wall between two adjoining buildings but common to and used to advantage of both buildings.

Patio is a paved backyard area.

Pelmet is a built-in head to a window to conceal the curtain rod or to a sliding door to conceal the tracks. Usually made of wood.

Pergola is an open framework over a path, terrace or patio.

Perpend is the vertical joint in a masonry wall. A “ned joint” is the horizontal joint.

Picture rail is a wooden or plaster moulding fixed to a wall at or above door height for hanging pictures or for decorative purposes.

Pier is a vertical member of base structure.

Pilot hole is a hole drilled to receive a nail or screw.

Pitch roof is the ratio of the height to span, usually measured in degrees.

Pitch is the angle of inclination to the horizontal of a roof or stair.

Plank is a timber member between 50mm and 100mm thick and over 150mm wide.

Planning permit: Municipal councils place restrictions on building activities in their jurisdiction.

Plans: technical drawings completed by an architect or draftsperson and used in the construction of a house.

Plant tools and equipment are used in building operations. To attach or fix by
nailing or otherwise, eg planted door stop.

**Plaster** material is a mortar like consistency used for covering walls and ceilings of buildings usually made of portland cement mixed with sand and water.

**Plasterboard** is a rigid insulating board made of plastering material covered on both sides with heavy paper.

**Plasterer** is a tradesperson who mixes plasters wall surfaces of buildings to prepare them for decoration. The main role of a plasterer is to paste layers of plaster onto walls, floors and ceilings. A plasterer also cement render walls prior to painting. Plastering serves a protective function, in that it makes buildings more robust, and an aesthetic function.

**Plaster** is any calcareous compound, usually of gypsum plaster, portland cement or lime putty and sand, that has been applied to a surface in a plaster state and sets hard.

**Plastic paints** synthesised paints using a form of liquid plastic as vehicle.

**Plates (Top and Bottom)** are the horizontal members used at the top and bottom of a wall frame. They hold the studs in place.

**Plumb means** vertical or perpendicular.

**Plumber** is a qualified tradesperson who fixes metal roofing, installs waste pipes, water systems and gas piping.

**Ply or plywood** is two or more thin sheets of wood glued together, with the grain of adjacent layers usually at right angles to each other to form a sheet.

**Plywood** is sheeting made from thin layers of veneer at right angles to each other and bonded together under heat and pressure. Can be used as flooring, wall sheeting, bracing and formwork.

**Plywood** is a piece of wood made from three layers of veneer wood bonded with glue. For strength, the middle layer is usually laid with the grain perpendicular to the layers above and below.

**Pointing** is the completion of jointing between ridge or hip tiles with a matching colour after bedding of tiles or troweling of mortar into joints after bricks have been laid to touch up.

**Portable power saw** is a circular saw powered by an electric current. Can be carried and operated when held by hand.

**Portland cement** is a component of concrete and mortars which combines with water to provide the cement agent. Named for its resemblance to portland stone.

**Pre-cast concrete** is manufactured away from its ultimate location.

**Pre-cast** poured or cast in any place other than its ultimate position (eg pre-cast units of concrete houses).

**Prefabricated construction** means the manufacture in a factory of whole or parts of buildings such as individual rooms, walls and roofs, in contrast with the conventional construction of a building piece by piece on the site.

**Prime cost items** this is an allowance or a reasonable estimate for fixtures and fittings that you select after the contract is signed and may include special kitchen and bathroom items.

**Profile** a frame set up on a building site on which is indicated the position of the building. (sometimes called hurdle).

**Progress payments** are made to the builder at specified stages during the
building process.

**Purlin** is a horizontal timber which supports rafters, or one that supports the roof sheathing directly.

**Putty** is a ‘mastic’ formed by binding whiting with linseed oil.

**PVC (polyvinyl chloride)** is a widely used plastic. Its main uses include water pipes, waste pipes and floor covering.

**Quad moulding** is that having a profile of a quarter of a circle.

**Rafter (common)** is used in roof construction. It is a timber framing member providing the principal support for the roofing material.

**Rebate** is a step-shaped reduction cut along an edge or face or projecting angle of wood.

**Regulations** are rules made to implement an act of parliament (ordinances).

**Reinforced concrete construction** is a building construction in which the principal structural members are made of concrete which is poured around isolated steel bars, or steel meshwork, in such a way that the two materials act together.

**Reinforced** means o strengthen by the addition of new or extra material (eg reinforced concrete, steel rods are embedded to give additional strength).

**Reinforcing fabric** means prefabricated steel reinforcement for concrete, consisting of an oblong or square mesh of parallel steel wires welded at points of contact and manufactured in flat sheets or rolls.

**Reinforcing steel** bars of various sizes and shapes used in concrete construction for giving added strength.

**Rendering cement** is the covering of a wall surface with one or more coats of cement mortar.

**Retaining wall** is any wall subjected to lateral pressure other than wind pressure and built to retain material.

**Return** is a term denoting that a feature has been continued at another angle.

**Reveal** is the thickness of wall from the wall face to the door or window frame. The remainder of the thickness of wall is known as the ‘jamb’.

**Ridge** is the highest part (apex) of a roof, which is usually a horizontal line.

**Ridge capping** is the weather proofing material at the very apex of the roof.

**Ridge** is the horizontal member at the highest point of a roof where the common rafters meet.

**Ripping** sawing timber in the direction of the grain.

**Roof pitch** is the angle formed between a sloping roof surface and a horizontal line.

**Roof pitch** is the incline or slope of a roof.

**Roof truss** is a frame designed to carry the loads of a roof and its covering over the full span without intermediate support.

**Rough sawn** timber direct from the saw.

**R-value** is a measure of how effective a material (glass, for instance) is at resisting heat flow.

**Sanding** is the smoothing down of visible timber or other surfaces with sandpaper.

**Sapwood** is the outer layers of a tree which are still living and contain nutrients.

**Sarking** is a covering of water-proof building paper beneath the external roof covering. It is a reflective foil laminate that is installed inside roofs. It has many benefits including weather proofing, insulation and reduction of
Sash is the framework in a window, into which the glass is fitted.

Scaffolding is a temporary structure specifically erected to support access platforms or working platforms.

Scantlings are sawn framing timbers of comparatively small dimensions (eg 100 x 50) in a building.

Scarifying is the joining of two pieces of timber together in length by which the two ends are cut to lap over and fit each other.

Screed board is a board used to level off concrete between screeds. Boards or battens set up to establish the height at which concrete is to be leveled off.

Scribing means cutting a piece of timber (eg a moulding), to fit the profile of another to which it is to be fitted.

Seasoned means dried timber by air or kiln.

Seasoning means eliminating excess moisture from timber by air or kiln drying.

Segregation is the tendency for coarse aggregate in concrete to become separated from the cement paste.

Services are supply or distribution pipes for cold or hot water, steam or gas; also power cables, telephone cables, lift machinery, transformers, drains, ventilation ducts, and so on.

Sheet flooring is made up and laid in large sheets.

Sheeting are flat sheets of material to protect or cover a building framework.

Shingles are roofing material installed in an overlapping manner. Shingles can be made from wood, cement, tile, asphalt or metal.

Shoring is the temporary or permanent support of an existing building, often due to demolition or of footing excavation to prevent collapse.

Sill is the horizontal member at the bottom of a window frame.

Skew nail is driven at an oblique angle through a piece of timber and into receiving piece. Usually in opposite pairs.

Skillion is a roof shape consisting of a single sloping surface.

Skirting board is a wooden board fixed to the bottom of a wall at the junction of the floor to prevent damage to the wall or to conceal small gaps.

Skirting moulding is used to cover the joint between floor and wall flooring.

Slab: is a concrete floor placed directly on earth or on a gravel base; usually about 100 to 150mm thick.

Slip joint is a joint so designed that movement of the units joined, by expansion or contraction, is possible without affecting structural soundness or stability.

Soffit is the lower face or under-surface of anything (eg the underface of an arch, the underside of the eaves of a roof).

Softwood is wood harvested from trees that have needles, such as pines, firs and cedars. Does not necessarily refer to how hard the wood is.

Soil test is a core of earth taken from specific positions on a building site to test and select the type of footing needed.

Solid plaster is material of a mortar like consistency (usually made of cement mixed with sand and water) covering rough walls of a building to produce a smooth finish.

Spandrel is that part of a wall that is roughly triangular in area, enclosed by the curve of an arch on one side, a horizontal line through the crown of the
arch on the top side and a vertical line from its springing on the third side. The triangular space under the outer string of stairs. Infill panel between window sill and floor.

**Splice joint** is used to extend timber in length.

**Stair stringer** refers to the pieces of timber that is cut out to form the actual stairs.

**Steel frame construction** building is one in which the structural members are of steel or dependent on a steel frame for support.

**Stirrups used** in reinforced concrete beams, vertical or inclined rods to resist shear stress.

**Stop (stopping)** is used to fill blemishes in work to be painted, eg nail holes, cracks, to bring them to an even surface after the application of the first or priming coat in timber work generally and prior to painting in plaster work.

**Storey rod** is used to measure during construction the vertical heights of brick courses, and doors, windows and other openings. Prepared at the start of the job to ensure uniformity of heights throughout.

**Storey** is that portion of a building between any “floor level” and the floor level above it.

**Straight edge** is a length of timber with the sides and edges even and true, and the edges parallel; used for trueing and plumbing and levelling work.

**Strata title** grants ownership over a section of a larger building.

**Stretcher** is a brick laid with its largest side to the face of the wall.

**Strip flooring** is laid as separate boards, fitting together with a tongue on one edge and a mating groove on the other.

**Stucco** is traditionally an external render to provide a decorative finish but now generally referred to as a fibro wall sheet with a decorative finish.

**Stud** is a vertical member in wall framing.

**Stump** is a vertical post of timber, concrete or steel sunk into the ground and used to support a building structure off the ground.

**Subcontractor** is a person, partnership or company who contracts with the builder to carry out part of the building works.

**Subfloor** is a floor that will serve as the base for another floor; for example, a concrete floor that is covered over with floating floorboards.

**Surveyor** is a professional who carries out surveys of property elevations and boundaries.

**Suspended ceiling** is a ceiling which is suspended from and is not in direct contact with the floor or roof construction above and generally used to conceal services.

**Survey pegs** are established by a surveyor and are used by the builder the perimeter boundaries of the building plot.

**Suspended concrete slab** is a slab spanning between supporting walls or posts.

**Tamp means** to pound down or consolidate the material eg soil.

**Template** is a guide for forming work to be done.

**Thermal mass** is a concept in architecture that relates to the amount of time it takes for a material to gain or lose heat. Materials with a high thermal mass are energy efficient.

**Tiler** is a tradesperson who specializes in laying ceramic tiles on floors and walls.
Timber is wood used for building applications. Tongue and groove timber are boards that have a groove on one side and a tongue on the other so they can be joined together. Used often for floor boards.

Tooled joints are mortar joints which are specially prepared by compressing and spreading the mortar after it has set slightly (e.g. weathered joint, v joint and concave joint).

Trench in joinery is a groove in a piece of timber. In drainage and plumbing it is the excavation in which pipes are laid. In foundations it is the excavation in which footings are placed.

Trestle is a steel or wooden ladder structure used to support, planks to form a working platform.

Truss is a structural support unit of three or more members, usually arranged in a triangular shape. Trusses are often used to support roofs and floors.

Trussed roof is roof which uses roof trusses for support.

Tungsten-tipped means inserts of tungsten carbide welded to the tips of circular saw teeth or drills to minimize the need for re-sharpening.

U bolt is an iron rod bent into a u-shaped bolt, with screw threads and nuts on each end.

Undercoat is a coat of paint between the priming and the finishing coats.

Underpinning means the construction of new footings and walling under the footings of an existing structure which have failed or may fail.

Valley is the internal angle formed by two inclined slopes of a roof of an internal corner.

Vapour barrier means impervious membrane providing a barrier against water vapour.

Variation is an omission, addition or change to the works, or a change in the manner of carrying out the works and should be outlined in the contract. A variation can be made at your request or at the request of the builder.

Veneer is a thin layer of high-quality wood that is glued on top of other wood for aesthetic purposes.

Vermin proofing can mean a wire mesh fixed to bottom plate and set into mortar joint in brick veneer buildings to prevent entry of vermin into cavity.

Waffle pods are a lightweight but strong void former system for concrete slabs meaning construction can be completed quicker.

Wall sheeting means materials used for external and internal linings, e.g. strawboard, fibre cement, fibrous plaster, plaster wall board, compressed wood fibre board.

Wall tie is a thin steel wire tying brickwork to timber frame on a brick veneer house. It can also be a strip of metal built across cavity walls to join the inner and outer skins.

Water cement ratio is the ratio between the amount of water and the amount of cement present in concrete.

Water closet (WC) is a room which contains a flush toilet, usually accompanied by a washbowl or sink. The term may also be used to refer specifically to a flush toilet.

Waterproof cement is a cement which, when set, is watertight.

Waterproof materials in construction are used to prevent water from passing through walls and joints.
**Waterproofing walls** means the making of walls impervious to water or dampness by mixing a compound with the concrete, or by applying a compound to the surface of the wall.

**Weatherboard** refers to overlapping boards for external surfaces that keep out rain.

**Weep holes** are openings sometimes left in the perpend of a brickwork course over flashings, and at the bottom of wall cavities for drainage purposes.

**Wind brace** is a structural member, either a tie or a strut, used to resist lateral wind loads.

**Wind load** is the estimated pressure or force exerted upon a structure by the wind, which must be provided for in the design of the structure.

**Wiring closet** is a special room set aside in a home automation system where all the wires terminate.

**Works** means the work to be carried out, completed and handed over to you in accordance with what is set out in your contract documents including the

**Wrot (wrought)** means dressed or worked, either by hand or machine.

**Zoning** refers to council rules regarding the uses that an area of land may be put to.

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**Warning: Working with Copper Chrome Arsenic (CCA) Treated Timber**


While CCA treated timber appears to be a safe product, you should limit possible exposure to the chemicals as a precaution. While using CCA treated timber you should:

- Observe warning labels on CCA treated timber.
- Cover any existing skin injuries such as cuts, wounds or abrasions before you work with CCA treated timber.
- Wear a dust mask labelled either as P1 or P2 to avoid inhaling sawdust (P2 masks are sometimes referred to as N95 masks).
- Wear eye goggles, gloves and appropriate clothing to prevent splinters.
- Keep food and drinks away from sawdust or CCA wood surfaces.
- Avoid sawing or sanding the wood in confined spaces. Work with CCA wood outdoors whenever possible.
- Reseal cut surfaces with a timber preservative.
- Use stainless steel or ‘hot-dip’ galvanised plates, bolts and nails.
- Wash your hands and face after working with the wood and before eating, drinking or any other activity that involves hand-to-mouth contact such as smoking.
- Clean sawdust from personal protective equipment (PPE) before you use it again.
Co-Operation between the Trades
At various stages of construction there are certain tasks that the electrician must carry out. Achieving these tasks requires a certain degree of co-operation with other trades involved in the buildings construction.

One of the first tasks the electrician must do is to arrange for electricity to be available on site. This may involve the placement of a temporary builders supply pole or the placement of the switchboard and running of the consumer’s mains. Often, this switchboard will be the one that will eventually be supplying the completed building. In the case of a concrete slab construction this requires co-operation between, the electrician and the builder to ensure that the consumer’s mains conduit is placed appropriately so that the electrical conduit will exit the finished slab such that it will eventually be situated within the wall cavity.

During the construction of the slab the electrician needs to place any other conduits and or junction boxes that run through or under the slab such as feeds for distribution switchboards, and feeds for such areas as and “island bench” in a kitchen. In the case of concrete pours for suspended slabs the electrician needs to ensure all conduits are in place for lighting cables etc. Any conduits placed at the time of pouring concrete slabs should be protected so that concrete cannot enter at the ends. It is also important that draw-wires are included and secured to allow cables to be pulled through later.

In a typical concrete slab, brick veneer construction the electrician cannot do much more until the internal wall frames and roof trusses are in place. (some prefer to wait until the roofing material is in place) At this point, the electrician can commence the “pre-wire”. During the “rough-out” (pre-wire) the electrician will nail all horizontal and vertical wall brackets onto the appropriate wall studs. These brackets will later support the power and light fittings. Once these are in place the electrician can then begin the run the electrical cables from the switchboard (or from where the switchboard will eventually sit) to each bracket, pulling through the bracket, ensuring that enough cable is protruding for later connection.

Cables should be secured so that they cannot become dislodged and if there are a number of cables at a bracket they should be marked accordingly. Cables are typically run through the ceiling (draped of the roof trusses and ceiling battens) and down the walls to the brackets. When drilling holes through the top-plate for the cables, you should only drill as big a hole as is sufficient for the cable to fit comfortably through.

Once down the wall cables can be run through wall studs and noggings but once again any drilled holes should be kept to a minimum size. It is also permissible to run cables within the cavity between the timber frame-work and the external brick wall. Where the cables are going to terminate at any ceiling fixtures (lights, fans, etc) they should be hung in such a manner as to indicate exactly where they are intended to come through the fitted ceiling sheets.

Some electricians prefer to place them out of the way and put them through the
ceiling sheets themselves later. This means that you must be able to have access to the ceiling space, which on some roofs, may not be the case.

Securing ceiling cables and wall cables in the correct position is essential as the electrician generally relies on the plasterers to pull the cables through the internal wall sheets as they are put in place. It is important to get it right as this sheeting will more than likely be done when the electrician is not on-site.

Once the pre-wire has been done there is little that can be done electrically until the other trades have finished. The next stage for the electrician is the “fit-off”.

During the fit-off the cables are stripped and terminated at the light and power fittings. Appliances such as stoves and hot water systems will be connected and the switchboard wiring will be completed. Hot water systems should not be connected until the plumber has connected water to it and the tank is filled. Also once the plumber has placed the water pipes in the building the electrician needs to attach an earth bonding conductor. It will vary as to when the fit-off is done but it is usually completed after the internal walls have been painted and any wall tiling has been completed.

Once the switchboard has been fitted off and all other fittings and equipment have been connected the electrician needs to perform a full electrical test on the installation to ensure that it complies with the AS3000 requirements.

Different construction methods may require a different approach to the electrical wiring and the electrician may need to work closer with other trades at various points of construction. In the case of block construction for instance, the electrician will need to work in with the block layers to place conduits and wall mounting boxes in place as the walls are being laid. In all cases the electrician needs to be aware of the type of construction and the electrical requirements of the building to ensure that they have completed their tasks at the appropriate time.
Building construction types, terms, materials and sequence
It is important that you develop an understanding of the construction sequence for commonly used construction methods, and to enable the wiring of accessories to be installed at the most appropriate time.

Before any building construction is commenced, plans and specifications are drawn up. As shown, these contain details of the type and arrangement of structures, including all accessories, fittings, etc. and the position of the structure/s on the site.

Detailed information contained in plans and specs (specifications) allow the calculation of the appropriate supply system, cable type and sizes, wiring methods, accessory / appliance selection and the determination of the location of all accessories and appliances.

The electrician must have a sound knowledge of the various materials commonly used for construction of buildings, knowledge of the general practices used in applying and repairing the various materials, a knowledge of commonly used building terms and of the building construction classifications (eg: brick, veneer, timber)

The focus will be single domestic buildings
Due to the extensive range of building types the most common forms of domestic construction will be discussed in general terms. Types of building vary greatly, dependant on climatic conditions and local building restrictions.

The two most common forms of domestic construction in Queensland are:
- High-set or low-set timber frame with varying types of cladding.
- High-set or low-set brick of varied construction

Domestic building types
- Timber frame, clad with timber or sheet material. (Weather-board, chamfer-board or fibrous cement sheeting)
- Steel frame, clad with timber or sheet material.
- Brick veneer, either timber or steel frame with brick cladding.
- Brick
  - Solid or
  - Cavity
- Block or concrete masonry
- Prefabricated

Building approval
The building/ house etc. is first designed by an architect or structural engineer or both. Detailed plans are then drawn up and a price / quotation / estimate are obtained from a registered builder. The building plans are then lodged with the local council for building approval.

Building Stages
The processes shown below are for a low-set brick veneer construction, but the
basic principles apply for all construction. One building approval is obtained, the main construction stages are:

1. Setting out – building profiles
2. Drainer, foundation trenches, install temporary power supply, and / or meter box in position and fed via underground conduit
3. Foundation poured
4. Slab, Installation of heating systems, bearers, joists and floor erected
5. Wall frames erected
6. Roof framing, fascia and barge board fitted
7. Roof tiled and sheeted
8. Windows and external doors installed
9. External cladding erected
10. Soffits fitted
11. Plumbing installed
12. Electrical cables “rough-in” (fit-out or first fix) installed
13. Ceiling and walls lined and cornice fitted
14. Bath, shower, WC (Water closet) and kitchen installed
15. Doors, architraves, and skirting board fitted
16. Plumbing fittings installed and Hot water System fitted
17. Painting
18. Electrical accessories and switchboard installed and installation tested
19. Documentation submitted to supply entity to enable connection of electrical supply

Site preparation
- The site is surveyed and pegged to indicate property boundaries
- The site is cleared where required (trees felled where necessary)
- The construction area is levelled (the top soil may be removed or scraped to provide a secure or level base)
- Profiles are setup clear of the construction to provide accurate datum points from which the structure boundaries can be established and marked
- Footings and service trenches are measured and marked out for excavation
- Footings and service trenches are excavated
- All under slab services are laid (sewerage and drainage)
- Steel reinforcing is formed for footings

Establishment of utility services such as:
- Water
- Electricity / Gas
- Storm-water
- Sewerage

NB: Municipal councils typically require that a temporary electrical supply and toilet facilities be established on-site before construction commences. Site fencing will also need to be erected and is to remain for the entire construction period.
Phases of House Construction
NB: The key stages where the electrician has an input are shown on the right side of the diagram.
Temporary Power Supply
The first electrical work is typically to provide temporary power for the site.

Temporary Builder’s service pole
(Overhead supply)

Temporary builder’s service in permanent position - (Underground supply)
Setting out construction profiles
Set out of dwelling: The builder / surveyor produces “profiles” (pegs) for the dwelling’s footprint from the design drawings. They start at a boundary corner, and “peg” a corner of the building, then lay a string line to describe the perimeter of construction. If the building has walls that step in and out then the change in direction will need to be included in the profiles.

Footings
The footings help spread out the load from the building structure to the foundation. They also create a level surface from which the building can be erected. The type of footings employed is dependent on:

- Weight of building
- Wall construction type and height
- Soil type
- Slope of the block
- Budget
- Drainage requirements on the block
**Waffle Slab**
A waffle slab is currently a very common construction type. It is like an egg box arrangement i.e. it is not a solid slab. Trenches are dug perpendicular to the perimeter of the building's footprint. Steel reinforcement is laid in the trenches to give it a rigid structure. Large polystyrene squares are laid between beams (instead of aggregate and sand). Waffle slabs use less concrete, however if well engineered, they can be stronger than a solid slab.

**Base / floor**
As shown in previous pages, the floor of a building is typically constructed of timber or concrete.
Wall frames
These are constructed of brick, concrete block, timber or steel or combinations of materials.

Under the current building regulations houses must be built to a “Cyclone Rating”. One method of ensuring this is the “tie-down” bolts used to tie the top-plate to the “slab”.

Wall frames are secured by means of a threaded rod from the bottom plate to the top plate. The threaded rod is either fastened to the reinforcing in the footings or to the slab by means of chemical bolts and is attached to the roof frame by a fixing bracket above the top plate.
Drilling Holes in Studs and Plates
When an electrician is required to run cables through the frame of a house
holes have to be drilled through the top plate, noggings and studs. If the holes
are too large or too close
together, it will structurally
weaken these timbers.
Australian Standard
AS1684.2_2010 Residential
timber-framed construction -
Part 2 sets the maximum hole
size at 25mm diameter and the
minimum spacing between holes
at three times the stud width.
Eg: For a 90 mm stud width, the
minimum distance between
holes is 270mm.

Clause 6.2.1.4 Notching,
trenching and holes in studs
and plates
The maximum size and spacing
of cuts, holes, notches, and
similar section-reductions, in
studs and plates shall be in
accordance with Figure 6.4
(shown to the right) and Table
6.1 (shown below).

Holes in studs and plates shall be located within the middle half of the depth
and breadth of the member, respectively.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Distance between holes and/or notches</td>
<td>Min. 3D</td>
</tr>
<tr>
<td></td>
<td>in stud breadth</td>
<td>Min. 3D</td>
</tr>
<tr>
<td>H</td>
<td>Hole diameter (studs and plates)</td>
<td>Max. 25 mm (wide face only)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. 25 mm (wide face only)</td>
</tr>
<tr>
<td>C</td>
<td>Notch into stud breadth</td>
<td>Max. 10 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. 10 mm</td>
</tr>
<tr>
<td>E</td>
<td>Notch into stud depth</td>
<td>Max. 20 mm (for diagonal cut in bracing only)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not permitted (see Note 1)</td>
</tr>
<tr>
<td>F</td>
<td>Distance between notches in stud depth</td>
<td>Min. 12B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>P</td>
<td>Trenches in plates</td>
<td>3 mm max.</td>
</tr>
</tbody>
</table>
**Protection Against Mechanical Damage**

All TPS (Thermoplastic Plastic Sheathed) cables require mechanical protection if they are installed within 50 mm of the exterior or interior lining surface. The danger is that a nail or screw could be driven into the cable causing a hazard.

AS/NZ3000:2007 Clause 3.9.4.1 General

Wiring systems installed in positions where they may reasonably be expected to be subject to mechanical damage shall be adequately protected in accordance with Clause 3.3.2.6 and the applicable requirements of Clauses 3.9.4.2 to 3.9.4.4.

Cl. 3.9.4.2 Wiring systems near building surfaces.

Wiring systems shall be protected by one of the methods outlined in Clause 3.9.4.4 if they are— (a) concealed within 50 mm from the surface of a wall, floor, ceiling or roof; and (b) located more than 150 mm from internal wall-to-wall or wall-to-ceiling corners; and (c) fixed in position by either fasteners or passing through an opening in a structural member.

**Exception:** These requirements need not apply to wiring systems that can move freely to a point not less than 50 mm from the surface in the event of a nail or screw penetrating the cavity at the location of the wiring system. Figures 3.3 to 3.5 provide examples of protection of wiring systems near building surfaces.

![Diagram of protection against mechanical damage](image.png)

**FIGURE 3.3 PROTECTION OF WIRING SYSTEMS WITHIN WALL SPACES**
The protection referred to in Clause 3.9.4.2 is required for cables in cavities if they are fixed or restrained less than 50 mm from finished surfaces. This applies to each accessible side.

FIGURE 3.4 PROTECTION OF WIRING SYSTEMS WITHIN CEILINGS, FLOORS AND WALL SPACES

Protection referred to in Clause 3.9.4.2 is required within 50 mm of an accessible surface.

FIGURE 3.5 PROTECTION OF WIRING SYSTEMS WITHIN CONCRETE ROOFS, CEILINGS OR FLOORS

Protection referred to in Clause 3.9.4.2 is required if the cable is fixed within 50 mm of the upper surface of the rafters or battens (excluding the outer roofing material itself) or within 50 mm of the lower surface of the ceiling, if any.

FIGURE 3.7 PROTECTION OF WIRING BELOW ROOFING MATERIAL
AS/NZ3000:2007 Clause 3.9.4.4 Protection methods
Where protection of a wiring system is required, in accordance with Clauses 3.9.4.2 and 3.9.4.3.2, the wiring system shall be— (a) provided with adequate mechanical protection to prevent damage; or (b) provided with an earthed metallic armouring, screen, covering or enclosure; or (c) protected by an RCD with a maximum rated operating residual current of 30 mA.

Sisilation
Sisilation is a specific brand of RFL (Reflective foil laminate) used as both “sarking” (vapour barrier) and thermal barrier. An RFL has an aluminium metallic coating over a durable backing. Various products are used under roofs or in wall cavity.
Rough-In
Prior to the installation of the internal lining, the electrical circuits are wired, this is sometimes referred to as a “rough-in”.

This involves the following steps:

- Setting out the electrical requirements
- Attaching nail-on brackets to the wall frames at the appropriate locations
- Drilling holes through the wall frames to accommodate the cabling
- Wiring the circuits in TPS cables
- Identifying particular cables at termination points
- Marking positions of termination points on floor at appropriate locations

Groups of cables are marked and taped together at mounting bracket fixtures to assist in identification and to ensure that all cables are brought through the lining material in the correct locations.
Areas of cooperation between electrical/communications and other building trades

Cooperation is a very important part of the job. As shown, the build sequence is so fragmented that the electrical contractor will most likely not be on-the-job for certain small tasks.

For example, getting the “builder” to place a short piece of conduit below the position of the main switchboard and out through the side of the concrete formwork to accommodate the incoming consumer’s mains. This must be done prior to pouring the concrete slab and while it may take only a few minute to accomplish, you would have to drive all the way out to the site.

Another example is getting the plasterers to cutting holes through the plasterboard for the electrical cables to protrude. A cooperative “tiler” will cut neat holes at the socket outlets and light switches to enable the fixing screws.

When doing the final fit-out of electrical accessories it is very easy to smudge a finished painted surface. A “cooperative painter” will often “touch up” these indiscretions. There are countless examples on the job where cooperation is essential.

All of the “cooperation” mentioned above has been “one-way”, but an electrician on-the-job can often assist other trades with temporary lighting or power to a particular location or sometimes even fix a faulty electrical lead etc. Always remember, “cooperation” is a “two-way-street”.
Electrical Documentation
This may include the following details:

- Electrical plan
- Electrical specification
- Electrical schedule

Electrical plan
The electrical plan is a layout, showing the location details of the electrical accessories and appliances generally on a floor plan or service plan.

- Graphical symbols are used to represent the various fittings and fixtures
- The symbols used should comply with AS/NZS 1102.111:1997
- The location is a general position only and is intended to be used in conjunction with the electrical specification for exact positional detail and mounting
- All lighting outlets should include switching arrangements

Typical Electrical Plan – Lighting
On small jobs, the electrician may have to advise the client on appliance, fitting and accessory types and suggest a recommended number for each. A ‘count’ is made of the number of lights and socket outlets required, and the cost of the installation. The electrician will then have to work out the number of circuits, the number of points on each circuit, and which “point” will be wired into each circuit.

In larger projects, these details will be supplied to the electrician in a specification schedule and it will be up to the tradesperson to carry out the supply and fitting a specified.

**Electrical Specification Schedule**

The electrical specification schedule is a detailed document outlining the following:

- Material / equipment lists, brand, model, type (catalogue numbers) of accessories
- Specific written detail of the location, mounting detail, and type of fittings and fixtures indicated on the electrical plan
- Details of switching and circuit arrangements and cable specifications
- Wiring installation methods and requirements
- Standards of prescribed workmanship
Examples of an electrical schedule for light and socket outlets are shown below.

### Electrical Schedule - Lighting

<table>
<thead>
<tr>
<th>Room</th>
<th>No. of Points</th>
<th>Switching</th>
<th>Location Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porch</td>
<td>2</td>
<td>One-way</td>
<td>Wall brackets on each side of door</td>
</tr>
<tr>
<td>Living room</td>
<td>1</td>
<td>Two-way</td>
<td>Room centre</td>
</tr>
<tr>
<td>Dining room</td>
<td>1</td>
<td>Two-way</td>
<td>Room centre</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1</td>
<td>One-way</td>
<td>Room centre</td>
</tr>
<tr>
<td>Family room</td>
<td>2</td>
<td>Two-way</td>
<td>Wall bracket, centre western wall</td>
</tr>
<tr>
<td>Terrace</td>
<td>1</td>
<td>One-way</td>
<td>Terrace centre</td>
</tr>
<tr>
<td>Toilet</td>
<td>1</td>
<td>One-way</td>
<td>Room centre</td>
</tr>
<tr>
<td>Bath-Laundry</td>
<td>1</td>
<td>One-way</td>
<td>Room centre</td>
</tr>
<tr>
<td>Bedroom 1</td>
<td>1</td>
<td>One-way</td>
<td>Room centre</td>
</tr>
<tr>
<td>Bedroom 2</td>
<td>1</td>
<td>One-way</td>
<td>Room centre</td>
</tr>
<tr>
<td>Garage</td>
<td>2</td>
<td>One-way</td>
<td>Equal spaced in room centre</td>
</tr>
</tbody>
</table>

### Electrical Schedule – Socket Outlets

<table>
<thead>
<tr>
<th>Room</th>
<th>No. of Outlets</th>
<th>Type</th>
<th>Location Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living room</td>
<td>1</td>
<td>Double 10A</td>
<td>Western wall 450mm from SW corner</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Double 10A</td>
<td>Northern wall 300mm from NW corner</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Double 10A</td>
<td>Northern wall 300mm from NE corner</td>
</tr>
<tr>
<td>Dining room</td>
<td>1</td>
<td>Single 10A</td>
<td>Eastern wall 500mm from NE corner</td>
</tr>
<tr>
<td>Family room</td>
<td>1</td>
<td>Double 10A</td>
<td>Western wall 450mm from SW corner</td>
</tr>
<tr>
<td>Bath-Laundry</td>
<td>1</td>
<td>Double 10A</td>
<td>Centre eastern wall</td>
</tr>
<tr>
<td>Bedroom 1</td>
<td>1</td>
<td>Double 10A</td>
<td>Western wall 500mm from NW corner</td>
</tr>
<tr>
<td>Bedroom 2</td>
<td>1</td>
<td>Double 10A</td>
<td>Centre southern wall</td>
</tr>
<tr>
<td>Garage</td>
<td>1</td>
<td>Double 10A</td>
<td>Southern wall 300mm from SE corner</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1</td>
<td>Double 10A</td>
<td>Southern wall 300mm from SE corner</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Double 10A</td>
<td>Southern wall 300mm from SW corner</td>
</tr>
</tbody>
</table>
Sample House Electrical Plan
Note: The numbers on the plan are indexed to an electrical schedule.

Note 1: Item numbers refer to specification schedule details.

Note 2: Standard symbols used are listed in Fig. 6.37.
Class exercise
Determine the position and number of lights and socket outlets that you would recommend for the following house plan.
Cable Schedule
A cable schedule is a table that lists information about the actual cables installed in a particular building or installation. The information could include: circuit or cable number, purpose, origin, destination, cable size, route length, connection details etc.

Example of a basic Cable Schedule:

<table>
<thead>
<tr>
<th>Circuit Number</th>
<th>Function</th>
<th>Origin</th>
<th>Cable Type</th>
<th>Route length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lighting</td>
<td>MSB C/B 1</td>
<td>1mm² T&amp;E Flat</td>
<td>30m</td>
</tr>
<tr>
<td>2</td>
<td>Lighting</td>
<td>MSB C/B 2</td>
<td>1mm² T&amp;E Flat</td>
<td>25m</td>
</tr>
<tr>
<td>3</td>
<td>Power</td>
<td>MSB C/B 3</td>
<td>2.5mm² T&amp;E Flat</td>
<td>35m</td>
</tr>
<tr>
<td>4</td>
<td>Power</td>
<td>MSB C/B 4</td>
<td>2.5mm² T&amp;E Flat</td>
<td>30m</td>
</tr>
<tr>
<td>5</td>
<td>Range</td>
<td>MSB C/B 5</td>
<td>6mm² T&amp;E Flat</td>
<td>12m</td>
</tr>
<tr>
<td>6</td>
<td>Hot Water</td>
<td>MSB C/B 6</td>
<td>2.5mm² T&amp;E Flat</td>
<td>20m</td>
</tr>
</tbody>
</table>

Electrical Drawing - Standard Symbols
A drawing symbol is a graphical representation of a component or item to be included in a plan or diagram. The use of standardized symbols enables drawings to be interpreted correctly. Individual components are represented in a simplified form, especially when the item is too complex to draw simply and clearly.

The standard symbol is used to indicate that a particular item or component is represented on the drawing in a specific location, but does not infer appearance or function. For example, the symbol of a light switch represents the “concept” but does not represent the brand etc.

The use of symbols makes for an effective means of communication between individuals and organisations without the need for complex or long complicated and often confusing written explanations.

The International Standards Organisation (ISO), standards are the accepted International Standards and these are normally adopted / adapted for use within Australia. This allows for clear and concise communications between countries, overcoming language barriers, etc.

Note: The Australian Standards for Electrical Symbols is the ASNZ1102 (Series)
Architectural Style Electrical Symbols
The following symbols are used on electrical plans. Some of these symbols are not used on circuit diagrams.

Graphical Symbols for Electrotechnical Documentation
referenced from Standards AS/NZ 1102.111:1997

Luminaire

Luminaire - Wall mounted

Spot light

Flood light

Fluorescent lamp, general
1 lamp

Fluorescent lamp, general
2 lamps

Fluorescent lamp, general
Multiple lamps

Switch Board - General symbol

Examples
Main switch board
Distribution board
Meter board

Appliances - General Symbol

Accepted abbreviations for specific appliance

Elect. Range WO Garbage disposal GD
Wall oven Cook top Dish washer

Hot Water System

Socket outlet general symbol

Socket outlet (telecommunications)

Telephone

Television
Examples of the use of symbols

1 Light single switched

1 Light 2 way switched

Single light controlled by 1 switch

2 Lights separately switched

2 Lights separately switched

Socket outlets

The Australian Standard Handbook *HB3 Electrical and electronic drawing practice for students* offers a range of symbols that should be used in Australian designed electrical drawings. On the following pages there are a selection of some of these symbols commonly used in electrotechnology industry drawings.
The tables shown below illustrate some of the standard symbols used in electrical diagrams.

<table>
<thead>
<tr>
<th>Contactor Coil</th>
<th>Power contacts</th>
<th>Auxiliary contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Contactor Coil" /></td>
<td><img src="image" alt="Power contacts" /></td>
<td><img src="image" alt="Auxiliary contacts" /></td>
</tr>
<tr>
<td>symbol for contactor coil</td>
<td>Normally open contact</td>
<td>Normally open contact</td>
</tr>
<tr>
<td>letter code K</td>
<td>Normally closed contact</td>
<td>Normally closed contact</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relay Coil</th>
<th>Contacts</th>
<th>Change over contact</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Relay Coil" /></td>
<td><img src="image" alt="Contacts" /></td>
<td><img src="image" alt="Change over contact" /></td>
</tr>
<tr>
<td>symbol for relay coil</td>
<td>Normally open contact</td>
<td></td>
</tr>
<tr>
<td>letter code K</td>
<td>Normally closed contact</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Timer Coil</th>
<th>Timed Contacts</th>
<th>Instantaneous Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Timer Coil" /></td>
<td><img src="image" alt="Timed Contacts" /></td>
<td><img src="image" alt="Instantaneous Contacts" /></td>
</tr>
<tr>
<td>symbol for ON DELAY timer coil</td>
<td>Normally open</td>
<td>Change over</td>
</tr>
<tr>
<td>letter code K</td>
<td>Normally closed</td>
<td>Normally open</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Timer Coil</th>
<th>Timed Contacts</th>
<th>Instantaneous Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Timer Coil" /></td>
<td><img src="image" alt="Timed Contacts" /></td>
<td><img src="image" alt="Instantaneous Contacts" /></td>
</tr>
<tr>
<td>ON and OFF DELAY timer coil</td>
<td>Normally open</td>
<td>Change over</td>
</tr>
<tr>
<td>letter code K</td>
<td>Normally closed</td>
<td>Normally open</td>
</tr>
</tbody>
</table>
Some Standard circuit symbols
The use of symbols allows complex components to be represented by a simple symbols.
**Electrical Drawings**

Electrical drawings are a major ‘tool’ in the installation, service and maintenance of electrotechnology systems. They show how a system operates. They communicate ideas, concepts or specific details about a unit, system or plant. Tradespersons need to be able to understand and interpreting electrical drawings. Each drawing demonstrates how and what should be working or not working at a given time.

It is very important to note, that electrical drawings are always drawn in the “de-energized state”.

Different types of drawing used in the electrotechnology industry to illustrate the operation of equipment and processes include; “block diagrams”, “line diagrams”, “circuit diagrams” and “wiring diagrams”.

The symbols used in these drawings are given in Australian Standard AS/NZ1102.102_1997 Graphical symbols for electrotechnology - Symbol elements, qualifying symbols.

**Block diagrams**

The block diagram is a method of displaying complex diagram in simple form. They are the easiest way to provide a general overview of the relationships and operation of a circuit or system. It provides an understanding of the basic principles of operation of a circuit or system. It does not provide detailed information. This type of diagram is commonly used when designing and discussing equipment and circuit layout. Because of the limited information provided, they have limited application beyond planning and development.

The block diagram for a Regulated Power Supply is shown below:

![Block diagram of a Regulated Power Supply](image1)

The block diagram for a motor starter is shown below:

![Block diagram of a Resistor Motor Starter Circuit](image2)
The block diagram is used to:
- Develop ideas and broad concepts of the circuit as to what functions the circuit is to perform.
- Provide a single line representation of the operation of the system.
- Rectangular or square blocks are used to indicate each section of the circuit.
- Single lines join the blocks, and contain arrows showing the direction of energy flow.
- Follow the standards convention of the INPUT is either on the LEFT or at the TOP of the diagram, flowing through the various stages, to the OUTPUT which is either at the RIGHT or at the BOTTOM of the diagram.
- Block diagrams are most commonly drawn in the horizontal arrangement.
- Block diagrams do not usually show any power supply separately.
- The block diagram does not show exact details of the operation of the circuit.

Circuit Diagram
A “circuit diagram” (Also called a schematic diagram) provides detailed information on the operation of a circuit or system. The circuit diagram describes the “scheme” of the electrical operation of the wiring system. That is, it shows the electrical operation, but not the physical layout of the circuit.

Two examples of circuit diagrams are shown to the right. The top diagram is for a simple lighting circuit and the bottom drawing is for a “primary resistance motor starter”.

Symbols are used to represent the circuit components and are joined by lines which represent the conductors that connect the components. The symbolised components are shown and arranged in their electrical relationship, to indicate which components operate, affect, or interact with each other.

The diagram describes the detail of operation, but does not represent the actual physical appearance, the mounting relationship, or the constructional details of the equipment or components.

Basic conventions of circuit diagrams:
- They consist of interconnected graphical symbols.
• The symbols represent actual components.
• Lines are drawn to represent conductors.
• Only one conductor appears to terminate at any one terminal.
• The energy flow follows an accepted logical sequence.

A circuit diagram is used to trace and understand the electrical operational sequence of a circuit.

Particularly complex circuitry may have conductors that are bundled, grouped and or pass through conduits and fittings, the circuit diagram allows the conductor path to be “seen” and traced through the diagram to the applicable controlling components.

With the aid of circuit diagrams, testing procedures for short circuits, open circuits, and incorrect operation of devices can be performed without dismantling either equipment or the installation.

Major applications of the circuit diagram are:
• Circuit design and modification.
• Maintenance and servicing.
• Fault finding procedures.

Typical control circuit diagram.
Example of a circuit diagram of a motor starter with inching button

![Circuit Diagram]

The circuit diagram is the one most commonly used when servicing equipment. They are found in most electrical appliances such as washing machines, refrigerators, microwave ovens, etc. In fact, the circuit diagram may be the only diagram available to the service-person.

**Large Circuit Diagrams**

As equipment becomes more complex there is a limit to how much of the circuit diagram can be fitted on to one sheet of paper. When this happens and more than one sheet is used, there are a number of methods used to link parts of the entire circuit diagram.

Sheet numbers are typically used to link sheets together. By stating how many sheets there are in total you can be certain that all the sheets for the circuit diagram are available.

Row and column references are also used to enable quick location of components within large drawings. Large diagrams will often include an index of all components, listing their sheet, row and column references.

**References to Other Drawings**

It is sometimes more practical to not include all the circuit diagram details of a “stand alone” piece of equipment within a single circuit diagram, (such things as a plug-in printed circuit card or a power supply unit, for example). If we suspect such a component to be faulty we may simply replace that whole unit to get the plant functioning again. We may then take the faulty unit back to the workshop and repair it. In such a case we don’t need to know all the circuit details for the unit and so we represent it as a block on the main circuit diagram.

This block would have its own circuit diagram for use back in the workshop and all we do is refer to that drawing on our main circuit diagram.
**Electrical drawing convention**

To accurately read and obtain information from an electrical drawing, they must adhere to certain conventions and principles. Generally, they should flow consistently as either as a “horizontal drawing” or a “vertical drawing”. Each line of the drawing which contains contacts and coils etc. is referred to as a "rung". The power lines are commonly referred to as “rails”.

A **horizontal drawing** shall have the power supply flowing from left-to-right and the sequence of control operation from top-to-bottom whilst in a **vertical drawing** the power supply flow is from top-to-bottom and the control sequence of operation is from left-to-right.

**Horizontal arrangement**

![Horizontal Drawing](image)

**Vertical arrangement**

![Vertical Drawing](image)

A summary of drawing convention is displayed below.

**Horizontal**

- **POWER FLOW**: left to right
- **SEQUENCE OF OPERATION**: top to bottom

**Vertical**

- **POWER FLOW**: top to bottom
- **SEQUENCE OF OPERATION**: left to right
Example of a “Vertical” circuit arrangement

Wiring diagram
A “wiring diagram” is a detailed diagram showing how a circuit has been physically wired. It details the actual route taken by each cable and conductor and precisely where the physical connections are made.
The wiring diagram is not usually drawn to scale. However, scaled drawings of the components showing construction and connection details are often used.

The following points are applicable to a wiring diagram.
- Components are often drawn in a simplified manner, shown in outline only.
- External connections only are shown.
- All terminal connections are shown weather used or not.
- A number of connections may be shown being connected to a single terminal connection.
- All necessary conductors required to connect and operate the circuit are shown.
- Conductors forming part of a cable are grouped and indicated.
- The wiring diagram is used to physically wire the circuit.
- May be used in conjunction with specification sheets, to provide details of all connections, and numbering codes.

- Generally indicates:
  - Cable size.
  - Cable type.
  - Cable colour coding.

- Used for fault finding when circuits have been altered, modified, or otherwise changed from the original format.
- Ideal when attempting to locate wiring errors.
- Wiring diagrams are used to provide detailed information in relation to the assembly and wiring of equipment.

There is typically a progression from concepts and ideas for a project using a block diagram, through to a circuit diagram to determine how it functions. But, to efficiently manufacture the item then a circuit diagram is developed into a wiring diagram. This makes it much easier to assemble and wire the system.

A conversion from “circuit diagram” to “wiring diagram” is usually not necessary with simple circuits, but is very helpful for large and complex circuits. Wiring diagrams are ideal when more than one person is performing the wiring task. Each person is given a specific section.

Developing a wiring circuit from the circuit diagram allows for the efficient design of the wiring layouts of cable routes, groupings, etc. thus resulting in the most economic and efficient project. The use of a wiring diagram enables checks for errors in wiring, numbering, colour coding, etc. prior to connection. A faulty circuit drawing, and/or electrical connection may cause catastrophic results, for both equipment and personnel.
**Wiring Diagram conventions**

- All conductors should be represented by a line with the colour indicating the conductor type
- The conductors are joined at appropriate terminal connections
- The conductor lines should be equally spaced straight lines
- The conductors should be at right angles when linking to terminals
- Avoid unnecessary crossovers of conductors
- All conductors forming part of a cable should be grouped and indicated appropriately

**Examples of TPS cable grouping:**

![Diagram of TPS cable grouping](image)

**Wiring diagram for a motor starter**

Note how this diagram displays the physical connections for all conductors.
Switches Used In General Lighting Circuits
A switch is a mechanical device that makes, breaks, or changes the course of an electric circuit in a circuit. Basically, an electric switch consists of two or more contacts mounted on an insulating structure and arranged so that they can be moved into and out of contact with each other by a suitable operating mechanism.

The terms “pole” and “throw” are also used to describe switch contact variations.

The number of "poles" is the number of separate circuits which are controlled by a switch. For example, a "2-pole" switch has two separate, identical sets of contacts controlled by the same knob.

The number of "throws" is the number of separate switching positions that the switch can adopt. A single-throw switch has one pair of contacts that can either be "closed" or "open". A double-throw switch has a contact that can be connected to either of two other contacts. A triple-throw has a contact which can be connected to one of three other contacts, etc. Common type switches are shown below:

a) Single pole, single throw (SPST)
b) Double pole, single throw (DPST)
c) Single pole double throw (SPDT)
d) Double pole changeover (DPCO)
e) Intermediate switches
f) Single pole three position

Testing Switch Positions
One of the most common problems encountered in electrical installation work, is connecting wiring to unfamiliar apparatus or control devices. Before making connections to an unfamiliar switch etc, it is important to understand the operation of the switch mechanism and its internal connections.

Testing the operation of a switch mechanism in a de-energised state is normally achieved by using some form of very-low-voltage battery powered continuity tester. The most common testing devices used are a:

- Multi-meter (on Ohms scale setting)
- Insulation Resistance Tester (Megger) On continuity setting
- Circuit continuity tester (buzzer)
A switch mechanism is typically numbered as shown below. The circuit connections of the switch mechanism should be noted on a switching chart. The switching chart will show results in the “on” position and the “off” position of the switch.

Switching terminals of (Clipsal 30M 1-way/ 2-way mechanism)

Types of Mechanism and switching charts

An electrician needs to be very familiar with the operation of each switch before making the connections. If the switching sheet or positions are not provided by the manufacturer, then you must construct one. (Sometimes it is mental only.)

To develop the switching charts you need to:

- Write down all the terminals for the switch
- Draw a column for each possible switch position
- Using a meter check for continuity between each possible terminal combination for each possible switch position
Switching Chart 1

<table>
<thead>
<tr>
<th>Terminals</th>
<th>Toggle position</th>
</tr>
</thead>
<tbody>
<tr>
<td>C - 1</td>
<td><img src="image1.png" alt="Diagram showing terminal 1" /></td>
</tr>
<tr>
<td>C - 2</td>
<td><img src="image2.png" alt="Diagram showing terminal 2" /></td>
</tr>
<tr>
<td>C - L</td>
<td><img src="image3.png" alt="Diagram showing common terminal" /></td>
</tr>
<tr>
<td>1 - 2</td>
<td><img src="image4.png" alt="Diagram showing terminal 2" /></td>
</tr>
<tr>
<td>1 - L</td>
<td><img src="image5.png" alt="Diagram showing terminal 1" /></td>
</tr>
<tr>
<td>2 - L</td>
<td><img src="image6.png" alt="Diagram showing terminal 2" /></td>
</tr>
</tbody>
</table>

1 - Switch terminal on mechanism

C - Common middle terminal on mechanism

2 – Switch terminal on mechanism

L – Looping terminal on mechanism

30MI Clipsal Intermediate Light Switch Mechanism

Terminal 1 >

Common terminal >

Terminal 2 > < Looping terminal

To 2-Way Switch

To 2-Way Switch

To 2-Way Switch

To 2-Way Switch
Internal switching function

Switching Chart 2
Intermediate

<table>
<thead>
<tr>
<th>Terminals</th>
<th>Toggle position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up</td>
</tr>
<tr>
<td>1 - 2</td>
<td></td>
</tr>
<tr>
<td>1 - 3</td>
<td></td>
</tr>
<tr>
<td>1 - 4</td>
<td>✔</td>
</tr>
<tr>
<td>2 - 3</td>
<td>✔</td>
</tr>
<tr>
<td>2 - 4</td>
<td></td>
</tr>
<tr>
<td>3 - 4</td>
<td></td>
</tr>
</tbody>
</table>

1 - Switch terminal on mechanism
2 – Switch terminal on mechanism
3 - Switch terminal on mechanism
4 – Switch terminal on mechanism

Wiring designs for lighting circuits
Different wiring systems are used in various installation conditions and applications. The selection of a particular wiring system is based on the installation environment and building construction type. The primary factors are the need to minimise the number of connections at a given terminal (because of construction type) and finding a method will be most efficient and cost effective.

Note: AS/NZS 3000:2007 requires that all lighting points be provided with an earthing conductor and it is for this reason that Twin and Earth - TPS cables are predominately used for lighting arrangements.

There are two basic forms of wiring lighting circuits. The difference between the
two methods is whether the supply (Active/Neutral & Earth) (the feed) is fed to and loops at the light point itself or at the switch. The two methods are referred to as:

- "Loop at the light" method
- "Loop at the switch" method’

"Loop at the light" method (light to light method)
This is where the supply or feed from the switch board goes to the first lighting outlet or point, and then proceeds to loop from lighting point to lighting point throughout the circuit. The switching or control for the individual lights, drops from the lighting point down to the switch position. This method tends to use less electrical cable, but takes more installation time to make off connections.
“Loop at the switch” method (switch to switch method)
This is where the supply or electrical feed from the switch board goes to the first switch point, and then proceeds to loop from switch to switch throughout the circuit. The switching or control for the individual lights, drops from the lighting point down to the switch position. This method tends to use more electrical cable but takes less time to make off connections.

When using the loop at the light method the active, neutral and earth conductors are looped at the lighting point and a switch drop is taken from each lighting point to its switch.

Switching Charts
When dealing with complex machines, a switching chart provides useful information as to which contacts of a switch are closed and open in the different switch positions. As a switch becomes more complex with many switch positions and many terminals, switching charts are essential in determining which parts of a circuit should be working and which parts should not.

Switching charts are drawn as shown below. They list all the terminals of the switch and have a column for each possible switch position. In these columns an “X” is used to indicate that a connection exists between terminals when the switch is in that position.
The diagram to the right shows that in position “I” terminals “1-2” are connected as are “3-4” and “5-6”. In position “O” no connections are made.

Sequence Switching Charts
Sequence charts are used to show which contacts are open or closed at various stages or cycles for such items as an automatic washing machine or other automated processes.

<table>
<thead>
<tr>
<th>MINUTES</th>
<th>START</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>OFF</th>
<th>30</th>
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</thead>
<tbody>
<tr>
<td>FILL</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WASH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IDLE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RINSE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OPERATIONS

- TIMER MOTOR
- HOT FILL SOLENOID
- COLD FILL SOLENOID
- WASHER MOTOR

COMPONENTS ENERGISED

<table>
<thead>
<tr>
<th>TIMER TERMINALS</th>
<th>CONTACT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>BR TO TM-W</td>
<td>7</td>
</tr>
<tr>
<td>BR TO BU</td>
<td>8</td>
</tr>
<tr>
<td>DR TO BU</td>
<td>9</td>
</tr>
<tr>
<td>DR TO TM-W</td>
<td>10</td>
</tr>
<tr>
<td>R-0 TO TM</td>
<td>13</td>
</tr>
<tr>
<td>BU TO TM</td>
<td>14</td>
</tr>
<tr>
<td>T TO TM</td>
<td>16</td>
</tr>
<tr>
<td>R TO TM</td>
<td>18</td>
</tr>
</tbody>
</table>

TIMER CONTINUITY AND SEQUENCE

- Contact closed, circuit complete
- Contact may be open or closed
- Contact closed, circuit incomplete
- Overflowing while washing or agitating

Note: Contacts 7,8,9 and 10 are energised only long enough to start washer motor.
Single Line Diagrams
In power engineering, a one-line diagram or single-line diagram is a simplified notation for representing a three-phase power flow system. Electrical elements such as circuit breakers, transformers, capacitors, bus bars, and conductors are depicted by standardized schematic symbols. Instead of representing each of three phases with a separate line or terminal, only one conductor is represented. Examples are shown below.
Common circuit component descriptions

Relays
A relay is an electromechanical device, consisting of a current carrying coil, which is used to exert a mechanical action on a moveable magnetic object.

A magnetic effect is produced in the coil as a result of the current flowing in the coil's windings. The electromagnet can be controlled, (turned on or off) by energising or de-energising the coil circuit. The moveable magnetic object is called the “armature” and is moved when the coil is energised. The movement of the armature is used to actuate one or more sets of electrical switching contacts. Typically, relay contacts carry only low values of current. (eg: Couple of amps.) They are used mainly for control circuits.

Contactors
The main contacts of a contactor are designed to carry much larger currents than the contacts of a relay. A contactor is a “power” switching device. The coil of the contactor is operated with only a relatively small current, but its “main” contacts can carry higher currents.

This enables the contactor to control or switch large electrical load currents through the contactor’s main contacts by controlling the small current in the coil. The coil is electrically isolated from the contactor’s switching circuit and may even operate at a different voltage level.

Most contactors have several sets of contacts, mechanically linked, but electrically isolated from each other. One set of contacts are normally closed N.C. (closed in the de-energized state) and one set of contacts are normally open (normally open in the de-energized state)
When the contactor is energized the normally closed contacts open and the normally open contacts close.

**Electrical Relay: Reference:**

**Electrical Contactor: Reference:**

A typical contactor and circuit are shown. The dotted line through the main contacts indicates that they are all mechanically linked and all three operate together. They are, however, electrically isolated from each other. The contactor’s coil is represented by the rectangle with “K1” marked in it. The normally open contact “K1” is a low current “auxiliary contact” shown at the very bottom of the circuit.
Thermal over-load (TOL) protection
Reference: [http://www.meba.cn/Products/Contactor/MBR1-D-Thermal-Overload-Relay.html](http://www.meba.cn/Products/Contactor/MBR1-D-Thermal-Overload-Relay.html)

To provide motors with overload or overcurrent protection, thermal over-load contacts (TOL) are normally fitted in line with the load conductors to the motor.

The TOL typically consists of low-resistance strips which overheat when predetermined currents are exceeded for an extended period. When this occurs, the normally closed contacts spring open. The opening of this contact does not directly disconnect the motor, but the operation first disconnects the coil of the control contactor making it de-energize the motor. This normally closed contact is usually connected in series with the contactor coil, so that the TOL open circuits the coil which automatically de-energises, thereby shutting off power to the motor.

**Thermal overload TOL**
The TOL is fitted in circuit with each phase conductor of the motor circuit. The operation of any TOL interlinked will operate all three.

**Thermal overload TOL contact**
When the TOL operates in the power circuit, it will cause the N.C. contact in the control circuit to open and de-energize the coil and this will interrupt supply to the motor.
Push Buttons
A push button is an electrical switch operated by pressing a button, which in-turn closes or opens a circuit. When the pressure is removed, it typically returns to it previous steady state.

They are commonly used in the electrotechnology industry to initiate the starting of electric motors. Typically, a “red” coloured button is used as a “stop” and a “green” coloured button is used for a “start”. The standard symbols are shown below. They are always drawn in the static or non-depressed state. This means that the contacts for a normally-open contact will “close” when pressed and a normally closed will “open”. The current rating for the contacts is typically “low” which means they are suitable for use in control circuits only.

A typical button design and standard symbols are shown below.
Electrotechnology Industry and Documentation
Scope of work covered by licensing in the electrotechnology industry

Electrical Licensing Information for Queensland

Doing electrical work without a licence is illegal in Queensland. Section 55 of the "Electrical Safety Act 2002" states that only very limited unlicensed tasks are allowed, such as:

- authorised testing of electrical equipment
- installing or repairing telecommunication cables
- electrical work while performing the profession of an electrical engineer
- learning electrical work as an apprentice or trainee.

Section 18 of the Electrical Safety Act 2002 provides more examples of related work not classified as electrical work.

Section 56 of the Electrical Safety Act 2002 states that an "electrical contractor licence" is required for businesses carrying out electrical work for others.

Classes of licences
- Electrical mechanic licence
- Electrical linesperson licence
- Electrical fitter licence
- Electrical jointer licence
- Restricted electrical work licence
- Electrical work training permit

Electrical mechanic licence – (Open electrical work licence).
An electrical mechanic can perform all electrical work, such as:
- install or change an overhead electrical line
- install electrical wiring
- repair any electrical equipment.

Refer to Section 34 of the Electrical Safety Regulation 2002 for more information on eligibility requirements for an electrical mechanic licence.

Electrical linesperson licence
Allows the holder to perform all electric line work, such as:
- electrical work involved in building or maintaining an overhead electric line
- electrical work in the building or maintenance of an underground electric line
- testing of overhead electric lines.

Refer to Section 35 of the Electrical Safety Regulation 2002 (PDF File, 1.02 MB) for eligibility requirements for an electrical linesperson licence.
Electrical fitter licence
Allows the holder to perform electrical equipment work, such as:
- rewinding and repairing an electric motor
- building and assembling a switchboard
- maintain/repair electrical equipment.

Refer to Section 36 of the Electrical Safety Regulation 2002 for eligibility requirements for an electrical fitter licence.

Electrical joiner licence
Allows the holder to perform limited specialist installing, jointing and terminating electrical cables and work relating to electrical cables and equipment, such as:
- jointing and terminating a high voltage cable.

Refer to Section 37 of the Electrical Safety Regulation 2002 for eligibility requirements for an electrical joiner licence.

Restricted electrical work licence
This licence limits the holder to specific electrical work associated with work from another trade. The need to perform electrical work must be legitimate, saving time or money are not good enough reasons. Trades and callings that are recognized as having a “legitimate” need to sometimes perform electrical work are:
- Aircraft maintenance engineer
- Composite equipment service person
- Data communications technician
- Diesel fitter (in relation to electrical equipment coupled to engines)
- Earth moving equipment fitter
- Electric motor service person
- Electronic equipment service person
- Entertainment and servicing technician
- First class machinist
- Fitter and turner
- Gas fitter
- Injection moulding technician
- Instrumentation/process control technician
- Laboratory and scientific electrical equipment technician
- Marine mechanic
- Mechanical fitter
- Office equipment service person
- Photographic equipment service person
- Plumber and drainer
- Neon sign manufacturer
- Refrigeration and air-conditioning equipment service person
- Sewing machine technician
- Systems and instrument technician
- Telecommunication technician
Electrical work licence/permit (other than apprentice)
An electrical work training permit allows a person to train and gain the experience necessary to meet the eligibility requirements for an electrical work licence. Permit holders may need to complete a structured on-the-job training program coordinated by a supervising registered training organisation. It is issued for one year unless cancelled sooner.

Legislative requirements for ensuring electrical or electronic equipment is safe i.e. Compliance requirements of electrical installations


Queensland Electrical Safety Act 2002
The Electrical Safety Act 2002 is the legislative framework for electrical safety in Queensland.

The purpose of this Act is to prevent people from being killed or injured and property from being destroyed or damaged by electricity. It establishes a framework that:

- imposes obligations on those who may affect the electrical safety of others
- establishes standards for industry and the public through regulations and codes of practice for working around electricity
- establishes safety management systems for electricity entities (including power authorities and Queensland Rail)
- provides a system of licensing for electrical workers and contractors
- provides penalties for breaches of the Act
- provides consumer protection against electrical work not being properly performed or completed
- establishes a consultative structure for industry, workers and the community to participate in improving electrical safety


The Electrical Safety Act 2002 is supported by the Electrical Safety Regulation 2002 and a series of codes of practice.

- Electrical Safety Code Of Practice 2010 Risk Management
- Electrical Safety Code Of Practice 2010 Works
- Electrical Safety Code of Practice 2010 Electrical Work
The **Electrical Safety Act 2002** applies to all:

- electricity entities
- employers
- self-employed persons
- designers of electrical equipment and electrical installations
- manufacturers of electrical equipment
- importers of electrical equipment
- suppliers of electrical equipment
- installers of electrical equipment and electrical installations
- repairers of electrical equipment and electrical installations
- persons in control of electrical equipment
- workers at places where electrical equipment is located
- other persons at places where electrical equipment is located

Section 26 of the *Electrical Safety Act 2002* also imposes **electrical safety obligations** on a range of people who may affect the electrical safety of others, including electricity entities, employers, self-employed contractors, workers, designers, manufacturers, importers, installers, repairers and suppliers.

Some provisions of the Act do not apply to:
- a coal mine under the “Coal Mining Safety and Health Act 1999”
- a mine under the “Mining and Quarrying Safety and Health Act 1999”
- petroleum plant
- parts of railway installations

**Structure for consultation and administration of the Act**
The *Electrical Safety Act 2002* establishes a consultative framework for industry, workers and the community, providing for:
- An Electrical Safety Board
- An Electrical Licensing Committee which develops requirements for the licensing and discipline of people who perform electrical work.
- Appointed inspectors to monitor and ensure compliance with the Act

**Electrical Safety Office in Queensland**

**The Queensland Electrical Safety Office in part of the Queensland Department of Justice and Attorney-General**
(Ref: Electrical Safety Plan Queensland 2009 – 2014)

The role of the Electrical Safety Office includes:

- Development of the legislative framework, subordinate legislation and standards for electrical safety;
- Strategic policy advice to the minister on electrical safety matters;
- Advice to statutory bodies including the electrical safety board, the electrical safety education
- Committee, the electrical licensing committee and the electrical equipment committee;
- Inspection (including audits, incident investigations and some fire investigations), advisory and enforcement activities to promote compliance with electrical safety laws and standards;
- Information, education and training activities to assist industry employees and the community reduce the risk of death and injury from electrocution, fire and explosion and improve electrical safety; and
- Management of registration, licensing, approval (electrical equipment) and accreditation regimes required under the act.

**Purpose of technical standards and their development**

Standardization is defined as, “A framework of agreements to which all relevant parties in an industry or organization must adhere to ensure that all processes are performed within set guidelines. This is done to ensure that the end product has consistent quality and that any conclusions made are comparable with all other equivalent items in the same class”.

Standards have been around a long time. From the earliest societies to the present day, there have been physical standards for weight and measure. It is a single reference point against which all other weights and measures can be checked. As society developed, written standards evolved which set down mutually agreed standards for products and services in all fields of life.

The current definition is: A Standard is a published document which sets out technical specifications or other criteria necessary to ensure that a material or method will consistently do the job it is intended to do.


Standards establish a common language that defines quality and safety criteria. They cover everything from consumer products and services, construction, engineering, business, information technology, human services to energy and water utilities, the environment and much more.

Standards are developed for a number of purposes, including:

**Voluntary or mandatory applications** - Standards that specify requirements to achieve minimum objectives of safety, quality or performance of a product or service.

**Regulatory compliance** - Standards that are used to specify minimum least-cost solutions to technical requirements expressing characteristics, performance and design criteria compatible with legislative requirements

**Contractual purpose** - Standards that serve as purchasing specifications or technical conditions of contract between two parties.
Guidance - Standards that may be intended for educational purposes and which include recommendations, or administrative or project management procedures. In general, these Standards will not be adopted in either legislation or contract specifications.

Role of Standards Australia/New Zealand, International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC)

Standards Australia (formerly the Standards Association of Australia - SAA), has for some time published technical standards on a huge range of subjects. (Currently >6000) Australian standards now range from electrical installations to bicycle helmets.

In simple terms, “standards” are technical books prepared by committees with expertise over a wide range of issues related to the subject of the proposed Standard. The development of the standard proceeds only if there is general agreement among the committee members.

This is called consensus and results in a standard that is acceptable to a majority of potential users, rather than one prepared by, say, a committee of manufacturers that might prefer a higher price for a product, or a committee of consumers that may not understand the costs involved in providing a safe or environmentally friendly product.

Many are now joint standards between Australia and New Zealand and these have a designation “AS/NZS”. Even with a joint standard, small sections of text etc are often designated as Australian or New Zealand only.

Benefits of Standardization

Standardization provides enormous social and economic benefits. Safety, interchange ability, quality, reliability. The list is endless, e.g. All traffic lights throughout the world, use “red” for stop and “green” for go. Credit cards are a standard size and fit in all automatic teller machines (ATMs) and most of them can be used anywhere in the world to withdraw cash in the local currency.

http://www.standards.org.au/Pages/default.aspx

Standards Australia is an independent, not-for-profit organisation, recognised by the Australian Government as the peak non-government Standards body in Australia. Standards Australia develops internationally aligned Australian Standards® that deliver Net Benefit to Australia and is the Australian member of ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission). (These group are discussed below).
Standards and the Law
Standards Australia is not part of government, and as such it does NOT make laws or regulations. **Australian Standards by themselves are not legal documents** but many, because of their critical importance (usually to safety), are "called up" into legislation by governments and become then mandatory under the legislation’s jurisdiction.

But, this is a decision made by elected governments, not by Standards Australia. In addition, “Standards” are also often incorporated into legal contracts”.


Standards and Regulation
Standards are **voluntary consensus documents** that are developed by agreement and their application is by choice unless their use is mandated by government or called up in a contract. Standards are but one tool in a regulatory spectrum that may be applied by governments to provide a solution to a “problem”.

Depending on the issue, the optimal solution might be 'no action', or a “non-regulatory solution” like a publicity campaign, or "self-regulation" by means of a voluntary industry code or standard, or quasi-regulation such as a standard endorsed by government, or co-regulation such as a standard cross-referenced in a general or high-level regulation, or legislation.

The chart below illustrates the regulatory spectrum, identifying key ‘Choice Criteria’ to guide selection of the appropriate regulatory tool. The basic principle is that risk assessment should be applied to an issue to identify the most appropriate solution. The more risk attached to the behaviour or issue, the more government involvement is likely. In principle, progress to the right of the spectrum should be in response to increased risk to justify the increased cost and impact upon society. Standards are not always the most appropriate tool.
Benefits of Standards

Australian Standards set out the specifications and design procedures to ensure goods and services consistently perform in the way they are intended. They make a sustained contribution to generating national wealth, improving our quality of life, increasing employment, improving safety and health and using our national resources more efficiently.

International Standards
Standards Australia represents our nation on the two major International Standardizing bodies; the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

The policy of Standards Australia is to base “new” Australian Standards on International Standards to the maximum extent feasible. This means that Australian Standards should be direct adoptions of International Standards unless there are good reasons to the contrary.

The major sources of International Standards are the International Electrotechnical Commission (IEC) for electrical and electronic Standards, the International Organisation for Standardisation (ISO) for non-electrical subjects, Standards published by other recognised international bodies, and Standards published by national Standards bodies that may have become de facto International Standards through widespread usage.

Although the intent is to use the International Standard to the fullest extent possible, there is often the need, for one reason or another, to incorporate changes or alterations.

Benefits of International Standards
ISO (International Organization for Standardization) is the world’s largest developer of voluntary International Standards. International Standards give state of the art specifications for products, services and good practice, helping to make industry more efficient and effective. Developed through global consensus, they help to break down barriers to international trade. International Standards bring technological, economic and societal benefits. They help to harmonize technical specifications of products and services making industry more efficient and breaking down barriers to international trade. Conformity to International Standards helps reassure consumers that products are safe, efficient and good for the environment.

International Electrotechnical Commission (IEC)
The International Electrotechnical Commission (IEC) is a non-profit, non-governmental international standards organization that prepares and publishes International Standards for all electrical, electronic and related technologies – collectively known as "electrotechnology". IEC standards cover a vast range of technologies from power generation, transmission and distribution to home
appliances and office equipment, semiconductors, fibre optics, batteries, solar energy, nanotechnology and marine energy as well as many others.

How standards are used in compulsory and accreditation compliance schemes.
http://www.standards.org.au/Pages/FAQ.aspx#_Toc257193844

As shown, on their own, Standards have no legal status and no requirement for compliance by manufacturers, consumers or the public, hence the term 'voluntary Standard'.

But, when Australian (AS) or joint Australian/New Zealand (AS/NZS) standards are “called up” in State or Commonwealth legislation, these Standards then become mandatory in that jurisdiction and can be subject to the scrutiny of the courts.

In Queensland, the two major “electrical” Acts are the “Electricity Act 1994” and the “Electrical Safety Act 2002”. An act is a “law” passed by parliament and administered by a government department. These “acts” are in turn supported by government “regulation(s)”. A regulation is a more specific description of what the designated administrative body requires as a means of implementing the Act or obtaining compliance with the Act. The “Regulation” is based on the act and receives its legal status from the Act. The regulation makes the act much easier to follow and adhere to. (All parts of an “Act” and its accompanying “Regulation” are “law” and are “mandatory”.

In Queensland, the two main pieces of electrical legislation include:

- The Queensland “Electricity Act 1994” is supported by the “Electricity Regulation 2006”.
- The Queensland “Electrical Safety Act 2002” is supported by the “Electrical Safety Regulation 2002”.

To reduce the technical complexity of “acts” and “regulations” when they are drafted, they “call up” (make reference to) applicable Australia Standards. This citing then makes the “standard” a mandatory document within this jurisdiction.

Some examples of “call-ups” are shown below:

“Queensland Electricity Regulation 2006”

Schedule 9 (p.170) – “wiring rules” means AS/NZ3000 —Electrical installations (known as the Australian/New Zealand Wiring Rules). This means that all references to the words “wiring rules” in the “regulation” means AS/NZ3000. As this regulation encompasses virtually all types and applications of electrical work in the state, then AS/NZ3000 then has universal legal coverage.

The Electrical Safety Act 2002 “calls up” AS/NZS3000 when it makes reference to: “hazardous area” (P.20)

Electrical Safety Regulation 2002 “calls up” a number of standards including
(P21) “safe system of work”, for live work on a low voltage electrical installation, includes, but is not limited to, a system of work that complies with the provisions of AS/NZS4836 (Safe working on low-voltage electrical installations) about ensuring the safety of persons while performing live work.

(P7) Part 67 Employer to ensure electrical installation complies
An employer who employs a licensed electrical worker to perform electrical work on an electrical installation must ensure that the electrical installation, to the extent it is affected by the electrical work, is in accordance with—
(a) if the electrical installation is to be used for construction work—the wiring rules and AS/NZS3012 (Electrical installations—Construction and demolition sites); or (b) if the electrical installation is not to be used for construction work—the wiring rules.

(P106) – Part 91 Safety switches, including portable safety switches
(1) An employer or self-employed person must not use, or allow to be used, a safety switch unless it complies with AS/NZS3760 (In-service safety inspection and testing of electrical equipment) when tested.
(2) An employer or self-employed person must ensure that each safety switch, other than a portable safety switch, the employer or self-employed person has at the workplace—
(a) is tested by a competent person in accordance with AS/NZS3760 immediately after it is connected; and (b) is tested in accordance with, and at the intervals stated in, AS/NZS 3760.
(3) An employer or self-employed person must ensure that each portable safety switch the employer or self-employed person has at the workplace—
(a) is tested by pushing the test button on the safety switch immediately after it is connected; and (b) is tested in accordance with, and at the intervals stated in, AS/NZS3760.
(4) If a safety switch is not working properly, the employer or self-employed person must ensure—
(a) a durable tag is immediately attached to the safety switch that warns people not to use the safety switch; and (b) the safety switch is immediately withdrawn from use.

(P250) – “wiring rules” means AS/NZS3000 (Electrical installations) (known as the Australian/New Zealand Wiring Rules).

Endorsed or Adopted Standards
As shown above, a “Standard” can also be “endorsed” by governments or “adopted” as part of industry self-regulation. While this will not make it law it can still be “enforceable” through other discretionary powers.

Accreditation
Accreditation provides a means of determining and formally recognizing the competence of individuals or organizations to perform activities to a level of technical competence. Accreditation is distinct from “certification”, which focuses on an organization’s overall compliance with systems and products standards rather than technical competence.
The National Association of Testing Authorities, Australia (NATA) is the national organization for conformity assessment of technical operations such as laboratories, inspection bodies, proficiency testing scheme providers and reference material producers. By way of a Memorandum of Understanding, the Commonwealth Government recognizes NATA as the sole national accreditation body for establishing and maintaining competent laboratory practice. NATA also represents Australia in the International Laboratory Accreditation Cooperation (ILAC), the Asia Pacific Laboratory Accreditation Cooperation (APLAC) and on the OECD Working Group on Good Laboratory Practice.

**NATA’s Accreditation Requirements**
The NATA Accreditation Requirements (NAR) is made up of a number of documents. An example is shown below.

Eg: The relevant standard (eg. AS ISO/IEC 17025 or AS/NZS ISO/IEC 17020) for which accreditation is held or sought. This must be obtained by the facility. The following table provides information about the applicable standards or documents and where to obtain them.

| AS/NZS ISO/IEC 17020 | Inspection | Supplier of Australian standards |

NATA accreditation then provides a means of determining, formally recognizing and promoting the competence of facilities to perform specific types of testing, inspection, calibration, and other related activities.

**Standards and codes that apply to all types of electrical installations**

**Arrangement and use of technical standards in relation to electrical and electronic work**

Numerous Australian standards apply to the electrotechnology industry where they specify the requirements to achieve minimum objectives of safety, quality or performance of a product or service. The titles for some of the more commonly used standards are listed below: (Note: The year of release and any amendments is very important. Amendments (changes) are made periodically to information in the standards to accommodate changing circumstances. The amendment could be a result of a recent safety issue or a change in technology etc. An electrician is required to always have access to the current information and have good work knowledge of each of the common standards.)

**AS/NZS 3000:2007 Wiring Rules** (Incorporating Amendment Nos 1 and 2)

Clause 1.1 SCOPE: This Standard sets out requirements for the design, construction and verification of electrical installations, including the selection and installation of electrical equipment forming part of such electrical installations.

**AS/NZS 3017:2007 Electrical installations—Verification guidelines**

Clause 1.1 SCOPE: This Standard sets out some of the common inspection and test methods required to verify that a low voltage, multiple earthed neutral
(MEN) (TN-C-S) electrical installation complies with safety requirements for the prevention of fire, or a person or livestock from sustaining an electric shock.

AS/NZS 3008.1.1:2009 Electrical installations—Selection of cables
(Incorporating Amendment No. 1)
Clause 1.1 SCOPE: This Standard sets out a method for cable selection for those types of electrical cables and methods of installation that are in common use at working voltages up to and including 0.6/1 kV at 50 Hz a.c.

AS/NZS 3001:2008 Electrical installations—Transportable structures and vehicles including their site supplies
Clause 1.1 SCOPE: This Standard sets out the requirements for electrical installations associated with transportable structures and vehicles that are intended for connection to low-voltage a.c. supply systems (i.e. exceeding 50 V a.c. but not exceeding 1 000 V a.c.).

AS/NZS 3002:2008 Electrical installations—Shows and carnivals
Clause 1.1 SCOPE: This Standard sets out requirements for the supply of electricity at low-voltage by wiring systems to power consuming devices used for accommodation, entertainment or display purposes

AS/NZS 3003:2011 Electrical installations—Patient areas
Clause 1.1 SCOPE: This Standard sets out requirements for new electrical installations and for alterations, additions and repairs of existing electrical installations in patient areas.

AS/NZS 3004.1:2008 Electrical installations—Marinas and recreational boats
Part 1: Marinas
Clause 1.1 SCOPE: This Part of AS/NZS 3004 sets out requirements for electrical installations associated with marinas supplied at low-voltage a.c. supply systems (i.e. exceeding 50 V a.c. but not exceeding 1 000 V a.c.).

AS/NZS 3004.2:2008 Electrical installations—Marinas and recreational boats
Part 2: Recreational boats installations
Clause 1.1 SCOPE: This Part of AS/NZS 3004 specifies requirements for the design, construction and installation of electrical systems in recreational boats that have a length of up to 50 m, and are designed for use on inland waters or at sea. It is not intended to apply to small boats equipped with a battery supplying circuits for engine starting and navigation lighting only that are recharged from an inboard or outboard engine driven alternator.

AS/NZS 3012:2010 Electrical installations—Construction and demolition sites
Clause 1.1 SCOPE: This Standard sets out minimum requirements for the design, construction and testing of electrical installations that supply electricity to appliances and equipment on construction and demolition sites, and for the in-service testing of portable, transportable and fixed electrical equipment used on construction and demolition sites.

AS/NZS 3760:2010 In-service safety inspection and testing of electrical equipment
Incorporating Amendments No. 1 and No. 2
Clause 1.1 SCOPE: This Standard specifies procedures for the safety inspection and testing of low voltage single phase and polyphase electrical equipment, connected to the electrical supply by a flexible cord or connecting device...

AS/NZS 4836:2011 Safe working on or near low-voltage electrical installations and equipment
Clause 1.1 SCOPE: This Standard outlines principles and procedures of safe work, organization and performance on or near low-voltage electrical installations and equipment. It provides a minimum set of procedures, safety requirements and recommendations to manage the hazards associated with electricity, specifically arc blast, arc flash, electric shock and electrocution. Adopting these will provide a safe working environment for work on or near low-voltage electrical installations (see Clause 1.6.9) and equipment (see Clause 1.6.8).

Nb: The key point is that while those standards listed above are the main ones "referenced" there are many others that may need to be cited from time-to-time.

How to read and apply a standard.
Nb: Because AS/NZS 3000:2007 Wiring Rules is the most commonly used standard (for electricians) it will be the primary focus of this discussion. This document will often be referred to hereafter as the “wiring rules”.

The “wiring rules” is regarded as another one of the “tools” in the kit of the electrician. A licensed electrical worker must be very familiar with the “use” and “application” of the wiring rules.

Queensland “Electrical Safety Regulation – 2002” “66” Licensed electrical worker to comply with wiring rules. A licensed electrical worker who performs electrical work on an electrical installation must ensure that the electrical installation, to the extent it is affected by the electrical work, is in accordance with the wiring rules. Maximum penalty—40 penalty units. This means that continual access to the “wiring rules” must be available on the job to ensure compliance.

Since its inception as “part of AS CC1—1931” to the latest “fifth edition” issued in the year “2007”, the wiring rules has undergone many changes (and grown in size and complexity). New releases of the “wiring rules” are made every few years. The latest issue was in “2007” and the previous to that was in the year “2000”. Due to changing industry requirements, critical events that take place, including accidents and near misses etc and the introduction of new technologies, substantial changes are made between one issue and the next. In addition, “amendments” are made between issues and these are areas that require immediate attention and rectification.

Amendments to the current “2007” issue of the “wiring rules” include Amendment No. 1 (“A1”) (July 2009) and Amendment No. 2 (“A2”) (December 2012).
Immediately amendments are issued they become enforceable for all “new” work.

Nb: In the image immediately below, note how the fact that this clause has been amended is indicated with tag “A2” and a vertical line highlighting the “clause” part that has been changed.

1.4.6 Appliance

A consuming device, other than a lamp, in which electricity is converted into heat, motion, or any other form of energy, or is substantially changed in its electrical character.

It is the responsibility of ALL licensed electrotechnology workers to be “current” with the latest changes to the standards.

Analysis of:

AS/NZS 3000:2007 Wiring Rules (Incorporating Amendment Nos 1 and 2)

Electrical installations (known as the Australian/New Zealand Wiring Rules)

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-001, Wiring Rules, to supersede, in Australia/New Zealand, AS/NZS 3000:2000, Electrical installations (known as the Australian/New Zealand Wiring Rules).

This Standard incorporates Amendment No. 1 (July 2009) and Amendment No. 2 (December 2012). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected. The development of this Standard has been based on the following considerations:

Parts

The presentation of the “2007” edition differs from previous editions of AS/NZS 3000 in that the Standard comprises two parts but with both parts bound as one document.

Part 1: This part provides uniform essential elements that constitute the minimum regulatory requirements for a safe electrical installation. It also provides an alternative regulatory vehicle for Australian and New Zealand regulators seeking to move from the present prescription of AS/NZS3000 in electrical installation safety and licensing legislation.

Part 1: Satisfies the following objectives:

- It is generally complete in itself to avoid cross-referencing to Part 2.
- It may be called up in regulation as a separate Part or together with Part 2.
- It provides ‘high level’ safety performance outcomes/conditions without prescriptive work methods that demonstrate means of compliance.
- It establishes an enforcement link to Part 2. Failure to comply with a work method provision in Part 2 would breach high level safety conditions of Part 1 unless an alternative mechanism is satisfied.
It establishes the ‘deemed to comply’ status of Part 2, confirming that installations that comply with Part 2 comply with high level safety conditions of Part 1.

It establishes ‘deemed to comply’ status of AS/NZS 3018, relating to simple domestic applications, and parts of other standards, confirming compliance with ‘high level’ safety conditions of Part 1.

It maintains alignment with IEC60364 developments at the level of essential safety.

It provides a mechanism for acceptance of alternative design and installation practices that are not addressed, or are inconsistent with, those given in the ‘deemed to comply’ Part 2. This mechanism is intended to apply where departures from the methods in Part 2 are significant rather than minor aspects that remain within the flexibility of Part 2.

It details responsibilities, documentation and verification criteria for designers or installers that seek to apply an alternative method to the ‘deemed to comply’ methods contained in Part 2.

Part 2: Provides installation practices that achieve certainty of compliance with the essential safety requirements of Part 1. It is primarily a revision of the “2000” edition to provide work methods and installation practices that are ‘deemed to comply’ with the associated performance outcomes/safety conditions.

Part 2: Satisfies the following objectives:

- It may be called up in regulation in addition to Part 1 to reflect a range of regulatory adoption options.
- It incorporates and elaborates on all ‘high level’ performance outcomes of Part 1 with the addition of requirements and recommendations to clarify and support compliance.
- It establishes the ‘deemed to comply’ status of AS/NZS 3018 relating to simple domestic applications, and parts of other standards, confirming compliance with the work methods of Part 2 and the ‘high level’ safety conditions of Part 1.
- It generally retains the structure of AS/NZS 3000:2000, except that Verification (inspection and testing) has been moved to the final section of substantive text as it would be the last function performed in the formation of an electrical installation, and damp situations have been separated from other special electrical installations as they are the more commonly occurring of special electrical installations.
- New introductory selection and installation clauses have been included in Sections 2, 3, 4, 5, 6 and 7.
- It restores information from AS 3000—1991 as requirements, recommendations and examples of typical, effective compliant solutions.
- Emphasis has been placed on common, practicable and cost-effective methods that achieve safety compliance, fitness for purpose and a level of good practice rather than overly conservative or obscure measures.
- Greater use has been made of illustrations and examples to promote understanding of common or difficult aspects, e.g. line diagrams, alternative overcurrent device locations, International Protection (IP).
rating summary, switchboard access.

Testing and inspection provisions have been updated in alignment with AS/NZS 3017, including provisions for periodic inspection in accordance with AS/NZS 3019.

Note:
Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard. The term, ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

Interpretation of Text
Application of different typefaces: There are four different typefaces used in this Standard and each of these has a specific purpose. The typefaces and their application are as follows:

(a) **Bold print** These are opening statements defining the fundamental principle and are generally positioned at the beginning of a clause or major part of a section.

(b) **Normal print** These are mandatory requirements that form the substance of a clause in that they indicate certain methods that satisfy the essential requirements.

(c) **Italic print** These are exceptions or variations to mandatory requirements. These generally give specific examples where the essential requirements do not apply or where they are varied for certain applications. Italic print also represents examples or clarifications given.

(d) **Reduced normal print** These are explanatory notes that may give advice. They are preceded by ‘NOTE’ in the manner used in previous editions. It is important not to read any single typeface by itself as the preceding or following paragraphs may contain additional or modifying requirements.

Cross-references Throughout this Standard, where reference to another clause or portion of a clause has been made to avoid repetition, such reference, unless otherwise stated, shall include all appropriate sub-clauses and paragraphs of the clause or portion thereof referred to.

Frequently asked questions (FAQs) Clarifications to requirements of the Wiring Rules that were covered by rulings and interpretations in earlier editions will be included in FAQs as the need arises. These FAQs will be applicable throughout Australia and New Zealand and will be developed by the Joint Standards Australian/Standards New Zealand Committee EL-001, Wiring Rules. These FAQs can be found online at: [www.wiringrules.standards.org.au](http://www.wiringrules.standards.org.au)

Provision for revision This Standard necessarily deals with existing conditions, but it is not intended to discourage invention or to exclude materials, equipment and methods that may be developed. Revisions will be made from time to time in view of such developments and amendments to this edition will be made only where essential.
Special national requirements: Certain provisions of the Standard have a different application in Australia and New Zealand. The following symbols appearing in the outer margin indicate that the identified Section or Clause is:

1 Applicable in Australia only.  
2 Applicable in New Zealand only.

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The “wiring rules” are comprised of EIGHT separate sections. There is however, a number of “cross references” where earlier information is cited.

The key parts of the wiring rules are:
Part 1: Scope, application and fundamental principles
Section 1 Scope, application and fundamental principles (ie: Mainly definitions)
Part 2: Installation practices—sections 2 to 8
   Section 2 General arrangement, control and protection
   Section 3 Selection and installation of wiring systems
Section 4 Selection and installation of appliances and accessories
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D - Minimum sizes of posts, poles and struts for aerial line conductors
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G - Degrees of protection of enclosed equipment
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I - Protective device ratings and metric, Equivalent sizes for imperial cables used in alterations additions and repairs
J - Symbols used in this standard
K (deleted)
L - Electric shock survival—Australia
M - Electric shock survival—New Zealand

Index (This section is discussed later in detail)

Clauses
The “wiring rules” are written in the form of “clauses” using a “points” numbering system. An example is shown in the image below. This is “Clause 2.3.3.1 “General”. Note that the “2” in the “clause number” means it is from “Section 2” in Part 2.

2.3.3.1 General

The supply to every electrical installation shall be controlled on the main switchboard by a main switch or switches that control the whole of the electrical installation.

Where multiple supplies are provided, each supply shall be controlled by a main switch or switches on the main switchboard for each supply.

Exception: Alternative supplies may be connected to the installation at positions other than at the main switchboard. For further information refer to the applicable Standards: AS/NZS 3010 or AS 4777.

The “bold” text represents the introduction (fundamental principles) of the clause, the “normal” text is “mandatory” (must be done etc) and any possible “Exception(s)” may be shown below in “italics”. Not all clauses are structured in this way. The intention is that the clause text details what you can or cannot “do” and the "exception" then details possible ways to avoid this. If further explanation is required, then additional “Notes” may be provided. These will be situated “below” the clause in reduced sized font. These notes can be very important and must NOT be disregarded.
The key point here is that the clause text is arranged as:
1) Introduction (bold print)
2) Mandatory requirements (normal print)
3) Exceptions (Italics)
4) Notes (Reduced font size)

Note: In the example shown above, the “A2” (and vertical line) at the side indicates that this clause has been changed as part of amendment “A2” (ie: the latest (Dec/12) set of changes). It is highlighting that “YOU” should check this part very carefully as you may need to make a change to what you were doing on earlier jobs.

**Tables**

Tables are an extremely important part of AS/NZS3000:2007. They provide precise details based on specific selection criteria. Some tables provide numerical information; some provide textual information and others direct you to other tables. Two examples of tables are shown below. Note how the first uses pictorial images to represent cabling methods and the second gives numeric details related to “maximum permissible” temperature ratings of cable types.

### TABLE 3.1

**CABLE TYPES AND THEIR APPLICATION IN WIRING SYSTEMS**

<table>
<thead>
<tr>
<th>Installation method</th>
<th>Description</th>
<th>Typical cable types</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Image" /></td>
<td>On a surface (including cable tray or ladder)</td>
<td>Insulated and sheathed</td>
</tr>
<tr>
<td><img src="image2" alt="Image" /></td>
<td>Unenclosed</td>
<td>Screened or armoured</td>
</tr>
<tr>
<td><img src="image3" alt="Image" /></td>
<td>On a surface partly surrounded by thermal insulation</td>
<td>Mineral insulated, metal sheathed (MIMS)</td>
</tr>
<tr>
<td><img src="image4" alt="Image" /></td>
<td></td>
<td>Earthing conductors</td>
</tr>
</tbody>
</table>

### TABLE 3.2

**LIMITING TEMPERATURES FOR INSULATED CABLES**

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<th>Type of cable insulation (see Note 1)</th>
<th>Operating temperature of conductor, °C</th>
</tr>
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<td>Normal use (see Note 2)</td>
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<td>Thermoplastic (see Note 4)</td>
<td>V-75</td>
</tr>
<tr>
<td>VHI-75, TPE-75</td>
<td>HFI-90, TP-90</td>
</tr>
<tr>
<td>V-90</td>
<td>V-90HT</td>
</tr>
</tbody>
</table>

Nb: Some tables of AS/NZS3000:2007 are rarely used while others such as "Table 8.1 and Table 8.2" - **Maximum Values Of Earth Fault-Loop Impedance and Resistance** are used extensively by electricians in the field.
A list of the available “tables” is given at the beginning of the standard (Page 12). A small part of that list is shown below.

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Figures

There are a number of “figures” (sketches) included in the standards. Figures are very helpful to simplify or clarify a textual clause. While the “authority” will always reside in the “clause”, the figures can give a concrete example of “how” it is to be applied.

LIST OF FIGURES

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A typical example of a “figure” used in the standards is shown below. The “example” shows “Figure 6.7” which is designed to clarify the key “zones” around a bathroom “shower” space to indicate where certain types of electrical socket outlets and light etc. may be installed.

**Overview of the standard format**

The “scope” clause of a standard provides a brief detail of it main aims. When perusing a “new” standard for the first time to determine if it is suitable for your needs, always read the “scope” clause first. If the “scope” appears promising, then next go to the table of “Contents” which gives a more detailed analysis of what is included.

**Typical Example AS/NZS3000:2007**

**Section 1 Scope, Application and Fundamental Principles**

This Standard sets out requirements for the design, construction and verification of electrical installations, including the selection and installation of electrical equipment forming part of such electrical installations.

These requirements are intended to protect persons, livestock, and property from electric shock, fire and physical injury hazards that may arise from an electrical installation that is used with reasonable care and with due regard to the intended purpose of the electrical installation.

In addition, guidance is provided so that the electrical installation will function correctly for the purpose intended.

**1.2 Application**

This Standard may be applied through legislative requirements, made in each State and Territory of Australia and in New Zealand, concerned with the safety of electrical installations. The Standard may also be applied in conjunction with any additional requirements, exemptions or restrictions in such legislation.
The principal application of this Standard is to electrical installations in all types of premises and land used by electricity consumers. However, the Standard may also be referenced or applied through legislative or other requirements relating to the effect of electrical installations in matters such as the following:

(a) Safety of workplaces.
NOTE: For example, Occupational Health & Safety legislation and associated codes.

(b) Safe design and construction of buildings.

NOTE: For example, National Building Codes [such as the Building Code of Australia (BCA), New Zealand Building Code (NZBC)] and the associated referenced Standards.

(c) Electricity generation, transmission and distribution systems.

(d) Safe connection to electricity distribution systems.

NOTE: For example, service rules and conditions provided by local electricity distributors.

(e) Qualifications of electricity workers.

Part 1 (Section 1) of this Standard provides a mechanism for acceptance of design and installation practices that may not be addressed by those given in Part 2 (Sections 2 to 8) of this Standard. This mechanism is only intended to apply where departures from the methods in Part 2 are significant.

NOTE: A degree of flexibility exists within Part 2.

Appendices
An “appendix” is a section or table of additional matter normally located at the end of a book or document. All “Appendices” in a “standard” are classified as either “Normative” or “Informative”.

Once again, the following paragraph will usually appear in the Preface of the standard to explain the difference:

The terms “Normative” and “Informative” have been used in this Standard to define the application of the appendix to which they apply. A “Normative” appendix is an integral part of a Standard and compliance with such an appendix is a requirement of the Standard. An “Informative” appendix is only for information and guidance and compliance with it is not a requirement of the Standard.

Ref: HB107:1998

A typical heading is shown below:

APPENDIX B
CIRCUIT PROTECTION GUIDE
(Informative)
A “Normative” Appendix is part of the Standard and, depending on how it is called up, must be followed to comply with the Standard. Normative Appendices are called up from a Clause in the main part of the Standard. They are usually test methods or procedures related to the main content of the Standard, but not necessarily something that applies in all cases. Hence, it is essential to check where the Appendix is called up in the Standard. For example, it may only be relevant if a test is required, or some other procedure that can be omitted if some other Clauses are followed etc.

However, once the Appendix is called up, then it must be followed in exactly the same way as the rest of the “mandatory” bits of the Standard. Requirements are written with “shall”, not “should”. On the other hand, “Informative Appendices” are, as the name suggests, “for information or guidance only” and do not need to be followed to comply with the Standard. It is for this reason that Informative Appendices are “called up from a Note” in a mandatory Standard. For example, “Commentaries” are often presented as Informative Appendices.

Note the full list of appendices used by AS/NZS3000:2007 are shown below

APPENDICES
A REFERENCED DOCUMENTS .......................................................... 343
B CIRCUIT PROTECTION GUIDE .................................................... 351
C CIRCUIT ARRANGEMENTS ......................................................... 366
D MINIMUM SIZES OF POSTS, POLES AND STRUTS
   FOR AERIAL LINE CONDUCTORS ......................................... 401
E ELECTRICAL INSTALLATION REQUIREMENTS IN
   NATIONAL BUILDING CODES ................................................ 420
F INSTALLATION OF SURGE PROTECTIVE DEVICES ..................... 425
G DEGREES OF PROTECTION OF ENCLOSED
   EQUIPMENT ............................................................................. 430
H WS CLASSIFICATION OF WIRING SYSTEMS ................................ 435
I PROTECTIVE DEVICE RATINGS AND METRIC
   EQUIVALENT SIZES FOR IMPERIAL CABLES USED
   IN ALTERATIONS ADDITIONS AND REPAIRS ....................... 443
J SYMBOLS USED IN THIS STANDARD ......................................... 446
K (Deleted)
L ELECTRIC SHOCK SURVIVAL—Australia .................................... 449
M ELECTRIC SHOCK SURVIVAL—New Zealand ............................. 451

Note that for “Appendix A Referenced Documents” the title now is “Normative” but is broken into two parts:

- Section – “A1 Normative References
- Section – “A2” Informative References
**Searching for Information**

In a typical workplace situation, an electrician will use the AS/NZ3000:2007 Wiring Rules to seek guidance or confirmation regarding a particular workplace task. (As shown above, “conformance” with the “wiring rules” standard is a “mandatory” requirement of the electrical “regulations”.

If the electrician is in doubt about a certain task, then they must locate the precise “clause” and “clause number” from the (471 pages) text that directly affects this situation. This is where “experience” with the “wiring rules” is so important. The person must first consider the “practical task” at hand and then identify the “key words” that define it. (Ie: Uniquely separate it from similar tasks.)

To locate the pertinent clause, the electrician must then either go to the “Table of Contents” located at the beginning of the standard or the “Index” section which is normally located at the back of the book. (Nb: In the latest revision of the standard the Index starts on Page 453). The best search technique is to use the “key words” as part of a systematic process. Random scanning of pages may occasionally fluke the correct clause but a methodical approach will be much more consistent.

**Index**

A book “Index” is an alphabetical list of key names, terms, subjects, etc, which are mentioned verbatim in the text of a printed work. The “Index” section is typically located in the back section and indicates the precise page number(s) in which each word or term appears. The aim of an “Index” is to enable the reader to quickly locate a specific word or phrase within a large volume of text.

Nb: A very small sample of the AS/NZS3000:2007 “Index” is shown below. This is a

To follow the index build a “phrase” from the outer “Level 1” word plus (if any) the “Level 2” word and plus (if any) “Level 3” word. For the example shown it would be; “accessories; protection; against thermal effects” Clause 4.2.1 (ie: In Section “4”).

The applicable “clause number” is the one(s) which is/are located adjacent to the deepest indent. Always write this number down as searching can be very time consuming.

The next step is to locate the page with this clause number and read it thoroughly. If this clause does not specifically cover specific situation then you must re-define the key words and begin the search again. For novice users, location information in a standard can be a very frustrating exercise. But, it will/should get easier with experience.
Standards include Standards mandated under regulation (e.g. Wiring Rules) or by an authority, deemed-to-comply standard and local service requirements (e.g. Service rules).

**Distribution Entity Local Service Rules**
The Electricity Act 1994 (s22) **Electricity entities**
(1) An electricity entity is an entity that is a participant in the electricity industry.

(2) The following entities are the participants in the electricity industry—

(a) Generation entities;
(b) Transmission entities;
(c) Distribution entities;
(d) Retail entities.

A “**generation entity**” is a person who holds a generation authority which authorises its holder to connect the generating plant stated in the authority to the transmission grid or supply network stated in the authority; and to sell electricity. (Eg: Power station owners)
A “transmission entity” is a person who holds a transmission authority which then authorizes its holder to operate the (long distance) transmission grid stated in the authority. (Ie: Powerlink in Queensland)

A “distribution entity” approval holder provides customer connection services to an electrical installation or premises

A “retail entity” is a person who holds a retail authority which authorises its holder to provide customer retail services under the terms of the authority. Ie: Companies such as AGL

**Distribution Entities**
Queensland “Distribution entities” “Energex” and Ergon Energy provide and make freely available the “Queensland Electricity Connection and Metering Manual Service and Installation Rules” (Version 7)

The Queensland Electricity Connection and Metering Manual (QECMM) has been compiled in conjunction with the Network Engineering Standards Department of ENERGEX and the Network Standards Department of Ergon Energy and is the same jurisdictional document referred to as the Electricity Connection and Metering Manual (ECMM) in the Metrology Procedure: Part A National Electricity Market.

The purpose of this manual is to promote industry uniformity through standardization of practices throughout Queensland. The document is for use by Electrical Contractors, Consulting Engineers, Architects and others directly concerned with electrical installations that are connected, or are to be connected, to the respective supply network. Metering installation compliance and obligations contained in this manual forms part of the (Queensland) Electricity Industry Code and the National Electricity Rules.

**Table of Contents**
- Distributors’ Contact Details
- Dial Before You Dig
- Foreword
- Purpose and Scope
- Definitions, Abbreviations and Acronyms
- References
- Responsibilities

**Important Information**
1. Customer's Installations
2. Determination of the Number of Phases to be Installed
3. Balancing of Load and Limitation on Equipment
4. Service Lines and Connection point
5. Metering Requirements
6. Installation Requirements for Meters and Control Equipment
7. Controlled Supplies - Method of Control
8. Installation Requirements for Low Voltage Current Transformer Metering
10. High Voltage Metering

Appendix A - Specification for Metallic Enclosures for Meters in Direct
Appendix B - Glossary of terms
Appendix C - Amendment Record

The “service rules” detail the specific requirements for the interconnections between the “distribution entity” supply network and the customer’s premises. Typical drawings from the manual are shown below.
Codes including those applicable to electrical safe working practices and some aspects of the Building Code of Australia.

“Safety” Codes of Practice
As explained above the Queensland Electrical Safety Act 2002 which is supported by the Electrical Safety Regulation 2002 is responsible for maintaining electrical safe working practices in this state. To provide specific direction, the “act” is supported by and a series of codes of practice. These are listed below.

- Electrical Safety Code Of Practice 2010 Risk Management
- Electrical Safety Code Of Practice 2010 Works
- Electrical Safety Code of Practice 2010 Electrical Work

Nb: Codes of practice are freely available off the Internet in PDF format.

A “code of practice” is a document made under section 44 of the Act. It gives practical advice on ways to discharge electrical safety obligations. Included in a code are ways to identify and manage exposure to risks of injury and property damage caused, directly or indirectly, by electricity. Under section 45 of the Act, a code of practice does not state all that a person must do, or must not do, to discharge their electrical safety obligation. However, the person fails to discharge the electrical safety obligation if they:

(a) contravene, or otherwise act inconsistently with, the code of practice; and
(b) do not follow a way that is as effective as, or more effective than, the code of practice for discharging the electrical safety obligation.

Electrical Safety Code of Practice 2010 Risk Management
This Code recommends practical methods for managing electrical risks and defines and explains the five step risk management process to perform to make sure all electrical risks are minimised. This Code covers the five step risk management process for electrical work performed by licensed electrical workers. It describes:

- identifying electrical risks present for electrical work;
- assessing or evaluating risks for electrical work;
- deciding on risk treatment measures; and
- implementing and monitoring risk treatment measures.

Electrical Safety Code of Practice 2010 Works
This Code gives practical advice on ways for an electricity entity to manage electrical safety risks associated with earthing systems, underground cable systems, and supporting structures for overhead lines forming parts of the works of an electricity entity.
Electrical Safety Code of Practice 2010 Working Near Exposed Live Parts
This Code gives practical advice on ways to manage electrical risk when working near exposed live electrical parts. This Code will apply to people such as plant operators, painters, people erecting or working on scaffolds, sign makers and people working with irrigation pipes near exposed live electrical parts. The practical guidance provided in this Code may be relevant to electrical workers when they are performing electrical work near another exposed live part e.g. installing the electrics on a billboard next to electric lines.

This Code does not apply to electrical workers working on exposed live electrical parts e.g. an electrician performing fault finding work on a live switchboard. A separate code has been developed to provide practical advice to electrical workers performing electrical work.

Electrical Safety Code of Practice 2010 Electrical Work
This Code provides practical advice and gives benchmarks for performing electrical work in ways that are electrically safe. It provides guidance on managing electrical risk only; no guidance on other risks is provided. This Code has been designed to reflect the two ways to perform electrical work: working de-energized and working live.

National Construction Code
The “National Construction Code” (NCC) is an initiative of the Council of Australian Governments (COAG) developed to incorporate all on-site construction requirements into a single code. The NCC comprises the Building Code of Australia (BCA), Volume One and Two; and the Plumbing Code of Australia (PCA), as Volume Three.

NCC Volume One: pertains primarily to Class 2 to 9 buildings.
NCC Volume Two: pertains primarily to Class 1 and 10 buildings.
NCC Volume Three: pertains primarily to plumbing and drainage associated with all classes of buildings.

Nb: The class details are discussed below.

All three volumes are drafted in a performance format allowing a choice of Deemed-to-Satisfy Provisions or flexibility to develop Alternative Solutions based on existing or new innovative building, plumbing and drainage products, systems and designs.

To assist in interpreting the requirement of
Volume One, the ABCB also publishes a non-mandatory **Guide to Volume One** each year. For Volumes Two and Three, clearly identified non-mandatory explanatory information boxes are included in the text to assist users.


Ref: National Construction Code Volume 1 -2011
Part A3 Classification Of Buildings and Structures

**A3.1 Principles of classification**
The classification of a building or part of a building is determined by the purpose for which it is designed, constructed or adapted to be used.

**A3.2 Classifications**
Buildings are classified as follows:

**Class 1:** one or more buildings which in association constitute—
(a) **Class 1a** — a single dwelling being—
   (i) a detached house; or
   (ii) one of a group of two or more attached dwellings, each being a building, separated by a fire-resisting wall, including a row house, terrace house, town house or villa unit; or
(b) **Class 1b** —
   (i) a boarding house, guest house, hostel or the like—
      (A) with a total area of all floors not exceeding 300m² measured over the enclosing walls of the Class 1b; and
      (B) in which not more than 12 persons would ordinarily be resident; or
   (ii) 4 or more single dwellings located on one allotment and used for short-term holiday accommodation, which are not located above or below another dwelling or another Class of building other than a private garage.

**Class 2:** a building containing 2 or more sole-occupancy units each being a separate dwelling.

**Class 3:** a residential building, other than a building of Class 1 or 2, which is a common place of long term or transient living for a number of unrelated persons, including—
(a) a boarding house, guest house, hostel, lodging house or backpackers accommodation; or
(b) a residential part of a hotel or motel; or
(c) a residential part of a school; or
(d) accommodation for the aged, children or people with disabilities; or
(e) a residential part of a health-care building which accommodates members of staff; or
(f) a residential part of a detention centre.

**Class 4:** a dwelling in a building that is Class 5, 6, 7, 8 or 9 if it is the only dwelling in the building.

**Class 5:** an office building used for professional or commercial purposes, excluding buildings of Class 6, 7, 8 or 9
NSW Class 6

Class 6: a shop or other building for the sale of goods by retail or the supply of services direct to the public, including—
(a) an eating room, café, restaurant, milk or soft-drink bar; or
(b) a dining room, bar area that is not an assembly building, shop or kiosk part of a hotel or motel; or
(c) a hairdresser’s or barber’s shop, public laundry, or undertaker’s establishment; or
(d) market or sale room, showroom, or service station.

Class 7: a building which is—
(a) Class 7a — a carpark; or
(b) Class 7b — for storage, or display of goods or produce for sale by wholesale.

Class 8: a laboratory, or a building in which a handicraft or process for the production, assembling, altering, repairing, packing, finishing, or cleaning of goods or produce is carried on for trade, sale, or gain.

Class 9: a building of a public nature—
(a) Class 9a — a health-care building, including those parts of the building set aside as a laboratory; or
(b) Class 9b — an assembly building, including a trade workshop, laboratory or the like in a primary or secondary school, but excluding any other parts of the building that are of another Class; or
(c) Class 9c — an aged care building.

Class 10: a non-habitable building or structure—
(a) Class 10a — a non-habitable building being a private garage, carport, shed, or the like; or
(b) Class 10b — a structure being a fence, mast, antenna, retaining or free-standing wall, swimming pool, or the like; or
(c) Class 10c — a private bushfire shelter.

Building Code of Australia
The Building Code of Australia (BCA) is comprised of Volumes One and Two of the National Construction Code (NCC). The BCA is produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Australian Government and State and Territory Governments. The BCA has been given the status of building regulations by all States and Territories.

BCA Goal
The goal of the BCA is to enable the achievement of nationally consistent, minimum necessary standards of relevant safety (including structural safety and safety from fire), health, amenity and sustainability objectives efficiently.

This goal is applied so—

- there is a rigorously tested rationale for the regulation;
- the regulation generates benefits to society greater than the costs (that is, net benefits);
- the competitive effects of the regulation have been considered and the regulation is no more restrictive than necessary in the public interest; and
• there is no regulatory or non-regulatory alternative that would generate higher net benefits.

Proposals to change the BCA are subjected, as applicable, to a Regulatory Impact Assessment process. The BCA contains technical provisions for the design and construction of buildings and other structures, covering such matters as structure, fire resistance, access and egress, services and equipment, and energy efficiency as well as certain aspects of health and amenity. It allows for variations in climate and geological or geographic conditions.

BCA Volumes
(a) The Building Code of Australia consists of two volumes, Volume One and Volume Two.
(b) This is Volume Two of the Building Code of Australia (hereafter described as the Housing Provisions) which contains the requirements for—

(i) Class 1 and 10a buildings (other than access requirements for people with a disability in Class 1b and 10a buildings); and
(ii) certain Class 10b structures (other than access requirements for people with a disability in Class 10b swimming pools); and
(iii) Class 10c private bushfire shelters.

(Refer to Part 1.3 for a full description of the Class 1 and 10 building classifications).

(c) Volume One contains the requirements for—

I. all Class 2 to 9 buildings; and
II. access requirements for people with a disability in Class 1b and 10a buildings; and
III. certain Class 10b structures including access requirements for people with a disability in Class 10b swimming pools.

BCA Structure
The structure of the BCA comprises the following as shown in Figure 1.0.3:
(a) The Objectives.
(b) The Functional Statements.
(c) The Performance Requirements with which all Building Solutions must comply.
(d) The Building Solutions.

Three references to “electrical” systems in the (National Construction Code Series “Vol. 2” - Building Code of Australia 2011 - Class 1 and Class 10 Buildings) are shown immediately below:
P2.4.4 Light

(a) A *habitable room* must be provided with *windows* so that natural light, when available, provides a level of *illuminance* appropriate to the function or use of that part of the building.

(b) Artificial lighting must be installed to provide a level of *illuminance* appropriate to the function or use of the building to enable safe movement by occupants.

**Application:**

P2.4.4(b) only applies—

(a) to *sanitary compartments*, bathrooms, shower rooms, airlocks, laundries and the like; and

(b) if natural lighting of a suitable standard is not available.

3.7.2.5 Lighting to assist evacuation — Class 1b buildings

In a Class 1b building, a system of lighting must be installed to assist evacuation of occupants in the event of a fire, and—

(a) be activated by the smoke alarm *required* by 3.7.2.4(b); and

(b) consist of—

(i) a light incorporated within the smoke alarm; or

(ii) the lighting located in the corridor, hallway or area served by the smoke alarm.

**Explanatory information:**

The lighting *required* by 3.7.2.5 may consist of the artificial lighting which may already be installed in a corridor, hallway or area, provided that lighting is activated by the smoke alarm.

Figure 3.7.2.1 from BCA illustrating possible locations of smoke alarms

![Diagram showing possible locations of smoke alarms](image)

**Building Codes Queensland**


Building Codes Queensland which is part of the Department of Housing and Public Works, ensures high-quality and cost-effective building and plumbing codes and an efficient system for approving building and plumbing work. This
protects and enhances the health, safety and wellbeing of Queenslanders.

Building Codes Queensland provides advice about applying building and plumbing regulations to:
- building and plumbing practitioners
- councils
- state government departments
- the general public.

Building Codes Queensland oversees the Plumbing and Drainage Act 2002 and provides plumbing information on on-site sewerage facilities, water saving measures (including greywater use), sub-meters and more. Building Codes Queensland also oversees the Building Act 1975 and provides building information on the Building Code of Australia and the Queensland Development Code.


Who's affected by this legislation?
- Queensland's building and construction industry including BSA (Building Services Authority) licensees
- Building professionals including building certifiers, engineers and planners
- General community
- Peak bodies including Queensland Master Builders Association and the Housing Industry Association
- Local councils

Current laws and regulations
- Building Act 1975
  Queensland's building legislation
- Building Regulation 2006
  Building regulations related to the Queensland Building Act 1975

Current codes and standards
- Queensland Development Code
  Queensland's building standards framework which extends the scope of the Building Code of Australia
- Building certification system in Queensland

Heritage Legislation
The Queensland Heritage Act 1992 and Queensland Heritage Regulation 20003 may also affect electricians engaged in installation work.

Owners of properties entered in the Queensland Heritage Register (database) who are considering changes such as subdivision, change of use, renovation or demolition must apply for an approval before carrying out any such works. Under Section 44 of the Queensland Heritage Act 1992 the “owner” must obtain approval from the Queensland Heritage Council to develop or change a
registered place.

Therefore, if you are required to perform electrical installation work on listed premises then all work must follow the guidelines set down by the approval notice. When performing any work on a place that you suspect may be under heritage control then you must always perform a thorough check/search before starting. It could prove very costly (to you) if you fail to do so as the work may have to be removed.

Department of Environment and Resource Management (DERM) “General Exemption Certificate”
This permits owners to carry out certain development on a Queensland Heritage Place (ie: a place that is entered in the Queensland Heritage Register). The purpose of the exemption certificate is to provide upfront permission for the ongoing maintenance and minor work necessary to keep Queensland Heritage Places in active use, good repair and optimal operational condition.

The General Exemption Certificate (Queensland Heritage Places) is a general exemption certificate that is given without application. It is issued by the Department of Environment and Resource Management (DERM) under section 75 of the Queensland Heritage Act 1992. It applies to all Queensland heritage places.

Contracts, Specifications, Schedules and Drawings
An “electrician” will either work for (be employed by) or “be” the “electrical contractor”. For all types of work a “contract” will exist between the “contractor” and the “client”. The “contract” can range in size from the most simple “light and socket outlet” retro fit for a domestic customer to a very large commercial or industrial building or factory etc.

But in every case, a contract does exist between the two parties; the “owner” and the “service provider” (electrical contractor). This may be a complex formal contract for a large job or a verbal agreement or even over the telephone for a small job. Both types are “legal” and binding (to both parties) contracts.

In its simplest form there are three parts to a contract: the “offer”, “acceptance” and “consideration”. An offer is what someone is willing to do or to give. This may include electrical services such as installing electrical equipment etc. or possibly electrical maintenance work. The acceptance is agreeing to the offer. Consideration means that the law requires that something of value be given in exchange for receiving the offer.

Once the offer, the acceptance and the consideration have been determined, the contract describes in detail all the parts. A contract answers; the who, what, how, where and when of the agreement. It is important that the terms of the agreement be clearly stated. The terms of the contract—the obligations, expectations, and responsibilities of all the parties—must be detailed and without ambiguity. Once all the parties have read and understood the contract, the parties sign and date the contract. A contract is then legally binding which means that once it is signed; all parties are then legally obligated to do what
they have agreed to.

Contracts are legally enforceable. Breach of contract is when one party does not do what the party agreed to do in the contract. The aggrieved party then has the right to apply to a court of competent jurisdiction to either compel or force that party to follow the terms of the contract or seek damages (whichever the case may necessitate). This is how a contract is enforceable. Oral contracts are much harder to enforce as there is no evidence, such as a written agreement to show what the parties agreed to or what the consideration was.

A contract for “electrical services” therefore, must cover the “scope of the job”, “price”, “time frame for completion” and “how and when payment is to be made”. Other factors to be included are any warranty/maintenance period, and indemnity for breakage etc.

A large formal contract will make reference to a range of related “technical documents” such as the “drawings” (site and construction etc as shown above), “specifications” and “schedules”.

**Schedule (Equipment Schedule)**

An equipment schedule is a detailed list showing all items of a certain category to be used on the job. It can be stand-alone list where items are cross-referenced to the applicable drawings or sometimes the schedule list/table can be directly incorporated into the actual drawing which details the item. Sometimes the schedule is incorporated as part of the specification.

Typical examples of “equipment” schedules include, a “lighting schedule” which lists each type of light fitting (luminaire) to be used on the job and the specific location where each is to be installed. A cabling schedule is another common use which details the precise types of cables to be used for every circuit type in the installation.

Schedules are used to assist the persons when estimating/quoting for a “new” contract. They are also used when ordering equipment for the job where they are used as a take-off sheet.

**Electrical Specifications**

A “specification” is a detailed written statement outlining the precise requirements for a new “project”. It will typically include the methodology, materials, dimensions, quality and possibly, even the final testing criteria. A simple “electrical specification” could be developed by the “property owner” or “builder”, but for large or complex jobs it is typically an architect or an engineer (Sometimes referred to as the electrical consultant).

Specifications are normally written in “sections” similar to the clauses of the “standards”. They are written to a standard format and superficially, they look the same, but there will always be small differences. They must be read very, very carefully.

It is highly unlikely that a specification will conflict with the “standards”, but it is
likely that some of the “options” offered in the standards will not be permitted by the specification.

When reading a “new” specification the contractor must not only interpret what the client/consultant wants, but also ensure that it does meet the requirements of the applicable “electrical standards”, “Queensland Electricity Connection and Metering Manual Service and Installation Rules” (Service rules from the distribution entities Energex and Ergon Energy), National Construction Code (ie: Building Codes of Australia), Building Codes Queensland and possibly Queensland Heritage legislation. Other considerations include Commonwealth legislation and local council bylaws etc. The work of an estimator is not easy.

Whenever an electrical contractor “quotes/prices” for a large job, it is the combined information gleaned for the supplied “drawings”, “schedules” and the job “specifications” (colloquially called the “specs”!) that must provide all of the relevant information. As such, the level of detail and accuracy required for a specification is critical.

Financial success (ie: making a profit) for a business is largely dependent on the skills of the “estimator”. (The person/team who produce and submit the quotation). It is the estimator’s ability and experience to carefully read and interpret ALL of the supplied information and thereby ensure that nothing of consequence (ie: high cost) is “missed” when assembling the quotation. Once the quotation is submitted, accepted and signed, the “contract” price becomes legally “binding”.

On a small job, the specification may just include the locations and types of accessory items etc to be installed. The electrical contractor would then use the standards AS/NZ3000 and AS/NZS3008 etc to determine circuit configurations, cable types and sizes etc. Further minor decisions for the job are then part of a verbal agreement between the contractor and the owner (client).

On a large job, the specification will be very detailed and quite complex. If the “job” is awarded to a contractor, then the “specification” document becomes a prescriptive “working” document detailing precisely how each area MUST be completed.

Clearly then, there is a need for standardization in the way that “specifications” are structured and written. In Australia this role has been taken up by NATSPEC.

The Australian Specification System - NATSPEC
NATSPEC specification system – provide (at a $ price) standard “templates” (paper based and file) on which job specifications are written. Construction Information Systems Australia Pty Ltd is a not-for-profit organisation founded in 1975, which has twenty leading building industry organisations as its shareholders. The company’s primary function is to develop, produce and maintain the national building specification packages.

NATSPEC’s major service is the provision of the comprehensive national
specification systems endorsed by government and professional bodies. NATSPEC, the National Building Specification, is available for all building structures, with specialist packages for architects, interior designers, landscape architects, structural engineers, service engineers and domestic owners. AUSSPEC is the Local Government specification system for the life-cycle management of assets.

There are a number of NATSPEC specification template packages available including:

- NATSPEC BASIC is for simple building projects where brevity is a priority; NATSPEC BUILDING is for more complex projects, and is NATSPEC’s definitive specification;
- NATSPEC SITE+STRUCTURE is for civil engineering and landscaping work;
- NATSPEC SERVICES covers hydraulic, fire, electrical and mechanical installations; and NATSPEC DOMESTIC is for individual houses.

The types of specification templates available are detailed in the graphic below.

Each package consists of NATSPEC Templates, which combine text and prompts for the preparation of one-part specifications, and a Commentary, which supplements the NATSPEC material and gives guidance on how to edit and customise text for specific projects.

The Templates and Commentary are published in loose-leaf form and electronically (soft copy) on CD (known as the NATSPEC//TOOLBOX). Core NATSPEC template text is published annually as a book called NATSPEC Reference – the national building and services reference specification.
Packages
SERVICES Electrical: This package is for engineers engaged on the electrical installations of projects of all complexities. It also includes separate basic versions of common work sections pre-edited for fast production of specifications for smaller, straightforward projects. Demolition, tendering and contract preliminaries are also covered. The content is informed by the Building Code of Australia.

Domestic: This template has been developed for those projects simple enough not to require the engagement of an architect or building designer by the owners. It defines what is deemed to be the minimum level of workmanship for satisfactory work. The primary function of the drawings and specification is to give effect to design decisions. Many design decisions cannot be expressed in graphic form and therefore rely on words for their expression. Other decisions would be too tedious or impractical to be conveyed in graphic form. The drawings and specification compliment each other. The quality of a building project is dependent on the documentation provided. The contract documentation includes the conditions of contract, the drawings, the schedules and the specification. Whilst the specification is a multi-purpose document, its primary function is to define precisely and succinctly the quality required and the processes necessary for achieving it. Its role includes but extends beyond the selection of materials by providing the baseline for acceptable quality of construction.

Nb: Specifications are written in “sections” and clauses similar to AS/NZS3000. Extracts from a typical NATSPEC “specification” is given below

Example “NATSPEC” Specification
Title: Specification of work to be done and materials to be used in the building of the “Heathfield General Learning Areas (4)” Reference Design as part of the Building the Education Revolution project. (April 2009)

Note: The full specification is a “751” page document, and the “electrical section” alone is “89” pages in length. Therefore, only a part of the “electrical section” is included here for analysis. It is import to “scan” the sections to develop an understanding of the “detail” that is included in a major specification such as this.

The key point to grasp is that when you are working on a large job, you cannot make arbitrary decisions about how a particular task is to be done. It must be done in accordance with the “specification”. Work on this type of site will be thoroughly inspected “against the clauses of the specification” by the “electrical consultant” or an appointed agent.

Any work that does NOT meet the specification will then have to be rectified and this can be very $$$$ costly for the contractor.
## Electrical general requirements

### General

#### Aims

**Responsibilities**
General: Provide electrical systems as documented.

#### Design Criteria

Design criteria associated with the installation are listed below:

<table>
<thead>
<tr>
<th>Item</th>
<th>Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme ambient conditions under which all services and systems shall operate</td>
<td>50.0°C dry bulb maximum  24.0°C wet bulb maximum  Full solar load  -2.0°C dry bulb minimum.</td>
</tr>
<tr>
<td>Ambient conditions within air conditioned spaces under which all services and systems shall achieve full load performance</td>
<td>24.0°C dry bulb maximum  60% relative humidity maximum with humidity varying dependent on ambient and internal loads  20.0°C dry bulb minimum.</td>
</tr>
<tr>
<td>Ambient conditions within ventilated non air conditioned spaces under which all services and systems shall achieve full load performance</td>
<td>39.0°C dry bulb maximum  21.0°C wet bulb maximum  4.0°C dry bulb minimum.</td>
</tr>
<tr>
<td>Earth resistivity</td>
<td>100 ohm - metres nominal.</td>
</tr>
<tr>
<td>Earthing</td>
<td>2m earth stake, minimum, within poly pit</td>
</tr>
<tr>
<td>Hours of operation - general</td>
<td>24 hour operation  7 days</td>
</tr>
<tr>
<td>Hours of operation - DECS</td>
<td>7 hour operation  Weekdays.  190 days per annum</td>
</tr>
<tr>
<td>Maximum noise levels at adjoining property boundaries</td>
<td>Not to exceed levels specified for commercial properties and residential properties in the Environmental Protection Act.</td>
</tr>
<tr>
<td>Equipment balancing criteria - maximum allowable vibration levels (maximum peak to peak displacement mm)</td>
<td>All equipment not to exceed limits set in Australian Standard 1359 - Rotating electrical machines - General requirements and Australian Standard 2625 - Rotating and reciprocating machinery - Mechanical vibration.</td>
</tr>
<tr>
<td>Earthing systems:</td>
<td>MEN earthing system in accordance with Australian Standard 3000 - SAA Wiring Rules and ETSA Utilities Rules and Conditions of Supply</td>
</tr>
<tr>
<td>Protective earthing system</td>
<td>Electricity supply  400/230 volts, +10%, -6%, 3 phase, 4 wire, 50 Hz in accordance with ETSA Utilities Service Rules and Conditions of Supply.  Design and utilise only systems and equipment to be capable of guaranteed rated performance on both present and future supply voltages.  Consumers mains  400/230 volt, 3 phase, 50 Hz supplies from the ETSA Utilities transformer.  Metering  Retailer metering to minimise operating costs.</td>
</tr>
<tr>
<td>Item</td>
<td>Design Criteria</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Electrical reticulation</td>
<td>In accordance with Australian Standard 3000 - SAA Wiring Rules and Australian Standard 3008 - Electrical installations - Selection of cables.</td>
</tr>
<tr>
<td>Electrical capacities</td>
<td>Equipment and cable capacities calculated to achieve 30% spare capacity.</td>
</tr>
<tr>
<td>Automatic fire detection and alarm system</td>
<td>In accordance DECS combined security and fire detection system.</td>
</tr>
<tr>
<td>Smoke/Heat Detectors</td>
<td>Occupied Areas: As indicated on drawings accompanying the Specification and to requirements of Australian Standard 1670 – Fire detection, warning, control and intercom systems – System design, installation and commissioning.</td>
</tr>
<tr>
<td>Voltage drop</td>
<td>Voltage drop at switchboards limited to 2.5% (maximum) of nominal LV supply voltage of 400 volt, 3 phase. Voltage drop at final distribution points limited to 5% (maximum) of nominal LV supply voltage of 400 volt, 3 phase.</td>
</tr>
<tr>
<td>Electromagnetic emission</td>
<td>In accordance with Australian/New Zealand Standard 4251.1 - Electromagnetic compatibility - Generic emission standard - Residential, commercial and light industry. AS/NZS 61000.</td>
</tr>
<tr>
<td>Electromagnetic immunity</td>
<td>In accordance with Australian/New Zealand Standard 4252.1 - Electromagnetic compatibility - Generic immunity standard - Residential, commercial and light industry. AS/NZS 61000.</td>
</tr>
<tr>
<td>Degree of protection (IP Code)</td>
<td>In accordance with AS/NZS 60529.</td>
</tr>
<tr>
<td>Illuminance levels</td>
<td>In accordance with the minimum requirements of the following:</td>
</tr>
<tr>
<td>General building interiors</td>
<td>Australian Standard 1680.1 - Interior lighting - General principles and recommendations and Australian Standard 1680.2.0 Interior lighting - Recommendations for specific tasks and interiors.</td>
</tr>
<tr>
<td>Circulation spaces</td>
<td>Australian Standard 1680.2.1 - Interior lighting - Circulations spaces and other general areas.</td>
</tr>
<tr>
<td>Office and screen based tasks</td>
<td>Australian Standard 1680.2.2 - Interior lighting - Office and screen based tasks.</td>
</tr>
<tr>
<td>External, amenity</td>
<td>Australian Standard 1158 - Road lighting.</td>
</tr>
<tr>
<td>Specific minimum maintained average illuminance levels:</td>
<td>GLA</td>
</tr>
<tr>
<td></td>
<td>240 lux at working plane.</td>
</tr>
<tr>
<td></td>
<td>Office areas 320 lux at working plane.</td>
</tr>
<tr>
<td></td>
<td>Gym halls 320 lux at working plane.</td>
</tr>
<tr>
<td></td>
<td>Secure carparks 40 lux.</td>
</tr>
<tr>
<td></td>
<td>Toilets, lockers 100 lux at 1 metre above floor level.</td>
</tr>
<tr>
<td></td>
<td>Access Toilets 200 lux at 1 metre above floor level.</td>
</tr>
<tr>
<td>Item</td>
<td>Design Criteria</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Conference rooms</td>
<td>320 lux at working plane.</td>
</tr>
<tr>
<td>Foyer areas</td>
<td>240 lux at working plane.</td>
</tr>
<tr>
<td>Corridors</td>
<td>80 lux at working plane.</td>
</tr>
<tr>
<td>Exit and emergency lighting</td>
<td>In accordance with the Building Code of Australia and Australian/New Zealand Standard 2293.1 - Emergency evacuation lighting for buildings - System design, installation and operation, Australian/New Zealand Standard 2293.2 - Emergency evacuation lighting for buildings - Inspection and maintenance and Australian/New Zealand Standard 2293.3 - Emergency evacuation lighting for buildings - Emergency luminaires and exit signs.</td>
</tr>
<tr>
<td>Master antennae television</td>
<td>system In accordance with the minimum requirements of Australian Standard 1367 - Multiple outlet distribution systems - Sound and vision.</td>
</tr>
<tr>
<td>Voice/data cabling</td>
<td>In accordance with Australian/New Zealand Standard 3080 - Telecommunications installations - Integrated telecommunications cabling systems for commercial premises.</td>
</tr>
</tbody>
</table>

**Cross references**

**General**
General: Conform to the *General requirements* worksection.

**Associated worksections**
Associated worksections: Conform to the following:
- Adhesives, sealants and fasteners.
- Fire-stopping.
- Metals and prefinishes for off-site painting and electroplated or in-line galvanized finishes.
- Demolition.
- Service trenching.

**Precedence**
Technical worksections: The requirements of subsequent electrical services worksections of the specification override conflicting requirements in this worksection.

**Standards**

**General**
General: To AS/NZS 3000 Part 2 unless otherwise documented.
Electrical systems: To AS/NZS 3008.1.1 and SAA HB 301.
Degrees of protection (IP code): To AS/NZS 60529.
EMC: To AS/NZS 61000.
Telecommunications systems: To AS/ACIF S008, AS/ACIF S009, AS/NZS 3080, SAA HB 243 and SAA HB 29.

**Permits Notices And Inspections**
Make applications, obtain all permits, and arrange testing, all as necessary for the installation and placing into operation of the works where required by any Authority including:
- SA Water Corporation.
- Department for Administrative and Information Services - Workplace Services.
- Department for Administrative and Information Services - The Office of the Technical...
Regulator.
- Australian Communications Authority.
- Site Telecommunications Carrier.
- ETSA Utilities.
- SA Fire Services.
- Energy retailer.
- Police Security Services Branch

Provide all associated documentation required for the applications.
Pay all associated fees.

Standards
- Comply in all respects with the requirements of the current standards applicable to the works in respect to equipment, materials, workmanship and installation techniques.
- Comply with the following standards and regulations:
- Building Code of Australia.
- Australian Standards.
- SA Water Corporation regulations.
- Australian Gas Association Regulations.
- Department of Health Regulations.
- SA Fire Services Regulations.
- Australian Communications Authority Regulations.
- ETSA Utilities Regulations and Conditions of Supply.
- SA Government Acts governing the works.
- Occupational Health and Safety Regulations.

Interpretations

Abbreviations
General: For the purposes of this contract the abbreviations given below apply.
- EMC: Electromagnetic compatibility.
- EMI: Electromagnetic interference.

Definitions
General: For the purposes of this contract the definitions given below apply:
- Accessible: Readily accessible to AS/NZS 3000.
- High level interface: Systems transfer information in a digital format using an open system interface.
- Hot-dip galvanized: Zinc coated to AS/NZS 4680 after fabrication with coating thickness and mass to AS/NZS 4680 Table 1.
  . Metallic-coated: Steel coated with zinc or aluminium-zinc alloy as follows:
  . Metallic-coated steel sheet: To AS 1397. Metal thicknesses specified are base metal thicknesses.
- Ferrous open sections coated by an in-line process: To AS/NZS 4791.
- Ferrous hollow sections coated by a continuous or specialised process: To AS/NZS 4792.
- Industrial: IP56 to AS/NZS 60529.
- Low level interface: Systems transfer information via terminals and voltage free contacts.
- Weatherproof: IPX6 to AS/NZS 60529.

Drawings and manuals for existing services

General
General: No warranty is given as to the completeness or accuracy of drawings and/or manuals of existing services.

Submissions

General

Default timing: Make submissions ≥ 5 business days prior to the ordering of products for, or starting the installation of, the respective portions of the works.

Drawings

General: Minimum A1 drawing size.
Standard: To AS 1100 Parts 101 and 301, AS 1102 Parts 101, 102, 103, 106, 107, 108, and
111, and AS/NZS 3085.1 as applicable.

Building work drawings: Submit detailed dimensioned drawings showing all:
- Access doors and panels.
- Conduits to be cast in slabs.
- Holding down bolts and other anchorage and/or fixings required complete with loads to be imposed on the structure during installation and operation.
- Openings, penetrations and block-outs.
- Pipe sleeves.
- Plinths, kerbs and bases.
- Required external openings.

Services coordination: Coordinate with other building and service elements. Show adjusted positions on the shop and record drawings.

Space requirements: Check space requirements of equipment and services indicated diagrammatically in the contract documents.

**Execution details**

General: Before starting the respective portions of the installation, submit the following:
- Embedded services: Proposed method for embedding services in concrete walls or floors or chasing into concrete or masonry walls.
- Fixing of services: Typical details of locations, types and methods of fixing of services to structure.
- Inaccessible services: If services will be enclosed and not accessible after completion, submit proposals for location of service runs and fittings.

**Marking and labelling**

General: Before marking and labelling submit:
- Samples of the proposed labels.
- A schedule showing, for each item or type of item:
  - A description of the item or type of item sufficient to identify it.
  - The proposed text of the marking or label.
  - The proposed location of the marking or label.

**Building penetrations**

General: If it is proposed to penetrate or fix to the following, submit details of the methods proposed to maintain the required structural, fire and other properties:
- Structural building elements including external walls, fire walls, fire doors and access panels, other tested and rated assemblies or elements, floor slabs and beams.
- Membrane elements including damp-proof courses, waterproofing membranes and roof coverings. If penetrating membranes, provide a waterproof seal between the membrane and the penetrating component.

**Technical data**

Data to be submitted: Include at least the following information in technical submissions:
- Assumptions.
- Calculations.
- Certification of compliance with the applicable code or standard.
- Design basis and performance parameters.
- Drawings.
- Installation and maintenance requirements.
- Manufacturers’ technical literature.
- Risk assessment.
- Samples where relevant.
- Sketch, single line diagram, flowchart.
- Technical data schedules corresponding to the equipment schedules in the contract documents. If there is a discrepancy between the two, substantiate the change.

**Certification**

Submit certification that the plant and equipment submitted meets all requirements and capacities of the contract documents except for departures that are identified in the submission.
**Products**

**Accessories**

**General**
Responsibilities: Provide accessories as documented.
Proprietary equipment: The requirements of this specification over-ride the specifications inherent in the selection of a particular make and model of accessory.
Uniformity: All accessories and outlets located in close proximity are to be the same manufacture, size, finish and material.
Default finish: To be selected from the manufacturers standard range.

**Quality Assurance**
Implement a quality system for the works in accordance with Australian/New Zealand ISO 9000.1 - Quality management and quality assurance Standards - Guidelines for selection and use and Australian/New Zealand ISO 9001 - Quality systems - Model for quality assurance in design, development, production, installation and servicing.

**Accessories, Outlets and Appliances**
Provide and install all accessories, outlets, appliances and appliance connections complete with required fixings and fastenings.
Accessory selection and locations require approval to ensure that each item is compatible with the final interior design of the space.

Provide accessories and outlets as follows:
- Accessory flush plates - "Clipsal 15/25" or "HPM 787/777" series, with retaining screws.
- Protected and/or weatherproof accessories - non-corroding metal or polycarbonate enclosures. As Clipsal 56 series or approved equivalent.
- Accessories in plantrooms - grey PVC or Metal "Protected" type.
- Isolating switches or direct connected equipment including Mechanical Services plant - "Clipsal 56" series or approved equivalent.
- Isolating switches for fire and life safety plant including Mechanical Services smoke control systems - "Wilco A" series or approved equivalent.

**Switches:**
- Provide 15 A minimum rated rocker switches suitable for fluorescent lighting loads equal to "Clipsal 30FLM15" or "HPM 770/15" and flush wall mount generally.
- Provide multi switch positions ganged under one cover plate, arranged in ganged boxes similar in plan to the lighting points controlled. Where more than 6 switches are required at the one location, install mechanisms on a flush mounted multigang lighting control panel.

**Power outlets:**
- Provide combination rocker switched socket outlets, generally flush wall mounted and of identical manufacture to switches. Mount double outlets under one flush plate.
- Fit neon indicators as an integral part of the flush plate to all laboratory, workshop and cleaners socket outlets.
- Provide three phase outlets of 5 pin (3mm diameter earth and neutral) pattern, housed in non-corroding metal or polycarbonate enclosures, "Wilco A" or "Clipsal 56" series or approved equivalent.

**TV outlets:**
- Provide flush wall mounted plates to TV points of the same manufacture as switches complete with 75 ohm crimp connect TV antennae socket suitable for connection to an RG6 quad shield cable.

**Voice/Data points:**
- Provide 25mm conduit and draw wire from accessible ceiling cavities above and below to deep wall box at each outlet location.
Provide flush plates to telephone points of the same manufacture as switches and suitable for mounting of one, two or three RJ45 outlet plugs.

**APPLIANCES**

**General:**
- Provide all appliances internally wired and complete with control switches, controllers and connecting links.
- Unless stated otherwise provide isolating switch adjacent all direct connected appliances and equipment.
- Connect each three phase appliance with a separate neutral and earth.
- Install the final connection to any equipment installed away from, but within 600mm of, a wall or column in flexible PVC conduit.
- Where any equipment is located at greater than 600mm from the wall, provide cabling installed within concealed conduit, in-floor ducting cast into the slab or service pole.
- Check immediately all equipment arriving on site for its electrical loading and phase connections. Advise in writing where equipment is deemed to be unsuitable for connection to the designated building supply.

Television antennae:
Provide an approved combined VHF/UHF and digital antennae securely fixed to the roof in an approved location. Wire to the television outlets using low-loss 75 ohm coaxial cable.

Execution
Performance
General
Performance criteria: Meet the performance criteria as documented.

Demolition
General
General: Decommission, isolate, demolish and remove from the site all existing redundant cables and equipment including minor associated components that become redundant as a result of the demolition.

Breaking down: Disassemble or cut up equipment where necessary to allow removal.
Recovered materials: Recover all components associated with the listed items. Minimise damage during removal and deliver to the locations scheduled.

Demolished materials

Demolished materials classes
Ownership and implementation: Comply with the Demolished materials classes table.

Demolished materials classes table

<table>
<thead>
<tr>
<th>Class</th>
<th>Requirement</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovered items for re-use in the works</td>
<td>Recover without damage items identified in the Recovered items for re-use in the works schedule</td>
<td>Principal/Proprietor</td>
</tr>
<tr>
<td>Recovered items for delivery to the principal</td>
<td>Recover items identified in the Recovered items for delivery to the principal schedule</td>
<td>Principal/Proprietor</td>
</tr>
<tr>
<td>Demolished for removal</td>
<td>Remove from the site demolished materials identified in the Demolish for removal schedule. Do not burn or bury on site Transit: Prevent spillage of demolishing materials in transit</td>
<td>Contractor</td>
</tr>
</tbody>
</table>

Re-used components
General: Clean re-used components and test for compliance with current Australian Standards before returning to service. Provide results of compliance tests.

Work on existing systems
General
General: Before starting work on existing systems, measure existing conditions (phase sequence, supply voltage, measured maximum demand). Submit the results for information.
- If the existing conditions are less than necessary to meet the requirements in the contract documents, submit proposals to rectify the deficiencies with related costing, time and other impacts.
- Subject to the results from the preceding work on existing systems, achieve the performance
in the contract documents.

**Services connections**

**Connections**
General: Connect to network distributor services or service points. Excavate to locate and expose connection points. On completion reinstate the surfaces and facilities that have been disturbed.

**Network distributors’ requirements**
General: If the network distributor elects to perform or supply part of the works, make the necessary arrangements. Install equipment supplied, but not installed, by the authorities.

**Installation**

**General**
Fixing: If non-structural building elements are not suitable for fixing equipment and services to, fix directly to structure and trim around holes or penetrations in non-structural elements.
Installation: Install equipment and services plumb, fix securely and organise reticulated services neatly. Allow for movement in both structure and services.
Concealment: Conceal all cables, ducts, trays, pipes etc. unless installed in plant spaces, ceilings, riser cupboards, etc. or unless otherwise documented. If possible, do not locate on external walls.
Lifting: Provide heavy items of equipment with permanent fixtures for lifting as recommended by the manufacturer.
Suspected ground floors: Keep all parts of services under suspended ground floors > 150 mm clear of the ground surface. Make sure services do not impede access.
Arrangement: Arrange services so that services running together are parallel with each other and with adjacent building elements.

**Cable systems**
Systems: Provide the following:
- Inaccessible concealed spaces: Cable in UPVC conduit.
- Face, plastered or rendered masonry surfaces: Cable in UPVC conduit.
- Walls filled with bulk thermal insulation: Cables in PVC conduit.
- Plant rooms: Cable in heavy duty UPVC conduit, or on tray or in duct.

**Installation of accessories**
General: Unless installed on purpose built ductwork. Install accessories in conformance with the installation of accessories table.
Location: Final location of all outlets and equipment to be confirmed on site prior to installation.
Spacing from adjacent horizontal surface: ≥ 75 mm to the centre of accessory socket.
Default mounting heights to centre of accessory plate:

<table>
<thead>
<tr>
<th>Outlet</th>
<th>300 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switches</td>
<td>10100 mm</td>
</tr>
</tbody>
</table>

Flush mounting: Provide flush mounted accessories except in plant rooms.
Common face plates: Mount adjacent flush mounted accessories under a common faceplate.
Restricted location: Do not install wall boxes across junctions of wall finishes.
Surface mounting: Proprietary mounting blocks.

**Installation of accessories table**

<table>
<thead>
<tr>
<th>Wall construction</th>
<th>Installation and concealed cabling facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rendered masonry partition</td>
<td>Flush wall box with PVC rigid conduit chased into wall, top edge of the conduit to finished wall surface height 15mm, expand metal mesh to be fixed over chases prior to rendering conduit chased into wall</td>
</tr>
<tr>
<td>Double sided face brick partition</td>
<td>Vertically mounted flush wall box with conduit concealed in cut bricks</td>
</tr>
<tr>
<td>Face brick external cavity wall</td>
<td>Flush wall box with thermoplastic insulated cables in</td>
</tr>
<tr>
<td>Wall construction</td>
<td>Installation and concealed cabling facilities</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>conduit run in cavity and tied against inner brick surface, or thermoplastic sheathed cables run in cavity</td>
</tr>
<tr>
<td>Stud partition</td>
<td>Rewirable, earth and shroud all metal frame partitions at each accessory location. Flush plate secured to proprietary support bracket or wall box</td>
</tr>
</tbody>
</table>

**Installation of ceiling mounted appliances**

Connections: Appliances: Provide flush mounted outlets on the ceiling next to support brackets.
Mounting: Mount appliances independent of ceiling tiles and suspended ceiling material.
Connections: Fixed equipment: Provide concealed permanent connections.
Fixing: For equipment and appliances heavier than 30 kg provide support through the suspended ceiling to the building structure. Brace appliances that have excessive bending moments, are heavy or vibrate, to prevent horizontal movement.
Shroud: shrouded and sealed to AS/NZS 3000.
Structural support: provide additional support where accessories installed on or mineral fibre acoustic ceiling tiles. 10m plaster board laminated to the mineral fibre acoustic ceiling tile would be deemed suitable.
**Differential movement**

General: If the geotechnical site investigation report predicts differential movements between buildings and the ground in which conduits are buried, provide movement control joints in the conduits.
- Location: Adjacent to the conduit supports which are closest to the perimeter of the building.
- Arrangement: Arrange conduits to minimise the number of movement control joints.
- Magnitude: Accommodate the predicted movements.

**Building penetrations**

**Penetrations**

Fire rated building elements: Seal penetrations with a system conforming to AS 4072.1.
Non-fire rated building elements: Seal penetrations around conduits and sleeves. Seal around cables within sleeves. If the building element is acoustically rated, maintain the rating.

**Sleeves**

General: If piping or conduit penetrates building elements, provide metal or UPVC sleeves formed from pipe sections as follows:
- Movement: Arrange to permit normal pipe or conduit movement.
- Diameter (for non fire-rated building elements): Sufficient to provide an annular space around the pipe or pipe insulation of at least 12 mm.
- Prime paint ferrous surfaces.
- Terminations:
  - If cover plates are fitted: Flush with the finished building surface.
  - In fire-rated and acoustic-rated building elements: 50 mm beyond finished building surface.
  - In floors draining to floor wastes: 50 mm above finished floor.
  - Elsewhere: 5 mm beyond finished building surface.
- Termite management: To AS 3660.1.
- Thickness:
  - Metal: ≥ 1 mm.
  - UPVC: ≥ 3 mm.

**Sleeves for cables**

General: For penetrations of cables not enclosed in conduit through ground floor slabs, beams and external walls provide sleeves formed from UPVC pipe sections.
- MIMS cables: Provide sleeves for penetrations through masonry.

**Concrete plinths**

**Construction**

General: Provide plinths conforming to the
- For all floor mounted equipment. Hot dipped or galvanised.
- Concrete: Grade N25
- Finish: Steel float flush with the surround.
- Finish: Steel float flush with the surround.
- Surround: Provide galvanized steel surround at least 75 mm high and 1.6 mm thick. Fix to the floor with masonry anchors. Fill with concrete.
- Minimum height: 100mm for main switchboard.

**Plant and equipment access**

**General**

Services and equipment: Locate and arrange all services and equipment so that:
- They comply with the relevant requirements of the appropriate Occupational Health and Safety regulations.
- Failure of plant and equipment (including leaks) does not create a hazard for the building occupants.
- Failure of plant and equipment (including leaks) cause a minimum or no damage to the building, its finishes and contents.
- Inspection and maintenance operations can be arranged to minimise inconvenience and disruption to building occupants or damage to the building structure or finishes.
- Services and equipment are readily accessible for inspection and maintenance and arranged so that inspection and maintenance can be carried out in a safe and efficient manner. Include the following:
  . Conform to the relevant requirements of AS 1470, AS 1657, AS/NZS 1892.1 and AS/NZS 2865.
  . If parts of the plant require regular inspection and maintenance either locate plant so it is safely accessible from floor level or provide permanent access platforms and ladders.
  . In false ceilings locate items of equipment that require inspection and maintenance above tiled parts where possible. If this is not possible (for example if above set plaster or other inaccessible ceilings) provide access panels. Arrange services and plant locations to reduce the number of access panels. Coordinate with other trades to use common access panels where feasible.
  . Modify manufacturer’s standard equipment when necessary to provide the plant access in the contract documents.
- Securely fix/mount ancillary equipment (remote transformers, ballasts, control gear, battery boxes, etc) clear of ceilings, lighting equipment sitting on top of t-bar type ceiling tiles is not acceptable.
  . Ensure additional structural support is provided for any accessories installed on or in mineral fibre acoustic ceiling tiles. 10mm plaster board laminated to the mineral fibre acoustic ceiling tile would be deemed suitable.
Seismic restraint

Provisions
General: Arrange all components, other than service items exempted in AS 1170.4, to resist seismic loads determined in accordance with AS 1170.4. Securely fix all plant and equipment to the building structure. Do not rely on gravity and/or friction to resist seismic forces. Anti-vibration mounts: Use horizontally restrained type. Components: Do not use components that will be damaged by earthquake conditions. Protect systems against the adverse effects of components such as mercury switches that, although not damaged by earthquake, may malfunction.

Painting and finishes

General
General: If exposed to view (including in plant rooms) paint new services and equipment. Surfaces painted or finished off-site: Conform to Metals and prefinishes. Exceptions: Do not paint chromium or nickel plating, anodised aluminium, GRP, stainless steel, non-metallic flexible materials and normally lubricated machined surfaces. Surfaces with finishes applied off-site need not be re-painted on-site provided the corrosion resistance of the finish is not less than that of the respective finish in this clause.

Standard
General: Conform to the recommendations of AS/NZS 2311 Sections 3, 6 and 7 or AS/NZS 2312 Sections 5, 8 and 10, as applicable.

Low VOC emitting paints
Provide the following low odour/low environmental impact paint types with the following VOC limits:
- Primers and undercoats: < 5 g/litre.
- Low gloss white or light coloured latex paints for broadwall areas: < 5 g/litre.
- Coloured low gloss latex paints: < 85 g/litre.
- Gloss latex paints: < 90 g/litre.

Painting systems
New unpainted interior surfaces: To AS/NZS 2311 Table 5.1.
New unpainted exterior surfaces: To AS/NZS 2311 Table 5.2.

Paint application
Coats: Apply the first coat immediately after substrate preparation and before contamination of the substrate can occur. Ensure each coat of paint or clear finish is uniform in colour, gloss, thickness and texture and free of runs, sags, blisters or other discontinuities. Combinations: Do not combine paints from different manufacturers in a paint system. Protection: Remove fixtures before starting to paint and refix in position undamaged on completion.

Marking and labelling

General
General: Mark services and equipment to provide a ready means of identification.
- Locations exposed to weather: Provide durable materials.
- Pipes, conduits and ducts: Identify and label to AS 1345.
- Cables: Label at each end to indicate the origin and destination of the cable. Consistency: Label and mark equipment using a consistent scheme across all services elements of the project. Operating and maintenance manuals: Provide marking an labelling text identical to the text and terminology used in operating and maintenance manuals.

Accessories
Label isolating switches and outlets to identify circuit origin. Type: IPA stud to switchboard colour phase and numbering sequence. Fixing: Securely fixed.
Unacceptable: Pre printed self-adhesive flexible plastic labels.

Labels and notices
General: Select from the following materials:
- Cast metal.
- For indoor applications only, engraved two-colour laminated plastic.
- Proprietary pre-printed self-adhesive flexible plastic labels to DTEI approval.
- Stainless steel or brass ≥ 1 mm thick with black filled engraved lettering.
Emergency functions: To AS 1319.
Colours: Generally in conformance with AS 1345 as appropriate, otherwise black lettering on white background except as follows.
- Danger, warning labels: White lettering on red background.
- Main switch and caution labels: Red lettering on white background.
Edges: If labels exceed 1.5 mm thickness, radius or bevel the edges.
Fixing: Fix labels securely using screws, rivets, proprietary self-adhesive labels or double-sided adhesive tape.
- If labels are mounted in extruded aluminium sections, use rivets or countersunk screws to fix the extrusions.
- Use aluminium or monel rivets for aluminium labels.
Label locations: Locate labels so that they are easily seen and are either attached to, below or next to the item being marked.
Label text: To correspond to terminology and identifying number of the respective item as shown on the record drawings and documents.
Lettering heights:
- Danger, warning and caution notices: ≥ 10 mm for main heading, ≥ 5 mm for remainder.
- Equipment labels within cabinets: ≥ 3.5 mm.
- Identifying labels on outside of cabinets: ≥ 5 mm.
- Other locations: ≥ 3 mm.
Operable devices: Mark to provide a ready means of identification. Include the following:
- Controls.
- Indicators, gauges, meters and the like.
- Isolating switches.
- Outlets.

Underground cable routes
Survey: Accurately record the routes of underground cables before backfilling. Include on the record drawings.
Records: Provide digital photographic records of underground cable routes before backfilling. Include in operation and maintenance manual.
Location marking: Accurately mark the location of underground cables with route markers consisting of a marker plate set flush in a concrete base.
Markers: Place markers at each joint, route junction, change of direction, termination and building entry point and in straight runs at intervals of not more than 3100 m.
Marker bases: 200 mm diameter x 200 mm deep, minimum concrete.
Direction marking: Show the direction of the cable run by means of direction arrows on the marker plate. Indicate distance to the next marker.
Plates: Brass, aluminium or mild steel hot-dipped galvanized, minimum size 75 x 75 x 21 mm thick.
Plate fixing: Waterproof adhesive and 4 brass or stainless steel countersunk screws.
Marker height: Set the marker plate flush with paved surfaces, and 25 mm above other surfaces.
Marker tape: Where electric bricks or covers are not provided over underground wiring, provide a 150 mm wide yellow or orange marker tape bearing the words ‘WARNING – electric cable buried below’, laid in the trench 150 mm below ground level.
Draw wire: provide for all spare conduits.

Operation and maintenance manuals
Additional information
General: Provide maintenance manuals including the following in addition to that specified in the General requirements worksection:
- Installation description: General description of the installation.
- Systems descriptions: Technical description of the systems installed, written to ensure that the principal’s staff fully understand the scope and facilities provided. Identify function, normal operating characteristics, and limiting conditions.
- Equipment descriptions:
  - Manufacturers’ technical literature for equipment installed, assembled specifically for the project, excluding irrelevant matter. Mark each product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation.
  - Supplements to product data to illustrate relations of component parts. Include typed text as necessary.
- Operation procedures:
  - Safe starting up, running in, operating and shutting down procedures for systems installed.
  - Control sequences and flow diagrams for systems installed.
  - Legend for colour-coded services.
  - Schedules of fixed and variable equipment settings established during commissioning and maintenance.
- Maintenance procedures:
  - Schedule of normal consumable items, local sources of supply, and expected replacement intervals up to a running time of 40 000 hours. Include lubricant and lubrication schedules for equipment.
  - Instructions for use of tools and testing equipment.
  - Emergency procedures, including telephone numbers for emergency services, and procedures for fault finding.
  - Material safety data sheets (MSDS).
- Certificates:
  - Copies of test certificates for the installation and equipment used in the installation.
  - Test reports.
  - Australian Communications Authority TCA1 form
  - Warranty certificates for all systems.
  - Electronic Security Installation
  - Fire Detection Installation
- Drawings:
  - Single line diagrams.
  - Service route layouts.
  - Switchgear and control gear assembly circuit schedules including electrical service characteristics, controls and communications.
- Hard copy – A1-A3 AutoCad drawings and software DWG file and PDF’s on CDROM electronic copies.
- Performance Test:
  - Include commissioning data and performance test results.
  - Electronic security and fire detection equipment list
  - Training:
  - Certificate of training completion.
  - Contact details for further training.

**Record drawings**

**General**

General: Show dimensions, types and location of the services in relation to permanent site features and other underground services. Show the spatial relationship to building structure and other services. Include all changes made during commissioning and the maintenance period.

Drawings: Include all documented shop drawings.

Extensions and/or changes to existing: If a drawing shows extensions and/or alterations to existing installations, include sufficient of the existing installation to make the drawing comprehensible without reference to drawings of the original installation.
Tools and spare parts

Tools and spare parts schedule
General: At least 8 weeks before the date for practical completion, submit a schedule of tools, portable instruments and spare parts necessary for maintenance of the installation. For each item state the recommended quantity and the manufacturer’s current price. Include the following in the prices:
- Checking receipt, marking and numbering in accordance with the spare parts schedule.
- Packaging and delivery to site.
- Painting, greasing and packing to prevent deterioration during storage.
- Referencing equipment schedules in the operation and maintenance manuals.
- Suitable means of identifying, storing and securing the tools and instruments. Include instructions for use.

Spares
General: Provide spare parts listed in the appropriate worksections.
Replacement: Replace spare parts consumed during the maintenance period.

Commissioning
Circuit protection
General: Confirm that circuit protective devices are sized and adjusted to protect installed circuits.
Controls
General: Calibrate, set and adjust control instruments, control systems and safety controls.
Notice
General: Give sufficient notice for inspection to be made of the commissioning of the installation.
Reports
General: Submit reports indicating observations and results of tests and compliance or non-compliance with requirements.

Cleaning
General
Practical completion: At practical completion, clean the following:
- Insides of switchgear and control gear assemblies.
- Luminaires.
- Switchgear and contactors, and other electrical contacts. Adjust as necessary.
- Switchboards, communications cabinets.

Completion tests
General
General: Test the works under the contract to demonstrate compliance with the documented performance requirements.
Functional checks
General: Carry out functional and operational checks on energised equipment and circuits and make final adjustments for the correct operation of safety devices and control functions.
Proprietary equipment
General: Submit type test reports confirming compliance of proprietary equipment.
Sound pressure level measurements
Correction for background noise: To AS/NZS 2107 Table B1.
External: To AS 1055.1.
Internal: To AS/NZS 2107.
Measurement positions: If a test position is designated only by reference to a room or space, do not take measurements less than 1 m from the floor, ground or walls.
Sound pressure level analysis: Measure the sound pressure level and the background sound pressure level over the full range of octave band centre frequencies from 31.5 Hz to 8 kHz at the designated positions.
Sound pressure levels: Measure the A-weighted sound pressure levels and the A-weighted background sound pressure levels at the designated positions.
Test instruments
General: Use instruments calibrated by a registered testing authority. Ensure equipment test parameters meet all current standards.

Training
General
Duration: Instruction to be available for the whole of the commissioning and running-in periods.
Format: Conduct training at agreed times, at system or equipment location. Also provide seminar instruction to cover all major components.
Operation and maintenance manuals: Use items and procedures listed in the final draft operation and maintenance manuals as the basis for instruction. Review contents in detail with the principal’s staff.
Certification: Provide written certification of attendance and participation in training for each attendee. Provide register of certificates issued.

Demonstrators
General: Use only qualified manufacturer’s representatives who are knowledgeable about the installations.

Maintenance
General: Explain and demonstrate to the principal’s staff the purpose, function and maintenance of the installations.

Operation
General: Explain and demonstrate to the principal’s staff the purpose, function and operation of the installations.

Maintenance
General: During the maintenance and defects liability periods, carry out periodic inspections and maintenance work as recommended by manufacturers of supplied equipment, and promptly rectify faults.
Emergencies: Attend emergency calls promptly.

Servicing Access
Arrange all plant and equipment to provide minimum access and maintenance requirements in accordance with the equipment manufacturers recommendations and the requirements of the Occupational Health, Safety and Welfare Act and Regulations.

Maintenance program
General: Submit details of maintenance procedures and program, relating to installed plant and equipment, 6 weeks before the date for practical completion. Indicate dates of service visits. State contact telephone numbers of service operators and describe arrangements for emergency calls.

Maintenance records
General: Submit, in binders which match the manuals, loose leaf log book pages designed for recording completion activities including operational and maintenance procedures, materials used, test results, comments for future maintenance actions and notes covering the condition of the installation. Include completed log book pages recording the operational and maintenance activities performed up to the time of practical completion.
Existing binders: Update all binders with the relevant information
Certificates: Include test and approval certificates.
Certification: On satisfactory completion of the installation, submit certificates stating that each installation is operating correctly.
Number of pages: The greater of 100 pages or enough pages for the maintenance period and a further 12 months.
Referenced documents: If referenced documents or technical worksections require that log books or records be submitted, include this material in the maintenance records.

Service visits: Record comments on the functioning of the systems, work carried out, items requiring corrective action, adjustments made and name of service operator. Obtain the
signature of the principal’s designated representative.

Site control
General: Report to the principal’s designated representative on arriving at and before leaving the site.

Cable support and duct systems

General

Aims
Responsibilities
General: Provide cable support, trunking and duct systems as documented.

Cross references

General
General: Conform to the General requirements worksection.
Associated worksections
Associated worksections: Conform to the following:
- Electrical general requirements.

Submissions

Shop drawings
General: Submit shop drawings showing the following:
- Cable tray and trunking routes.
- Layout of cable supports and enclosures on the current architectural background coordinated with the structure and other services.
- Layout of underground conduits, pits and drainage trenches.
- Invert levels for underground conduits.
- Depth of burial for cables and conduits.
- In situ pits.
- Provision for expansion and ground movement.
- Fabricated columns.
- Footing for columns.

Technical data
General: Submit technical data for the following:
- Ducted wiring enclosure systems.
- Cable support systems.
- Proprietary pits.
- Proprietary columns.
- Load calculations for aerial cable supports.

Products

Conduits
General
Standards: AS/NZS 2053 Parts 1, 2, 3, 4, 5, 6, 7 and 8.

Type
General: Rigid.
Electrical:- Rigid heavy duty PVC

Sizes
Conduits: 20 mm.
Underground: 4025 mm.
Conduits for telecommunications: 25 mm.

Fixings
Saddles: Double sided fixed.

Colour
Conduits for telecommunications systems: White.
Galvanized water pipe
Medium or heavy: To AS 1074.
Metallic conduits and fittings

General
Standards: AS/NZS 2053.7 or AS/NZS 2053.8.

Type
General: Screwed steel.

Fixings
Saddles:
- Internal: Zinc plated.
- External: Hot-dipped galvanized.

Corrosion protection
Steel conduits: Paint ends and joint threads with zinc rich organic primer to AS/NZS 3750.9.

Non-metallic conduits and fittings

General
Standards: Non-metallic conduits and fittings: AS/NZS 2053 Parts 2, 3, 4, 5 or 6.

Solar radiation protection: Required for exposed conduits and fittings.

Flexible conduit
General: Provide flexible conduit to connect with equipment and plant subjected to vibration. If necessary, provide for adjustment or ease of maintenance. Provide the minimum possible length.

Associated fittings
Type: The same type and material as the conduit.
Wall boxes on UPVC conduits: For special size wall boxes not available in UPVC, provide prefabricated earthed metal boxes.

Inspection fittings
General: Provide inspection-type fittings only in accessible locations and where exposed to view.

Joints
Type: Cemented or snap on joints.

UV protection
General: All exposed conduits to be UV protected. Fixings protected.

Fixings and Supports
Type: Metal; Metal saddles are to be double sided. Zinc plated for internal use and hot dipped galvanised for external use or where exposed.

Cable duct/trunking

General
Standards:
- Cable duct/trunking systems: To AS/NZS 4296.
- Earthing: All metal ducts to be bonded and earthed.

Cable duct
Material: Metal.
Material finish: Metallic-coated to AS 1397 Grade G2, Coating Class Z275.
Construction: Solid.

Covers:
- Accessible locations: Screw-fixed or clip-on type removable only with the use of tools.

Accessories: Purpose-made to match the duct system.

Cable support: Except for horizontal runs where the covers are on top, support wiring with retaining clips at intervals of not more than 1000 mm.

Proprietary trunking systems
General: Provide proprietary, skirting duct, wall duct, floor duct and service column systems, incorporating segregation where used for multiple services. Provide rigid supports. Round off sharp edges and provide bushed or proprietary cable entries into metallic trunking.

Accessories: Provide proprietary fixings and mountings facilities for accessories and outlets.

Covers: Screw-fixed or clip-on type removable only with the use of tools.

Cable tray/ladder support systems

General
System: Provide a complete cable support system consisting of trays or ladders and including brackets, fixings and accessories.
Selection: Run cables < 13 mm diameter on cable trays or in ducts.
Standard: NEMA VE-1.
Type tests: To NEMA VE-1.
Manufacture: Provide proprietary trays, ladders, fittings and accessories from a single manufacturer for the same support system.
Selection: Select cable tray/ladder in conjunction with support system installation to achieve the documented loading and deflection requirements.
Spare capacity: ≥ 50%.
Support:
- Power cables: Trapeze or centre rail structure.
- Communications cables: Single sided.
Dimensions: To the preferred dimensions nominated in NEMA VE-1.
Material: Corrosion-resistant finished steel.
Material finish: Metallic-coated to AS 1397, Grade G2, Coating Class Z275. All cut ends to be de-burred and painted with cold galvanising paint.
Covers: Provide ventilated flat covers to cable trays/ladders installed in accessible locations.

Catenary systems
General
Catenary systems: May be used within suspended ceiling spaces in lieu of cable tray and ladder systems.
Wire: Provide stainless steel or coated galvanized cable and couplings for catenary systems.
Fixing: Secure independently to building structure. Tying off to mechanical and hydraulic plant and equipment is not acceptable.

Cable pits
General
Cable draw-in pits: Provide. Sizes given are internal dimensions.
Proprietary cable pits
Pits 1200 x 1200 mm: Provide proprietary concrete or polymer moulded pits.
In situ construction
Pits > 1200 x 1200 mm: Provide either:
- Proprietary cable pits.
- Construct walls and bottoms from rendered brickwork or 75 mm thick reinforced concrete.
  Incorporate a waterproofing agent in the render or concrete.
Pit covers
General: Provide pit covers to suit external loads. Fit flush with the top of the pit.
Standard: To AS 3996.
Locking: Provide proprietary locking lids for high risk areas.

Weight: < 40 kg for any section of the cover.
Lifting handles: Provide a lifting handle for each size and type of cover section.
Drainage
General: Provide drainage from the bottom of cable pits, either to absorption trenches filled with rubble or to the stormwater drainage system.
Absorption trenches: Minimum size 300 x 300 x 2000 mm.

Columns
General
Columns: Conform to the following for fabricated columns more than 2400 mm high which are designed to support accessories outdoors.
Standards: Comply with the following standards as appropriate:
All work shall be carried out to the following standards:
AS1170.1 - Dead & live loads and load combinations
AS1170.2 - Wind loading
AS1650 - Hot-dipped galvanized coating on ferrous articles.
AS1798 - Public lighting pole
AS3600 - Concrete structures
AS4100 - Steel structures
Design
Footings: To be designed by an accredited structural engineer and independently certified.
Site Specifics: Take into consideration the design wind category and soil conditions.

Construction
General: Galvanize columns and fittings after fabrication.
Bases: Provide columns with mounting bases for fixing to reinforced concrete footings via rag bolt assembly.
Rag Bolt Assembly: Holding bolts to be cut within 3 threads above top of base plate top lock nuts.
Base fixing: galvanised holding down nut with galvanised lock nut above.
Base sealing: Seal space under pole base plate with grout.
Accessory mountings: Provide adjustable mountings, to suit accessories, and with provision for rigidly clamping each item in position, once adjusted correctly.
Maintenance access: Provide pole stirrups secured to either side of the column for access to accessories. Locate the first stirrup at least 3 m above ground level.
Electrical connections: Provide a recess at the base of the column for access to cable connections and equipment, fitted with a flush mounted cover. For connections higher than 3 m provide a catenary wire cable support system.
Paint colour – Unless otherwise specified, to Architectural colours.
- AS 1798 for public lighting poles.
- AS 3600 for concrete structures.
- AS 4100 for steel structures.
- AS/NZS 4676 for structural design of columns.
- AS 4680 for hot-dipped galvanized (zinc) coatings on ferrous articles.

POWER POLES
General
Material: Hardwood.
Service connection: Provide pole mounted equipment including weatherproof box and service fuses at the service connection point as required by the Network Distributor.
Design
Standards: To the local Network Distributors standards and to the local Service and Installation Rules.
Hardwood poles
Selection: Dressed, natural, round poles with all sapwood removed.
Capping: Galvanized steel, domed cap extending 25 mm down the sides. Fix with galvanized steel nails.
Treatment: Provide termite and fungus treatment to 600 mm above ground level.
Hardwood crossarms
Material: 75 x 75 x 1500 minimum hardwood.
Fixing: Securely fix to pole with M20 galvanized bolts, nuts and washers.
Bracing: Provide two 5 x 40 x 690 galvanized steel fixed at 45 degrees to the pole below the cross arm with M12x75 galvanized coach screws in the pole and M12 galvanized bolts, nuts and washers in the crossarms.
Design
General: Provide columns designed, manufactured and tested by a specialist manufacturer.
Footings: To be designed by an accredited structural engineer and independently certified.
Site specifics: Take into consideration the design wind category and the soil conditions.
Dimensions: To AS 1798.
Construction
General: Hot-dip galvanize columns and fittings after fabrication.
Bases: Provide columns with mounting bases for fixing to reinforced concrete footings via rag bolt assembly.
Rag bolt assembly: Holding bolts to be cut within 3 threads above top of base plate top lock nuts.
Base fixing: Galvanized holding down nut with galvanized lock nut above.
Base sealing: Seal space under pole base plate with grout.
Finish: Paint, colour as documented.
Accessory mountings: Provide adjustable mountings, to suit accessories. Include provision for rigidly clamping each item in position, once adjusted correctly.
Maintenance access: Provide pole stirrups secured to either side of the column for access to accessories. Locate the first stirrup ≥ 3 m above ground level.
Electrical connections: Provide a recess fitted with a flush mounted cover at the base of the column for access to cable connections and equipment.
Cable support: For connections higher than 3 m provide a catenary wire cable support system.

**Execution**

**Unsheathed cables – installation**

*General*
General: Provide permanently fixed enclosure systems, assembled before installing wiring. Provide draw wires to pull in conductor groups from outlet to outlet, or provide ducts with removable covers.

**Conduit systems – installation**

*Set out*
General: If exposed to view, install conduits in parallel runs with right angle changes of direction.
*Bends*
General: Install conduits with the equivalent of \( \leq 2 \) right angled bends per cable draw-in run.
*Approval*
Superintendent approval required for \( > 2 \) bends.

*Conduits in roof spaces:*
General: Locate below roof insulation and sarking. In accessible roof spaces, provide mechanical protection for light-duty conduits.

*Inspection fittings*
General: Locate in accessible positions.

*Draw cords*
General: Provide 5 mm\(^2\) polypropylene draw cords in conduits not in use.

*Draw-in boxes*
General: Provide draw-in boxes as follows:
- Spacing: \( < 2830 \) m.
- At changes of level or direction.
Underground draw-in boxes: Provide casketed covers and seal against moisture. Install in accessible pits.

**Expansion**

General: Allow for thermal expansion/contraction of conduits and fittings due to changes in ambient temperature conditions. Provide expansion couplings as required.

**Rigid conduits**

General: Provide straight long runs, smooth and free from rags, burrs and sharp edges. Set conduits to minimise the number of fittings.

**Routes**

General: Run conduits concealed in wall chases, embedded in floor slabs or installed in inaccessible locations directly between points of termination, minimising the number of sets. Do not provide inspection fittings.

**Conduits in concrete slabs**

Route: Do not run in concrete toppings. Do not run within pretensioning cable zones. Cross pretensioning cable zones at right angles. Route to avoid crossovers and minimise the number of conduits in any location. Space parallel conduits 50 mm apart.

Minimum cover: The greater of the conduit diameter and 20 mm.

Fixing: Fix directly to top of the bottom layer of reinforcing.

**Hollow-block floors**

Locate conduits in the core-filled sections of precast hollow-block type floors.

**Columns**

Conduits in columns:
- \( \leq 4 \) per column.
- \( \leq 25 \) mm diameter.
- Locate conduits centrally in each column.

Bends: Enter columns via 150 mm radius sweep bends. Do not use elbows.

Chasing: Do not chase columns.
Cable tray/ladder support systems – installation

General
Standard: To NEMA VE-2.
Design: Support cable trays/ladders to achieve the following:
- Concealed trays/ladders: Support spacing ≤ length of tray/ladder section.
- Visible trays/ladders: Loaded deflection ≤ span/350.

Fixing to building structure
General: Fix supports to the building structure or fabric by means of ≥ 8 10 mm (hot dipped galvanised within 1km from the sea and zinc plated for other areas) threaded rod hangers attached to hot-dipped galvanized U-brackets, or by means of proprietary brackets.
Cut ends: De-burred and painted with cold galvanised paint.

Cable fixing
General: Provide strapping or saddles suitable for fixing cable ties.
MIMS cables: provide non-magnetic straps installed to manufacturers recommendations.

Bend radius
General: Provide bends with an inside radius 12 times the outside diameter of the largest diameter cable carried.

Cable protection
General: Provide rounded support surfaces under cables where they leave trays or ladders.

Access
General: Locate trays and ladders to provide ≥ 150 mm free space above and ≥ 600 mm free space on at least one side.

Clearances
From hot water pipes: > 200 mm.
From boilers or furnaces: > 500 mm.
EMI: Locate support systems for electrical power cabling and communication cabling to minimise electromagnetic interference.

Catenary systems – installation

General
Anchoring: Anchor catenary systems to the structure. Do not fix to any part of a suspended ceiling system.
Design loads: Provide catenary systems designed to support the proposed load of the cables with a spare capacity of 50% loading.
Fixing: Fix cables to the catenary system such that no cable is under stress due to tension or compression. Use proprietary fixings that allow cables to be added or removed without destroying the integrity of the system.

Cables in trenches – installation

Sand bed and surround
General: Provide clean sharp sand ≥ 150 mm around cables and conduits installed underground.

Sealing ducts and conduits
General: Seal buried entries to ducts and conduits with waterproof seals. Seal spare ducts and conduits immediately after installation. Seal other ducts and conduits after cable installation. Seals to be removable.

Columns – installation

General
General: Install columns as documented including the provision of in situ reinforced concrete footings to the Wiring enclosures and cable support systems schedule.

POWER POLES – INSTALLATION

General
Standards: To the Service and Installation Rules and to the standards published by the local Network Distributor for the project environment and for the selected aerial arrangement.

Hardwood poles
Burying depth: 1600 mm minimum.
Support: Baulk and stay to suit the design loads.
Cable protection: Provide protection for cables and conduits installed on the exterior of the pole to a height of 2000 mm above and 150 mm below ground using either galvanized water pipe or 3.2 mm thick hot dipped galvanized channel.

**Selections**

**Wiring enclosures and cable support systems schedule**

**Cable trunking**

<table>
<thead>
<tr>
<th>Size</th>
<th>Number of channels</th>
<th>Profile and dimensions</th>
<th>Material</th>
<th>Colour</th>
<th>Finish</th>
</tr>
</thead>
</table>

**Cable trays/ladders**

<table>
<thead>
<tr>
<th>Type</th>
<th>Material</th>
<th>Finish</th>
<th>Dimensions</th>
<th>Usable width</th>
<th>Usable depth</th>
<th>Minimum thickness</th>
<th>Unit length</th>
<th>Connector type and material</th>
</tr>
</thead>
</table>

**Catenary systems**

<table>
<thead>
<tr>
<th>Maximum number of cables permitted to be supported by a catenary system</th>
<th>Lighting circuits</th>
<th>Socket outlet circuits</th>
<th>Telecommunications cabling</th>
</tr>
</thead>
</table>

**Columns**

<table>
<thead>
<tr>
<th>Type</th>
<th>Fabricated/proprietary</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Height</th>
<th>Sections/dimensions</th>
<th>Footing type/dimensions</th>
<th>Colour/finish</th>
<th>Material</th>
</tr>
</thead>
</table>

**Low voltage power systems**

**General**

**Aims**

**Responsibilities**

General: Provide low voltage power systems as documented.

**System description**

**Network supply**
General: Liaise with the Network Distributor and provide network connection as documented.
Programme: Schedule the works and statutory inspections to suit the construction programme.

**Embedded generator supplies**
General: Provide embedded generator supplies as documented.

**Distribution system**
General: Provide power distribution system elements as documented.

**Circuit loading**
Lighting: 1920VA at 240Vac, 1840VA at 230Vac, on a 10amp circuit breaker.
General Power: 5 off double power socket outlet, on a 16amp circuit breaker

**Metering**
Retail: Provide metering to the requirements of the principal, the selected electricity retailer and the network distributor.
Private: Provide private metering as documented.

**Design**
Design responsibilities: Refer to the definition of ‘provide’ in the General requirements worksection.
Design parameters: As documented.
Fault protection: Automatic disconnection to AS/NZS 3000 clause 2.4.
Maximum demand: Calculation method to AS/NZS 3000 Appendix C.

**Cross references**
*General*
General: Conform to the General requirements worksection.
*Associated worksections*
Associated worksections: Conform to the following:
- Electrical general requirements.
- Cable support and duct systems.

**Standards**
*General*
General: To SAA HB 301.
Electrical equipment: To AS/NZS 3100.
Fire and mechanical performance classification: To AS/NZS 3013.
Selection of cables: To AS/NZS 3008.1.1.
Distribution cables: To AS/NZS 4961.
*Testing*
Standard: To AS/NZS 3017.

**Interpretations**
*Abbreviations*
General: For the purposes of this worksection the abbreviations given below apply.
- MIMS: Mineral-insulated metal-sheathed.

*Definitions*
Embedded generator: Electricity generator connected to the local electrical distribution network.
Extra-low voltage: Not exceeding 50 V a.c. or 120 V ripple-free d.c.
Low-voltage: Exceeding extra-low voltage, but not exceeding 1000 V a.c. or 1500 V d.c.
High voltage: Exceeding low-voltage.

**Submissions**
*Samples*
General: Submit samples of all visible accessories and equipment.
*Technical data*
General: Submit the following information for each main, submain and final subcircuit for which calculation is the responsibility of the contractor.
- Single line diagram.
- Fault Levels at switchboards.
- Maximum demand calculations.
- Cable and conductor cross sectional area and insulation type.
- Cable operating temperature at design load conditions.
- Voltage drop calculations at design load conditions.
- Protective device characteristics, e.g. curves, $I^2t$.
- Discrimination and grading of protective devices.
- Prospective short circuit current automatic disconnection times.
- Earth fault loop impedance calculations for testing and verification.
- Certify compliance with AS/NZS 3000, for electrical services.
- Stringing calculations for aerial cables.

Final subcircuits: May be treated as typical for common route lengths, loads and cable sizes.

**Shop drawings**

General: Submit shop drawings of the following:
- Cable routes.
- Busduct systems including routes, dimensions and connection details.

**Products**

**Wiring systems**

**General**

Selection: Provide wiring systems appropriate to the installation conditions and the function of the load.

**Power cables**

**Standard**

PVC and XLPE cables: To AS/NZS 5000.1.
Aerial cables: To AS 1746.

**Cable**

General: Select multi-stranded copper cable generally, except for mineral insulated metal sheathed (MIMS).

Minimum size:
- Lighting sub-circuits: 2.5 mm$^2$.
- Power sub-circuits: 2.5 mm$^2$.
- Sub-mains: 6 mm$^2$.

Voltage drop: Select final subcircuit cables within the voltage drop parameters dictated by the route length and load.

Fault loop impedance: Select final subcircuit cables selected to satisfy the requirements for automatic disconnection under short circuit and earth fault/touch voltage conditions.

Underground residential distribution systems: Select cables according to AS/NZS 4026.

Distribution cables: To AS/NZS 4961.

**Conductor colours**

General: For fixed wiring, provide coloured conductor insulation. If this is not practicable, slide at least 150 mm of close fitting coloured sleeving on to each conductor at the termination points.

Active conductors in single phase circuits: Red.
Active conductors in polyphase circuits:
- A phase: Red.
- B phase: White.
- C phase: Blue.

**Busducts**

**Systems**

Type: Proprietary type-tested systems made up of integral lengths and fittings containing solid busbar conductors and housings, assembled in sections to form complete fully enclosed and insulated low impedance power distribution systems.

Standard: To AS 3439.2.

**Selection**

Ratings: Provide busductbus duct selected to meet nominated current ratings and, if used as consumer's mains, to match the statutory authority’s substation equipment.

Degree of protection: For complete assembly, at least the following:
- Indoor use: IP41.
- Weatherproof (partial exposure): IP54.
- Outdoor use: IP56.

**Indoor system accessories**

For current ratings 400 A: Provide fuse, fuse switch or circuit breaker type plug-in connection boxes. Provide interlocks to enable plug-in boxes to be safely installed or removed on an
energised system. Provide plug-in boxes whereby earthing to the busductbus duct housing is achieved before connection of active conductors. For current ratings > 400 A: Provide bolt on accessible T-off boxes. T-ff boxes to be accessible. Expansion joints: Provide expansion joints in vertical runs, to allow for expansion and contraction of the bus duct system. End caps: Provide end caps or covers to fully enclose ends of bus ducts not connected to equipment.

**Accessories**

**General purpose socket outlets**

Standard:
- General: To AS/NZS 3112.
- Industrial: To AS/NZS 3123.

Pin arrangement: Mount outlets with the earth pins at the 6 o’clock position.

Faceplates: Securely fixed with retaining screw mechanism.

**Plugs – 230/400 volt**

General: Provide plugs with integral pins of the insulated type to AS/NZS 3112.

**Permanently connected equipment**

General: Provide final subcircuit to permanently connected equipment, as documented.
Isolation: Provide isolating switch adjacent to equipment.
Coordination: Coordinate with equipment supplier.

Wall/ceiling mounted equipment: Conceal final cable connection to equipment.

**Isolating switches**

Standard: To AS/NZS 3133.

**Emergency stop switches**

Standard: To IEC 60947-5-5.

**3-phase outlets**

Construction: Surface mounted type of high-impact resistant plastic, with flap lid on the outlet.
Minimum: 20 A, 400 V a.c.

Pin arrangement: Five round pins mounted with earth pins at the 6 o’clock position, neutral pins in the centre and the red, white and blue phases in a clockwise sequence when viewed from the front of the outlet.

Plug: Provide a matching plug top for each outlet.

**Appliances**

General: Provide appliances, as documented.
Connection: Shorten lead to minimum length for plug connections.

**Ceiling sweep fans**

Standard: To AS/NZS 60335.2.80.
Horizontal clearance: 1200 mm from blade tip to wall cupboards or shelves that require access by ladder or steps.
Size: 1200 mm diameter unless otherwise documented.
Mounting height: Use longest proprietary suspension rod to ensure that height from blades to finished floor level: > 2400 mm.

Speed regulators, capacitive and electronic: Flush mounted with OFF position.

**Ovens and hot plates**

General: functional switch
Single phase: 20amp isolator, minimum
Three phase: 32amp isolator, minimum

**Execution**

**Earthing**

**Earthing systems**

Standard: Provide an earthing system as documented.

**Electrodes**

General: Provide electrodes to suit soil resistivity.
Length: minimum 2m
Earth Pit: Galvaised hinged lid, set in concrete.

**Bonding**

General: Provide bonding to AS/NZS 3000 clause 5.6.
Earth and bonding clamps
General: Provide proprietary earthing and bonding clamps. Provide petroleum based tape.
Standard: To AS 1882.

Mineral insulated metal sheathed cable (mims)
General
General: Maintain manufacturer’s seals until joint or termination is made. Remove moisture by heating cable ends.
Seals
Temporary seals: Fit temporary seals to the open ends of cables cut and not immediately used.
Terminations: Fit termination seals at ends of cable runs as soon as the cable has been cut to length, stripped back, and the moisture driven out.
Through joints: Same fire-rating as the cable.
Sheath earthing
General: If MIMS cables enter metal enclosures, earth sheaths to non-ferrous plates secured to the enclosures. Where sheaths terminate at plates, fully insulate, colour code, and fix the conductors to the enclosures.
Bonding
General: Bond metal sheaths of single core cables in multi-phase circuits with proprietary earth bonding clips or clamps.
Separation
General: Separate MIMS cables from tough plastic sheathed (TPS) cables and UPVC conduits by at least 25 mm.
Eddy currents
General: Arrange single core cable entries into non-ferrous metal gland plates to minimise eddy currents.
Vibration
Connections with vibrating equipment: Loop cables in a complete circle next to the point of connection.
MIMS cable terminations
MIMS cable systems: Test the insulation resistance as follows:
- At the time of termination.
- 24 hours later.

Power cables
General
Standard: Classifications to AS/NZS 3013.
Handling cables: Report damage to cable insulation, serving or sheathing.
Stress: Ensure that installation methods do not exceed the cable’s pulling tension. Use cable rollers for cable installed on tray/ladders or in underground enclosures.
Straight-through joints: Unless unavoidable due to length or difficult installation conditions, run cables without intermediate straight-through joints.
Cable joints: Locate in accessible positions in junction boxes and/or in pits.
Extra-low voltage circuits: Individual wiring of extra-low voltage circuits: Tie together at regular intervals.
Tagging
General: Identify multi core cables and trefoil groups at each end with stamped non-ferrous tags clipped around each cable or trefoil group.
Marking
General: Identify the origin of all wiring by means of legible indelible marking.

Fire-rated (other than mims)
Protection
General: If exposed to mechanical damage, provide protection to AS/NZS 3013.

Copper conductor terminations
General
General: Other than for small accessory and luminaire terminals, terminate copper conductors to equipment, with compression-type lugs of the correct size for the conductor. Compress using the correct tool or solder.
Within assemblies and equipment
General: Loom and tie together conductors from within the same cable or conduit from the terminal block to the point of cable sheath or conduit termination. Neatly bend each conductor to enter directly into the terminal tunnel or terminal stud section, allowing sufficient slack for easy disconnection and reconnection.
Alternative: Run cables in UPVC cable duct with fitted cover.
Identification: Provide durable numbered ferrules fitted to each core, and permanently marked with numbers, letters or both to suit the connection diagrams.
Spare cores: Identify spare cores and terminate into spare terminals, if available. Otherwise, neatly insulate and neatly bind the spare cores to the terminated cores.

Aluminium conductor terminations
General
Conductor surface preparation: Remove oxide as follows:
- Wire brushing surfaces to be connected.
- Immediately applying oxidation inhibiting abrasive grease containing zinc or similar particles. Thoroughly cover the surfaces and work the grease between the strands of stranded conductors.
Fittings: Unless joint contact surfaces are factory tinned or factory pre-filled with oxidation inhibiting abrasive grease, prepare as for conductors.
Aluminium-to-aluminium jointing
Compression method:
- Provide aluminium or aluminium alloy crimp lugs or ferrules selected to suit the size and shape of the conductors.
- Use compression dies selected to suit lugs or ferrules, with hexagonal dies for stranded conductors and indent dies for solid conductors.
- Fill lugs or ferrules with oxidation inhibiting abrasive grease.
- Insert conductors into lugs or ferrules, driving out excess grease.
- Apply dies to provide at least 2 indentations at each joint or termination.
Aluminium-to-copper jointing
Method: Use compression method, as for Aluminium-to-aluminium jointing.
Connector types: Select from the following:
- Bi-metal: Lug or pin type with cast copper palm or pin, friction welded to an aluminium barrel section, subsequently factory filled with oxidation inhibiting abrasive grease.
- Case electro-tinned aluminium lug: Bolt the palm of the lug to the copper busbar or terminal by means of a stainless steel bolt and nut with a large diameter stainless steel flat washer and a spring cup washer.

AERIAL CABLES – POWER
Aerial cables
Tension: String and tension cables to meet the project specific design criteria.
Aerial connection – poles
For change of direction < 10 degrees: Pin insulators mounted on horizontal cross arms.
For change of direction ≥ 10 degrees: Shackle insulators secured by hooks on poles and bolts on crossarms or elsewhere.
Bundled conductors: To AS 3766.
Aerial connection – building attachment
General: Provide proprietary up-stands, as required.
Attachment: Shackle insulators and supports securely bolted to building structure.
Building entry: Angle conduit upwards at a minimum angle of 45 degrees for weather proofing.

Busduct installation
General
Standard: To AS/NZS 3439.2.
Horizontal runs: Support bus ducts at maximum intervals of 2 m, with adjustable hangers and steel angle supports. Provide runs that are straight and level. Install hangers at least 300 mm from joint centres. Secure bus ducts to angle supports with proprietary clamps.
Vertical runs: Support with a combination of fixed and spring type hangers to allow for expansion and contraction of the bus duct system.
Fittings: Provide elbows, offsets and junctions for changes in direction. If necessary, provide
weatherproof covers and gaskets.

**Completion tests**

*Site tests*
Inspection: Visually inspect the installation to AS/NZS 3000 before testing. Submit record on a checklist.
Test and verify the installation to AS/NZS 3000 Section 8 using the methods outlined in AS/NZS 3017. Record and submit the results of all tests.

*Dummy load tests*
General: Where electrical tests are required and the actual load is not available, provide a dummy load equal to at least 75% of the design load.

**Spare parts**

*General*
Spare parts: As documented.