

# ELECTRICAL DESIGN GROUP

ELECTRICAL COMMUNICATIONS FIRE SYSTEMS DESIGNERS

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PROJECT

PROJECT  
NAME

DOCUMENT

## ELECTRICAL SERVICES COMMISSIONING PLAN

SITE ADDRESS

STREET  
SUBURB STATE POST CODE

PROJECT MANAGER

NAME  
ADDRESS  
ADDRESS  
SUBURB STATE POST CODE

DESCRIPTION

REVISION: A  
DATE: 1 JUNE 2007



## 1.0 EXTENT OF WORKS

### 1.1 SCOPE

The objective of this document is to provide a structure for the commissioning of the electrical services included within the sub-contract including the following:

- Power distribution.
- Standby generator.
- Lighting.
- Communication cabling.
- Fire alarm system.
- Intruder detection.
- MATV.
- Lightning protection.
- CCTV.
- Background music PA.
- School bell.
- Access control.
- Intercom system.
- Ecovision system.
- UPS.
- Add in any other systems that form part of the electrical sub contract that are not scheduled above.

The electrical services are detailed in the documents referenced in the Contract Document Schedule C0000a-001.xls published by the Electrical Design Group.

### 1.2 PURPOSE

The purpose of this commissioning plan is to define the procedures and responsibly regarding the commissioning of the electrical services such that the final installation meets the design objectives including though not limited to the following:

- Layout.
- System operation.
- User training.
- Energy efficiency.
- Safety.
- Maintainability.

### 1.3 SUMMARY OF COMMISSIONING REQUIREMENTS

The person with overall responsibility for the commissioning of the electrical services has developed this commissioning plan. The key aspects of the commissioning plan include:

- Identify any specific site conditions that may have an effect on the commissioning process.
- Define the definitions that are to be used regarding the commissioning process.
- Define the process for management and storage of the commissioning records.
- Identify the persons and define their responsibility with regards to commissioning.
- Provide a commissioning method statement.
- Define the procedure for obtaining customer acceptance.
- Identify any legislative requirements regarding the commissioning of the electrical services.
- Identify the relevant standards and code requirements regarding the commissioning of the electrical services.
- Identify the authority requirements regarding the commissioning of the electrical services.
- Identify the general commissioning considerations
- Define the communication structure and procedure regarding the commissioning process.

- Define the commissioning team structure.
- Define the process to undertake a review of the design regarding commissioning.
- Identify the design objectives that are to be addressed by the commissioning.
- Define the installation dates and develop a commissioning timeline program.
- Define the intent commissioning process.
- Define an installation quality assurance procedure.
- Establish the pre-commissioning performance requirements.
- Provide a pre-commissioning risk assessment.
- Identify the off site pre-commissioning requirements and process.
- Identify the on site pre-commissioning requirements and process.
- Establish a pre-commissioning checklist.
- Define a pre-commissioning certificate.
- Establish the commissioning performance requirements.
- Provide a commissioning risk assessment
- Identify the commissioning requirements and process.
- Establish a commissioning checklist.
- Define a commissioning certificate.
- Define the witnessing compliance requirements and process.
- Define the manual requirements and process.
- Define the handover requirements and process.
- Define the training requirements and process.
- Define post-occupancy checks requirements and process.
- Define the maintenance / building tuning requirements and process.
- Add in any other key items within this commissioning plan that have not been included.

#### 1.4 SITE CONDITIONS

Following are the site conditions that have been considered in developing this commissioning plan:

- Access requirements.
- Tenancy fitout.
- Noise restrictions.
- Pollution restrictions.
- Add in any other site conditions that have been considered in developing this commissioning plan that have not been included.

#### 1.5 DEFINITIONS

Refer to the main contract and the CIBSE Commissioning codes for the definitions to be read into the documents associated with the commissioning of the electrical services.

#### 1.6 COMMISSIONING RECORDS

All commissioning records will be submitted for approval within one (1) week of the commissioning being undertaken on A4 paper and as an electronic PDF file copy via e-mail or on CD for approval. A copy of all approved commissioning records will be included in the manual.

#### 1.7 APPROVAL

Where a component or document is noted as requiring to be submitted for approval, the electrical sub contractor will obtain the approval in writing from the client, the project manager, the engineer and from a senior member of the electrical sub contractors firm. The electrical sub contractor will give each of the approving parties one weeks notice of the pending requirement for the approval and give each approving party a minimum of two working days to respond. Should an approval not be given the electrical sub contractor is to revise the material being submitted for approval and resubmit such material. The re-submission of material for approval does not constitute grounds for an extension of time.

## 1.18 CUSTOMER ACCEPTANCE

At the conclusion of the commissioning process a preliminary walkthrough with the installation contractor and the customer's representative will be performed to check for installation quality, accurate performance of the work, and to verify the accuracy of work-as-executed documents. Any modifications to the documentation or the installation that may be required will be completed within 2 weeks from the walkthrough. Customer Acceptance will be given following a final walkthrough with the installation contractor and the customer's representative if all previously identified issues have been addressed.

## 2.0 COMMISSIONING PROCESS

### 2.1 INTENT

The intent of the commissioning process is to ensure the components and systems are adequately commissioned and operating in accordance with the design requirements in accordance with the overall construction program.

This is achieved by:

- Defining a comprehensive commissioning procedure identifying responsibilities.
- Defining what is to be commissioned and what standard it is to be commissioned to.
- Undertake a commissioning risk assessment.
- Develop a commissioning timeline programme.
- Identify pre commissioning opportunities to reduce the commissioning risk.
- Establish a checking and record procedure.
- Establish a hand over procedure.

### 2.2 DEFINE SYSTEMS

To ensure that no system is inadvertently missed the systems that are to be commissioned are defined in clause 4.1.

### 2.3 ESTABLISH PERFORMANCE REQUIREMENTS

The performance requirements that the systems are to be commissioned to have been established by:

- Identifying all legal requirements as per section 3.0.
- Reviewing the design and contractual requirements as per section 5.0

### 2.4 ESTABLISH RESPONSIBILITIES

The commissioning responsibilities for each stage and each of the systems to be commissioned have been established by:

- Identifying a communication procedure as per clause 4.2.
- Providing a commissioning team structure as per clause 4.3.

### 2.5 RISK ASSESMENT

As per clause 4.4 a risk assessment considering the systems to be commissioned, the performance requirements and the project program has been undertaken to identify items and procedures that can be included reduce the risk of delays and faults and abortive works.

### 2.6 TIMELINE

Considering the findings of the risk assessment detailed in clause 4.4 and the project program a commissioning timeline has been developed as per clause 4.5.

## 2.7 PRE COMMISSIONING

Considering the findings of the risk assessment detailed in clause 4.4 and the commissioning timeline detailed in clause 4.5 pre commissioning as per section 7.0 will be required in to reduce the risk of problems and delays in the final commissioning.

## 2.8 COMMISSIONING

The procedures to commission the systems defined in clause 4.1 to achieve the performance requirements as detailed in sections 3.0 and 5.0 are detailed in section 8.0.

## 2.9 WITNESSING COMPLIANCE

The pre commissioning procedures detailed in section 7.0 and the commissioning procedures detailed in section 8.0 are to be formally witnessed and approved on behalf of the client or his/her representative as detailed in section 9.0.

## 2.10 MANUAL

The commissioning results are to be included in the operation and maintenance manual as detailed in section 10.0.

## 2.11 HANDOVER

Training of system operators and maintenance staff will be provided as detailed in clause 11.1.

Post-occupancy checks and the maintenance of the electrical installation during the defects liability period will be provide as detailed in clause 11.2 and clause 11.3.

The commissioned system handover is detailed in clause 11.4.

## 2.12 CHECKLIST

Produce a commissioning plan checklist (a sample commissioning plan checklist is available on the EDG web site [www.edg.net.au](http://www.edg.net.au)) and submit it for approval.

This checklist is to include the commissioning plan tasks and nominate the person responsible for the task. Those responsible for the tasks are to sign the completed checklist to signify that the checks have been completed satisfactorily and submit the completed (signed) checklist for approval.

A commissioning plan checklist has been produced separate to this document and has been approved. This checklist includes the commissioning plan tasks and nominates the person responsible for the task. Those responsible for the tasks are to sign the completed checklist to signify that the checks have been completed satisfactorily and submit the completed (signed) checklist for approval.

## 3.0 LEGISLATION

### 3.1 STANDARDS

Irrespective of information contained in this commissioning plan, the electrical service's documents or in instructions, the electrical sub contractor's will ensure all electrical services works are be installed in accordance with the requirements of the following.

- Building Code of Australia.
- Electricity Act.
- Electrical Safety Act.

- Workplace Health and Safety Act.
- Telecommunications Act.
- The commissioning requirements of the electrical services contract documents.
- The commissioning requirements of the CIBSE Commissioning codes.
- Add in any other standards that the commissioning is to be undertaken in accordance with that have not been included.

### 3.2 AUTHORITIES

The electrical services will comply with the requirements of all regulatory authorities having jurisdiction over the site including but not limited to the following:

- ACMA.
- Local Council.
- Local Supply Authority.
- State Government Department of Environment and Heritage.
- Qld Government, Division of Workplace, Health and Safety.
- Queensland Fire and Rescue Authority.

If any of the responsible Authorities, pursuant to the statutory powers vested in them, elect to perform, supply, inspect or test wholly or part of the works, all necessary arrangements and co-ordination will be provided by the Electrical Sub Contractor to facilitate such actions by the Authority.

A copy of all Authorities' Approvals will be provided for approval.

### 4.0 GENERAL CONSIDERATIONS

#### 4.1 COMMISSIONING MANAGEMENT

The electrical services form part of a larger contract that includes an overall project commissioning manager. This commissioning plan is to be implemented in close association with the project commissioning manager. This commissioning plan is include the requirements of and be approved by the overall project commissioning manager.

or

The electrical services forms part of a larger contract that does not includes an overall commissioning manager. The electrical subcontractors commissioning manager has consulted the following associated trades and incorporated the relevant commissioning requirements such as interfaces into this commissioning plan:

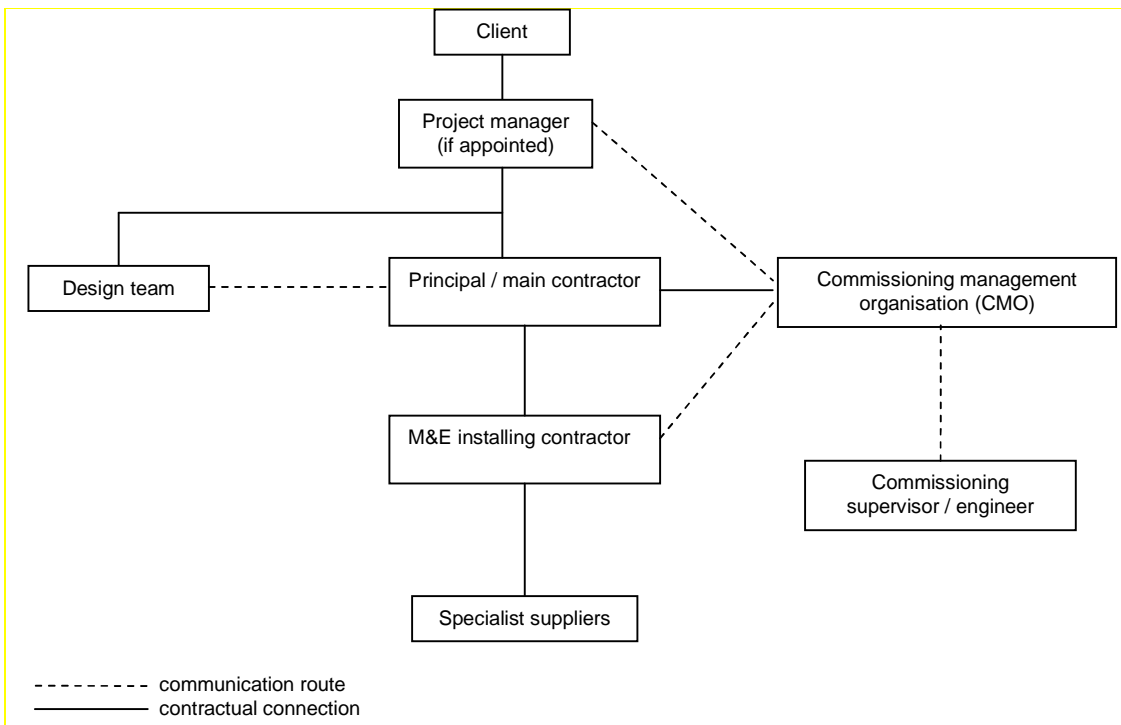
- Mechanical services.
- Building management system.
- Hydraulic services.
- Lift services.
- Landscaping.
- Signage.
- Building works.
- Tenancy fitout.
- Power distribution.
- Standby generator.
- Lighting.
- Communication cabling.
- Fire alarm system.
- Intruder detection
- MATV.
- Lightning protection.

- CCTV
- Background music PA
- School bell
- Access control
- Intercom system
- Ecovision system
- UPS
- Add in any other systems that form part of the project that need to be considered that are not scheduled above.

**4.2 COMMUNICATION**

All communications regarding commissioning will be in writing with the preferred method being e-mail. All records and component or document is noted as requiring to be submitted for approval are to be submitted preferably as a PDF file attached to an e-mail.

All e-mails are to be to the attention of the person defined in the following flowchart. It is acceptable to CC the e-mail onto other relevant parties.



**4.3 TEAM STRUCTURE**

Define the electrical services installation team and commissioning team. Submit a team structure report of the installation team and the commissioning team structures and personnel for approval. Additionally the team structure report with respect to the electrical services is to include the following:

- Nominate who will have overall responsibility for the brief as the representative of the client's needs and overview the design in its entirety.
- Nominate who will have overall responsibility for the design.
- Nominate who will have overall responsibility for the installation.
- Nominate who will have overall responsibility for the commissioning.

- Include a clear definition of the respective roles of the various parties involved in the installation and commissioning of the project
- Nominate the major and key installation and commissioning tasks and activities.
- Place a name against each of the tasks and activities in the list. Indicate which items are not relevant.
- Nominate the project information communication 'pathways' and define the project information communication network.
- Schedule installation and commissioning meetings nominating the required attendees.

#### 4.4 RISK ASSESMENT

The risk assessment has been undertaken of the commissioning process and identified items and procedures that can be included as part of the pre commission process including:

- Is the equipment and component types used as per the design documents.
- Is the layout and location of the equipment and components as per the design documents.
- Are all of the components correctly labelled.
- Has the labelling on all control cables been checked.
- All components assembled off site are to be commissioned off site prior to delivery.
- Impact on the electrical installation from other services and external factors that may change upon the completion of the project. (such items may include, ventilation rates, temperature control and daylight obstructions.)
- Add in any other items that have been considered within the risk assessment that need to be addressed as part of the pre-commissioning that are not scheduled above.

The risk assessment is to include:

- Possible risk.
- Degree of risk.
- Potential impact on the final commissioning process.

In cases the risk is considered significant, a method statement (it may be included as part of this document) is to be produced identifying how the risk minimisation work is to be carried out. The method statement is to define step by step the specific stages and works to be undertaken.

The risk assessment and associated results are to be included within this commissioning plan.

#### 4.5 COMMISSIONING PROGRAMME

The following commissioning programme has been developed considering the construction program to allow the commissioning detailed within this plan to be undertaken in a timely manner to achieve the project completion date. The commissioning activities have been calculated back from the planned completion date to avoid clashes of priority with the construction programme.

Insert a project specific commissioning program including the following information for each commissioning stage for each item / system to be commissioned.

- Start date.
- Number of working days duration.
- Completion date.
- Date the results / records are submitted for approval.
- Date the approval is required by.

As part of developing the project specific commissioning program the following items need to be addressed:

- Identify the electrical services commissioning dates on the construction program / time lines issued to contractors and clients.

- Conduct critical path analysis to plan the pre-commissioning, commissioning and handover tasks, their duration and interdependencies with each other and other services.
- Identify critical points in the process by which time certain tasks must be completed for the next task to start – strategic co-ordination points (eg electrical power must be available before luminaire function can be tested).
- Identify where tasks may be completed early (ie during the construction phase) or off-site.
- Consider whether phased completion, if feasible, will help to reduce the overall commissioning time scale and plan accordingly.
- Monitor progress against timetable, warn project management if deviations in other schedules are likely to have a significant effect on the commissioning schedule.
- Ensure that the client's representative is involved, particularly with regard to any programming requirements.

Phased completion may be a requirement of the contract where a large and/or complex building services installation is to be commissioned. Phased completion will need the checking and handover procedures to be broken down into manageable packages. The approach to phased completion will depend on the nature of the building and its engineering services.

Where there is a possibility of phased completion being required, it is important that, as early as possible, all the systems to be completed and commissioned early and ready for the operators use are identified and agreed with the operator.

It is therefore essential to identify which systems are to be operational to allow phased completion and also how to prove them as complete and ready for operation as independent entities.

A 'certificate of readiness for occupancy (COR) can be a useful tool as part of the process. The COR is a series of documents that gather together all of the submittal data, tests reports, snag lists etc. and present them in such a way as to show that a particular system is complete and ready to be set to work as designed and specified.

The COR should be designed to enable all parties to identify particular systems that are essential for operation of the project and may need early completion but which either contractually or logically cannot be identified as complete before the issue of a certificate of (partial) completion.

## 5.0 DESIGN

Undertake a design handover meeting with the electrical consultant and other design team members as recommended by the electrical consultant to identify the design objectives including though not limited to the following:

- Layout.
- System operation.
- User training.
- Energy efficiency.
- Safety.
- Maintainability.
- Contractual requirements.

The design objectives are to be included within this commissioning plan once identified. The design handover meeting is to be undertaken within four weeks of being awarded the contract. The minutes of the design handover are to be included within this commissioning plan.

Undertake a design review of the electrical services design with the electrical consultant, the installer and the commissioning team considering the commissionability of the electrical design. The design review is to include all necessary specialist suppliers and installers including programmers and trainers. The minutes of the design review are to be included within this commissioning plan.

## 6.0 INSTALLATION QUALITY ASSURANCE

It is noted that this commissioning plan and the commissioning in general do not replace the normal quality assurance procedures that are required to be carried out during manufacture and installation. The commissioning process will confirm that the normal quality assurance procedures have been undertaken.

## 7.0 PRE COMMISSIONING

### 7.1 INTENT

The intent of pre commissioning is to reduce the risk of problems and delays in the final commissioning.

### 7.2 ESTABLISH PERFORMANCE REQUIREMENTS

Once the risk assessment has been completed identify the systems, components and performance requirements that need to be addressed as part of the pre-commissioning and document such requirements within this section of the commissioning plan.

The systems that need to be addressed as part of the pre-commissioning include:

- Power distribution.
- Standby generator.
- Lighting.
- Communication cabling.
- Fire alarm system.
- Intruder detection.
- MATV.
- Lightning protection.
- CCTV.
- Background music PA.
- School bell.
- Access control.
- Intercom system.
- Ecovision system.
- UPS.
- Add in any other systems that form part of the project that need to be addressed as part of the pre-commissioning that are not scheduled above.

The components and performance requirements that need to be addressed as part of the pre-commissioning include:

- Is the equipment and component types used as per the design documents.
- Is the layout and location of the equipment and components as per the design documents.
- Are all of the components correctly labelled.
- Has the labelling on all control cables been checked.
- All components assembled off site are to be commissioned off site prior to delivery.
- Impact on the electrical installation from other services and external factors that may change upon the completion of the project. (such items may include, ventilation rates, temperature control and daylight obstructions.)

- Add in any other components and performance requirements that form part of the project that need to be addressed as part of the pre-commissioning that are not scheduled above.

Take the following general pre-commissioning actions:

- Maintain a record of all settings, set points and offsets etc
- Indelibly mark all final physical adjustments to the control system field devices so that any movement from the commissioned setting is immediately apparent.
- Ensure all packaged plant interfaced with the control system is fully tested and commissioned by the manufacturer or installer.
- Check that volt-free and control terminals are separated from the mains voltage.

Record all pre-commissioning checks on a pre-commissioning checklist and submit the pre-commissioning checklist for approval.

### 7.3 OFF SITE PRE-COMMISSIONING

Perform as much pre-commissioning as possible off-site, according to tasks below:

Pre-commissioning action	Pre-commissioning off-site
Control application software	Yes (final commissioning on-site)
User interface software	Yes (final commissioning on-site)
Control panels	Yes (final commissioning on-site)
Equipment locations	No
Wiring	No
Communication bus	No
Sensors	No
Actuators	No
Integration gateways	Partial

Add in any other pre-commissioning off-site items that are not scheduled above.

### 7.4 ON SITE PRE-COMMISSIONING

Perform as much pre-commissioning as possible off-site, according to tasks below:

Pre-commissioning action	Pre-commissioning on-site
Control application software	No (final commissioning on-site)
User interface software	No (final commissioning on-site)
Control panels	No (final commissioning on-site)
Equipment locations	Yes
Wiring	Yes
Communication bus	Yes
Sensors	Yes
Actuators	Yes
Integration gateways	Yes

Add in any other pre-commissioning on-site items that are not scheduled above.

### 7.5 CHECKLIST

Produce a pre-commissioning checklist (a sample pre-commissioning checklist is available on the EDG web site [www.edg.net.au](http://www.edg.net.au)) and submit it for approval.

This checklist is to include the pre-commissioning tasks and nominate the person responsible for the task. Those responsible for the tasks are to sign the completed checklist to signify that the checks have been completed satisfactorily and submit the completed (signed) checklist for approval.

A pre-commissioning checklist has been produced separate to this document and has been approved. This checklist includes the pre-commissioning tasks and nominates the person responsible for the task. Those responsible for the tasks are to sign the completed checklist to signify that the checks have been completed satisfactorily and submit the completed (signed) checklist for approval.

#### 7.6 PRE-COMMISSIONING COMPLETION CERTIFICATE

Produce a pre-commissioning completion certificate (a sample pre-commissioning certificate is available on the EDG web site [www.edg.net.au](http://www.edg.net.au)) and submit it for approval.

This pre-commissioning completion certificate is to include the pre-commissioning tasks and nominate that they have been completed satisfactorily. Those responsible for the tasks are to sign the completed pre-commissioning completion certificate to signify that the checks have been completed satisfactorily and submit the completed (signed) certificate for approval.

A pre-commissioning completion certificate has been produced separate to this document and has been approved for use. This pre-commissioning completion certificate includes the pre-commissioning tasks and nominates that they have been completed satisfactorily. Those responsible for the tasks are to sign the completed pre-commissioning completion certificate to signify that the checks have been completed satisfactorily and submit the completed (signed) certificate for approval.

#### 8.0 COMMISSIONING

##### 8.1 UNIVERSAL COMMISSIONING REQUIREMENTS

###### 8.1.1 GENERAL REQUIREMENTS

All components of the electrical services will be commissioned to ensure the correct interfacing operation and control of all systems to the satisfaction of the engineer as per the approved commissioning method statement and commissioning plan. The electrical sub contractor will arrange and give two weeks notice so the commissioning may be witnessed for approval.

The electrical contractor will provide all necessary software, equipment and personnel to fully program and configure all systems.

Following the completion of the commissioning and prior to Practical Completion the electrical sub contractor will thoroughly clean all components of the electrical installation.

Following commissioning, the electrical contractor will operate each component and system at the convenience of the engineer to provide evidence to the engineer that each component and system is working correctly.

###### 8.1.2 CONTROL STRATEGY CHECKING

As part of the commissioning process the following actions will be completed:

- Check that time schedules enable the intended operation at the correct times.
- Check that any specified out-of-occupancy periods, weekend and holiday time schedules operate correctly (note that the current operating date can be changed to simulate weekend and holiday dates).
- Check that the specified routine to ensure unified time clocks throughout the complete control system operates correctly.
- Check that any specified summer/winter seasonal changes to control strategies are properly enabled.

- Check that the calendar function can take leap years into account.
- Check the correct operation of the interlocks by individually switching interlocked items of plant.
- Check all safety interlocks, e.g electro-thermal links and emergency knocks off buttons etc.
- Check the specified interlocking between different control systems, for example any interlocking between a fire detection system and a BMS.
- Check that the specified temperature interlocks operate correctly, e.g low temperature frost protection.
- Check for the correct sequencing control in response to varying inputs operates in the correct order and at the desired set points.
- Check for the correct control and operation on start-up and shutdown. Check that the defined restart routine operates correctly when power is reinstated after failure. Check for any specified sequenced start-up to accommodate high loads.

**Include a list of all such actions. Such a list may form part of the commissioning checklist.**

#### 8.1.3 INTERRUPTION OF ELECTRICAL POWER SUPPLY

The control system will be checked to confirm its specified operation following a mains power supply failure. In particular the following checks as a minimum will be undertaken:

- Check that controllers preserve control strategy configuration data for a specified period when the mains power is lost.
- Check that the condition of any volatile data protection system is regularly and automatically monitored. Check that an alarm is raised on loss of data by any controller or other device and/or failure of the monitoring system.
- Check that the control system operates correctly under generator standby and UPS power if applicable,
- Check that the control system will automatically return to normal action without operator intervention restoration of the mains electrical power supply.
- Check that any specified load shedding procedures operate correctly.

**Include a list of all such control systems. Such a list may form part of the commissioning checklist.**

#### 8.1.4 TESTING

The following tests will be undertaken:

- Insulation resistance measurements: on motors and major medium voltage equipment items, at 1000-volt D.C.; On cables and wiring.
- Functional checks: Full functional and operational checks on energised control equipment and circuits, including adjustments for the correct operation of safety devices.
- Motor rotation: Checking and where necessary altering connections for the correct motor rotation.
- Earth resistance.
- Earthing: Confirmation of effective earthing of the exposed metal of electrical equipment.

During testing, replace fuses and equipment damaged as a result of incorrect installation work.

**Include a list of all such tests. Such a list may form part of the commissioning checklist.**

#### 8.1.5 CONTROL APPLICATION SOFTWARE

The application software and certify quality control off-site and again on site as part of the final commissioning. Specific items or routines to be checked include though is not limited to:

- Specified set points have been configured.
- Suitable on/off times are entered for all time schedules and are associated with the correct items of plant.
- In principle all interlocks are configured correctly.

- Life safety interlocks are hard-wired unless approved by the relevant authorities (must be performed on-site).
- Each control loop is in place and that realistic default values have been added to enable commissioning to proceed.
- Any sequence control is configured and in principle associated with the correct items of plant.
- Configured software will start-up and shutdown the specified items of plant in the correct sequence.
- The configured software will trigger automatic plant change over in response to the specified signal (plant failure or hours run etc).
- All specified alarms are configured along with any specified time delays, masking and alarm categorisation in order to avoid unwarranted alarms.
- The use of mnemonics and abbreviations be checked between the display and the graphics to avoid inconsistencies.
- Data logging routines and parameters are set up in accordance with the control system specification.
- The binding of graphics with monitored points.

Include a list of all such control application software tests. Such a list may form part of the commissioning checklist.

#### 8.1.6 CONTROL PANELS AND SWITCHBOARDS

The manufacturer will check all switchboards and control panels at the factory. Specific items or routines to be checked off-site and again on site as part of the final commissioning include though are not limited to:

##### Visual outside

- The finish to ensure there are no sharp edges.
- The metalwork: hinges on doors, flush doors, opening and closing doors, no sagging or drooping of doors when open, interlocking of doors.
- The door seals and gland plate gaskets are in place and securely fixed.
- The common key for all panels.
- For secure operation of door locks.
- That safe access to the control equipment is possible without having to isolate the control panel where specified.
- That the physical arrangement of the panel will allow transport to site and mounting in the final location.
- If the completed panel weighs more than 50kg check that eyebolts are fitted.
- The location and labelling of switches and indicators (including colour).
- That plastic rivets or screws are used to mount labels.
- The scale of analogue devices and the status of digital devices.

##### Inside

- That all doors on any panel containing exposed dangerous voltages are provided with interlocking isolators so that the door cannot be opened except with the isolator in the 'off' position.
- That equipment that requires on-line adjustment and testing by non-electrically qualified personnel is accessible and usable without interrupting the supply or overriding the safety interlocks. (In general, outstations must not be located within control panels where isolation is necessary to gain access.)
- Access for incoming cables
- Access for outgoing power and control cables
- Provision of suitable gland plates
- All doors/gland plates to be earthed by cable links
- Bus bars and power cabling as specified
- Anti-condensation heaters and thermostats are included and correctly set where specified
- Ventilation grills, filters and fans and thermostats are included and correctly set where specified
- Panel ventilation is adequate for the heat load

- Tightness of all connections, bolted power connections and bus-bar bolts tightened to the correct torque
- Neatness of cable looms with no pinching
- Sufficient spare capacity in all cable trunking to comply with BS 7671(13).
- Colour coding and numbering of all cables where specified and corresponding with numbering of terminals.
- Numbering of all terminals
- Shrouding and labelling of non-isolated equipment
- Shrouding of switches, lamps etc on doors if low voltage
- Segregation of power cabling and switch-gear from control cabling and electronic equipment
- Trunking lids cross referenced
- Connections between panel sections are numbered as specified, accessible and physically simple to connect/disconnect.
- Link type terminals for control system cables if specified
- Spare fuses and fuse ways if specified
- Drawing holder
- Fuses (type and ratings) against fuse chart
- Layout of equipment against drawings
- Ensure spare back panel space is provided as specified
- Ensure no equipment is mounted on the bottom or sides of the panel (similarly terminations) unless back/side plates are fitted
- Labelling of equipment in panel
- Access to all equipment especially devices requiring adjustment
- Power outlet is provided complete with 30 mA RCD protection
- Flexible looms connecting door mounted to interior mounted components will not weaken or break with repeated door opening. Check that the loom is arranged to avoid pinching or looping when the door is closed and is fully supported at each end.
- Screen and earth connections associated with the control system equipment comply with the manufacturer's installation requirements

#### Flash test

- Conduct a flash test of all mains powered equipment. All isolators must be closed and power fuses fitted. However, control fuses and other low voltage equipment fuses are to be removed for the duration of the test to avoid damaging any extra-low voltage equipment. Note that flash tests should be performed for mains powered equipment only.

#### General Function test

- The lamp test facility, if specified.
- Wiring interlocks by progressively energising or de-energising relay contacts, switches, timers etc in each circuit. Switches must be used to test that the system operates correctly in response to input signals.
- All indicators and signals out of the panel, e.g. those used to switch items of plant or to send status signals to the control system. Safety interlocks, e.g. coil freeze protection and fire overrides, must be checked in 'manual', 'off' and 'auto' switch modes.

#### Typical starter/power circuit

- Fuse or circuit breaker frame size, trip unit type and settings against the drawings.
- Correct labelling has been provided.
- Energise the starter/contactors by 'making' the control circuit and ensure the starter operates correctly and that power is provided to outgoing terminals.
- Trip the starter and check that it de-energises and the trip indicator lights up.

All switchboards and control panels are to undergo on site checks including though not limited to the following specific items or routines:

- If the control panel is left on site for a long period then undertake adequate steps to ensure that it is protected from dirt, damage and moisture (e.g. by the use of anti-condensation heaters). Remove and store separately sensitive electronic components.
- When the field wiring is complete to the power section, repeat the flash test before closing the main isolator.
- Check all new connections into the panel and the interlocks re-checked before the power is switched on and is operated.
- Do not hand over the panel until it has been wired in and fully functionally tested and the testing has been witness and approved by the engineer.
- Perform a complete panel test on-site if the panel has not been tested in the factory, or if a multi-section panel has been received on-site having been split for shipment.

**Include a list of all such control panel and switchboard tests. Such a list may form part of the commissioning checklist.**

#### 8.1.7 WIRING

Undertake the following checks and tests on all wiring:

- Cable type as specified
- Cable identified at both ends
- Cable cores identified at both ends if not self numbered or colour coded
- Security of fixing/protection of cables to walls etc where surface-run
- Cable carrier/container in accordance with the specification (tray, basket, conduit/trunking etc)
- Cable management in accordance with the specification
- Cables not damaged
- Secure termination of wires (using ferrules)
- Screening continuity
- Cable only earthed at one end (field controller) or as specified
- Electrical continuity ('belling out')
- Correct polarity where applicable
- Correct input/output (by briefly disconnecting cable)
- Correct and secure termination
- Separation of mains and signals cables
- No short circuits line-to-line and line-to-earth
- Volt-free contacts are volt-free (prior to the installation of the field controllers).

**Include a list of all such wiring tests. Such a list may form part of the commissioning checklist.**

#### 8.4.8 COMMUNICATION NETWORKS

The following on site communications network checks and tests will be undertaken:

- All network devices such as routers and bridges are installed correctly.
- All control devices can be addressed over the communication network.
- When used in conjunction with an office IT network ensure that permission has been granted from the IT manager. All network data routing is correctly set up by the IT department including allocation of the appropriate TCP/IP addresses and default router addresses.
- For structured cabling systems ensure that all outlets are properly labelled and assigned. Ensure that any changes to the cabling system are reflected in the updated documentation.

**Include a list of all such communication network tests. Such a list may form part of the commissioning checklist.**

#### 8.1.9 SENSORS

The following on site insitu sensor checks and tests using NATA approved testing equipment will be undertaken:

- correct location and orientation of the sensor
- adequate access for the commissioning engineer(s) and future maintenance requirements
- type of sensor as specified
- appropriate sensor identification
- sensor wired correctly
- Confirm the sensor output indicated by the control system with the reading on the test instrument.
- If there are no suitable test points the sensor is to be removed and then tested (with the exception of velocity sensors). If a sensor is not linear over its working range check the sensor at the upper, middle and lower points of its normal working range.

Include a list of all such sensor tests. Such a list may form part of the commissioning checklist.

#### 8.1.10 ACTUATORS

The following on site insitu actuator checks and tests using NATA approved testing equipment will be undertaken:

- Correct location
- Adequate access for the commissioning engineer(s) and future maintenance requirements
- Type of actuator as specified
- Actuator linkage connected and adjusted
- Correct identification
- Valves are ported correctly.
- Operate the device using the control system by applying a 100% signal, followed by a 0% signal. Check that the actuator moves smoothly over the full control range. Repeat the test under operating conditions, i.e. pumps or fans operating under normal operating conditions. (Not applicable for self-tuning actuators.)
- Check that the actuator has the correct movement to give the required travel of the final control device and that any mechanical and/or electronic travel ranges and limits have been set.
- Permanently mark reversible actuators with an 'as commissioned' switch position.
- Ensure that any linkage adjustment for rotation, lift or close-off have been suitably set.
- For actuators with spring return motors check that the position assumed upon interruption of the power supply is correct.
- If battery-backed actuators are used check that a battery is installed and the appropriate links are fitted.

Include a list of all such control application software tests. Such a list may form part of the commissioning checklist.

#### 8.1.11 DIGITAL INPUTS/OUTPUTS

The following on site insitu digital input / output checks and tests using NATA approved testing equipment will be undertaken:

- The signal at each configured digital input is sensed correctly by the control system.
- Each contact assumes its correct normally open or closed state and that it changes in response to the relevant item of the plant being switched.
- Each digital output switches the correct item of plant with the correct sense. Ensure that the associated status signal (if any) functions correctly.
- Ensure that each check is entered on the relevant checklist.

- The pulsed output from any specified utility meter is correctly processed and scaled to record the correct figure.

Include a list of all such control application software tests. Such a list may form part of the commissioning checklist.

#### 8.1.12 FIELD CONTROL DEVICES

The following on site insitu checks and tests using NATA approved testing equipment will be undertaken on all field control devices (controllers, outstations and unitary controllers etc):

- Type as specified
- Size as specified
- Enclosures as specified
- Number and location (height, access) as specified
- Adequate mechanical fixing
- Identification by mnemonic labelling
- All cables terminated and identified
- All terminals used (check that any unused terminals are intended to be spare)
- Continuous power available and of an appropriate quality
- Fuse correct type/spares if specified
- hardware configuration agrees with the specification
- All printed circuit boards in place
- All connection cables plugged in
- Document wallet containing wiring diagram where appropriate, i.e when located in a control panel

Include a list of all such field control device tests. Such a list may form part of the commissioning checklist.

#### 8.2 SPECIFIC REQUIREMENT

Include all specific commissioning requirements as noted in the contract documents and by the system / equipment suppliers.

#### 8.3 COMMISSIONING CHECKLIST

Produce a commissioning checklist (a sample commissioning checklist is available on the EDG web site [www.edg.net.au](http://www.edg.net.au)) and submit it for approval.

This checklist is to include the commissioning tasks and nominate the person responsible for the task. Those responsible for the tasks are to sign the completed checklist to signify that the checks have been completed satisfactorily and submit the completed (signed) checklist for approval.

A commissioning checklist has been produced separate to this document and has been approved for use. This checklist includes the commissioning tasks and nominates the person responsible for the task. Those responsible for the tasks are to sign the completed checklist to signify that the checks have been completed satisfactorily and submit the completed (signed) checklist for approval.

#### 8.4 COMMISSIONING COMPLETION CERTIFICATE

Produce a commissioning completion certificate (a sample commissioning certificate is available on the EDG web site [www.edg.net.au](http://www.edg.net.au)) and submit it for approval.

This commissioning completion certificate is to include the commissioning tasks and nominate that they have been completed satisfactorily. Those responsible for the tasks are to sign the completed commissioning completion certificate to signify that the checks have been completed satisfactorily and submit the completed (signed) certificate for approval.

A commissioning completion certificate has been produced separate to this document and has been approved for use. This commissioning completion certificate includes the commissioning tasks and nominates that they have been completed satisfactorily. Those responsible for the tasks are to sign the completed commissioning completion certificate to signify that the checks have been completed satisfactorily and submit the completed (signed) certificate for approval.

## 9.0 WITNESSING COMPLIANCE

The objective is formally to witness, on behalf of the client or his/her representative, the degree to which the requirements of the commissioning specification have been met. The commissioning management programme prepared by the CMO should establish check points when witnessing will occur; for example, when sections of an installation are deemed complete and suitable for witnessing, attendance at plant and system demonstrations, signing off certificates of completion.

The witnessing agent will be required to liaise in detail with the installer and the commissioning specialist, as necessary, with regard to:

- (a) the means to be used to demonstrate that fluid mass or volume flow rates are within the specified tolerances
- (b) coordination requirements where the performance aspects to be witnessed interact with other systems or equipment
- (c) the running and monitoring period of the BMS to prove its functionality.

Witnessing duties are to be undertaken by the CMO or other organisation appointed by the client.

The witnessing agent should:

- (a) be satisfied that, throughout the installation and balancing process, the requirements of the commissioning specification and the appropriate commissioning code have been met
- (b) check the flow rate at any selected flow measurement point using a similar instrument and compare with the data recorded by the commissioning engineer and with the designer's requirements, which should include any permitted tolerance
- (c) check performance of all plant and systems
- (d) visually inspect any part of the system covered by this section to ensure that certification is correct
- (e) countersign and endorse as necessary the certificate of the appointed commissioning specialist verifying that systems have been balanced in accordance with the specification requirements
- (f) where required, complete a separate witnessing certificate confirming satisfaction, one copy of which is handed to the commissioning specialist
- (g) check correct operation of the control system
- (h) check the correct operation of life safety systems

Inspection for approval at the following stages will be arranged:

- Concealed conduits: Prior to concrete pours, etc.
- Cables laid: After laying underground cables and before and after laying protective covering and marker tape.
- Roughin: Cables have been installed in walls and the ceiling space before the like has been sheeted.
- Connection: Connection of cabling and wiring.
- Factory testing of all control panels and switchboards.
- Factory inspection of all custom made components.
- Earthing: Installation and connection of earthing system.
- Acceptance: Installation ready for acceptance.
- Inspections required by Regulatory Authorities prior to their approval of the installation or its stages.
- All testing and commissioning.

To prevent an abortive factory visits the manufacturer is to provide written evidence, including appropriate certification, that testing has been carried out to the required specification prior to the factory visit. As part of

the factory testing and commissioning all operational, functional and safety sequences are to be simulated and checked.

The manufacture is to undertake the following prior to the factory visit:

- Undertake all required tests and ensure that signed test sheets and relevant product documentation and certification are in place.
- Obtain copies of the latest design specification and drawings
- Confirm the 'as built' drawings incorporate the latest modifications to the design drawings.
- Wire external switches on a temporary basis to simulate operational conditions for testing. Note that external switches and pots can be connected for test purposes.

## 10.0 MANUAL

A record of all settings, set point and offsets will be maintained throughout the commissioning period and included in the operation and maintenance manual. The operation and maintenance manual is to be updated following the completion of each of the post practical completion commissioning requirements.

## 11.0 HANDOVER

### 11.1 TRAINING

Adequate training of system operators is essential to the successful operation of the electrical services. It is advantageous for the intended system operator to be present during at least part of the commissioning stage to allow the operator to become familiar with the system and develop experience while commissioning staff are on site.

The operator with sufficient training such that they are capable of understanding how the system operates as a complete system and how the controls work as part of the system.

The operator's staff will trained in the recommended methods of operation the electrical services.

Basic operator training will be provided such that following the training an operator with this level of training will have a basic understanding of the control system architecture and have the ability to view point data. It is not expected that the operator will make any alterations to the system. The basic operator abilities include;

- call up and view point data from schematics and/or points lists
- acknowledge system alarms
- view trend logs

Add in any other basic operator training that is required that is not scheduled above.

Intermediate operator training will be provided such that following the training an operator with this level of training will have in addition to the basic operator skills noted above, the ability to make basic alterations to the system including:

- changes to time and occupancy programs
- changes to control set points
- setting up trend logs
- setting alarm routines

Add in any other intermediate operator training that is required that is not scheduled above.

Advanced operator training will be provided such that following the training an operator with this level of training will have in addition to the intermediate operator skills noted above, the ability to:

- add and change graphics
- change control strategies
- add analogue and digital inputs/outputs to the system
- undertake a system back up and archiving of logged data

- re-loading system software/ configuration details
- Add in any other advanced operator training that is required that is not scheduled above.

*Note:* Unauthorised changes to systems may affect warranties and should be checked with the installers and suppliers as appropriate.

In addition to the operator training the operator's maintenance staff will be trained in the recommended methods of operation and maintenance of the electrical services.

The maintenance staff training includes the following:

- A review of the operations and maintenance manual.
- The types of luminaries used.
- The correct types of lamps to be used for each luminaire type.
- The correct type and location of all consumables used within the electrical installation. This is to include though not be limited to lamps, indicating lamps, fuses, surge protection devices etc.
- Advised maintenance cycles.
- Access for maintenance.
- The location of spares.
- The location of switches.
- Basic trouble shooting and fault finding techniques.

Add in any other maintenance staff training that is required that is not scheduled above.

## 11.2 POST-OCCUPANCY CHECKS

Each of the control systems will be checked for correct operation under operational conditions. During the commissioning period these conditions may not arise because the building is unoccupied, and it is difficult properly to verify the performance of seasonal variations in control strategies. Control systems will therefore be checked when the building is occupied. In addition, illuminances cannot be checked until the space is completely fitted out and furnished. Representative operational conditions will involve checks throughout the day as well as at dusk and/or night time.

The lease documents should support the contractual requirements for post-occupancy evaluation and ensure that the leaseholder is required to provide reasonable access to allow the post-occupancy to be undertaken.

## 11.3 MAINTENANCE / BUILDING TUNING

The maintenance of the electrical installation during the Defects Liability Period for a period of 12 months will be undertaken as part of the contractual works.

Periodic inspections and maintenance work will be carried out at the following frequencies:

Add in a schedule of the maintenance recommended by the manufacturers of the systems and equipment that form part of the electrical works.

## 11.4 SYSTEM HANDOVER

System handover is the point where, to all intents and purposes, the engineering systems are determined to be complete and ready for the operator. Once practical completion has been granted, the client / operator takes over responsibility for the systems.

The CMO can play a key role at this stage by coordinating the activities needed to be achieved to reach this point, in accordance with the commissioning programme. The careful planning, organisation, coordination and control of the commissioning activities alongside other project processes are the key functions of the CMO. This role has been identified as an essential function that needs to be made specific responsibility of a designated party e.g. the CMO, to ensure certainty of the delivery of the project, particularly where it is large and complex.

The CMO may also coordinate the training of client and other personnel in the operation and maintenance of the installed systems as part of the handover process. It has been found beneficial to support this with a report to the client on the effectiveness of the training provided.

A further role of the CMO, which has been found to be beneficial to the client, is for the CMO to maintain a presence on site for a period (e.g. six months) after handover, possibly on a part time basis. This is to resolve any issues which may arise after handover and to provide a focal point to ensure liaison continues to take place between all parties involved in the construction process.

After handover there are several areas where a CMO can be called upon. Examples include:

- recommissioning of the building services during subsequent stages of the life of the building
- following major changes or adaptations
- periodic validation of control system settings, particularly where occupation or use has changed
- periodic building checks as required
- decommissioning of the building or specific services
- mothballing the building prior to a period when the building is out of use.