Assets Planning and Delivery Group
Engineering

DESIGN STANDARD DS 20

Design Process for Electrical Works

VERSION 2
REVISION 16

JUNE 2024

FOREWORD

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of the Western Australia's Work Health and Safety (General) Regulations 2022 to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

Overview of Western Australia's Work Health and Safety (General) Regulations 2022 (dmirs.wa.gov.au)

Enquiries relating to the technical content of a Design Standard should be directed to the Senior Principal Engineer, Electrical Engineering, Engineering Standards Section, Engineering. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

Head of Engineering

This document is prepared without the assumption of a duty of care by the Water Corporation. The document is not intended to be nor should it be relied on as a substitute for professional engineering design expertise or any other professional advice.

Users should use and reference the current version of this document.

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Any interpretation of anything in the Standards/Specifications that deviates from specific Water Corporation Project requirements must be referred to, and resolved by, reference to and for determination by the Water Corporation's project manager and/or designer for that particular Project.

REVISION STATUS

The revision status of this standard is shown section by section below:

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1	2/3	22.08.16	9-35	1.1.2, 1.1.3, 1.1.6, 1.2.1, 1.2.3, 1.2.10, 1.3.1, 1.3.2, 1.3.3, 1.3.8, 1.3.12, 1.3.13. 1.4.1, 1.4.3, 1.8.1, 1.8.3, 1.8.5, 1.8.7, 1.8.9, 1.8.14, 1.9.1, 1.9.2, 1.14.3, 1.16, 1.18.1,	NHJ	MSP
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2	1/0	30.06.06	24	2.12.1 revised	NHJ	AAK
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2	2/3	22.08.16	36-49	2.1.2, 2.1.3, 2.1.6, 2.2.1, 2.2.3, 2.3.1, 2.3.5, 2.5.2.2, 2.6, 2.7.1, 2.7.2, 2.9.2, 2.9.4,	NHL	MSP
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Design Process for Electrical Works

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1 Design Process for Major Power Electrical Works

1.1 Introduction

1.1.1 Purpose

The purpose of this standard is to clarify electrical design requirements so that the electrical design outputs meet Corporation expectations. The Corporation's process requirements for design are described in the Corporation's Engineering Design Manual. This standard supplements the Engineering Design Manual and shall be read in conjunction with the Engineering Design Manual.

This design standard does not address all issues that will need to be considered by the Engineering Designer in respect to a particular installation and reference will need to be made to the Engineering Design Manual. In the event of an apparent conflict between the requirements of this standard and those of the Engineering Design Manual, this standard shall take precedence.

Section 1 of this standard (i.e. Design Standard DS20.1) is specific to the design of major power electrical works as defined hereunder.

1.1.2 Scope

Design Standard DS20.1 covers the preparation and review of the design of the major power electrical works as documented in the associated Concept Report and Engineering Summary Reports, on the Design Summary Drawings and on the Detail Design Drawings.

Design Standard DS20.1 applies to electrical designs which are for major power electrical works having an estimated capital value of more than $500,000, or which for other reasons require a third-party design review.

For the purposes of this standard, major power electrical works are defined as power electrical works (as defined in clause 1.1.4 (j)) having a capacity rated in excess of 315 kVA.

This standard applies to the design of major power electrical works for both new assets and upgrade of existing assets.

1.1.3 References

References shall be made to the following associated design standards:

Water Corporation Engineering Design Manual

DS21 Major Pump Stations – Electrical

DS22 Ancillary Plant and Small Pump Stations – Electrical

DS23 Pipeline AC Interference and Substation Earthing

DS24 Electrical Drafting

DS25 Solar Energy Systems

DS26 Type Specifications

DS28 Water and Wastewater Treatment Plants – Electrical

DS29 Arc Flash Hazard Assessment of Switchgear Assemblies

Water Corporation Electrical Standard Drawings MN01 and FS Series

1.1.4 Definitions

(a) Corporation - the Water Corporation (of Western Australia)

(b) Design Manager - the Corporation officer responsible for the co-ordination of the design activities for the whole project of which the electrical work is a part.

(c) Project Consulting Engineers - the firm awarded the responsibility of preparing the project electrical design. In this respect the meaning of the term "firm" shall be deemed to include business units within the Corporation as well as other commercial entities.

(d) Design Summary Drawings - drawings prepared in respect to the electrical design for major electrical works which describe the critical aspects and statutory requirements in sufficient detail to direct the detail design.

(e) Principal's Detail Design Drawings - those drawings prepared by the Project Consulting Engineers and which are required to supplement Design Summary Drawings so as to describe the electrical design to the level of detail necessary to direct the construction and operation of the work.

(f) Contractor's Detail Design Drawings - those drawings prepared by the Contractor and which are required to supplement Design Summary Drawings so as to describe the electrical design to the level of detail necessary to direct the construction and operation of the work

(g) As Constructed Drawings - those Principal's Detail Design Drawings marked up by the Contract Superintendent to show all variations approved by the Contract Superintendent.

(h) Engineering Designer - the professional electrical engineer who is employed by the Project Consulting Engineers, and who is responsible for the electrical design as documented in the Design Summary Drawings and on any Detail Design Drawings prepared as part of the Engineering Design stage.

(i) Third-Party Reviewer - the independent senior electrical engineer approved by the Senior Principal Engineer and who is engaged directly by the Principal, or who is engaged by the Project Consulting Engineers, and whose task it is to undertake a Third-Party review of the Design Summary Drawings and of other critical aspects of the design and documentation, all as detailed in this design standard.

(j) Contractor's Designer - the professional electrical engineer or senior electrical engineering associate employed by, or engaged by, the Contractor and responsible for the electrical design as documented in the Contractor's Detail Design Drawings.

(k) Detail Reviewer - the senior electrical engineer approved by the Senior Principal Engineer, who is engaged by the Project Consulting Engineers, and whose task it is to review those Detail Design Drawings which are prepared by the Project Consulting Engineers.

(l) Power Electrical Work - all electrical equipment and installations concerned with the generation, distribution and utilisation of electric power at levels greater than 100 watts but excluding instrumentation, control and computing equipment associated with communications, control and SCADA systems.

(m) Review Evidence - the documentation which provides verification that the associated review has been carried out at an appropriate depth.

(n) Senior Principal Engineer – Senior Principal Engineer, Electrical Engineering, Electrical Standards Section, Engineering Business Unit, Water Corporation.

(o) Superintendent's Representative - the person appointed by the Contract Superintendent to supervise the day to day construction of the particular part of the electrical work.

(p) Contract Superintendent - the person appointed as Contract Superintendent for the contract covering the relevant electrical work or his appropriately qualified and authorised representative.

(q) Contractor - the firm awarded the contract for the supply and installation of the major power electrical works including the associated electrical detail design work.

In this respect the meaning of the term "firm" shall be deemed to include business units within the Corporation as well as other commercial entities.

(r) Contractor's Representative - the person appointed by the Contractor to ensure that the particular part of the work is constructed in accordance with the Contract.

(s) DMS - Drawing Management System - The software system which regulates and archives drawings within the Water Corporation.

1.1.5 Mandatory Requirements

In general, the requirements of this design standard are mandatory. If there are special circumstances which would justify deviation from the requirements of this standard, the matter shall be referred to the Senior Principal Engineer for his/her consideration. No deviations from the requirements of this standard shall be made without written approval of the Senior Principal Engineer. Any dispensation granted for a particular project applies only to the case in question, based on the merits of the argument presented, and shall not be deemed as setting a precedent.

1.1.6 Philosophy

The role of the Designer is to provide a compliant design that is fit for purpose, safe, correct and cost effective. The role of the Third-Party Reviewer is to review such design work for compliance with all relevant standards, to confirm that the design is safe, and is in line with good engineering industry practice, but not to promote personal preference. The review process is critical to demonstrate due diligence taken by the Corporation during asset creation. The role of the Design Manager is to coordinate the design project and ensure a good sustainable outcome for the Corporation.

One of the critical elements of the Design Standards is that at the stage of Engineering Design, we (Corporation, Designers, and Third-Party Reviewers) must be fully conversant with all the project design issues, and in a position to know what we want prior to going out to the market. The technology selected for a project is described in terms of performance requirements and care taken not to impose restrictions on elements of the equipment to be provided by the manufacturer. Furthermore, it is inappropriate to go to the market not knowing what technology is required and asking the market to dictate the solution.

1.1.7 Design Progression

Under the normal project implementation process, the design stages progress in sequence from one stage to another (concept design to engineering design to detail design) with minimal time delay. However, circumstances may arise whereby considerable time delays are experienced, or may be necessary due to funding constraints, that affect the orderly progression of design work through to project construction. Such delays may result in electrical technology or systems becoming obsolete with the result, that if the original design is implemented, there is a risk of non-compliance with appropriate safety standards and/or regulatory requirements. Hence, if such a delay extends beyond one year between stages then a review shall be implemented by the Designer and changes made to the design as necessary. The review of the design stage shall be completed, approved and accepted prior to entering the next stage of the project.

1.1.8 Change Control

The reviewing and updating of the Electrical Design Standards (DS20 to DS29 and the electrical standard drawings) is a continual improvement process whereby essential requirements dealing with both technical and process are documented for the benefit of project implementation and whole of life operational reliability.

Inevitably improvements to the Electrical Design Standards will come into effect during the course of a particular project and it may not be practical or cost effective to implement these improvements, for that project, at the time of release of the revised Design Standard.

Where an existing project is still at a stage that implementation of the design standard improvement will not be overly onerous then the change to the design shall be implemented. The judgment as to whether implementation would be overly onerous shall be made by the Design Manager/Electrical Technical

Adviser, with reference to and under the direction of the Senior Principal Engineer, on a project-by-project basis.

1.2 Design Process

1.2.1 General

Except where modified by this standard, the design process in respect to major power electrical designs shall be carried out in accordance with the process detailed in the Corporation's Engineering Design Manual.

All reports and drawings at the completion of every stage of the design process shall be signed as submitted by the Designer and approved by the Principal of the firm, with drawings submitted for archiving into the DMS, before issue for comment by the Corporation or third parties.

1.2.2 Designation of Design Drawings

Each Concept Design Drawing and each Design Summary Drawing shall be designated as such in the drawing title block. That is, the title block shall state "Concept Design" and "Design Summary" in the third line. Similarly, each Detail Design Drawing shall be designated appropriately in the drawing title block.

1.2.3 Qualifications of the Engineering Designer

The Engineering Designer shall be a professionally qualified electrical engineer with a least **10** years relevant electrical engineering experience including at least **5** years electrical design experience with proven competence in all areas of the electrical design work to be undertaken, all to the satisfaction of the Senior Principal Engineer.

1.2.4 Responsibilities of the Engineering Designer

The electrical engineering design work shall be carried out personally by the Engineering Designer or by junior professional electrical engineers working under his/her close supervision.

The Engineering Designer shall be responsible to ensure that the design is technically competent and complies with the Regulations, the Corporation's design standards and the relevant terms of the brief.

1.2.5 Responsibilities of Third-Party Design Reviewer

The electrical design as documented on the electrical Design Summary Drawings and Engineering Summary Report shall be submitted for review by the Third-Party Reviewer. The duties of the Third-Party Reviewer are detailed in Section 1.9 of this Design Standard.

1.2.6 Qualifications of the Detail Reviewer

The Detail Reviewer shall have similar qualifications and experience as those specified for the Engineering Designer. The Detail Reviewer shall be independent of the original detail design work.

1.2.7 Responsibilities of the Detail Reviewer

The Detail Reviewer shall review Principal's Detail Design Drawings so as to verify that design as documented on these drawings complies with the approved Design Summary Drawings, is technically competent and complies with the Corporation's design standards.

1.2.8 Qualifications of the Contractor's Designer

Contractor's Designer shall be a professionally qualified electrical engineer with a least **4** years relevant electrical engineering experience including at least **2** years electrical design experience, or a senior electrical engineering associate with a least **10** years relevant electrical engineering experience

including at least **3** years electrical design experience, all to the satisfaction of the Senior Principal Engineer.

1.2.9 Responsibilities of the Contractor's Designer

The Contractor's detail design electrical engineering work shall be carried out personally by the Contractor's Designer or by junior professional electrical engineers and/or engineering associates working under his/her close supervision.

The Contractor's Designer shall be responsible to ensure that the design approved, is technically competent and complies with the Design Summary Drawings, the Regulations, and the Corporation's design standards.

1.2.10 Certification of Designs

(a) The Electrical Draftsperson shall initial the Design Drawing as Drawn "Drn". By so doing the Electrical Draftsperson shall certify that the drawing complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(b) The Senior Electrical Draftsperson shall initial the Design Drawing as Quality Control Checked "Q.C. Chd". By so doing the Senior Electrical Draftsperson shall certify that the drawing has been checked and complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(c) The Engineering Designer shall initial the Design Drawing as Design Calculated "Des Calc". By so doing the Engineering Designer shall certify that all calculations that form the electrical design as documented on the drawing are technically correct, complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(d) The Engineering Reviewer shall initial the Design Drawing as Design Checked "Des Chd". By so doing the Engineering Reviewer shall certify that all calculations that form the electrical design as documented on the drawing have been checked and are technically correct, complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(e) The Engineering Designer shall sign the Design Drawing as Design "Recommended". By so doing the Engineering Designer shall certify that the electrical design as documented on the drawing is technically competent, complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(f) The Third-Party Reviewer shall sign the Design Summary Drawing as Design "Verified". By so doing, the Third-Party Reviewer shall verify that the electrical design as documented on the drawing is technically competent and complies with the Regulations, the Corporation's design standards and the relevant terms of the brief.

(g) The Detail Reviewer shall sign the Detail Design Drawing as Design "Verified". By so doing the Detail Reviewer shall verify that the electrical design as documented on the drawing complies with the approved Design Summary Drawings, is technically competent and complies with the Corporation's design standards.

(h) The Design Drawing prepared by the Project Consulting Engineers shall be signed as "Approved" by a Principal Officer of the Project Consulting Engineer's firm, thus certifying that the electrical design process as specified in this design standard has been followed and agreeing on behalf of the firm to accept design liability.

(i) Certification of drawings prepared as part of the construction phase shall be as detailed clause 1.17.

1.3 Concept Design Output

1.3.1 General

The basic requirements of the Concept Design Report are described in the Corporation's Engineering Design Manual.

Concept Design is an essential part of project development which leads to a well-considered, well defined, well-built and cost-effective solution.

Concept design provides the opportunity to consider the cost effective, safety and technical options presented for the project in a well-structured and disciplined environment. This is the stage whereby there is time for innovation and development of clever alternatives with the realisation that the final decision as to project direction is supported by a rigorous disciplined methodical approach providing a high degree of confidence in option selection. It should be noted that innovation and its development is most effective at the concept stage and diminishes during project advancement through engineering design with the least opportunity being during the detail design stage. Engineering design is focused on technical development of the favoured option with little scope for innovation.

Concept design allows for the early identification of initial constraints and latent conditions that could hamper successful project progress. These constraints can only be identified through thorough investigations that have the time available to do so.

All Concept drawings shall be in the form of a formal drawing allocated to bundle number 49 in the project drawing plan set. Electrical installation staging drawings (if required), showing the various stages of installation work, shall be allocated to bundle number 49 in the project drawing set and identified within the drawing title block with the term "Staging". These "staging" drawings shall be maintained throughout the Engineering and Detail Design stages under drawing bundle number 49 and cancelled at the completion of the project.

If Concept Design is omitted from the project, then the process outlined in clause 1.4.2 shall be implemented.

In respect to major electrical works the electrical Concept Design Report shall address the issues as described hereunder.

1.3.2 Purposes

The purposes of the Concept Design are:

(a) to identify the principal electrical assets to be provided as part of the works,

(b) to define and explain how the electrical assets will operate together so as to satisfy the operational requirements of the client organisation within the Corporation,

(c) to develop the design to the extent necessary to be able to provide a cost estimate within a tolerance of + 30%,

(d) to investigate the electrical supply constraints and the impact on the possible load or pumping configuration, and

(e) to identify the most appropriate option best suited for the project, and

(f) to identify the preliminary installation staging process required.

As a consequence, the Concept Design Report shall address all of the issues described hereunder.

The detail in which these issues are addressed shall be at a level consistent with purposes of the report and shall include comments on the various alternatives considered in respect to issues which have had a major impact on the development of the design proposed.

1.3.3 Design Options

As detailed in the Corporation's Design Manual, the brief to the Project Consulting Engineers may require various concept design options to be considered as part of the Concept Design Report.

If this is so, the Concept Design Report shall document the investigations carried out in respect to all concept design options specified in the brief and to any other concept design options that the Project Consulting Engineers may have considered.

The Concept Design Report shall:

(a) detail the pros and cons of all the concept design options considered,

(b) shall list the design concept design options which the Project Consulting Engineers would be prepared to recommend, and

(c) recommend a preferred concept design option together with justification for each such particular recommendation.

The Concept Design Report shall include the drawings listed hereunder in respect to the preferred concept design option.

Note: *Concept design for major pump stations and treatment plants shall include such options and considerations as:*

a. Most appropriate location of the asset, taking into account power supply constraints, flood levels, noise levels, hydraulic conditions etc

b. Preliminary pump station configurations. That is, whether fixed speed, variable speed, series pumping, parallel pumping or series/parallel configurations

c. Transformer type (dry or oil), motor type (squirrel cage, wound rotor, deep bar) and motor starting

d. Preliminary soil investigations to determine electrical substation design constraints. That is, development of the System Definition Report as per the requirements of Design Standard DS23

e. Most appropriate hardware for the plant process

f. Effective plant operational cost analysis (whole of life costing)

g. Environmental, security, voltage selection and power quality issues

h. Communication (SCADA) strategy developed with the aid of initial desk top studies

i. Initial approaches to the supply authority to gain an understanding of the supply conditions and costs being imposed

j. Energy efficiency calculations & comparisons for the life of the asset

1.3.4 Piping & Instrumentation Diagram

- Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.
- In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

1.3.5 Principal Electrical Assets

The Concept Design Report shall identify all principal electrical assets by type, function, location and ratings.

1.3.6 Power Supplies

(a) The Concept Design Report shall identify all sources of electrical power including incoming supply from an electrical supply authority, local generating sets, solar cells, batteries and uninterruptible power supplies.

(b) If power is to be provided by an electrical power authority, initial discussions shall have been held with the relevant supply authority in order to establish the conditions under which supply can be provided by the electrical supply authority and the costs pertaining thereto.

(c) If electrical motor starting is involved, the Concept Design shall determine the voltage dips which will be so caused, and shall modify the Concept Design so as to ensure that voltage dips at the various supply busbars are within the limits specified by Australian Standards and the relevant electrical supply authority.

(d) Similarly if variable speed drives are involved, the Concept Design shall determine the voltage and current harmonic distortions which will be so caused, and shall modify the preliminary design so as to ensure that voltage and current harmonic distortions at the various supply busbars are within the limits specified by Australian Standards and the relevant electrical supply authority.

1.3.7 Electrical Distribution

(a) The Concept Design Report shall include an electrical power single line diagram. The single line diagram shall be in the form of a formal drawing allocated to bundle number 49 in the project drawing plan set.

(b) For major electrical power works, the Concept Design Report shall show all principal electrical power assets together with their ratings. The following assets shall be shown as individual items:

(i) High Voltage switchboards

(ii) power distribution transformers

(iii) High Voltage motors

(iv) High Voltage generators

(v) Low Voltage switchboards with an estimated peak fault current level >17 kA

(vi) motors, and starters, supplied directly from the above Low Voltage switchboards,

(vii) motors, and variable speed controllers, supplied directly from the above Low Voltage switchboards

(viii) generators and uninterruptible power supplies connected directly to the above Low Voltage switchboards

Single line diagrams shall indicate the required circuit breakers and fuses, on the switchboards specified clause 1.3.7 (b) above. However, unless there are special reasons for doings so, associated circuit breaker protection settings and fuse ratings need not be shown.

Single line diagrams shall show the incoming fault level and the fault level at each of the switchboards included in the single line diagram.

Single line diagrams shall show the estimated maximum demand load on all circuits including those emanating from the Low Voltage switchboards shown in the single line diagram.

1.3.8 Control Functions

- Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

1.3.9 Communications

- Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

1.3.10 Earthing

(a) The Concept Design shall include preliminary on-site measurements of soil resistivity

(b) If the electrical supply to the site is at High Voltage, soil resistivity measurements shall be made sufficient to establish preliminary on-site soil resistivity strata profiles

(c) In view of the above measurements, the Concept Design Report shall comment on the likely form of earthing required to provide adequate step and touch voltage protection

1.3.11 Lightning Protection

The Concept Design shall include an investigation into the appropriate forms of lightning protection for electrical equipment, buildings, and personnel.

1.3.12 Pipeline Voltage Mitigation

The Concept Design shall include an investigation (including report) into whether there is exposure to hazardous touch voltages on pipelines in the vicinity of High Voltage power lines, in accordance with the requirements of DS23.

1.3.13 Hazardous Areas (potentially explosive atmosphere) in Treatment Plants

The Concept Design for water and wastewater treatment plants shall include an investigation (including report) into whether there is a risk of potentially explosive atmospheres in the treatment plant. The Hazardous Area Classification report shall detail the processes involved and their ability or otherwise to generate potentially explosive gases. It shall then clearly state (with technical justification) the hazardous area zonings in accordance with the relevant Electrical Equipment in Hazardous Areas (EEHA) standards.

The hazardous Area Classification Report shall be submitted to the Mechanical and Electrical Assets Section, Engineering Branch for review by a Third-Party (appointed by the Section) to ensure any hazardous area classifications are consistent with Water Corporation's EEHA standards.

1.4 Engineering Design Output

1.4.1 Scope of Engineering Design

- The electrical Engineering Design as documented on the Design Summary Drawings shall define precisely all major electrical components and associated electrical interconnections.
- Individual items of electrical equipment available from specialist manufacturers/suppliers may be defined in performance terms provided that the electrical interconnections conform to those shown on the Design Summary Drawings.
- The design documented on the Design Summary Drawings shall be the recommended design and shall not provide for alternatives. Any alternatives shall have been considered prior to the formal commencement of the Engineering Design and a decision made as part of the Engineering Design process leading to a firm recommended design.
- The Design Summary Drawings shall not include a provision inviting the Detail Designer or Contractor to make or recommend changes to the design as documented in the Design Summary Drawings.
- If the Detail Designer or the Contractor believes that the Engineering Design as shown on the Design Summary Drawings is in error, the matter shall be referred back to the Engineering Designer for any necessary corrections.

1.4.2 General

- Engineering Design is the stage by which the technical development is progressed for the selected option identified during the Concept Design stage. As identified in clause 1.6 below, the Concept Design report is one of the primary input documents to the Engineering Design stage.
- Design Summary drawings created during the Engineering Design stage of the project are the primary reference drawings for the asset and shall be updated as required during the life of the asset.
- If it is determined by the project team that the Concept Design stage is not to be progressed, but rather advanced to the Engineering Design stage, then Electrical Works covered by this Design Standard shall follow the process below:
- A brief options study, with report, shall be developed immediately for all electrical equipment and processes within the scope of the project.
- The options study report shall comply with the requirements of clause 1.3.3 and be presented to the Corporation for acceptance of the recommended option. Note: *Drawings only need to be produced that are essential to explain the options under consideration.*
- Once the options study report is accepted by the Corporation then the Engineering Design may proceed in the normal manner.
- The accepted options study report will form part of the Engineering Design report as an appendix and acknowledged as a primary input document to the Engineering Design.

1.4.3 Required Design Documentation

The requirements of an Engineering Summary Report are described in the Corporation's Engineering Design Manual. For major power electrical works the output from the Engineering Design stage shall be:

(a) Design Summary Drawings

(b) Power Systems Model (e.g. SKM Power Tools for Windows) Files

(c) Justification of major design decisions, and

(d) if so directed by the Principal, tender documents for the supply, and possibly installation, of special electrical equipment, the selection of which will have a significant impact on the Principal's Engineering Design.

1.4.4 Use of Design Summary Drawings

Design Summary Drawings shall be prepared so as to:

(a) Document the engineering design for review and records purposes

(b) Provide input information to the Detail Design Stage of the design process

(c) Be tender document drawings for the purchase of major items of electrical equipment (such as main switchboards, motors, variable speed drives etc) which are to be purchased on a mainly performance specification basis

(d) Be tender document drawings for the purchase of installation services

1.4.5 Drawing Bundle Number Allocation

All Design Summary drawings shall be allocated bundle number '40' within the drawing plan set for the site.

However, Treatment Plant legacy sites do not have Design Summary Drawings in the true sense of the phrase. All of the content of such drawings exists in different bundle numbers associated with the specific area of plant that they describe. When new work is to be implemented, it becomes a difficulty as to how we accommodate the requirements for bundle '40' allocation.

For these legacy sites, a single high level Design Summary drawing "map" that lists all of the key drawings that are normally required for the design summary drawings around the site e.g., single line diagrams; protection and interlock diagrams; grading curves; earthing diagrams; switch room and plant layouts; etc. shall be provided. This design summary map drawing shall be called 'Design Summary Map', and when these new works are implemented, this "map" can be used to direct personnel to the key drawings, without the need to have them all together in bundle '40'.

1.5 Schedule for Preparation and Review of Design Summary Drawings

1.5.1 General

Any revisions to Design Summary Drawings shall be reviewed by the Third-Party Reviewer and such revisions shall not be approved until the Third-Party Reviewer has verified that the revisions are acceptable.

Any major changes to a Design Summary drawing, such as a complete redraw or minor change shall be made as a formal revision to the drawing and registered into the DMS.

1.5.2 Engineering Design Stage

Design Summary Drawings shall have been completed reviewed and approved prior to calling tenders.

Unless authorised otherwise by the Senior Principal Engineer, equipment specified in Design Summary Drawings up until the analysis of tenders shall be specified generically. Such authorisation in respect to any minor item of equipment will not be granted if so doing would prevent a major tenderer from submitting a conforming tender.

1.5.3 After Analysis of Tenders

Prior to placing firm orders, the Design Summary Drawings shall be revised, reviewed and approved so as to indicate any critical vendor specific information. Such vendor specific information shall include equipment size, type, make and model.

1.5.4 During Preparation of Principal's Detail Design Drawings

Any revisions found to be necessary to the Design Summary Drawings during the preparation of the Principal's Detail Design Drawings shall be made, reviewed and approved prior to the calling of tenders.

1.5.5 During Preparation of Contractor's Detail Design Drawings

Any revisions found to be necessary to the Design Summary Drawings during the preparation of the Contractor's Detail Design Drawings shall be made, reviewed and approved prior to commencement of associated construction.

1.5.6 During Construction

Any revisions found to be necessary to the Design Summary Drawings during construction shall be made, reviewed and approved prior to commencement of implementation of the work associated with the revisions.

1.5.7 After Construction

The Design Summary Drawings shall be revised as constructed in accordance with Clause 1.17 hereunder and immediately after the completion of any modifications during the operational life of the electrical installation.

1.6 Input Documents for Design Summary Drawings

The input documents to the Design Summary Drawings shall be the output documents from the Concept Design Stage including the Concept Design drawings, the Corporation's design standards, and for pump stations only the Corporation's FS00 series standard drawings.

1.7 Input Documents for the Detail Design Drawings

The input documents to the Detail Design Drawings shall be Engineering Summary Report including the Design Summary Drawings, the Corporation's design standards, the recommended tender response schedules and for pump stations only the Corporation's FS00 series standard drawings.

1.8 Types of Design Summary Drawings

1.8.1 General

Design Summary Drawings are classified as either heavy current or light current as further defined hereunder:

(a) Heavy current Design Summary Drawings shall be limited to all High Voltage circuits, all Low Voltage circuits with nominal voltages greater than or equal to 415 Volts, all MCCs and all other

Low Voltage circuits having a peak fault current limit of > 17 kA. Heavy current Design Summary Drawings shall consist of:

i. single line power diagrams,
ii. electrical safety interlock diagrams,
iii. earthing diagrams,
iv. major earthing cables connections diagrams,
v. electrical protection diagrams,
vi. preliminary building arrangement and site layout drawings, and
vii. protection interconnections block diagrams.
viii. Arc Flash interconnection block diagram.

(b) Light current Design Summary Drawings shall consist of:

i. details of any minor power distribution circuits including RCD protection,
ii. details of final distribution boards,
iii. small motor decontactors, switched socket outlets for instruments & actuators and local emergency push buttons,
iv. details of any special light current circuit earthing requirements.

Light current Design Summary drawings are mandatory at the Engineering Design stage for all treatment plants. The Designer may decide to include light current drawings at the Engineering Design stage for pump stations if deemed appropriate or defer the detail of such to the Detail Design stage.

1.8.2 Critical Performance Targets

Design Summary Drawings shall specify numerical targets for those project specific critical performance parameters which must be achieved in order to meet statutory authority requirements and which shall be verified by commissioning tests, e.g. voltage & current harmonic distortion, earth touch & step voltage, voltage dip caused by motor starting current, power factor etc.

1.8.3 Single Line Power Diagrams

Heavy current Design Summary Drawings shall be limited to all High Voltage circuits, all Low Voltage circuits with nominal voltages greater than or equal to 415 Volts, all MCCs and all other Low Voltage circuits having a peak fault current limit > 17 kA and shall include the following detail:

(a) nominal voltage levels throughout the installation,

(b) type specification numbers relating to all major items of electrical equipment and clear identification of any special requirements not covered by the relevant standard type specifications (Corporation type specifications shall be used wherever practical),

(c) all performance requirements data and all service conditions data required to be provided in the annexure to each of the above standard type specifications,

(d) size, type and site rating of all major electrical cabling and of all of the electrical equipment shown which is not covered by type specifications,

(e) maximum duty power and frequency of starts for all motors,

(f) maximum kVA demand for the site, on all other outgoing circuits and each switchboard,

(g) the ‘contract’ capacity of the power supply to site,

(h) type of electrical supply authority metering,

(i) fault level and source impedance at the incoming point of supply and at other critical locations,

(j) insulation co-ordination level throughout the installation,

(k) load harmonic current levels, and

(l) voltage flicker, harmonic voltage waveform distortion levels, and voltage waveform notching levels at the point of common coupling with the supply authority and at other critical locations within the installation,

(m) Supply authority limits for voltage flicker, power factor, and harmonic distortion (THVD & THID and individual harmonic currents). These limits shall be compared to the calculated performance levels in sub clause (l) above and presented in tabular format.

(n) Provision of verified performance (site tests) values against allowable limits to be documented following commissioning.

(o) Reference to approved HV submissions and supply arrangements.

Note: *HV submissions and all supply arrangements shall be resolved and approved during the Engineering Design Stage and be recorded in the Engineering Summary Report.*

1.8.4 Electrical Safety Interlock Diagrams

Design Summary Drawings detailing electrical safety interlock diagrams shall be generic initially, but shall be revised if necessary, after tender analysis so as to show the precise switching and interlocking arrangements to be provided on the equipment being purchased.

Electrical safety interlock diagrams shall be provided in a form suitable for incorporation into Corporation switching programs.

1.8.5 Earthing Diagrams

The design of the earthing connections to the general body of earth shall be carried out by a specialist earthing sub consultant approved by the Principal and in accordance with the requirements of DS23.

The specialist earthing consultant shall carry out extensive on-site testing to determine site soil resistivity profiles and shall be responsible for the design of all earth electrodes, earth mats and grading rings.

The Design Summary Drawings documenting the design carried out by the specialist earthing consultant shall show:

(a) soil resistivity profiles,

(b) construction and location of all earth electrodes, earth mats and earth grading rings,

(c) the earth resistance of all earth electrodes, earth mats and earth grading rings,

(d) calculated step and touch voltages in critical locations, ERP, clearance times and fault level, and

(e) reference to the consultant's report document ID and the Corporation's Nexus number.

1.8.6 Major Earthing Cables Connection Diagrams

Design Summary Drawing major earthing cables connection diagrams shall show:

(a) the connection of all major earthing cables including the connections to earth electrodes, earth mats and to earth grading rings,

(b) the earthing connection of cable sheaths and armoring,

(c) the connection of earth bonding of steel work and concrete reinforcing bars,

(d) the size and type of all major earthing cables and,

(e) design details of the developed lightning protection scheme for the site.

1.8.7 Electrical Protection Diagram

Design Summary Drawing electrical protection diagrams shall show the tripping time versus the operating current protection grading curves for all main circuit electrical protection.

Except where special approval has been obtained to specify a particular protection device by make and model, protection grading curves for High Voltage switchgear protection devices shall be generic and shall be prepared on the basis of the appropriate international standard (e.g. IEC 60255).

Protection grading curves for Low Voltage switchgear protection devices shall be prepared on the basis of the characteristics of the preferred type of protection device in each instance. Such protection grading curves shall be marked “as indicative only”.

Arc Flash assessment and documentation for all switchboards shall be carried out in accordance with the requirements of Design Standard DS29.

Immediately after the analysis of tenders, Design Summary Drawing electrical protection diagrams shall be updated to show the made, model, ratings, setting ranges and actual settings for each protective device (clause 1.5.3 above refers).

1.8.8 Piping & Instrument Diagrams

- Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

1.8.9 Control Logic Drawings

- Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

1.8.10 Control Interconnection Block Diagrams

- Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

1.8.11 Protection Interconnection Block Diagrams

Design Summary Drawings protection interconnection block diagrams shall indicate the flow of protection monitoring and trip command signals between the various items of major equipment and which are to be transmitted to the Plant Control System.

Design Summary Drawings protection interconnection diagrams prepared as output from the Engineering Design Stage shall show the following as separate blocks:

(a) each major switchboard

(b) each electronic soft starter,

(c) each variable speed controller,

(d) each power factor correction unit,

(e) each separately mounted protection transducer.

These diagrams shall show for each interconnection the functions and/or data to be carried on the interconnection and which are required to be transmitted to the Plant Control System.

As an output from the Detail Design Stage, Design Summary Drawing protection interconnections diagrams shall be updated to show any minor changes found to be necessary during the Detail Design Stage.

1.8.12 Communications Links Block Diagram

- Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

1.8.13 Pipeline Voltage Mitigation Drawings

The specialist voltage mitigation sub consultant shall prepare engineering design drawings as part of the voltage mitigation design report. Such drawings and report shall form part of this engineering design stage.

1.8.14 Hazardous Area Drawings

If the Hazardous Area Classification report determines that there is a hazardous area introduced into the wastewater treatment plant due to the works, the competent Hazardous Areas consultant shall prepare and submit the engineering design drawings as part of the hazardous area report. They shall include the Hazardous Area classification drawings, Intrinsically Safe loop drawings and any other supporting documentation such as hazardous area calculations, simple apparatus justifications, etc. as part of this engineering design stage.

1.8.15 General Arrangements and Site Layout Drawings

Basic General Arrangement, Building Layout and Site Layout drawings shall be provided. These drawings shall show the point of attachment of incoming electrical power supply, cable routes and installation methods as well as the location and arrangement of the various items of major electrical equipment throughout the site and within buildings. The front and rear orientation of each switchboard, along with the location of the incomer cubicle in relation to the starter cubicles, shall be clearly shown on the drawings.

1.8.16 Arc Flash Interconnection Block Diagram

Design Summary Drawings arc flash interconnection block diagram shall indicate the flow of protection monitoring and trip command signals between the various items of major equipment.

Design Summary Drawings arc flash interconnection block diagram prepared as output from the Engineering Design Stage shall show the following as separate blocks:

(a) each major switchboard

(b) each electronic soft starter,

(c) each variable speed controller,

(d) each power factor correction unit,

(e) each disconnection motor cubicle,

(f) each connection generator cubicle,

(g) arc flash monitor.

These block diagrams shall show for each interconnection the trip signal to be carried on the interconnection, the breaker to be tripped and the alarm required to be transmitted to the Plant Control System. Clarification notes relating to the operational sequence of the arc flash system, along with arc flash sensor and current transformer locations, shall be documented on the block diagram.

As an output from the Detail Design Stage, Design Summary Drawing arc flash interconnection diagrams shall be updated to show any minor changes found to be necessary during the Detail Design Stage.

1.9 Third-Party Review of Engineering Design

1.9.1 Input Documentation

Input documentation presented to the Third-Party Reviewer shall include:

(a) the signed as approved Design Summary Drawings certified by the Engineering Designer in accordance with clause 1.2.10(a) and Design report (clause 1.2.1 refers),

(b) an explanation of the reasons behind major and/or unusual engineering decisions (usually being part of the associated design report),

(c) written evidence of the Principal's requirements in respect to required performance of the electrical plant (usually being part of the associated preliminary design report), and

(d) copies of any correspondence between the Engineering Designer and the relevant electric power supply authority.

(e) Copy of the Concept Design report

1.9.2 The Third-Party Reviewer

(a) The Third-Party Reviewer shall be selected from the Corporation's Panel of Approved Third-Party Reviewers by mutual agreement between the Principal and the Project Consulting Engineers.

(b) The Third-Party Reviewer shall be engaged to provide independent advice in respect to the competence of the design both to the Principal and to the Project Consulting Engineers. Hence the Third-Party Reviewer shall not be considered to be part of the Project Consulting Engineers' internal design team and shall not be under day to day direction from the Project Consulting Engineers.

(c) All written communications between the Third-Party Reviewer and the Project Design Engineers shall be copied to the Design Manager

(d) As far as is practical, the Third-Party Reviewer shall carry out his/her review independently of the Engineering Designer and without access to the Engineering Designer's calculations or methods of calculation. The Third-Party Reviewer shall not be involved in day to day decisions during the development of the design work.

(e) The Third-Party Reviewer's task shall be to review the design only after the relevant design documents have been checked, reviewed and approved by the Project Consulting Engineers. However, Single Line Diagrams drawings may be submitted for review prior to the submission of the other heavy current Design Summary Drawings. Similarly, P&ID drawings may be submitted for review prior to the submission of the other Design Summary Drawings.

(f) The Third-Party Reviewer is not expected to verify the results of every calculation made by the Engineering Designer, nor is the Engineering Designer relieved of his liability for the correctness of the design by the third-party review.

1.9.3 The Review Techniques

In carrying out his/her third-party review, the Third-Party Reviewer shall employ the following techniques:

(a) performing alternative calculations,

(b) comparing the design to the Principal's requirements as stated in the review input documentation,

(c) comparing the design to statutory requirements,

(d) comparing the design with the requirements of the Corporation's design standards and with the requirements of appropriate national and international standards,

(e) comparing the design to similar proven designs, including Corporation standard designs, and

(f) comparing the design to electrical industry recognised best practice.

1.9.4 Comments on Design

The Third-Party Reviewer shall not comment adversely on the design simply because the design does not conform to the reviewer's own personal preferences or is not in accordance with unspecified requirements.

However, the Third-Party Reviewer shall comment where the design differs markedly from generally accepted good engineering practice.

1.9.5 Third-Party Review Process

(a) The initial independent review shall be carried out solely on the basis of the drawings and documents provided by the Engineering Designer to the Third-Party Reviewer and without initial significant consultation between the two parties.

(b) Once the initial Third-Party Review report has been completed, it shall be forwarded to the Engineering Designer with a copy to the Design Manager. If a need arises to urgently address a specific issue (or issues) the Third-Party Reviewer may forward interim comments to the Engineering Designer, however these should be kept to a minimum.

(c) Having received the initial Third-Party Review report, the Engineering Designer shall consider promptly the matters raised and, without undue delay, shall discuss the issues raised with the Third-Party Reviewer.

(d) Any issues not resolved within 30 days of the issue of the Third-Party Review report to the satisfaction of both parties shall be referred promptly to the Senior Principal Engineer by the Third-Party Reviewer. This referral shall be accompanied with a copy of the complete Third-Party Review report. Then the Senior Principal Engineer shall determine the matter and direct the Engineering Designer and the Third-Party Reviewer accordingly.

(e) Once all issues arising of the Third-Party Review report have been resolved, any required revisions to the Design Summary Drawings shall proceed immediately.

(f) It may be agreed, following the above consultation, that the Design Summary Drawings do not need to be revised to address some of the issues raised by the Third-Party Reviewer. In such cases the Third-Party Reviewer shall provide an addendum to the Third-Party Review Report explaining the reasons for these decisions.

(g) Purchase of equipment, the specification of which is in dispute, shall not be authorised until the dispute has been resolved.

1.10 Third-Party Engineering Design Review Scope

1.10.1 Review of Various Issues

The third-party engineering design review shall be limited to the review of the original issues and subsequent revisions of the Design Summary Drawings.

1.10.2 Design Review Verification

The third-party engineering design review shall verify that the design as documented on the Design Summary Drawings:

(a) has been completed to an appropriate level,

(b) is in accordance with Principal's requirements as specified in the input documents,

(c) is in accordance with statutory requirements,

(d) is in accordance with previous approvals and Corporation standards,

(e) is safe in respect to both personnel and plant, and

(f) will result in plant which is practical both in respect to construction and operation.

1.10.3 Suitability of Drawings

In addition, the third-party engineering design review shall verify that the Design Summary Drawings are suitable for use in the next stage of the overall design process including their use as part of tender documents.

1.10.4 Cost Effectiveness

The third-party engineering review is not required to cover the cost effectiveness of the design and the Third-Party Reviewer shall not comment on the latter except where the design differs markedly from accepted good engineering practice.

1.11 Evidence of Third-Party Design Review

The Third-Party Reviewer shall submit a formal design review report for the project.

The formal design review report shall include evidence of the third-party reviewer's review which shall include:

(a) copies of alternative calculations performed,

(b) comments on the design as it is documented on the Design Summary Drawings (drawing by drawing),

(c) references to any similar drawings which were used for comparison purposes,

(d) references to relevant sections of Corporation standards,

(e) references to relevant statutory documents, and

(f) references to relevant sections of national standards or international standards.

The Third-Party Reviewer shall sign the Design Summary Drawings once all issues raised by the Third-Party Reviewer have been resolved and the Design Summary Drawings have been corrected accordingly.

Design Summary Drawings shall not be presented to the Corporation as part of the 'final version' of the Engineering Design Report until all Design Summary Drawings have been signed by the Third-Party Reviewer. This is to ensure any problems with the design are captured early and without imposing costly rectification work on the Project Manager's budget.

1.12 Third-Party Tender Documentation Review

The Third-Party Reviewer shall review all tender documents ("Supply" as well as "Installation" type documents) to verify that the correct standard type specifications have been used and that the tender document annexures have been completed correctly in accordance with the approved Design Summary Drawings.

Tenders shall not be called until the Third-Party Reviewer has verified that the tender document specifications are correct.

The Third-Party Reviewer is not expected to review tender documents in respect to commercial conditions.

1.13 Need to Update Corporation Standards

- In carrying out his/her reviews, the Third-Party Reviewer may come across instances where changes to the Corporation's Electrical Design Standards appear to be warranted. In such cases the Third-Party Reviewer shall highlight these matters in his/her report. The Design Manager shall forward these to the Senior Principal Engineer for consideration.

1.14 Detail Design Output

1.14.1 Principal's Detail Design Drawings

Detail design shall be undertaken by the Project Consulting Engineers only in instances where it is not practical or economic to delegate such design work to the Contractor(s). Such design shall be documented on the Principal's Detail Design Drawings.

Such detail design shall not be commenced prior to the approval of the Design Summary Drawings and shall not be included in the Engineering Summary Report.

The Design Manager, in association with the Designer, shall ensure the logical and suitable allocation of drawing bundle numbers in accordance with the requirements of DS80.

1.14.2 Preparation and Review of Detail Design Drawings

(a) The Principal's Detail Design drawings shall be prepared by the Engineering Designer or by suitably qualified staff under his/her direct supervision and shall be recommended by the Engineering Designer.

(b) The Principal's Detail Design drawings shall be reviewed by the Detail Reviewer and these drawings shall not be issued for inclusion in tender documents or for any other purpose until the electrical design documented thereon has been verified by the Detail Reviewer.

(c) Any Principal's Detail Design Drawings not included in the tender documents shall be identified therein by title and content.

(d) Principal's Detail Design Drawings shall be identified by title and content in the Engineering Summary Report.

(e) The required Contractor's Detail Design Drawings shall be specified by title and content in the tender documents and the preparation of such drawings shall be shown as a separate item in the associated contract bill of quantities.

(f) The Contractor's Detail Design drawings shall be reviewed by the Engineering Designer and these drawings shall not be issued for purchase of equipment or for construction of the works until the electrical design documented thereon has been verified by the Engineering Designer.

(g) The required Contractor's Detail Design Drawings shall be identified by title and content in the Engineering Summary Report.

1.14.3 Content of Detail Design Drawings

(a) Detail Design Drawings shall be based on the associated approved Design Summary Drawings and shall be consistent with the requirements of the approved Design Summary Drawings.

(b) Detail Design Drawings shall not be prepared until the relevant Design Summary Drawings have been approved.

(c) The repetition of information shown on the Design Summary Drawings onto the Detail Design Drawings shall be kept to the practical minimum. In order to avoid confusion and potential safety

hazards, full duplication of the Design Summary Drawings for use in detail design drawings shall not be permitted.

(d) Detail Design Drawings shall include the following types of drawing.

i. Cable schedules and cable block diagrams,

ii. Three phase circuit (multiline) power diagrams,

iii. Major cable and conduit routes,

iv. Final site and building arrangements (including light & power layout) showing locations of electrical equipment,

v. Suppliers' switchboard drawings (including switchboard layouts, label schedule, material schedule, equipment specifications, power circuits, motor control circuits and miscellaneous control circuits. *Refer notes 1 & 2*) and other suppliers' electrical equipment drawings (motors, transformers, variable speed drives, power factor correction units, starters, etc. *Refer note 2*),

vi. Cable termination diagrams. A spreadsheet may be used in lieu of drawings where appropriate.

Note 1: *Switchboard layouts and associated workshop drawings, shall only be prepared by the supplier of the switchboard.*

Note 2*: Drawings shall be archived into the DMS with the Corporation's standard drawing title block.*

1.15 Tender Preparation

The Engineering Designer shall prepare tender documentation for the supply of equipment and for installation services using the type specifications in DS26 and in accordance with the type specifications instructions for use documented in DS26.1

The drawings included within the tender documentation shall be formal signed drawings or sketches appropriately signed and numbered so as to be traceable.

The Designer shall ensure verification testing of critical performance targets (clause 1.8.2) are adequately and appropriately documented within tender documents.

1.16 Tender Analysis

Tender analysis shall be carried out by the Engineering Designer to verify that the recommended tender complies with the approved Design Summary Drawings.

If no offers are received which comply completely with the Design Summary Drawings, the matter shall be referred to the Design Manager for resolution by the Senior Principal Engineer.

The Designer shall seek technical clarifications from the lowest AAC (or cost where AAC is not applicable) only. If that bidder is ultimately found to be technically compliant, then the Designer shall recommend that bidder, if not then the Designer shall evaluate the next lowest AAC/cost bid, and so on, until a technically acceptable bid is achieved. The Designer shall review the general status of bidders which were not subjected to the clarification process (i.e. higher AAC/cost bids).

The recommendation made to the Corporation shall be in the form of a report from the Engineering Designer. The report shall clearly state the issues that require consideration by the Design Manager and the Engineering Designer shall make a statement, within the report, on the recommended offer's level of compliance with the tender documentation requirements. The report shall document the evaluation process which has been followed.

The report shall include two critical appendices required by the Corporation's Contract Branch. First being a technical clarification/response register, which records all the correspondence between the Designer and the bidder on each individual technical clarification item. The second will essentially be

a variation register to record any price additions required as a result of the clarifications. The intention is that this register can be signed by both parties (Corporation and the winning bidder) to acknowledge the additional items when the contract is finalised.

At the discretion of the Design Manager, the tender recommendation (or major equipment selection) may be either reviewed independently or by qualified technical personnel within the Corporation prior to approval and placement of the order, depending upon the circumstances of each project.

1.17 Design Functions During Construction Phase

1.17.1 Conformance to Approved Drawings

A failure by the Corporation to maintain up to date electrical drawings relating to a particular electrical installation may be found to be a failure to provide a safe working environment at that installation.

Consequently, the Works shall be built and maintained strictly in accordance with the latest revisions of approved drawings (both Primary Design and Detail Design).

The Contract Superintendent shall verify that the Works have been built strictly in accordance with the latest revisions of the approved drawings including any revisions approved by the Contract Superintendent.

1.17.2 Certification of Contractor's Detail Design Drawings

(a) The Electrical Draftsperson shall initial the Detail Design Drawing as Drawn "Drn". By so doing the Electrical Draftsperson shall certify that the drawing complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(b) The Senior Electrical Draftsperson shall initial the Detail Design Drawing as Quality Control Checked "Q.C. Chd". By so doing the Senior Electrical Draftsperson shall certify that the drawing has been checked and complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(c) The Contractor's Designer shall initial the Detail Design Drawing as Design Calculated "Des Calc". By so doing the Contractor's Designer shall certify that all calculations that form the electrical design as documented on the drawing are technically correct, complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(d) The Detail Reviewer shall initial the Detailed Design Drawing as Design Checked "Des Chd". By so doing the Detail Reviewer shall certify that all calculations that form the electrical design as documented on the drawing have been checked and are technically correct, complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(e) The Contractor's Designer shall sign the Contractor's Detail Design Drawing as Design "Recommended". By so doing, the Contractor's Designer shall certify that the electrical design as documented on the drawing is technically competent and complies with the approved Design Summary Drawings, the Regulations and the Corporation's design standards.

(f) The Detail Design Drawing prepared by the Contractor shall be signed as "Approved" by a Principal Officer of the firm, thus certifying that the electrical design process as specified in this design standard has been followed and agreeing on behalf of the firm to accept design liability.

1.17.3 Verification of the Contractor's Detail Design Drawings

The Contract Superintendent shall refer the Contractor's Detail Design Drawings to the Engineering Designer for verification that these drawings are technically competent and are in accordance with the approved Design Summary Drawings.

Once satisfied in this regard the Engineering Designer shall sign the Contractor's Detail Design Drawings as "Design Verified".

1.17.4 Verification of Vendor Drawings

The Contract Superintendent shall refer the Vendor Drawings to the Engineering Designer for verification that these drawings are technically competent and are in accordance with the approved Design Summary Drawings.

1.17.5 Variations to Design Summary Drawings

The Contract Superintendent shall not be authorised to vary the requirements of Design Summary Drawings.

In instances where the Contract Superintendent considers the Design Summary Drawings need to be varied to account for unforeseen circumstances, the matter shall be referred back to the Engineering Designer.

If the Engineering Designer agrees, the Design Summary Drawings shall be revised and reviewed by the Third-Party Reviewer in the normal manner.

If the Engineering Designer does not agree, the matter shall be referred to the Senior Principal Engineer for resolution.

1.17.6 Variations to Principal's Detail Design Drawings

The Contract Superintendent shall be authorised to vary the requirements of the Principal's Detail Design Drawings provided that after such variations the design remains technically competent and in accordance with the Design Summary Drawings and the Corporation's Design Standards. However, the Contract Superintendent may refer such matters to the Engineering Designer for advice if they so require.

The Contract Superintendent shall maintain a set of the Principal's Detail Design Drawings marked up in red to indicate any approved variations.

Once project commissioning has been completed successfully, the Contract Superintendent shall forward these marked up drawings to the Corporation's Engineering Business Unit via the project's Design Manager for archiving as "As Constructed" Drawings.

1.17.7 Variations to the Contractor's Detail Design Drawings

Any variations to the Contractor's Detail Design Drawings shall be required to be approved by the Contract Superintendent. However, the Contract Superintendent may refer such matters to the Engineering Designer for advice if they so require.

The Contractor shall maintain set of drawings of the Contractor's Detail Design Drawings marked up in red to indicate any approved variations.

1.17.8 Verification of Critical Test Results

At the final stage of commissioning, the Contract Superintendent shall verify that the tests results relating the critical performance parameters specified on the Design Summary Drawings meet the specified target values.

If the critical performance targets have not been met, the Contract Superintendent shall refer the matter back to the Engineering Designer for advice on necessary corrective action.

If critical performance targets have been achieved, the actual test values shall be recorded on the As Constructed Design Summary Drawings.

1.17.9 Certification of As Constructed Design Summary Drawings

Once commissioning of the works has been completed successfully, the Contract Superintendent shall verify that works have been built strictly in accordance with the latest approved revisions of the Design Summary Drawings.

Once their content has been verified, these red marked-up drawings shall be certified as As Constructed Drawings by the Contract Superintendent who shall sign and date each such drawing as "Certified As Constructed".

1.17.10 Certification of As Constructed Detail Design Drawings

Once commissioning of the works has been completed successfully, the Contract Superintendent shall verify that works have been built strictly in accordance with the latest approved revisions of the Principal's Detail Design Drawings and the Contractor's Detail Drawings.

Once their content has been verified, these red marked-up drawings shall be certified as As Constructed Drawings by the Contract Superintendent who shall sign and date each such drawing as "Certified As Constructed".

Note 1*: It is critical that As Constructed Drawings are accurate and maintained during the operational life of the asset to ensure a safe working environment at the installation (Clause 1.17.1 and 1.17.13 refers).*

Note 2*: Documents relating to the construction of the project (e.g. termination connections) shall also be certified as As Constructed in a similar manner to the drawings.*

1.17.11 Submission of As Constructed Drawings

Once the Contract Superintendent has certified As Constructed Drawings as above, these red marked-up drawings shall be forwarded to the Engineering Business Unit via the project's Design Manager for archiving of copies in the designated project folder in the Corporation file management system (Nexus).

A copy of the certified As Constructed Drawings shall be forwarded to the Contract Superintendent for filing with the Contract documents.

The Design Manager shall ensure any superseded drawings for the electrical installation (site) are cancelled.

1.17.12 Revision of CAD Versions of Principal's Drawings

Once the red marked-up certified As Constructed Drawings have been received by Engineering Business Unit, the project's Design Manager shall arrange for the information indicated on these drawings to be transferred onto the CAD versions of the drawings.

The CAD versions of the as constructed drawings shall be complete with a signature box within the body of each drawing so that the Contract Superintendent can sign and date these drawings as "Certified As Constructed".

Once satisfied that the CAD versions of the As Constructed Drawings are true copies of the submitted As Constructed Drawings, these drawings shall be signed and dated by the Contract Superintendent in accordance with Digital Signature requirements specified in Design Standard DS80.

1.17.13 Certification of As Constructed Drawings During Operational Life

Modifications made during the life of an asset shall be captured on both the electrical Design Summary and Detail Design drawings as "As Constructed" information. Qualified electrical personnel may sign as 'Recommended' but an Electrical Engineer shall sign as 'Approved'.

Certification of As Constructed drawings might follow the Engineering Management of Change (EMoC) process where the EMoC process is initiated.

1.18 Major Upgrades

1.18.1 General

In general, the design process specified above shall be followed for upgrades to electrical infrastructure with the additional requirements as specified hereunder.

1.18.2 Review of As Constructed Drawings

As part of investigations leading up to the preparation of the Concept Design Report, the Project Consulting Engineers shall review the As Constructed Drawings of the existing electrical installation so as to identify any aspects of the installation which:

(a) do not comply with current safety regulations,

(b) do not comply with current Supply Authority requirements, or

(c) do not comply with current design standards and are likely to cause future operational or maintenance problems.

The Concept Design Report shall include the Project Consulting Engineers' comments and recommendations in respect to any of these matters.

1.18.3 Review of Project Commissioning Report

As part of investigations leading up to the preparation of the Concept Design Report, the Project Consulting Engineers shall review the Project Commissioning Report for the existing electrical installation, so as to identify any performance issues which will need to be addressed in the design of the electrical upgrade. The Concept Design Report shall include the Project Consulting Engineers' comments and recommendations in respect to any of these matters.

1.18.4 Use of Existing as Constructed Drawings

Existing as constructed drawings shall not be amended in order to document the major upgrade works. Instead, new drawings shall be created and details of relevant parts of the existing works shall be copied onto the new drawings.

The new drawings shall have new signature boxes and the whole new design as documented on the new drawings shall be certified in accordance with clause 1.2.10.

The existing works to be retained in the new design shall be differentiated from the new works by "clouding" or by other suitable means.

2 Design Process for Minor Power Electrical Works

2.1 Introduction

2.1.1 Purpose

The purpose of this standard is to clarify electrical design requirements so that the electrical design outputs meet Corporation expectations.

The Corporation's process requirements for design are described in the Corporation's Engineering Design Manual. This standard supplements the Engineering Design Manual and shall be read in conjunction with the Engineering Design Manual.

This design standard does not address all issues that will need to be considered by the Engineering Designer in respect to a particular installation and reference will need to be made to the Engineering Design Manual. In the event of an apparent conflict between the requirements of this standard and those of the Engineering Design Manual, this standard shall take precedence.

Section 2 of this standard (i.e., Design Standard DS20.2) is specific to the design of minor power electrical works as defined hereunder.

2.1.2 Scope

Design Standard DS20.2 covers the preparation and review of the design of the minor power electrical works as documented in the associated Concept Design Report and/or Engineering Summary Report, on the Primary Design Drawings and on the Detail Design Drawings.

Design Standard DS20.2 applies only to electrical designs which are:

(a) for minor power electrical works as defined as power electrical works (as defined in clause 2.1.4(j)) having a capacity rated ≤ 315 kVA,

(b) having an estimated capital value of less than $500,000, and

(c) based principally on Corporation standard designs.

The design of minor power electrical works as defined in clause 2.1.4(j) shall be carried out in accordance with Design Standard DS20.2 regardless of whether such minor power electrical works are part of a large project which is following a major design process.

Note*: In such cases, during the Concept Design, the electrical content may include a brief description of the proposed electrical concept, arrangements, concept functional descriptions, power supply configuration and options along with concept power single line diagrams (bundle 49 of the drawing set). Full engineering design (Primary design drawings) is only required during the Engineering Design stage of the design process (refer clause 2.3).*

This standard applies to the design of minor power electrical works for both new assets and upgrades of existing assets.

2.1.3 References

References shall be made to the following associated design standards:

Water Corporation Engineering Design Manual

DS22 Ancillary Plant and Small Pump Stations - Electrical

DS24 Electrical Drafting

DS26 Type Specifications

DS28 Water and Wastewater Treatment Plants – Electrical

DS29 Arc Flash hazard Assessment of Switchgear Assemblies

Water Corporation Electrical Standard Drawings - Small Pump Stations - MN01 planset Series

2.1.4 Definitions

(a) Corporation - the Water Corporation (of Western Australia)

(b) Design Manager - the Corporation officer responsible for the co-ordination of the design activities for the whole project of which the electrical work is a part.

(c) Project Consulting Engineers - the firm awarded the responsibility of preparing the project electrical design. In this respect the meaning of the term "firm" shall be deemed to include business units within the Corporation as well as other commercial entities.

(d) Primary Design Drawings - those drawings which describe the critical aspects and statutory requirements of the electrical engineering design in sufficient detail to allow detail design to be completed by the Contractor.

(e) Detail Design Drawings - those drawings prepared by the Contractor which are required to supplement the Primary Design Drawings so as to describe the electrical design to the level of detail necessary to direct the construction and operation of the work

(f) Engineering Designer - the professional electrical engineer employed by the Project Consulting Engineers and responsible for the electrical design as documented in the Primary Design Drawings

(g) Primary Reviewer - the professional electrical engineer either employed by or engaged by the Project Consulting Engineers to undertake an independent review of the Primary Design Drawings.

(h) Contractor's Designer - the professional electrical engineer or senior electrical engineering associate employed by, or engaged by, the Contractor and responsible for the electrical design as documented in the Detail Design Drawings

(i) Detail Reviewer - the professional electrical engineer either employed by, or engaged by, the Contractor to undertake an independent review of the Detail Design Drawings.

(j) Power Electrical Work - all electrical equipment and installations concerned with the generation, distribution and utilisation of electric power at levels greater than 100 watts but excluding instrumentation, control and computing equipment associated with communications, control and SCADA systems.

(k) Minor Power Electrical Works - electrical works associated with small pump stations and/or treatment plants having individual drives rated not greater than 150 kW and an incoming electrical supply rated not greater than 315 kVA,

(l) Review Evidence - the documentation which provides verification that the associated review has been carried out at an appropriate depth.

(m) Senior Principal Engineer – Senior Principal Engineer, Electrical Engineering, Electrical Standards Section, Engineering, Water Corporation.

(n) Superintendent's Representative - the person appointed by the Contract Superintendent to supervise the day to day construction of the particular part of the electrical work.

(o) Contractor - the firm awarded the contract for the supply and installation of the minor power electrical works including the associated electrical detail design work

In this respect the meaning of the term "firm" shall be deemed to include business units within the Corporation as well as other commercial entities.

(p) Contractor's Representative - the person appointed by the Contractor to ensure that the particular part of the work is constructed in accordance with the Contract.

(q) DMS - Drawing Management System - The software system which regulates and archives drawings within the Water Corporation.

2.1.5 Mandatory Requirements

In general, the requirements of this Design Standard are mandatory. If there are special circumstances which would justify deviation from the requirements of this standard, the matter shall be referred to the Senior Principal Engineer for his/her consideration. No deviations from the requirements of this standard shall be made without written approval of the Senior Principal Engineer. Any dispensation granted for a particular project applies only to the case in question, based on the merits of the argument presented, and shall not be deemed as setting a precedent.

2.1.6 Philosophy

The role of the Designer is to provide a compliant design that is fit for purpose, safe, correct and cost effective. The role of the Primary Reviewer is to review such design work for compliance with all relevant standards, to confirm that the design is safe, and is in line with good engineering industry practice, but not to promote personal preference. The review process is critical to demonstrate due diligence taken by the Corporation during asset creation. The role of the Design Manager is to coordinate the design project and ensure a good sustainable outcome for the Corporation.

One of the critical elements of the Design Standards is that at the stage of Engineering Design, we (Corporation, Designers, and Primary Reviewers) must be fully conversant with all the project design issues, and in a position to know what we want prior to going out to the market. The technology selected for a project is described in terms of performance requirements and care taken not to impose restrictions on elements of the equipment to be provided by the manufacturer. Furthermore, it is inappropriate to go to the market not knowing what technology is required and asking the market to dictate the solution.

2.1.7 Design Progression

Under the normal project implementation process, the design stages progress in sequence from one stage to another (engineering design to detail design) with minimal time delay. However, circumstances may arise whereby considerable time delays are experienced, or may be necessary due to funding constraints, that affect the orderly progression of design work through to project construction. Such delays may result in electrical technology or systems becoming obsolete with the result, that if the original design is implemented, there is a risk of non-compliance with appropriate safety standards and/or regulatory requirements. Hence, if such a delay extends beyond one year between stages then a review shall be implemented by the Designer and changes made to the design as necessary. The review of the design stage shall be completed, approved and accepted prior to entering the next stage of the project.

2.1.8 Change Control

The reviewing and updating of the Electrical Design Standards (DS20 to DS29 and the electrical standard drawings) is a continual improvement process whereby essential requirements dealing with both technical and process are documented for the benefit of project implementation and whole of life operational reliability.

Inevitably improvements to the Electrical Design Standards will come into effect during the course of a particular project and it may not be practical or cost effective to implement these improvements, for that project, at the time of release of the revised Design Standard.

Where an existing project is still at a stage that implementation of the design standard improvement will not be overly onerous then the change to the design shall be implemented. The judgment as to whether implementation would be overly onerous shall be made by the Design Manager/Electrical Technical Adviser, with reference to and under the direction of the Senior Principal Engineer, on a project-by-project basis.

2.2 Design Process

2.2.1 General

The basic design process shall be that the primary design shall be carried out by the Project Consulting Engineers to a level of detail sufficient to allow tenders to be called for supply and installation of the works including preparation of the detail design. The Contractor shall be required to carry out the electrical detail design in accordance with this standard (i.e. Design Standard DS20.2). The Primary Design drawings shall be complete, signed, reviewed, accepted and placed into the drawing management system prior to commencement of the detail design.

All reports and drawings at the completion of every stage of the design process shall be signed as submitted by the Designer and approved by the Principal of the firm, with drawings placed into the DMS, before issue for comment by the Corporation or third parties.

Electrical installation staging drawings (if required), showing the various stages of installation work, shall be allocated to bundle number 49 in the project drawing set and identified within the drawing title block with the term "Staging". These "staging" drawings shall be maintained throughout the Engineering and Detail Design stages under drawing bundle number 49 and cancelled at the completion of the project.

Variation to the Design Process.

For switchboard renewal projects only (Clause 3.5 refers), where the primary scope of work is to replace an existing switchboard, the level of required Supply Authority information is limited to the fault level at the site and feeder protection characteristics. This is on the assumption that power quality limits for the electrical supply to site will not change when like for like performance is maintained for switchboard replacement. That is, the motor size and the method of motor starting do not change from the existing with implementation of the new switchboard.

These small Low Voltage switchboard replacement projects exhibit short time frame requirements, hence a streamlined process is required to reduce time and cost. To facilitate a streamlined process the production of Primary Design drawings and switchboard Detail Design drawings may overlap in time frame provided:

a) The Project Manager accepts the risk of possible rework, and associated costs and time delays, should assumptions during design prove incorrect.

b) The Project Manager directs this approach in writing to the Design Manager/Designer for a particular project.

c) The switchboard shall not be delivered to site until the Primary Design drawings and Detail Design drawings have been completed, signed, reviewed, accepted and placed into the drawing management system in accordance with the requirements of this design standard DS20.2.

d) This amended process shall only apply to Low Voltage switchboard renewal projects requiring the replacement of switchboards and no other equipment.

2.2.2 Designation of Primary Design Drawings

Each Primary Design Drawing shall be designated as such in the drawing title block.

2.2.3 Qualifications of the Engineering Designer

Engineering Designer shall be a professionally qualified electrical engineer with a least **4** years relevant electrical engineering experience including at least **2** years electrical design experience with proven competence in all areas of the electrical design work to be undertaken, all to the satisfaction of the Senior Principal Engineer.

2.2.4 Responsibilities of the Engineering Designer

The primary design electrical engineering work shall be carried out personally by the Engineering Designer or by junior professional electrical engineers and/or engineering associates working under his/her close supervision.

The Engineering Designer shall be responsible to ensure that the design as documented on the Primary Design Drawings is technically competent and complies with the Regulations, the Corporation's design standards and the relevant terms of the brief.

2.2.5 Qualifications of the Primary Reviewer

The Primary Reviewer shall be a professionally qualified electrical engineer with a least **6** years relevant electrical engineering experience including at least **3** years electrical design experience, all to the satisfaction of the Senior Principal Engineer. The Primary Reviewer shall be independent of the original primary design work.

2.2.6 Responsibilities of the Primary Reviewer

The Primary Reviewer shall review the Primary Design Drawings so as to verify that the electrical design as documented on each such drawing is technically competent and complies with the Regulations, the Corporation's Design Standards, and the relevant terms of the brief.

2.2.7 Qualifications of the Detail Reviewer

The Detail Reviewer shall be a professionally qualified electrical engineer with a least **6** years relevant electrical engineering experience including at least **3** years electrical design experience, all to the satisfaction of the Senior Principal Engineer. The Detail Reviewer shall be independent of the original detail design work.

2.2.8 Responsibilities of the Detail Reviewer

The Detail Reviewer shall review the Detail Design Drawings so as to verify that the electrical design as documented on each such drawing is technically competent and complies with the approved Primary Design Drawings, the Regulations, and the Corporation's design standards.

2.2.9 Qualifications of the Contractor's Designer

Contractor's Designer shall be a professionally qualified electrical engineer with a least **4** years relevant electrical engineering experience including at least **2** years electrical design experience, or a senior electrical engineering associate with a least **10** years relevant electrical engineering experience including at least **3** years electrical design experience, all to the satisfaction of the Senior Principal Engineer.

2.2.10 Responsibilities of the Contractor's Designer

The detail design electrical engineering work shall be carried out personally by the Contractor's Designer or by junior professional electrical engineers and/or engineering associates working under his/her close supervision.

The Contractor's Designer shall be responsible to ensure that the design approved, is technically competent and complies with the Primary Design Drawings, the Regulations, and the Corporation's design standards.

2.2.11 Certification of Designs

(a) The Electrical Draftsperson shall initial the Design Drawing as Drawn "Drn". By so doing the Electrical Draftsperson shall certify that the drawing complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(b) The Senior Electrical Draftsperson shall initial the Design Drawing as Quality Control Checked "Q.C. Chd". By so doing the Senior Electrical Draftsperson shall certify that the drawing has been checked and complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(c) The Engineering Designer shall initial the Design Drawing as Design Calculated "Des Calc". By so doing the Engineering Designer shall certify that all calculations that form the electrical design as documented on the drawing are technically correct, complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(d) The Engineering Reviewer shall initial the Design Drawing as Design Checked "Des Chd". By so doing the Engineering Reviewer shall certify that all calculations that form the electrical design as documented on the drawing have been checked and are technically correct, complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(e) The Engineering Designer shall sign the Design Drawing as Design "Recommended". By so doing the Engineering Designer shall certify that the electrical design as documented on the drawing is technically competent and complies with the Regulations, the Corporation's design standards and the relevant terms of brief.

(f) The Design Drawing shall be signed as "Approved" by a Principal Officer of the Project Consulting Engineer's firm thus certifying that the electrical design process as specified in this design standard has been followed and agreeing on behalf of the firm to accept the associated design liability.

2.3 Engineering Design Output

2.3.1 Required Design Documentation

The requirements of an Engineering Summary Report are described in the Corporation's Engineering Design Manual. For minor power electrical works the Primary Design Drawings and the correspondence described at para. 2.3.7 hereunder shall be deemed to satisfy the requirements of the Engineering Design Manual in respect to documentation of the engineering design.

The Primary Design Drawings shall consist of the following:

(a) Single line power diagram (para. 2.3.2 hereunder refers)

(b) Earthing diagram (para. 2.3.2 hereunder refers)

(c) Protection grading diagram (para. 2.3.2 hereunder refers)

(d) General arrangement drawing (para. 2.3.6 hereunder refers)

The electrical supply constraints and the impact on the possible load or pumping configuration shall be investigated during the Engineering Design stage.

Arc Flash assessment and documentation for all switchboards shall be carried out in accordance with the requirements of Design Standard DS29.

Primary design scope shall include power supply investigation, feasibility study application to the Supply Authority for engineering data and power quality limits, all calculations related to the design (voltage flicker, harmonic interference, fault level, arc flash, soil resistivity tests, cable sizing, protection setting selection, motor sizing, etc.), Supply Authority connection request, option investigation and primary design drawings necessary to complete the entire design in alignment with the MN01 example drawings. All work associated with the primary design scope shall be carried out by the one design entity (Firm and/or person) and no portion of the primary design shall be delegated to another entity.

All Primary Design drawings shall be allocated bundle number '40' within the drawing plan set for the site.

Primary Design drawings created during the Engineering Design stage of the project are the primary reference drawings for the asset and shall be updated as required during the life of the asset.

Note*: The Primary Design Drawings shall include significant parameter settings for major items of equipment such as VSC's; protection relays electronic instruments, etc.*

2.3.2 Single Line Power, Earthing & Protection Drawings

Primary Design template drawings for small pump station single line power diagram, earthing diagram and protection grading diagram have been prepared within the MN01 Electrical Standard Switchboard Designs plan set, for Designer use.

A flow chart, along with example drawing sets, is also included within the MN01 plan set to provide guidance to the Designer when preparing Primary Design drawings for specific projects.

All pump station Primary Design drawings shall be prepared strictly in accordance with the MN01 template drawings.

Primary Design Drawings prepared for minor treatment plants shall have a similar level of detail as provided within the MN01 series of drawings and the template drawings shall be used where appropriate. It is recognized that treatment plant Primary Design drawings may need to specify power equipment generically rather than make and model where the MN01 template drawings are not appropriate or applicable to a particular situation.

However, every endeavor shall be made to align with the MN01 template drawings and associated support drawings wherever possible for small treatment plants. For those cases where the standard MN01 protection device cannot be utilized for treatment plant designs, protection grading curves for Low Voltage switchgear shall be prepared on the basis of characteristics of a preferred type of protection device in each instance. Such protection grading curves shall be marked as being "indicative only".

2.3.3 Control Communications Block Diagrams

Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

2.3.4 Piping and Instrumentation Diagrams

Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

2.3.5 Control Logic Diagrams

Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

2.3.6 General Arrangements

Basic General Arrangement, Building Layout (if applicable) and Site Layout drawings shall be provided. These drawings shall show the point of attachment of incoming electrical power supply, conduit runs as well as the location and arrangement of the various items of major electrical equipment throughout the site and within buildings. The front and rear orientation of each switchboard, along with the location of the incomer cubicle in relation to the starter cubicles, shall be clearly shown on the drawings.

2.3.7 Correspondence

Copies of relevant correspondence to be provided shall include:

(a) correspondence with the associated statutory authorities,

(b) correspondence with equipment suppliers,

(c) any written dispensations from the Senior Principal Engineer permitting deviations from the Corporation standards.

2.4 Use of Primary Design Drawings

Primary Design Drawings shall be prepared so as to:

(a) document the primary design for review and records purposes,

(b) document the primary design in sufficient detail to allow tenderers to submit a fixed tender price for supply and installation of the work including the preparation of the detail design,

(c) provide information to allow the successful Contractor to carry out the detailed design in such a manner as will meet the requirements of the brief.

2.5 Schedule for the Preparation and Revision of Primary Design Drawings

Primary Design Drawings shall be produced and revised at various stages of the design process as detailed hereunder**.** Any major changes to a Primary Design drawing, such as a complete redraw, or minor change, shall be made as a formal revision to the drawing and registered into the DMS.

2.5.1 During Engineering Design Stage

2.5.1.1 Primary Design

By the end of the primary design, the Primary Design Drawings shall have been completed ready for calling tenders as per para. 2.4(b) above. At this time the Primary Design Drawings shall not include aspects of the design which are by necessity vendor specific.

2.5.1.2 Tendering

Once tendering and tender analysis is complete and prior to placing firm orders, the Primary Design Drawings shall be revised to include all vendor specific critical information.

2.5.2 During the Deliver Stage

2.5.2.1 Detail Design

If during detail design, revisions to the Primary Design Drawings are found to be necessary, the proposed revisions process shall be:

(a) All proposed revisions to the Primary Design Drawings shall be referred to the Engineering Designer. If the Engineering Designer agrees that the proposed revisions are warranted, are in accordance with the requirements of the design standards and reviewed by the Primary Reviewer, the Engineering Designer shall revise the Primary Design Drawings accordingly or,

(b) The designer for this stage of the design process may revise the Primary Design Drawings, rather than refer the change to the Primary Designer, provided the revision is formally reviewed, signed, and registered as per the requirements of clause 3.7. A copy of the revised Primary Design drawing shall be forwarded to the Engineering Designer. It should be noted that the Detail Designer making the revision takes on the liability for the design revision and this should be considered when deciding whom makes the revision to the Primary Design Drawings.

The Engineering Designer shall review Vendor Drawings for verification that these drawings are technically competent and are in accordance with the approved Primary Design Drawings. If necessary, the Engineering Designer shall update the Primary Design Drawings.

2.5.2.2 Construction

Primary Design Drawings shall be revised as constructed in accordance with clause 2.10 hereunder.

2.6 Input Documents for Primary Design Drawings

For Primary Design Drawings prepared as output documents from the Engineering Design Stage the input documents shall be the design brief, the Concept Design report, the relevant Corporation Design Standards and the Corporation MN01 series standard drawings.

2.7 Tendering

2.7.1 Tender Document Preparation

Tender documents shall be prepared by the Engineering Designer and wherever practical shall be based on the use of type specifications in accordance with Design Standard DS26.

Tender documents shall list the appropriate type specifications and the tender document shall include a requirement that the Contractor use such type specifications for the purchase of any equipment to be purchased as subcontracts.

Tender Documents shall be reviewed by the Primary Reviewer so as to verify that the correct standard type specifications have been specified and that the tender documents have been completed correctly in accordance with the approved Primary Design Drawings.

Tenders shall not be called until the Primary Reviewer has verified that the tender document specifications are correct.

The Primary Reviewer is not expected to review tender documents in respect to commercial conditions.

2.7.2 Tender Analysis

Tender analysis shall be carried out by the Engineering Designer so as to verify that the recommended tender complies with the approved Primary Design Drawings.

If no offer is received which complies completely with the Primary Design Drawings, the matter shall be referred to the Design Manager for resolution by the Senior Principal Engineer.

The Designer shall seek technical clarifications from the lowest AAC (or cost where AAC is not applicable) only. If that bidder is ultimately found to be technically compliant, then the Designer shall recommend that bidder, if not then the Designer shall evaluate the next lowest AAC/cost bid, and so on, until a technically acceptable bid is achieved. The Designer shall review the general status of bidders which were not subjected to the clarification process (i.e. higher AAC/cost bids).

Each tender recommendation made to the Corporation shall be in the form of a report from the Engineering Designer. The report shall clearly state the issues that require consideration by the Design Manager and the Engineering Designer shall make a statement, within the report, on the recommended offer's level of compliance with the tender requirements. The report shall document the evaluation process which has been followed.

The report shall include two critical appendices required by the Corporation's Contract Branch. First being a technical clarification/response register, which records all the correspondence between the Designer and the bidder on each individual technical clarification item. The second will essentially be a variation register to record any price additions required as a result of the clarifications. The intention is that this register can be signed by both parties (Corporation and the winning bidder) to acknowledge the additional items when the contract is finalised.

At the discretion of the Design Manager, the tender recommendation may be reviewed by qualified technical personnel within the Corporation prior to approval and placement of order depending upon the circumstances of the associated project.

2.8 Input Documents for Detail Design Drawings

For Detail Design Drawings prepared as output documents from the Deliver Stage the input documents shall be the associated tender document (including the Primary Design Drawings), the tender response schedules, the relevant Corporation Design Standards, and the Corporation MN01 series standard drawings.

2.9 Deliver Stage Output

2.9.1 Detail Design Drawings

Detail Design Drawings shall be based on the associated approved Primary Design Drawings and shall be consistent with the requirements of the approved Primary Design Drawings.

Detail Design Drawings shall not be prepared until the relevant Primary Design Drawings have been approved.

The repetition of information shown on the Primary Design Drawings onto the Detail Design Drawings shall be kept to the practical minimum. In order to avoid confusion and potential safety hazards, full duplication of the Primary Design Drawings for use in detail design drawings shall not be permitted.

The Design Manager, in association with the Designer, shall ensure the logical and suitable allocation of drawing bundle numbers in accordance with the requirements of DS80.

For minor power electrical works the following Detail Design Drawings shall be deemed to satisfy the requirements of the Engineering Design Manual for the Detailed Design Stage.

(a) Supplier's switchboard and other equipment drawings (para 2.9.2 hereunder refers.)

(b) Loop diagrams where not part of the switchboard design (para 2.9.4 hereunder refers)

(c) Cable schedules (para 2.9.5 hereunder refers.)

(d) General arrangement drawings (para 2.9.6 hereunder refers.)

2.9.2 Supplier's Switchboard Drawings

Supplier's switchboard drawings shall consist of the following:

(a) Panel and cubicle layouts (refer note below),

(b) Material schedules, including brief equipment specifications

(c) Label schedules,

(d) Three phase power (multiline) circuits,

(e) Single phase control circuits.

Note: *Switchboard layouts and associated workshop drawings, shall only be prepared by the supplier of the switchboard.*

2.9.3 Detailed Control Logic Diagrams

Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

2.9.4 Loop Diagrams

Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

2.9.5 Cable Schedules

Cable schedules shall be provided for Treatment Plants where there are a substantial number of cables to be installed under the scope of the project. Cable schedules need not be provided for small pump stations so long as appropriate details are shown on the drawings.

Cable schedules shall include the following information for each cable:

(a) Function,

(b) Voltage rating,

(c) Site current rating

(d) Number of cores

(e) Type and cross-sectional area of conductor,

(f) Type insulation and sheath

(g) Type and current rating of screen conductor (if any).

2.9.6 General Arrangement Drawings

Final general arrangement and site layout drawings shall show the following:

(a) Final site and building arrangements,

(b) Final location of all electrical equipment,

(c) All electrical power cable and conduit routes,

(d) Lighting and general-purpose power layouts,

(e) Earth electrode arrangements.

(f) The front and rear orientation of each switchboard.

(g) The location of the incomer cubicle in relation to the starter cubicles.

2.10 As Constructed Drawings

2.10.1 Legal Liability

A failure by the Corporation to maintain up to date electrical drawings relating to a particular electrical installation may be found to be a failure to provide a safe working environment at that installation.

Consequently, electrical drawings (both Primary Design and Detail Design) must be revised as constructed promptly after the completion of commissioning and immediately after the completion of any modifications during the operational life of the electrical installation. The Design Manager shall arrange for all superseded drawings to be cancelled.

2.10.2 Specification Requirements

Specifications for electrical installation work shall include the following requirements:

(a) At the time of awarding of the Contract, the Contract Superintendent shall provide the Contractor with an additional full set of the Principal's drawings pertaining to the Contract. These drawings shall be current at the time of supply and shall be in the form of electronic copies.

(b) Except for variations approved in writing by the Contract Superintendent, the electrical works shall be constructed strictly in accordance with the Principal's drawings.

(c) Within a specified time after the successful completion of commissioning of the Works the Contractor's Representative shall provide the Superintendent's Representative with a full set of draft as constructed drawings. These drawings shall be electronic copies of the above Principal's

drawings marked up neatly and completely in red ink to indicate any variations to the Principal's drawings.

(d) Each such red marked-up as constructed drawing shall be signed and dated by the Contractor's Representative as "As Constructed".

2.10.3 Certification of As Constructed Drawings

The Superintendent's Representative shall review the red marked-up as constructed drawings submitted by the Contractor's Representative to verify their validity.

Should the Superintendent's Representative discover any shortcomings in the drawings as submitted, these shall be returned to the Contractor's Representative for correction and resubmission.

Once the Superintendent's Representative is satisfied that the red marked-up as constructed drawings are correct and complete, the Superintendent's Representative shall sign and date each such drawing as "Certified As Constructed".

2.10.4 Revision of CAD Versions

Once the red marked-up as constructed drawings have been certified, as per Section 2.10.3, the Superintendent's Representative, in conjunction with the project's Design Manager, shall arrange for the information indicated on the certified as constructed drawings to be transferred onto the CAD versions of the drawings.

The CAD versions of the as constructed drawings shall be complete with a signature box within the body of each drawing so that the Superintendent's Representative can sign and date these drawings as "Certified As Constructed". The Contractor's Representative shall sign the drawings as "Recommended". These two signatures shall be signed in accordance with Digital Signature requirements specified in Design Standard DS80. The digitally signed drawings shall then be uploaded into the Corporation's Drawing Management System.

A copy of the certified As Constructed Drawings shall be forwarded to the Contract Superintendent for filing with the Contract Documents.

The project's Design Manager shall ensure any superseded drawings for the electrical installation (site) are cancelled.

2.11 Need to Update Corporation Standards

In carrying out his/her reviews the Primary Reviewer may come across instances where changes to the Corporation's Electrical Design Standards appear to be warranted. In such cases the Engineering Designer shall high light these matters in his/her report. The Design Manager shall forward these to the Senior Principal Engineer for consideration.

2.12 Certification of As Constructed Drawings During Operational Life

Modifications made during the life of an asset shall be captured on both the electrical Primary Design and Detail Design drawings as "as constructed" information. Qualified electrical personnel may sign as 'Recommended' but an Electrical Engineer shall sign as 'Approved'.

Certification of As Constructed drawings might follow the Engineering Management of Change (EMoC) process where the EMoC process is initiated.

3 General Design Process Requirements and Policy

3.1 Control Systems

Plant control is now beyond the scope of this design standard and will become a subject addressed in a different design standard.

In the meantime, this section of DS20 has been retained as Appendix A for information purposes only.

3.2 Information License Agreement with Western Power

A request for technical data associated with Water Corporation projects (such as pipeline voltage interference/mitigation studies, arc flash power system data, etc.), prepared by the Corporation or Designers (consultant), has become more prevalent and detailed in recent times. As much of this data is considered by Western Power to be confidential in nature, Western Power has developed an "Information License Agreement" for Western Power & Water Corporation setting out the terms and conditions upon which the data will be provided by Western Power to the Corporation and how that information is permitted to be used. The intent is to provide a degree of security for Western Power's data and establish a certain level of consistency of response time, quality, and cost for Technical Data Requests for the Corporation.

The permitted use is to enable the Corporation to undertake technical studies in relation to the co-location of Western Power and Corporation assets and infrastructure and to obtain bulk information for specific purposes (e.g. multiple site arc flash studies).

The process:

(a) Request submitted to Western Power (Ms Rachel Webb, Senior Customer Relations Consultant, Customer Service, Western Power) by the prime consultant or the electrical designer in Engineering, if design is "in-house".

(b) Western Power provides a written fee quotation, including time, based on the standard hourly rate (under terms of the Information License Agreement) and including a "Fee Quotation Reference Number".

(c) The Corporation must respond within 20 business days with an authority to proceed or notification that it does not wish to proceed.

(d) Western Power proceeds with the provision of data

Note: *this data is considered confidential and restricted for use by the Corporation and its agents (consultants) and is not to be divulged to third parties under any circumstances.*

3.3 Technology License Agreement & Process

The process for the supply of switchboards Type A (A1: ≤ 100 Amp, A2: >100 Amp, ≤ 220 Amp) and Type B (>220 Amp, ≤ 440 Amp), defined by DS22, to the Corporation is covered under the "Technology License Agreement" (part of the over-arching Low Voltage Switchboard Manufacturers Panel, clause 3.8 refers), signed by Leicon Notley, Western Controls, Kounis Resources and the Corporation. This agreement relates to the Corporation providing its intellectual property (switchboard and cubicle standard drawings) to be used for all small pump station and treatment plant sites. The Corporation is responsible for the standard switchboard and cubicle design development, design verification (type testing) and maintenance.

This means that only Leicon Notrley, Western Controls and Kounis Resources will quote for and build switchboards (including small outdoor cubicles) in the whole range (0 to 440 Amps) covered by DS22. No other switchboard manufacturer is permitted to design and construct these switchboards and cubicles.

The Technology License Agreement will ensure that the standard low voltage switchboard design can only be used for Corporation work and not for Third-Party work by the company. Clauses relating to audits of the licensee, breach of the license agreement, IP property rights, confidentiality, disclaimer/indemnity, disputes, termination, etc. also feature in the documentation.

Note*: The switchboard working drawings and the switchboard manufacture must be carried out by the same company. One cannot obtain the switchboard working drawings from one manufacturer and then ask another manufacturer to build the switchboard.*

3.4 Customer Design and Quotation Process and HV Submission

3.4.1 Supply Utilities Queries and Connections

It is noted that correspondence is required during the client design phase so as to obtain fault level data, protection settings, power quality limits and to discuss options (including estimated costs, location) and the like.

Refer to the supply utilities website for further information on the process.

3.4.2 High Voltage Submission

For major projects, the above process (clause 3.4.1) will allow finalisation of the Engineering Design drawings and the making of a formal H.V. submission.

It is essential that this application process (H.V. submission) is carried out during the Engineering Design stage, for both major and small (where applicable) projects, so as to establish technical and financial certainty to a high confidence level prior to the approval gateway for detail design and construction. This will ensure that, there are no major surprises during the detail design & construction phase.

3.4.3 Discussion with Supply Utility Engineer

If the Designer has a complex or technical query that needs to be answered before submitting an online service application, the supply utility has a service whereby the Designer can speak to one of their engineering experts for assistance.

Refer to the supply utilities website for further information on the process.

3.4.4 Land Development Projects

Due to the nature of land development projects it is generally not possible to obtain all the necessary electrical supply system information (source impedance/fault level, clearance time, power quality limits) for the Engineering Design to be completed in a timely manner. Applications to the Supply Authority for such information may be rejected as the electrical distribution system (H.V. & L.V.) design has not been completed by the developer and the Supply Authority has no infrastructure in place.

There is a process whereby the required network information for the future installation can be supplied to the Corporation (normally the Corporation's Designers) provided Western Power has a finalised electrical power reticulation design for the area. To assist in the submission of the feasibility study and ensure that the application is not rejected, Western Power has requested that the following wording be included in the application form:

This network information request is for a newly developed area. Please model the proposed network to the Point of Common Coupling and provide the requested network information to this point.

3.5 Small Pump Station Switchboard Design Process for Switchboard Renewal Projects

The following process for the procurement of small low voltage switchboards, for switchboard replacement projects only, applies to all small pump stations as defined in Corporation Design Standard DS22 (low voltage switchboard capacity of 0 to 440 Amps).

A turnkey Design and Construct (D&C) delivery strategy to streamline the procurement of small low voltage switchboards for switchboard renewal projects has been developed with a view to reduce time and promote cost savings. The existing Preferred Supplier Agreements for the Manufacture and Supply of Low Voltage Switchboards with Leicon Notley and Western Controls have been extended to include project engineering design (Primary Design Drawings), project detail design, switchboard design & manufacture, factory acceptance testing, installation, site acceptance testing, commissioning, SCADA integration and all related activities. A Design and Construct Specification template has been developed and will be used exclusively for the above purpose. A more streamlined design process has also been defined within the Design and Construct Specification template.

This process is not to be applied to major works or major switchboards as defined in DS21.

The process relates to switchboard replacement only and hence only the electrical discipline (power, control, instrumentation, SCADA) is included. Where projects involve civil, mechanical and other non-electrical disciplines then the normal process applies (goes through the consultant engagement process).

Process Summary:

(a) The Design Manager, generally an electrical engineer, will prepare the Design and Construct documentation (*refer Note 1 below*) based on the standard D & C template.

(b) Leicon Notley, Western Controls and/or Kounis Resources will be invited to submit a bid, via the Procurement and Property Business Unit, in accordance with the requirements of the D&C documentation.

(c) The Design Manager and Project Manager will carry out a technical evaluation of the D & C tender submissions.

(d) Once a tender submission for a project is accepted by the Design Manager, the Project Manager will initiate placement of a purchase order to award the job to the successful tenderer.

(e) The successful tenderer (Leicon Notley, Western Controls or Kounis Resources) will complete the work in accordance with the requirements of the D&C contract.

The Design and Construct Specification template to be used for switchboard replacement projects is Design Standard DS 26-46: Type Specifications – Electrical Design & Construction Specification for Minor LV Switchboard Replacement under ‘Technology License Agreement’. The associated bid document templates and “Procurement Bid Assessment” template are accessible from Procurement & Property

Note 1*: Complete documentation will consist of*:

(a) Schedule of Prices spreadsheet

(b) Special Conditions of Contract

(c) Request for Bid Invitation & Conditions of Bidding

(d) Commercial Bid Schedules

(e) Technical Bid Schedules

(f) D&C Specification (DS26-46) and Drawings

3.6 Switchboard Integrity Issues

The affixing of items of equipment to the exterior of switchboard enclosures or modification of the structural integrity of the switchboard enclosure are not permitted due to the safety and performance hazards that may result from such action.

Inappropriate modifications to existing switchboards, such as the action of drilling into the outside of a switchboard enclosure, may result in an internal arcing fault and a potential electrocution. Furthermore, such action may result in the integrity of the type tested and arc fault tested design being compromised thus increasing the risk of arc flash exposure and reducing switchgear performance. Temperature rise (verified by type test) within the switchboard relies to some degree on the available surface area to radiate heat from the switchboard. The action of placing external fixtures onto the enclosure reduces this surface area and may lead to over-temperature within the switchboard. Furthermore, in order to keep operating temperatures of equipment within prescribed limits, the exterior surfaces of outdoor switchboards are painted gloss white to reduce solar heat load on the switchboard. Hence it is not acceptable to apply any other paint colour to the exterior surface of outdoor switchboards. However, in recognition of the *Splash of Colour* community programme, the Electrical Design Standards group has investigated the possibility of a considered relaxation to the policy, to allow for very low power switchboards to be painted by artists. Being low power consumption switchboards, the risk of long-term thermal damage to electrical components within outdoor switchboards is considered low, and hence should not greatly affect the life of outdoor electrical switchboards.

To assist *Splash of Colour* policy requirements, and to ensure technical performance is not compromised, our technical policy is modified to allow artistic painting of some outdoor aluminium switchboards subject to the following rules:

(a) Switchboard single duty motor size allowable is less than or equal to 11 kW

(b) Motors are not driven by variable speed drives (due to the excessive heat generated)

(c) Only light paint colours to be used

(d) The Electrical Design Standards group is consulted for each project requiring artistic painting to seek technical approval

Structural changes to the enclosure can also, often inadvertently, alter the IP rating of the switchboard resulting in premature aging of components, reduced impulse rating or equipment failure due to excessive dust and moisture.

Therefore, it is essential that any proposed modifications to an existing switchboard, including;

a) the switchboard enclosure, or

b) to the power circuit, must be carried out by the original switchboard manufacturer where possible.

If a switchboard requires modification to power circuitry and/or enclosure integrity and the original switchboard assembly manufacturer still exists, then the Main Contractor will need to seek advice from the original switchboard assembly manufacturer. The switchboard modifications will then be made in accordance with the advice from the original switchboard assembly manufacturer. Note that the changes can then be made by the Main Contractor or the original switchboard assembly manufacturer, by agreement.

If a switchboard requires modification to power circuitry and/or cubicle integrity and the original switchboard assembly manufacturer no longer exists, the course of action is to have the assembly assessed by a competent Third-Party switchboard manufacturer and obtain a statement describing the fitness for purpose of the existing assembly and the acceptability or otherwise of the proposed modifications.

This alternative manufacturer cannot certify the modified assembly, but based on their own experience and knowledge with regard to the manufacture and testing of assemblies, may be able to advise whether or not, in their opinion, the modification will be safe in operation. However, it should be understood, the responsibility for implementing modifications remains with the contractor undertaking the change and the responsibility for continuing use of the assembly remains with the Corporation. The Main Contractor will then arrange for the switchboard modifications in accordance with the alternative switchboard manufacturer's advice.

Whether the original or alternative manufacturer advice is sought, payment for their advice may be appropriate and must be allowed for.

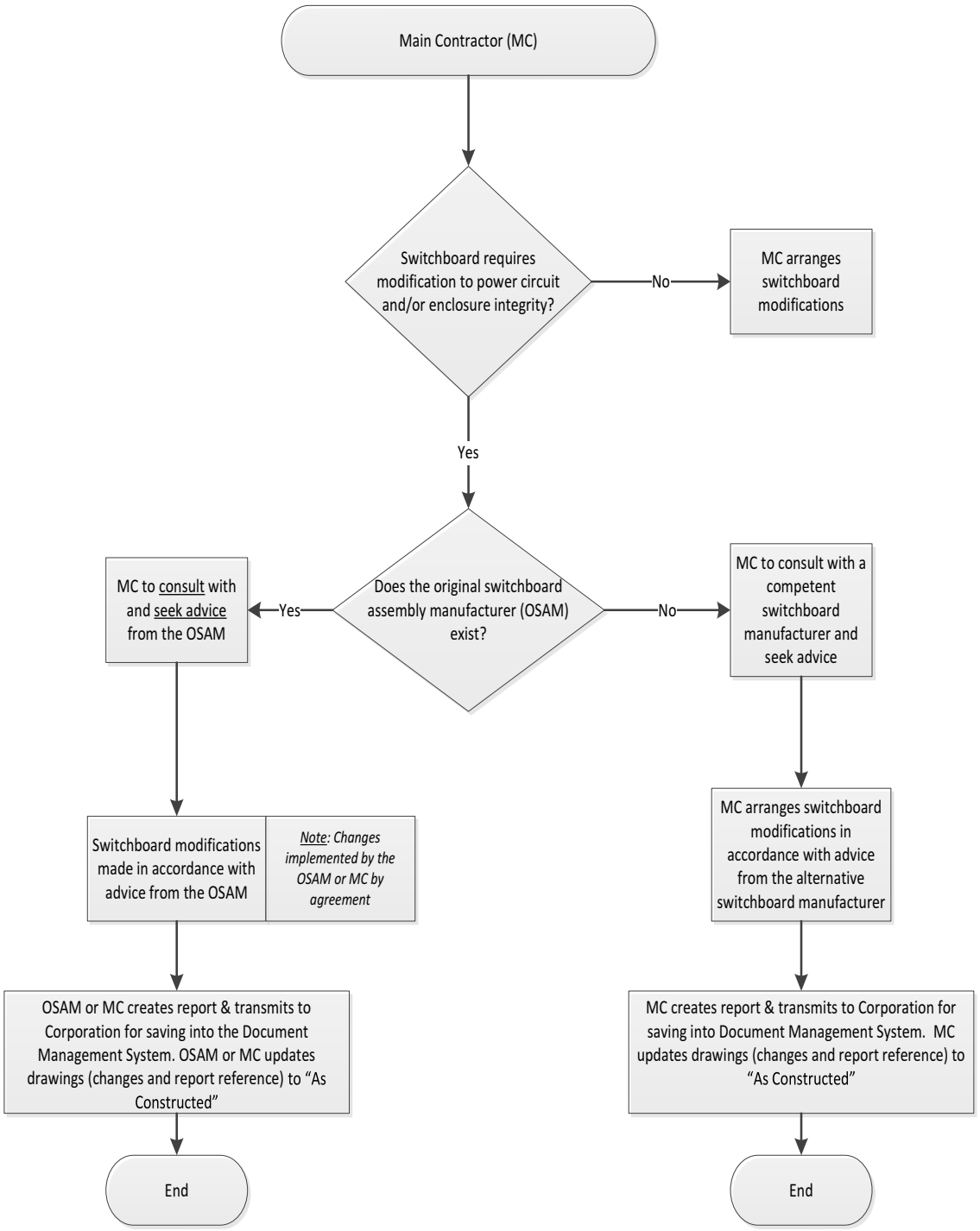
The risks associated with both the present condition and the use after modification of the switchboard assembly shall be assessed and documented (in report form) by a competent person prior to commencing work. All modifications shall be carried out by a competent person using a method statement and the guidance provided in BS6423:2014 Code of Practice for Maintenance of Low Voltage Switchgear and Control gear. Any modifications made shall be captured and clearly identified on the drawings as "as constructed" information. The report shall be saved into the Corporation's Document Management System and a reference included on the "as constructed" drawings.

Modifications may be made to switchboard control panels and control modules provided penetrations made do not compromise the integrity of the adjacent power compartments.

This process ensures a standard and consistent approach to technological development, safety, and operational functionality. Designers of projects shall ensure the above is adhered to.

Switchboard modifications shall follow the following flow chart.

Switchboard Modifications Process Flow Chart



3.7 Signing and Registering (DMS) Electrical Drawings

- All new electrical drawings:

When submitting new drawings for formal review and/or for final issue, shall be digitally signed in the "DES CALC", "DES CHD", "RECOMMENDED" and "APPROVED" boxes within the Corporation's drawing title block prior to delivery by the Designer to the Client.

- Revision of existing drawings:

When revising existing drawings, the "RECOMMENDED" and "APPROVED" title block boxes shall be digitally signed. It is not mandatory to populate the "DES CALC" and "DES CHD" categories if they have been previously populated.

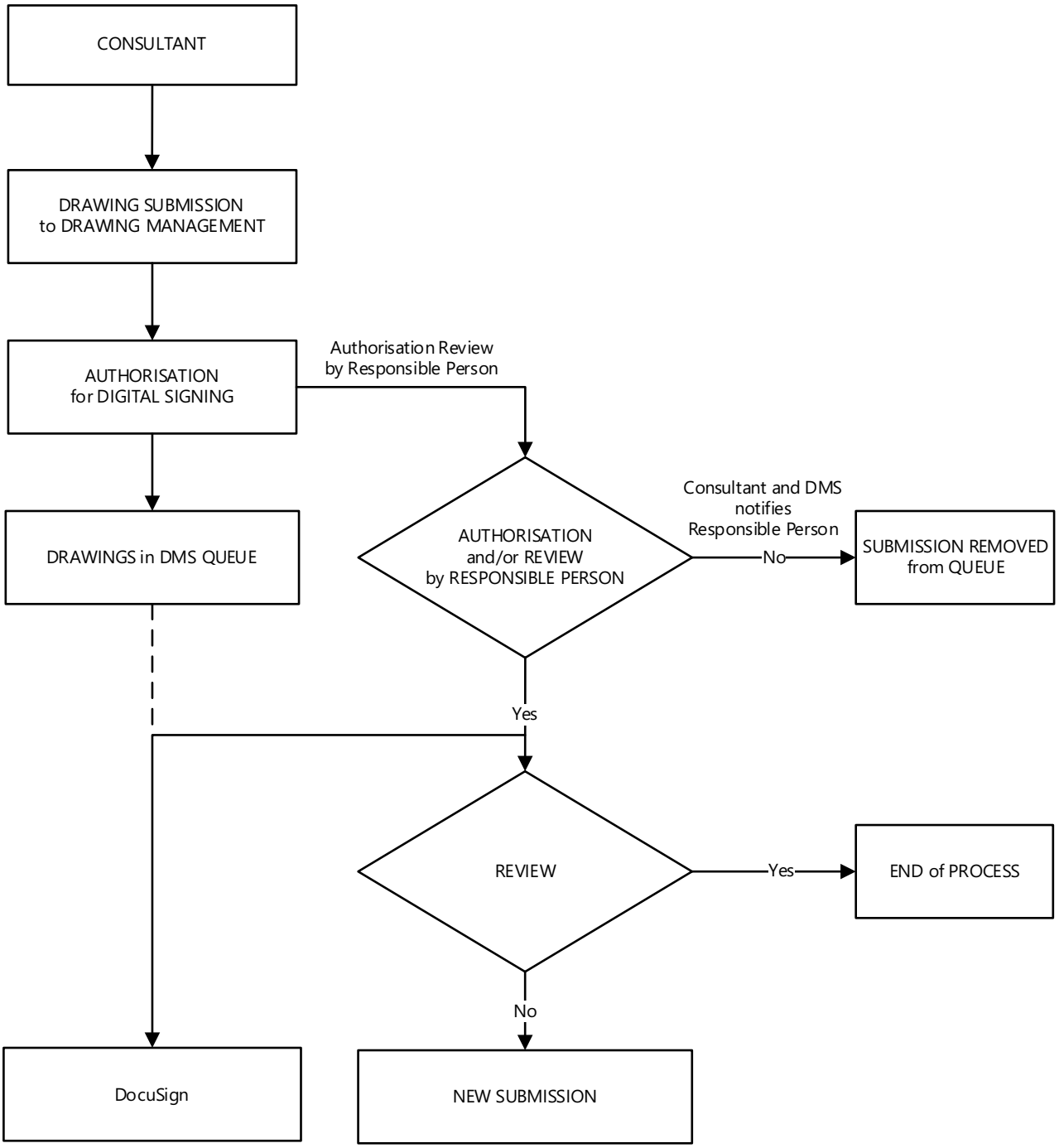
- Creation of non-project "As-Constructed" drawings:

The "DES CALC" and "DES CHD" categories are not required to be populated when new as-constructed drawings are created for the purpose of recording existing infrastructure as the original calculator will not be available to initial title block boxes.

Note: *No stamp of any kind (e.g., "preliminary-not for construction", "for information only", etc.) shall be applied to the side of or on any electrical drawing to be submitted to DMS.*

The responsibility, and hence liability, for recommending and approving design drawings lies with the Designer of the particular asset (e.g., the switchboard manufacturer designing the switchboard asset). Hence the Designer of the particular asset shall recommend and approve the drawings, not a Third-Party (e.g., the Main Contractor).

Note: *Where the original Designer no longer is employed by the company, the original Designer must be called back to sign the drawings or, should that not be possible, a new Designer shall review the drawings and make changes as required taking full responsibility and signing the drawings. The suggestion that the drawings be signed as "pp" by someone else is not acceptable.*



3.8 Switchboard Manufacturers Panel Details

The Corporation requires assurance that Low Voltage switchboards being installed in its assets will not present a safety hazard to personnel and will be fit for purpose in all other respects. To this end, the Corporation has established a panel (Switchboard Types A1, A2, B & C) of low voltage switchboard manufacturers, one for each of the switchboard types designated in accordance with the Types Specifications DS 26-36, DS 26-10, DS 26-11 and DS 26-17.

These approved switchboard manufacturers are to be used for all Corporation projects whether delivered by Alliances, Design & Construct Contracts, or conventional tendering processes.

For details, refer to the "APPROVED PANEL OF SWITCHBOARD MANUFACTURERS FOR THE SUPPLY OF LOW VOLTAGE SWITCHBOARDS":

- "INFORMATION FOR USE OF PANEL"
- "DETAILS SUMMARY"

Note: *Operational Technology (OT) are responsible for the development and design functions for Control Cubicles. The control cubicle shells can be of any design and make as determined by OT. However, if OT wish to use the same cubicle shell as used for electrical switchboards to house control equipment, sourcing (purchase) of such cubicle shells shall be from the above Switchboard Manufacturers Panel.*

3.9 Small D&C Treatment Plant Projects

Modular Design & Construct specifications employed by the Engineering Treatment Section for small modular treatment plants allows for the engineering and detail design to be carried out by the D&C contractor. For the electrical scope, this arrangement is limited to an incoming supply not greater than 50 Amps. For supplies larger than 50 Amps the engineering design must be performed by the Consultant Panel designer and the D&C Contract will comprise the detail design and construction only.

3.10 Indoor Switchboards for Small Pump Stations

At the present time the Corporation does not have a standard indoor switchboard arrangement, under the Technology License Agreement, for small pump stations. The plan is for the Corporation to commence development of the indoor type switchboard by mid-2019.

In the interim, the policy with respect to small pump station indoor switchboards is as follows:

(a) DS26-36 (100A, Type A1), DS26-10 (220A, Type A2) and DS26-11 (440A, Type B) switchboards of the outdoor type (with front and rear doors) may be used indoor where adequate clearance space is available. Rear doors only may be of the lift off type if this assists with the regulated clearance around switchboards.

(b) For small switchboards ≤ 100A (DS26-36, Type A1) Leicon Notley, Western Controls and Kounis Resources are permitted to design their own indoor type of switchboard (with front door only) in line with the requirements and intent of the Technology License Agreement. However, MCCs supplied in accordance with DS26.17 (Type C) are considered acceptable alternatives.

(c) Where adequate clearances are not available to accommodate the outdoor type switchboard (with front and rear doors) for the 220A (Type A2) and 440A (Type B) ratings, then an MCC type switchboard in accordance with DS26-17 (Type C) shall be used.

(d) If none of the above arrangements is suitable for an indoor application, then the switchboard shall be installed outdoors.

Note*: If it is determined that a MCC type switchboard is required for a small pump station then dispensation will need to be sought by the Designer, via the Design Manager, from the Senior Principal*

Engineer. If justified, the Senior Principal Engineer will grant dispensation to vary the "Technology License Agreement" and apply DS26-17 as the switchboard cubicle for the project.

Dispensation is required as the License Agreement strictly refers to the use of small switchboards in accordance with the LX drawings and not MCCs.

3.11 Switchboards for Modular Package Plants

3.11.1 Proprietary Electrical Power Systems

Modular Package Plants are an essential component of engineering plant providing specialised equipment for treatment (e.g. chemical, filtration etc.), hydraulic & other processes. Accepting such equipment, it is critical for the Corporation to ensure safety and reliability are maintained and that we have a consistent approach to technical standards. The Corporation has Design Standards in place to ensure the safety and reliability of electrical power equipment however it is also recognised that some minor concessions can be made in such instances that will not compromise our stance on safety and reliability of electrical power equipment.

Acknowledging that it is important also to be pragmatic and cost effective, the policy regarding the provision of small integrated switchboards for Modular Package Plants is determined as follows.

Modular Package Plants consist of equipment and processes that facilitate a process function within an installation and are proprietary in nature. Examples of these are modular chemical dosing units (chlorination, fluoridation, calgon etc.), small booster pumps on a skid and other small specialised process plant.

Modular Package Plants are supplied with proprietary electrical power systems that must be housed in suitable switchboards appropriate to the environment where they are to be deployed. These switchboards may be provided by the manufacturer of the Modular Package Plant provided:

(a) The load demand of the Modular Package Plant does not exceed 50 Amps single phase or 50Amps three phase.

(b) The sub mains feed to the Modular Package Plants shall be protected by an HRC current limiting fuse not greater than 50 Amps.

(c) They comply with the requirements of "Type Specification for Low Voltage Switchboards General Requirements DS26-09" as appropriate.

(d) They have a degree of protection rating of not less than IP56 where installed outdoors.

(e) They have a degree of protection rating of not less than IP53 where installed indoors and potentially exposed to spraying water or IP41 where installed indoors in a separate clean room.

(f) They have all equipment housed behind hinged lockable doors and where installed outdoors shall have no equipment placed on the external doors of the cubicles.

(g) That power distribution, external to the modular package plant, throughout the site shall be provided by switchboards manufactured and supplied under the terms of the "Approved Panel of Switchboard Manufacturers for the Supply of Low Voltage Switchboards". This includes the Supply Authority incoming supply and power distribution to Modular Package Plants.

(h) They are suitably labelled as to describe the function.

(i) They are provided with a complete set of switchboard drawings in accordance with the requirements of DS20.

3.11.2 Switchboard Location

Switchboards housed within Modular Packaged Plants shall comply with the requirements of clause 3.12.

3.12 Switchboards within Workstation Areas

Workstations are permitted in the vicinity of a switchboard provided:

(a) the switchboard has an Arc Flash Rated PPE Category of Cat 0 with the switchboard door(s) open and closed

(b) the minimum distance between the workstation and switchboard is 1.2 metres

(c) the switchboard access clearances are in accordance with AS/NZS 3000

For switchboards with a higher PPE category than Cat 0 (with doors open and closed) a separate room shall be provided for the switchboard.

3.13 Storage cabinet on the end of switchboards

An empty cubicle shell located on the end of a switchboard for the purpose of storage at Wastewater pump station sites, shall only be provided on projects for the North West Region, and then only when requested.

3.14 Motor Disconnect & Generator Connect Cubicles

These cubicles are designed for the specific purpose of connection and disconnection of power equipment (motors, generator sets and associated protection functions). No additional instrumentation or control equipment shall be housed within or attached to these cubicles. The affixing of any items to the exterior of these cubicles is not permitted.

3.15 Separation of Electrical Switchboards and Control Cubicles

3.15.1 Large Low Voltage Switchboards

To facilitate the separation of responsibilities, to reduce contractual complexities of power and control coordinating functions, reduce the risk of arc flash injury and to ensure access to the switchboard is only by competent electrically qualified personnel, the control cubicle shall not form an integral part of the switchgear assembly (switchboard). The control cubicle housing control, instrumentation, SCADA and communications equipment shall be located outside the arc flash boundary determined for each particular project/installation.

3.15.2 Minor Low Voltage Switchboards

To facilitate the separation of responsibilities, to reduce contractual complexities of power and control coordinating functions, reduce the risk of arc flash injury and to ensure access to the switchgear assembly (switchboard) is only by competent electrically qualified personnel, the control cubicle shall not form an integral part of the electrical switchboard.

The requirements are:

(a) The electrical switchboard and the control cubicle shall not be assembled on the same base but shall be provided with separate bases

(b) A spacing of not less than 100mm shall be maintained between the electrical switchboard and the control cubicle

(c) The electrical switchboard and the control cubicle shall not be physically connected by any means. (e.g. interconnecting ducts)

(d) The electrical switchboard and the control cubicle shall be electrically interconnected by cabling installed in underground conduits or similar approved

The above shall be applied to all new electrical switchboards whether new sites, upgraded existing sites or sites involving switchboard replacement only. The above is not intended for sites where SCADA/Control equipment is to be replaced and the electrical switchboard remains unchanged unless directed by the project scope.

Note: *The electrical Switchboard and Control Cubicle may be located on the same base if both the Switchboard and Control Cubicle are manufactured by the same company.*

3.15.3 High Voltage Switchboards

Control cubicles shall not be located within the same room as the High Voltage switchboard.

3.16 Electrical Drawing Bundle Allocation

To facilitate the separation of electrical and control responsibilities, the re-allocation of drawing bundle numbers has been agreed and is documented below. Design Standards DS80 and DS24 will be issued shortly to reflect this re-allocation.

Electrical:

- Primary Design drawings (Minor designs) ……..40
- Design Summary drawings (Major designs) …….40
- Detail Design Drawings ……41 - 48
- Concept design and electrical installation staging drawings……..49
- Detail Design Drawings (See note 1) ……401 - 499

Note:

1. *Separately identifiable locations within the plant/scheme shall be allocated different bundle numbers within the 41 to 48 group (e.g. different treatment plant areas or different bores in a borefield). Should there be more than 8 separately identifiable locations, the 41-48 series bundles shall be used first, followed by the 401-499 series bundles.*
2. *Separately identifiable switchboards and associated field equipment at a particular location (and therefore within a particular 41-48 or 401-499 bundle number) shall be allocated sheet numbers within the 1-99, 101-199 etc. groups, (e.g. Main Switchboard and Pump Station Switchboard).*

SCADA, Control, Instrumentation and Communications

- Primary design drawings (Minor designs) ……50
- Design summary drawings (Major designs)..……50
- Detail Design drawings - Readily identifiable project areas/components ……51 – 53, 55-58
- Instrumentation Loop Diagrams…….59

Cathodic protection remains as is currently shown in DS80, that is:

Cathodic protection.....54

3.17 Design & Construction Process for Minor Electrical Works

This process has been designed to accommodate the demand for electrical input to the civil engineering Design & Construct documentation for new projects.

Electrical work(s) is defined as Power, Control, SCADA, Instrumentation and Communication discipline systems.

The electrical work comprises engineering design, detailed design, switchboard design, control cubicle design, switchboard manufacture, control cubicle manufacture, equipment supply, installation, programming, testing, commissioning, documentation (operation manuals, "as constructed" drawings) and handover.

This process is applicable to power systems for switchboard capacity not greater than 440A (Panel Agreement Switchboard types A1, A2 and B in accordance with the Technology License Agreement, with Leicon Notley, Western Controls and Kounis Resources) and associated works defined by DS20.2, DS22 and drawings MN01.

The minor electrical works will be carried out following one of the defined contract strategies listed in the table below. The requirement is for the Main Contractor to manage and supervise all Contractors (sub-contractors) to ensure works are delivered in accordance with the Corporation's Design Standards, processes and the specification.

Note: *SCADA (including instrumentation, control and communication) works will be carried out by a PCS panel member in accordance with the DS40 series of standards for Instrumentation, Control and SCADA systems.*

	Contract Strategy		
	Engineering Design	**Detail Design and Switchboard/Control Cubicle supply**	**Construction and Commissioning**
Option 1	Design Consultant	Leicon Notley, Western Controls or Kounis Contractor	Construction Contractor
Option 2	Design Consultant	Leicon Notley or Western Controls Contractor	
Option 3	Leicon Notley or Western Controls Contractor		

The Design and Construct Specification template to be used for minor electrical works projects as discussed above is Design Standard **DS26-47: Type Specifications – Electrical Design and Construct Specification for Minor Electrical Works** and will form part of the civil engineering Design & Construct documentation for the project.

This process is not to be applied to major electrical works as defined in DS20.1 and DS21.

Process Summary:

(a) The Design Manager will prepare the Design and Construct documentation for the electrical component based on the standard D & C template DS26-47 and integrate this with the Main Design and Construct documentation.

(b) The Main Contractor for the Design and Construct project will determine the contracting strategy as defined in the table above.

(c) Leicon Notley and/or Western Controls and/or Kounis Resources will be invited to submit a bid in accordance with the requirements of the D&C documentation and the selected contract strategy

3.18 Specialist Earthing Panel

A panel for specialist earthing design services has been established to deal with High Voltage substation earthing and pipeline AC interference investigation, design and verification. There are three companies appointed to the panel.

Details of the Earthing Panel are:

PREFERRED SUPPLIER AGREEMENT

PANEL FOR SPECIALIST EARTHING DESIGN SERVICES

(PIPELINE AC INTERFERENCE & SUBSTATION EARTHING)

PowerEarth Technologies Pty Ltd

Agreement Number C2/2000001680 (eContract No. 4700010479)

Hooman Dehbonei, Senior Professional Engineer

Unit B10, 431 Roberts Road Subiaco WA 6008

Mobile: 0421 719 203 hooman.dehbonei@powerearth.com.au

Website: powerearth.com.au

SafeTech Consulting

Agreement Number C2/2000001680 (eContract No. 4700010481)

Phillip Morriss, Manager

Unit 13, 1 Douro Place, West Perth WA 6005

Mobile: 0418 694 508 philmorriss@safetechcon.com

Website: safetechcon.com

As per the requirements of Design Standard DS23, the same consultant MUST be used for all phases (Earthing Investigation, Design & Verification) of a particular earthing project.

3.19 Renewable Energy Projects Drawing Requirements and Process

Drawing and process requirements for Renewable Energy (RE) projects shall be in line with this standard DS20 but may be varied as follows:

(a) The structural assessments will be carried out by the Corporation for both the Regional Depots and the RE Program. As the results of the structural assessments may significantly affect the NPV, it is not appropriate to have the assessments conducted as part of the solar contractor's scope. The output of the structural assessment will form the basis for the Roof Layout drawing, which will be included as a separate part of the Site Layout drawing (as discussed further below)

(b) Electrical Engineering Design (both Design Summary and Primary Design) Drawings will be the responsibility of the Water Corporation, with the design done in-house for Regional Depots and most likely by our Panel Consultants for the RE Program

(c) Electrical Engineering Design drawings shall be as identified for Minor Designs in DS20, i.e.:

Site Layout, including a roof layout drawing as one part of the same drawing

1. For sites with installed kW greater than 30kW

The results of the structural assessment shall be documented in the Roof Layout drawing, complete with dimensioned clearances and roof slope. The drawing must include the number of panels, where panels are mounted, their tilt angle, the string arrangement and isolator positions. The solar contractor may review and update this drawing at the Detail Design stage, subject to the approval of the Principal (i.e. consistent with the existing Minor Design process). The roof layout, documented as part of the engineering design, will provide an objective baseline for evaluation of any alternative arrangements proposed by the contractor. The string arrangement and layout shown on the Roof Layout drawing must be based on nominated vendor equipment. The Contractor will revise this detail during the Detail Design stage if using alternative vendor equipment, subject to the approval of the Principal

2. For sites with installed kW up to 30kW

A short-hand approach to the Roof Layout drawing shall be adopted. In this case, the Roof Layout drawing will document only the results of the structural survey, showing the areas of the roof which may be used for the installation of panels, complete with dimensioned clearances and roof slope. If the Contractor's design is not optimal for these smaller sites, there will be a relatively lower impact on long-term cost to the Corporation

3. Drawings -40-1.1, -1.2 etc will be used for the Site Layout drawings, including the roof layout

4. Any change to the design shall be subject to a performance guarantee. For sites greater than 30kW, this reduction or increase in performance can be assessed using the simplified version of the Corporation screener software, which will be made available to the solar contractors

5. Fixings details are not Engineering Design and will not be included in the Site Layout Drawings. The Corporation is creating drawings specifying fixing details for different applications as part of the renewable energy standard drawing set. These renewable energy standard drawings will be located within the MN02 to MN10 plan-sets (the particular plan-set is yet to be determined). In the interim, it is proposed that any fixing requirements (e.g. how dissimilar metals are to be handled) will be addressed in the structural assessment;

(i) Single Line Power Diagram

(ii) Earthing Diagram

(iii) Protection Grading Diagram

- For existing sites, these drawings should normally exist and only modifications would be required.

(a) Compliance with Drafting Standard DS24 will be required where the Contractor's drawings are specific design solutions for the WC. Where the Contractor is supplying one of its standard solutions, then it will be acceptable for the Contractor to supply the drawings in AutoCAD and in the Corporation's standard electrical title block. This is consistent with the existing electrical philosophy. The existing depot drawings will remain in the existing format, with the solar components added, i.e. compliance with DS24 will not be mandated.

(b) The Contractor shall be requested to update the existing depot drawings as part of the Detail Design stage, to the extent practical. In some specific cases, the drafting of the Contractor's drawings will be carried out by the Principal. Where this applies will be determined on a case-by-case basis.

(c) Detail Design drawings will be produced in accordance with DS20, Section 2.9 to the extent applicable and consistent with point 4. above. Detail Design drawings shall include the following information for the Solar Control Cubicle:

- Panel and cubicle layouts
- Material schedules, including brief equipment specifications
- Label schedules
- Three phase power (multiline) circuits and
- Single phase control circuits

APPENDIX A

Control System

Plant control is now beyond the scope of this design standard DS20 and will become a subject addressed in a different design standard by the SCADA Branch.

As an interim the following sections of DS20 have been retained in this Appendix for information and guidance relating to control, instrumentation and communication purposes only. The clause numbers below relate to the relevant section of the main body of Design Standard DS20.

A1 Major Works

Concept Design

1.3.4 Piping & Instrumentation Diagram

The Concept Design Report shall include a Concept Piping & Instrumentation Diagram (P&ID) which shall identify the driven loads and the non-electrical parameters to be measured in order to facilitate control of the plant.

1.3.8 Control Functions

(a) The Concept Design Report shall include a preliminary control system functional description (FCD – Functional Control Description) (i.e. narrative specification as per AS IEC 61131.4) which shall describe the basic control functions in plain English terms. e.g. “The control system shall control the selection and speed of the delivery pumps on the basis of the delivery tank level, the flow rate out of the delivery tank, the time of day, and the electricity tariff schedules, so as to minimise electricity charges while maintaining security of water supply”.

(b) The Concept Design Report shall state whether or not the control system can be implemented using either Corporation standard control logic modules or proprietary standard logic modules, or whether special control logic will need to be developed.

(c) The Concept Design Report shall specify the level of control system redundancy required and recommend how that should be achieved (e.g. by specifying the number of PLCs to be provided and the functions which should be assigned to each).

1.3.9 Communications

(a) The Concept Design Report shall document how and where the control and instrumentation systems will be connected into the Corporation’s SCADA system.

(b) If new radio links are required, the Concept Design shall include desk top studies to determine the most practical and most economical means of providing such links. The Concept Design Report shall include a complete report in respect to such desk top studies.

Engineering Design

1.8.8 Piping & Instrument Diagrams

Piping and Instrument Diagrams (P&ID’s) shall define the hydraulic process requirements by showing the following:

(a) the pipework (diagrammatically),

(b) the electrically driven loads, i.e. pumps, fans, control valves, etc.

(c) the instrumentation measuring process nonelectrical variables, including the required measuring ranges for each variable

(d) the signals from the above instruments,

(e) incoming process control signals,

(f) electrically driven load control signals,

(g) which instrumentation and input control signals are combined in the various “interlocks” in order to derive each particular control signal,

(h) outgoing process related critical indications and critical alarms.

1.8.9 Control Logic Drawings

(a) Pump Stations: Design Summary control logic diagrams for pump stations, including those pump stations within the treatment plants, shall be based on the use of Water Corporation standard logic modules as detailed in the Water Corporation FS00 series of drawings and shall be in accordance with the Directions for Use detailed on drawing FS00-1-2. That is, each standard logic block module without its internal logic drawing plus each special logic block module with its associated internal logic diagram.

(b) Treatment Plants: Design Summary control narrative specifications for treatment plants shall be supported by flow charts, logic diagrams, sequential function charts and/or function & event lists in accordance with the requirements of Australian Standard AS IEC 61131.4

(c) Ladder logic diagrams shall not be permitted.

1.8.10 Control Interconnection Block Diagrams

Design Summary Drawing control interconnection block diagrams shall indicate the flow of control command and indication signals between the various items of major equipment.

Fault conditions which are reset automatically as part of the control system shall be considered control functions and included in the control interconnections block diagrams.

Design Summary Drawing control interconnection diagrams prepared as output from the Engineering Summary Stage shall show the following as separate blocks:

(a) each major item of switchgear which is connected to the control system,

(b) each electronic soft starter,

(c) each variable speed controller,

(d) each programmable logic controller

(e) each separately mounted control transducer

(f) each operator interface panel

(g) the SCADA remote terminal unit.

These diagrams shall show, for each interconnection, the functions and/or data to be carried on the interconnection.

As an output from the Detail Design Stage, Design Summary Drawing control interconnections diagrams shall be updated to show any minor changes found to be necessary during the Detail Design stage.

1.8.11 Communications Links Block Diagram

Design Summary Drawings communications links block diagrams shall show all of the communications links between the various items of major equipment, except for simple bistable contact closure signals.

Design Summary Drawings communications links diagrams prepared as output from the Engineering Design Stage shall show as separate blocks all equipment connected to any of the following:

(a) analogue signal links,

(b) serial communications links,

(c) radio signal links,

(d) telephone line signal links.

These diagrams shall show for each interconnection the type and characteristics of the particular communications link.

1.14.3 Content of Detail Design Drawings

(a) Detail Design Drawings shall be based on the associated approved Design Summary Drawings and shall be consistent with the requirements of the approved Design Summary Drawings.

(b) Detail Design Drawings shall not be prepared until the relevant Design Summary Drawings have been approved.

(c) The repetition of information shown on the Design Summary Drawings onto the Detail Design Drawings shall be kept to the practical minimum. In order to avoid confusion and potential safety hazards, full duplication of the Design Summary Drawings for use in detail design drawings shall not be permitted.

(d) For pump stations, logic drawings prepared in accordance with Corporation standard drawing FS00-1-2 Standard Logic System- Directions for Use.

(e) For water and wastewater treatment plants, control logic flow charts and/or logic diagrams strictly in accordance with the control narrative specifications and diagrammatic clarifications included in the Design Summary Drawings

If the programmable controller selected is capable of producing logic flow charts and/or logic diagrams in accordance with AS IEC 61131, the controller may be used to produce such diagrams.

However, the controller logic programme shall not be implemented at the site until such diagrams are transferred onto Detail Design Drawings and are submitted, reviewed and approved, in accordance this design standard.

(f) Separate loop diagrams for each instrumentation loop (The practice of providing a typical loop diagram with a table of data for various loops shall not be permitted). These diagrams may form part of the switchboard or control cubicle construction drawings.

A2 Minor Works

Engineering Design

2.3.1 Required Design Documentation

The Engineering Summary Design output shall include a control system functional description (FCD –Functional Control Description) (i.e. narrative specification as per AS IEC 61131.4) which shall describe the basic control functions in plain English terms.

The Primary Design Drawings shall consist of the following:

(a) Control communications block diagram

(b) A piping and instrumentation diagram

(c) Control logic narrative specifications supported by diagrammatic clarifications

2.3.3 Control Communications Block Diagrams

Primary Design Drawing control communications block diagrams shall indicate the flow of control command and indication signals between the various items of major equipment.

Fault conditions which are reset automatically as part of the control system shall be considered control functions and included in the control interconnections block diagrams.

Primary Design Drawing control interconnection diagrams shall show the following as separate blocks:

(a) each major item of switchgear which is connected to the control system,

(b) each electronic soft starter,

(c) each variable speed controller,

(d) the programmable logic controller,

(e) each separately mounted control transducer,

(f) each operator interface panel

(g) the SCADA remote terminal unit.

These diagrams shall show, for each interconnection, the functions and/or data to be carried on the interconnection.

2.3.4 Piping and Instrumentation Diagrams

Piping and Instrument Diagrams (P&ID's) shall define the hydraulic process requirements by showing the following:

(a) the pipework (diagrammatically),

(b) the electrically driven loads, i.e. pumps, fans, control valves, etc.

(c) the instrumentation measuring process nonelectrical variables, including the required measuring ranges for each variable

(d) the signals from the above instruments,

(e) incoming process control signals,

(f) electrically driven load control signals,

(g) which instrumentation and input control signals are combined in the various "interlocks" in order to derive each particular control signal,

(h) outgoing process related critical indications and critical alarms

However, P&ID's shall not show any of the following:

(i) particular interlock symbols as representing particular PLC's,

(ii) control logic functions within interlock symbols,

(iii) electrical switchgear or control gear,

(iv) signals relating to electrical equipment other than the above instrumentation,

(v) outgoing indications and alarms which relate solely to electrical equipment,

(vi) outgoing process related but noncritical indications and alarms,

(vii) incoming control signals which relate only to the electrical equipment, (e.g. duty select commands),

(viii) communication links.

2.3.5 Control Logic Diagrams

(a) Pump Stations: For small pump station electrical installations, including those pump stations within treatment plants, Primary Design Drawing logic module inter connection diagrams shall be prepared in accordance with Drawing FS01-1-2 (Standard Logic Diagrams - Directions for Use) and shall be similar to the examples shown on the FS01-3 series of drawings. That is, each standard logic block module without its internal logic drawing plus each special logic block module with its associated internal logic diagram.

(b) Treatment Plants: For minor treatment plant electrical installations, control narrative specifications for treatment plants shall be supported by flow charts, logic diagrams, sequential function charts and/or function & event lists in accordance with the requirements of Australian Standard AS IEC 61131.4

(c) Ladder logic diagrams shall not be permitted.

Detail Design

2.9.3 Detailed Control Logic Diagrams

For pump stations, control logic shall be documented by logic drawings prepared in accordance with Corporation standard drawing FS01-1-2 Standard Logic System- Directions for Use.

For water and wastewater treatment plants, control logic shall be documented by control logic flow charts and/or logic diagrams.

If the programmable controller selected is capable of producing logic flow charts and/or logic diagrams in accordance with AS IEC 61131, the controller may be used to produce such diagrams. However, the controller logic programme shall not be implemented at the site until such diagrams are transferred onto Detail Design Drawings and are submitted, reviewed and approved, in accordance this design standard.

Ladder logic diagrams shall not be permitted.

2.9.4 Loop Diagrams

Loop diagrams shall include range information for all instruments.

A separate loop diagram shall be provided for each instrument loop. The practice of providing a single typical loop diagram together with a table indicating the different data for multiple loops shall not be permitted. These diagrams may form part of the switchboard or control cubicle construction drawings.

3.1 Control Systems

A Functional Control Description is the first stage of the code development process followed by a Functional Control Specification and then finally code.

There are three distinct steps accepted as industry best practice in the development of control systems:

1. Functional Control Description - a written description (English text) of the required control functionality. This is a fundamental companion document to the Operations Manual and P&IDs.
2. Functional Control Specification – a detailed description of how the required functionality is to be implemented in code. Narrative specifications comprise literal descriptions of system operation and requirements. They are rarely adequate for system definition without additional diagrammatic clarifications. Hence, Functional Control Specifications shall be based on diagrammatic representations. It describes precisely, in engineering terms, how the process control logic will deliver the requirements of the Functional Control Description. The Corporation uses logic diagrams as the functional control specification for pump stations. For treatment plants the Functional Control Specification may be a combination of diagrammatic representations and text as described in clauses 1.8.9 and 2.3.5.
3. Code – the PLC/RTU program written by the programmer in strict adherence to the Functional Control Specification.

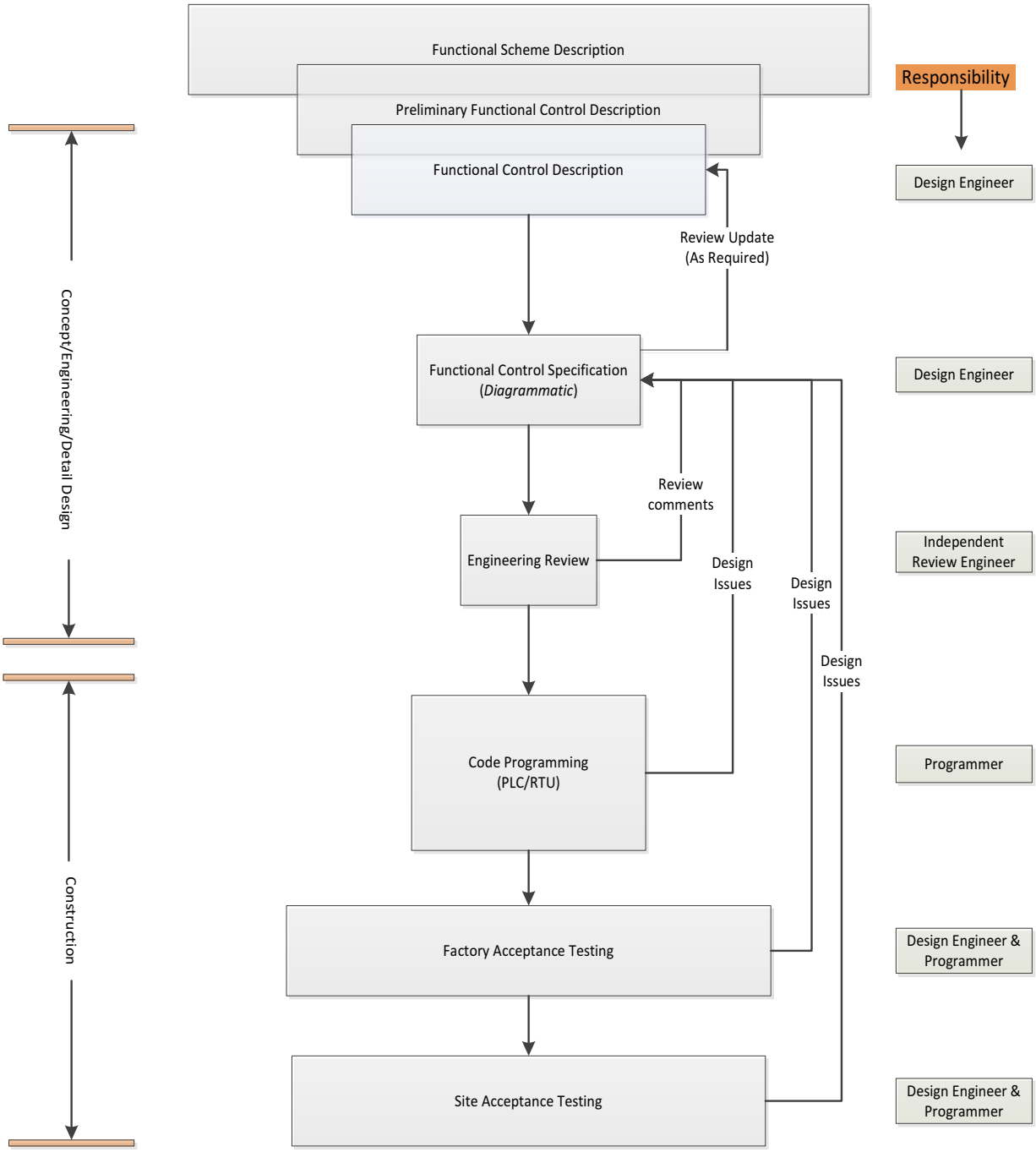
All documentation covering the three steps above shall be maintained over the life of the asset.

A graphical representation, such as logic drawings, produced during the Functional Control Specification stage provides a disciplined, well-structured, and methodical direction to the programmers. As with normal engineering practice, the process ensures that the design engineer is accountable and responsible for the programming design, right through to commissioning. The process ensures that functional requirements and their interaction with the plant protection system are not left to the interpretational skills of the programmer. Furthermore, this process encapsulates the essence of due diligence by virtue of integrating a formalised review process during the development stages of code.

Logic drawings, or any graphical representation in accordance with AS/IEC 61131.4, are an efficient method to provide clarity, certainty, assurance, and an audit process for code development. Furthermore, they are an invaluable tool for ongoing plant enhancement, fault finding and maintenance during the life of the asset.

The diagram below outlines the code development & review process that shall be followed.

Code Development and Review Process



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